NAVPERS 10111

THE 5"/38 GUN

Bureau of Naval Personnel

Washington, D.C. 20370

PREFACE

This publication has been designed to provide enlisted men assigned to the 5''/38 gun with a self-study, on-the-job training source for shipboard use. This information has been derived from strip films SN 1554 series—5''/38 Gun Mount, Mk 30, SN 1554 series—5''/38 Mount Rammer, Northern Pump Company Type, and SN 1804 series—5''/38 Projectile Hoist, Mk 2.

The material covered is shown in the Table of Contents. The letter-number combination following each chapter title is the designation of the strip film from which the chapter was derived. Section titles clearly define the material to be found therein. The material itself is presented in a simple step-by-step format and can be used in part or as a whole.

First Edition 1965

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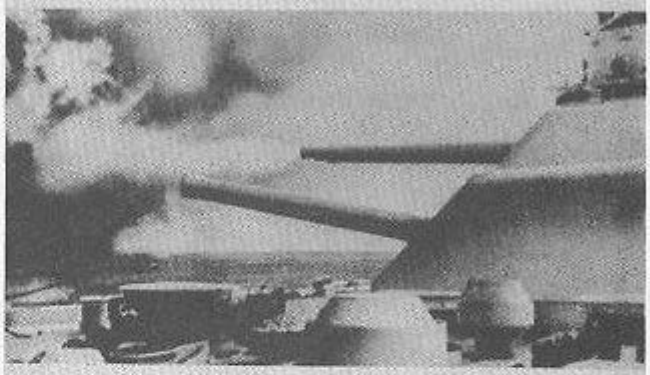
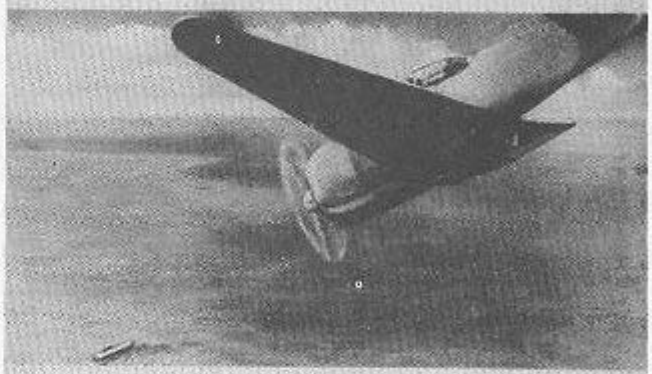
SECTION A—5"/38 GUN MOUNT, MK 30
CHAPTER 1—GENERAL INTRODUCTION

Until a few years ago naval gunnery had but one main objective—the destruction of enemy surface craft and shore bases.

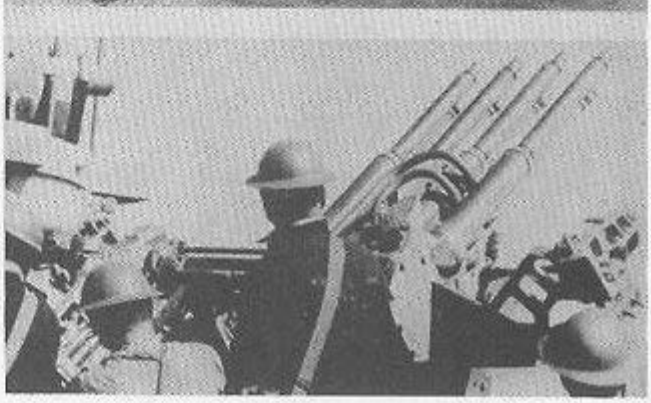
The familiar big turret gun served this purpose very effectively.

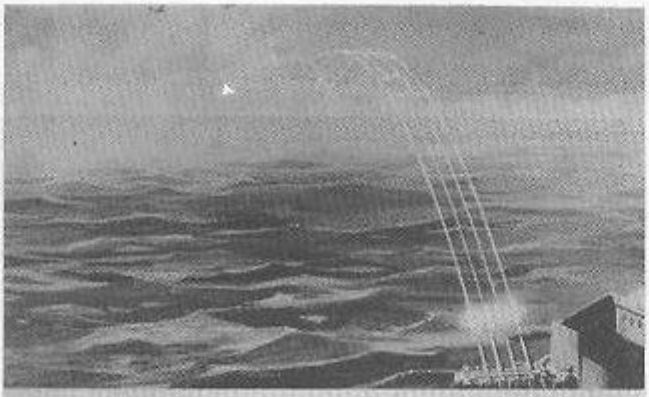


But with the introduction of the airplane as an offensive weapon, a new dimension was added to naval warfare. New and highly complex problems in gunnery and fire control were created and had to be solved. New guns had to be developed and added to the armament of fighting ships.

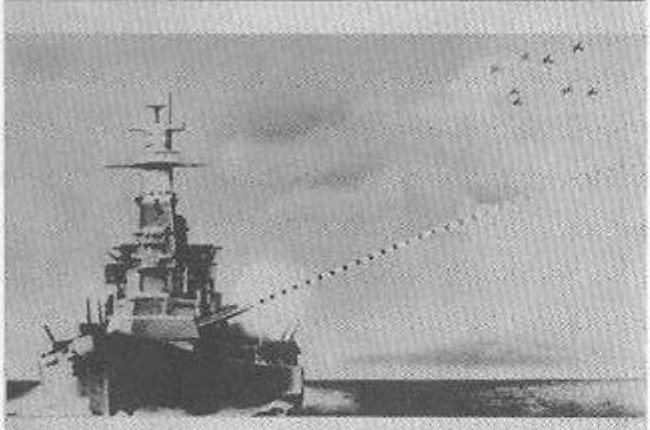


Among these were rapid-fire antiaircraft machine guns that proved to be very effective against close-in dive bombers and torpedo planes.

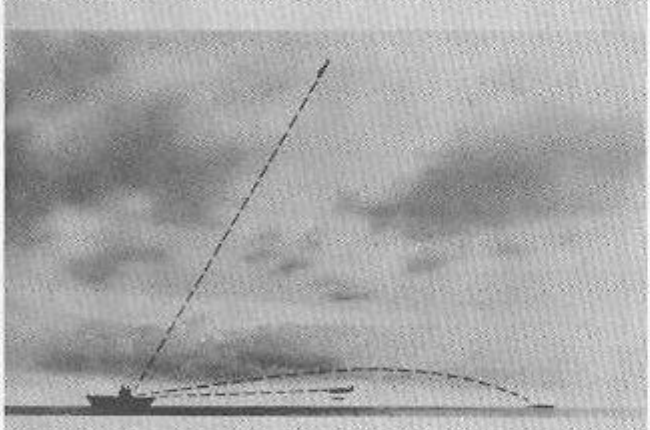




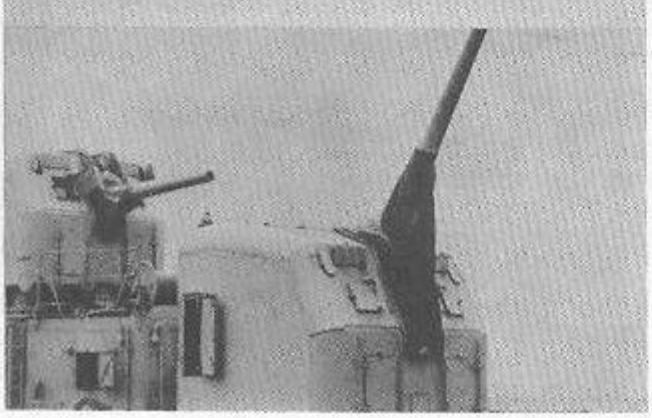
But these lighter weapons were limited in range and could not reach up far enough to hit high-level bombers.



The single purpose heavy caliber turret guns that were already in use had the range necessary for these high altitude targets, but could not be elevated sufficiently to hit them. Also, these large caliber guns could not fire rapidly enough to be effective against fast moving targets.

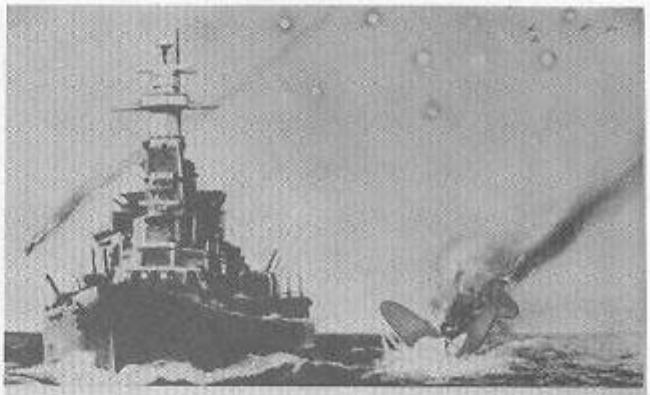


And so a new weapon was required; a dual purpose weapon that would pack sufficient wallop and would reach out and break up torpedo plane attacks before they came in; that could deliver this punch high enough to stop high altitude bombers, and that could, when required, also be used against enemy surface craft.

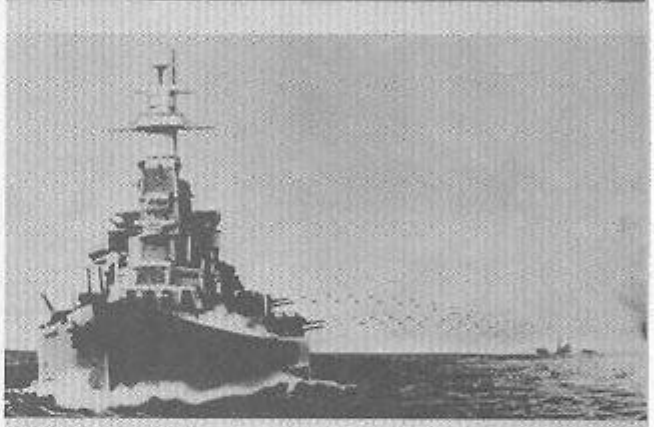


The answer to these problems is the 5''/38 gun. This gun meets very well the requirements of elevating ability, long range, and rapid fire.

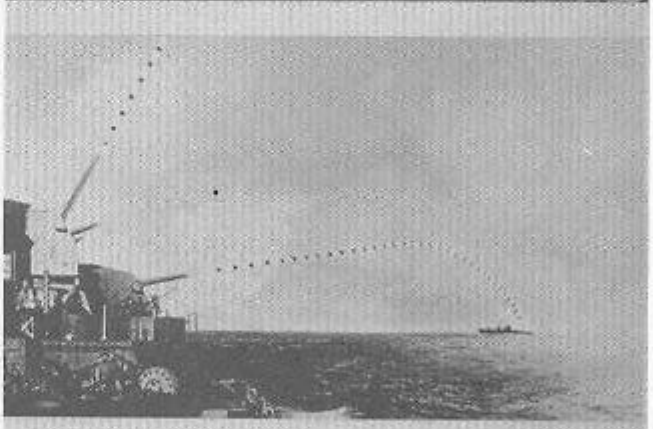
It is used in the fleet to destroy enemy aircraft, . . .



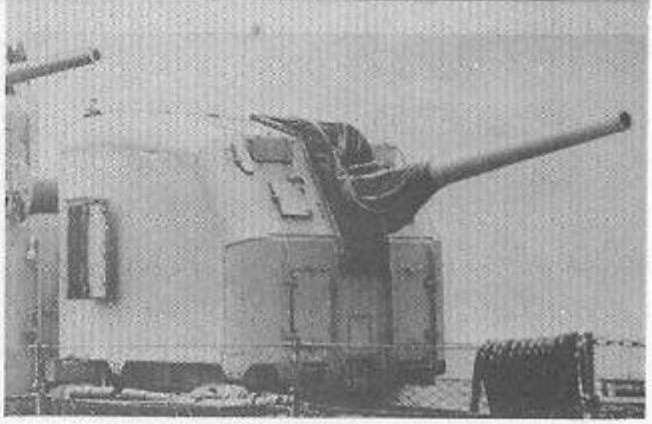
. . .to sink enemy surface ships, and for shore bombardment.



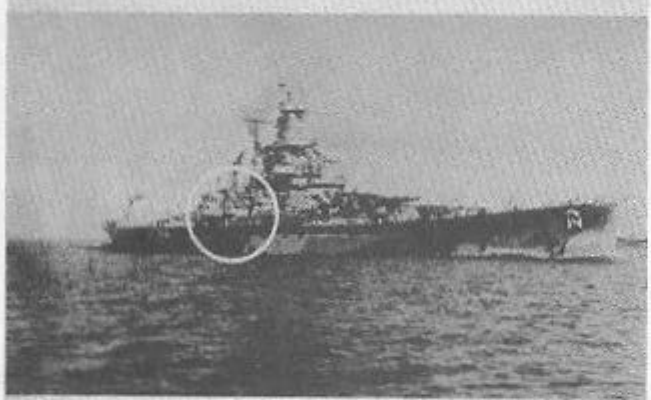
This is what we mean when we call the 5"/38 a dual purpose gun. It can be used effectively against both enemy aircraft and enemy surface ships.



This gun is mounted in a variety of assemblies depending upon the type of ship. As the main battery for destroyers it is generally installed as an enclosed or semienclosed single mount.

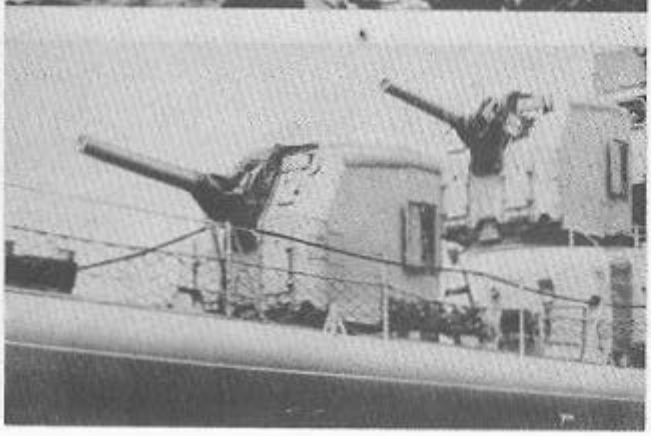


When mounted in enclosed twin mounts this gun is used as the main battery of some light cruisers. . .



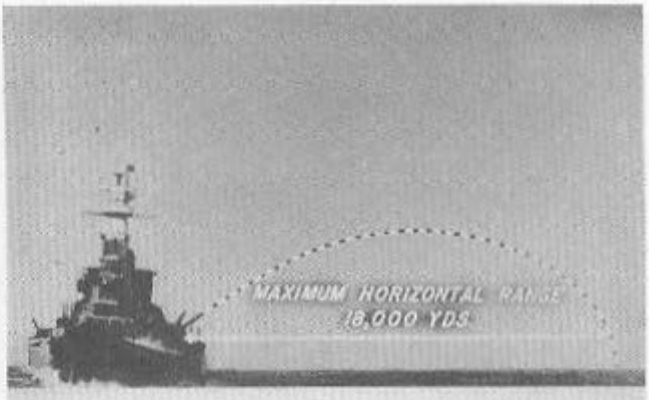
. . .and as the secondary battery of heavy cruisers and battle ships.

Aircraft carriers also depend on the 5''/38 for their own protection.

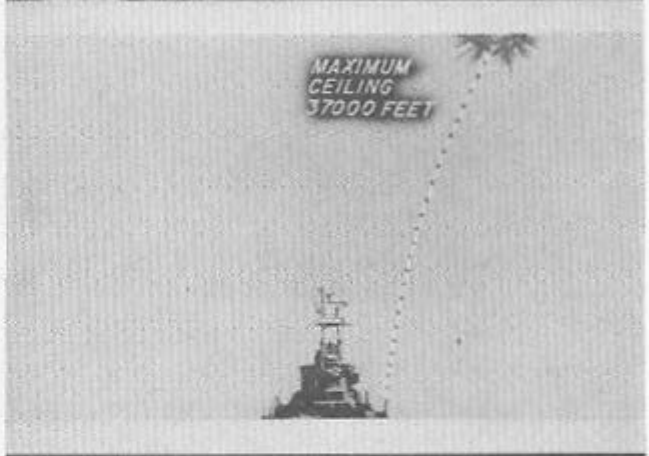


Although the 5''/38 gun is used in a variety of assemblies, we have selected for study the basic single Gun Mount, Mk 30.

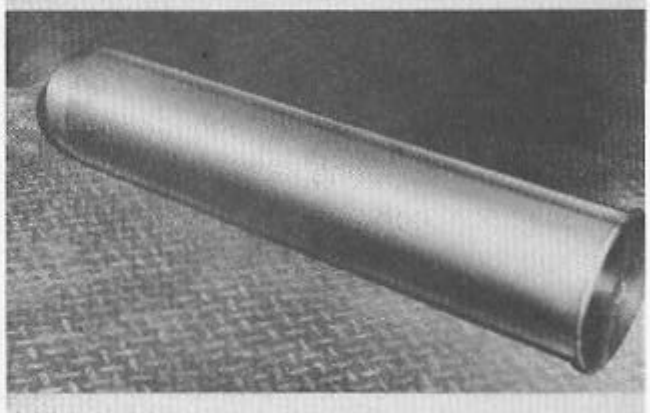
This gun's maximum horizontal range, 18,000 yards, gives it the reach necessary to stop the enemy's light forces before they can come close enough to do any damage.



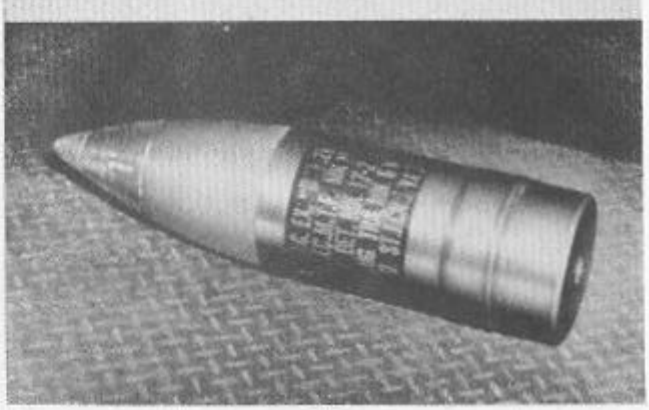
And a maximum ceiling of 37,000 feet, enables us to destroy high level planes before they are able to deliver an attack.

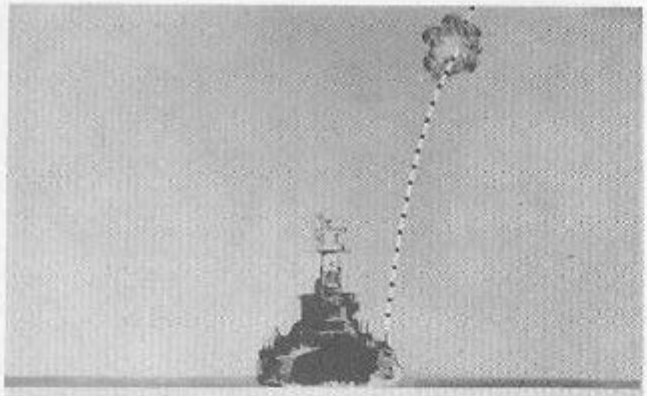


Powder is supplied to the gun in a metal cartridge case. This powder, when ignited, . . .

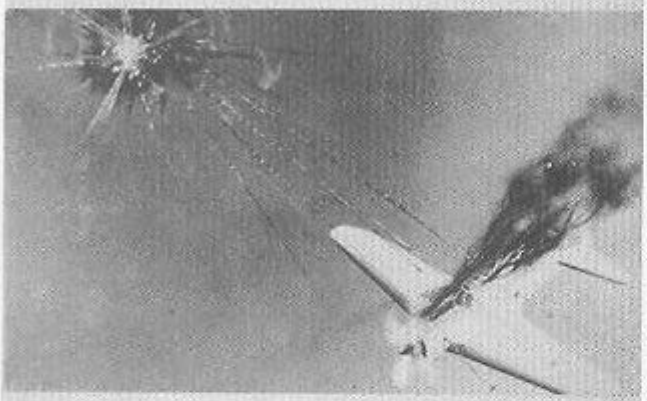


. . .serves to propel the projectile, which is itself filled with high explosives. For anti-aircraft firing the time fuze in the nose of the projectile can be set. . .

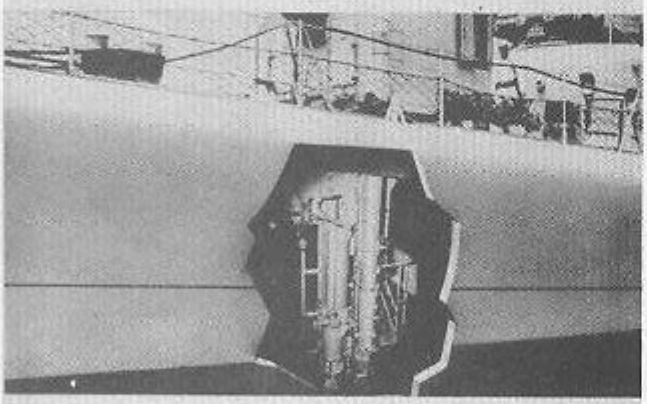




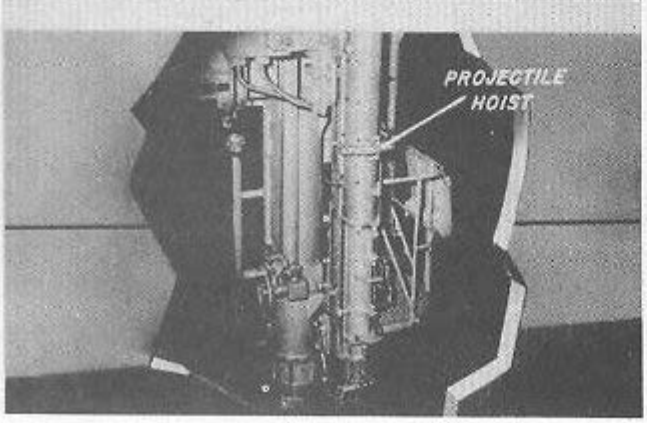
. . .to detonate its explosive charge at any desired point during flight.



The use of time fuzes greatly increases the effectiveness of the fire against aircraft since a direct hit is not necessary to bring down the target.

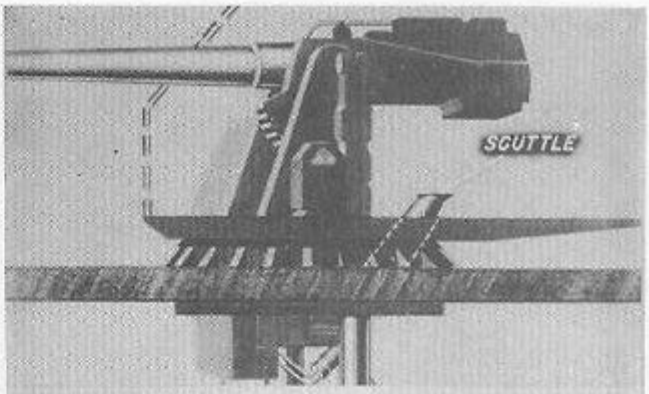


Ammunition from the magazines is supplied to the gun by equipment located in a handling room just below the mount platform.

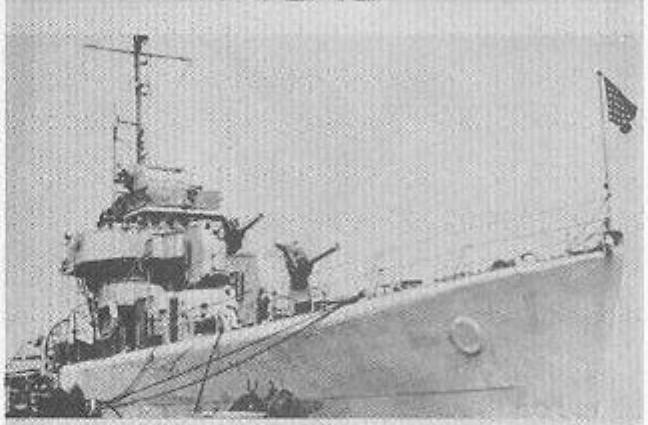


The projectiles are carried up to the gun by a power-driven projectile hoist. An interesting feature of this hoist is that it automatically sets the time fuse as the projectile is carried up. This eliminates the necessity for another man and much equipment and permits greater rates of fire than would otherwise be possible.

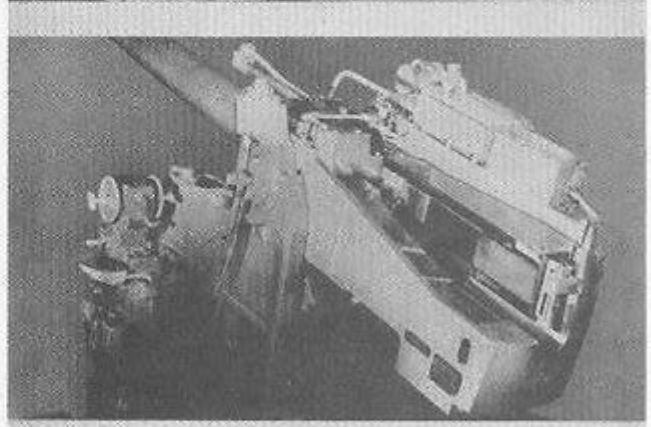
Cartridges are passed up manually to the loaders through a scuttle.



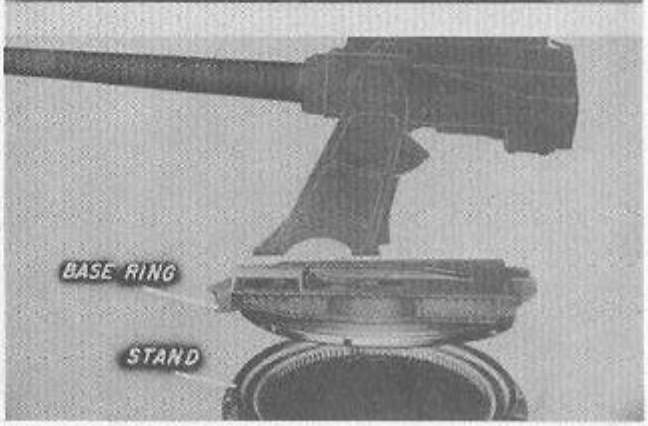
Five inch guns are generally assembled in enclosed mounts.

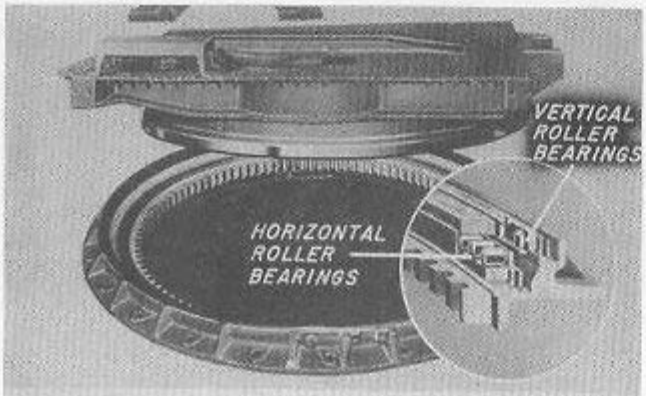


But, to examine the principle parts of the mount we must remove the shield.

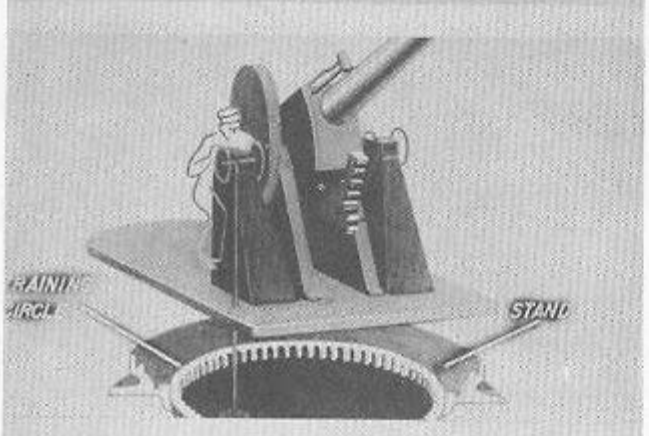


The gun proper is assembled on a base ring. This in turn is mounted on the stand, a heavy casting bolted to the deck. To permit freedom in training the gun the base ring is separated from the stand. . .

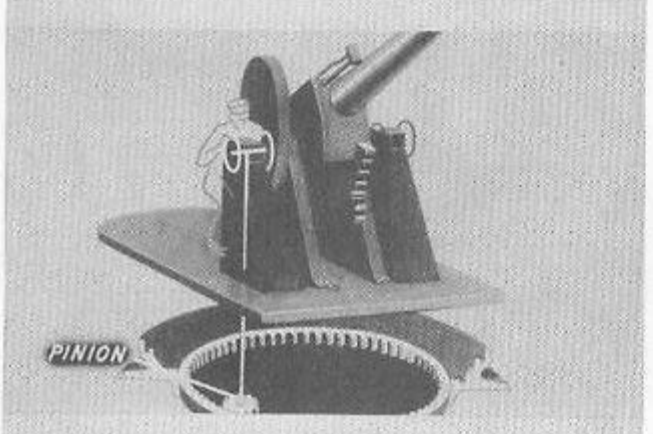




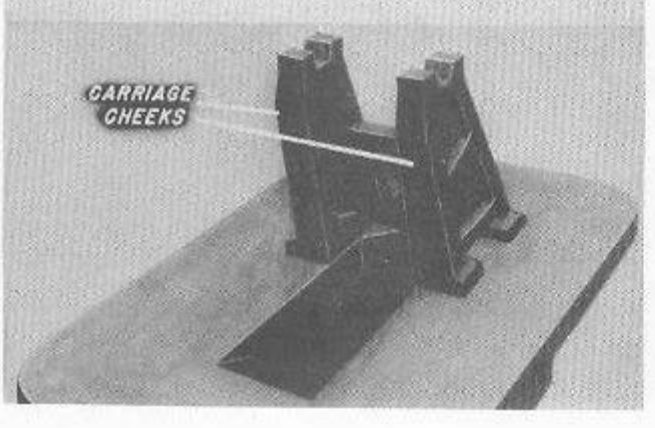
. . .by horizontal and vertical roller bearings.



Secured to the stand is an internal ring gear called a training circle. This training circle remains stationary. . .

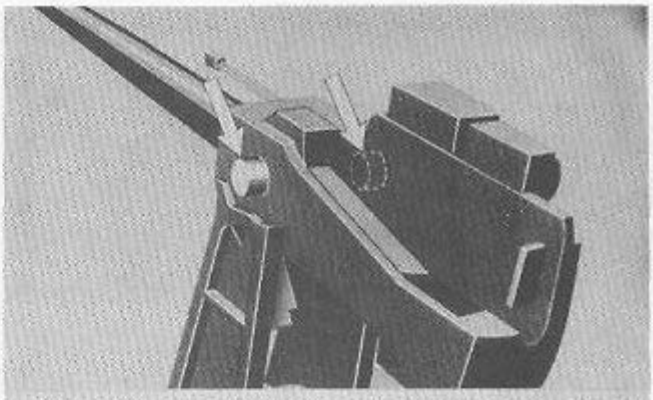


. . .and we can see here how the trainer, by means of a pinion rotated by his handwheels, is able to control the train of the mount.

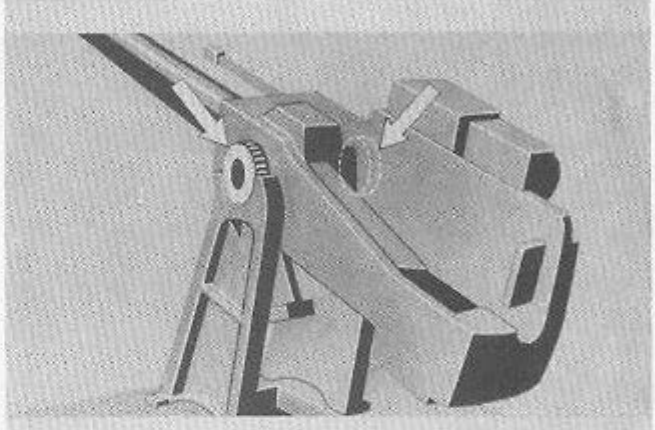


Secured to a platform on the base ring are 2 carriage cheeks. These cheeks, which support the gun on the mount, are much higher than those found on a single purpose gun. This additional height permits the gun to be elevated to the high angles demanded for antiaircraft fire.

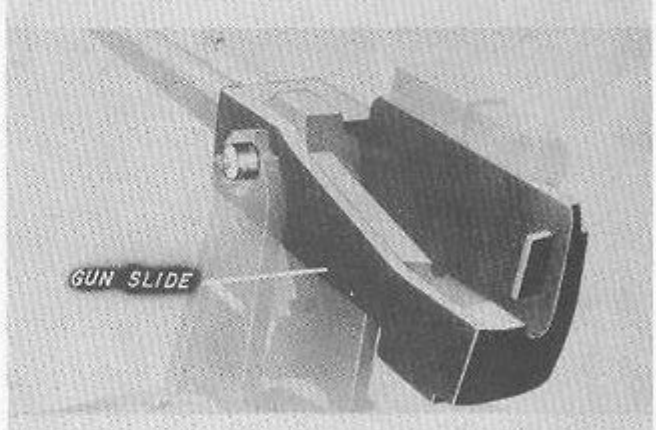
Trunnions, fitting in bearings, support the gun in the carriage cheeks.



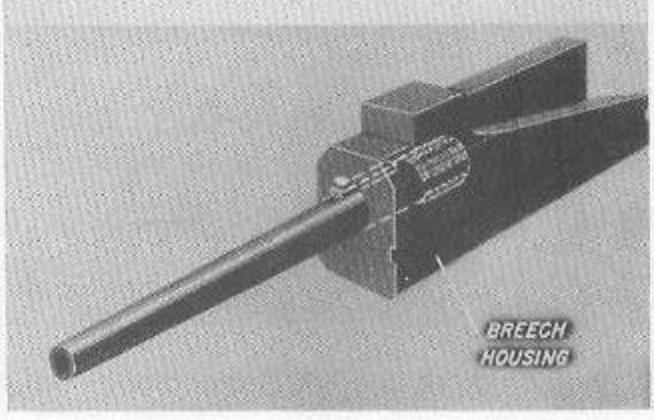
The trunnion bearings allow the gun to be moved easily and accurately in elevation at all times, even when the bearings are absorbing part of the shock of the gun's recoil.

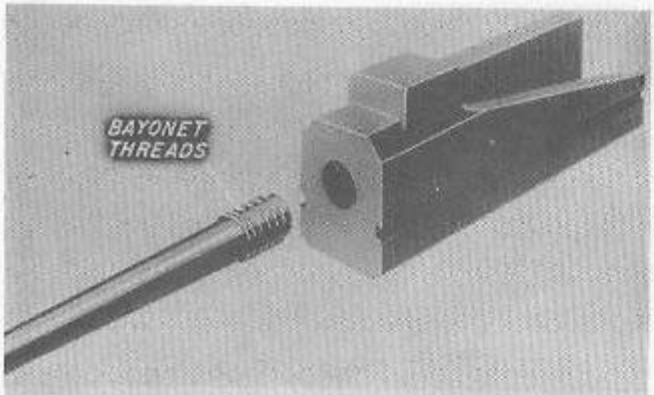


The trunnions themselves are part of the gun slide which supports the gun and provides a means for elevating and depressing the barrel in order to direct it at a target.

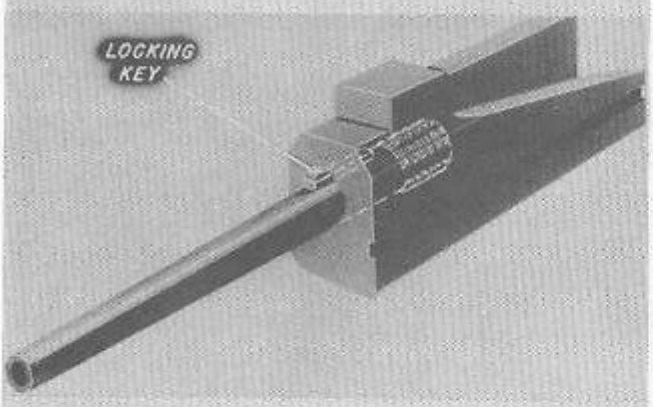


Carried within the slide are the barrel and breech housing.

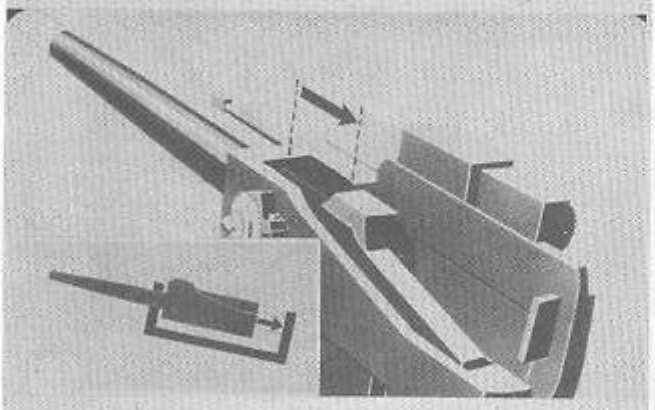




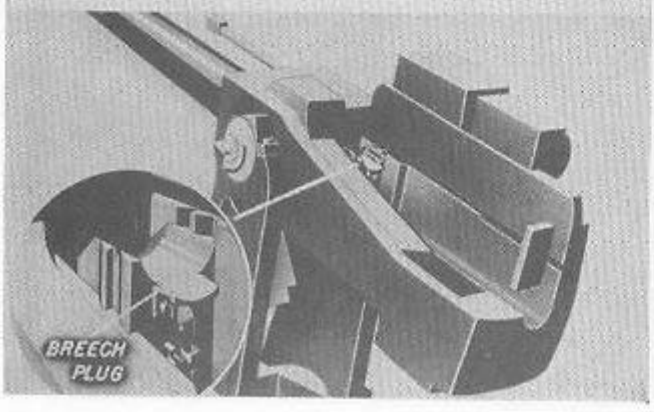
The barrel is joined to the breech housing by bayonet threads. . .



. . .and is secured by a locking key.

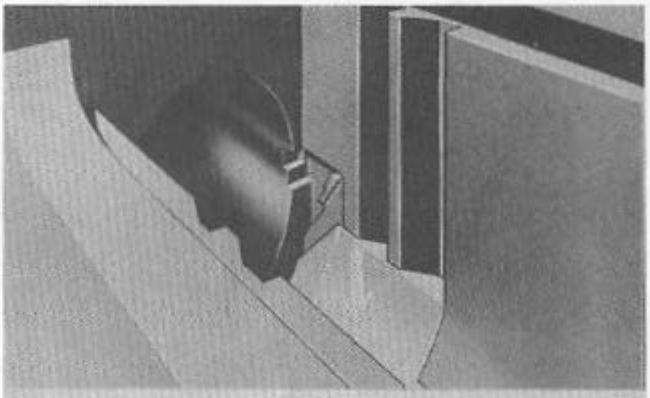


When the gun is fired, the barrel and breech housing recoil together within the slide.

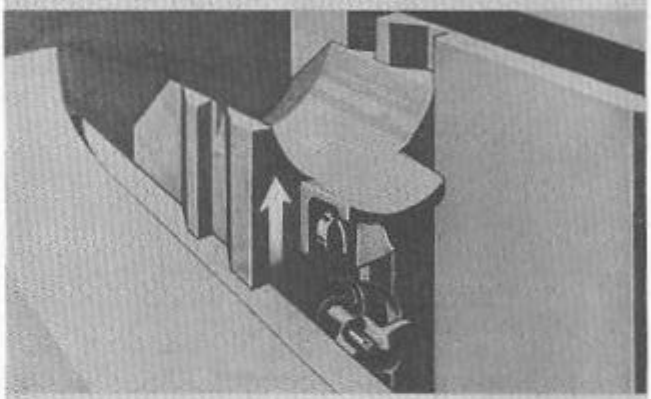


One of the features of the 5''/38 is a vertical sliding wedge breechplug. This plug is operated automatically by the breech mechanism and is largely responsible for the high rate of fire that makes this gun an ideal antiaircraft weapon.

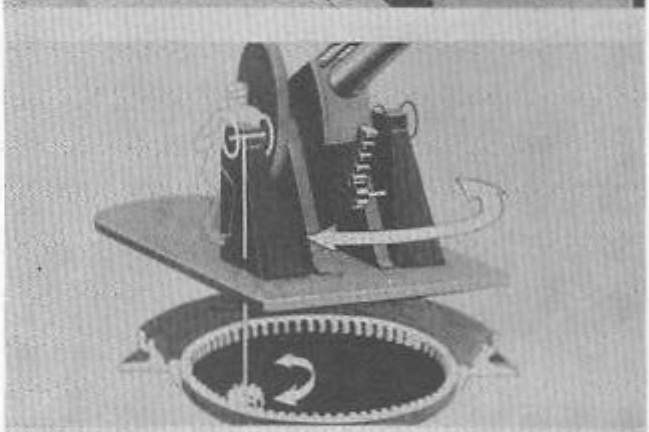
This breechplug is guided by vertical grooves in the breech housing. Riding in these grooves the plug is lowered to permit a round to be rammed into the gun chamber. .



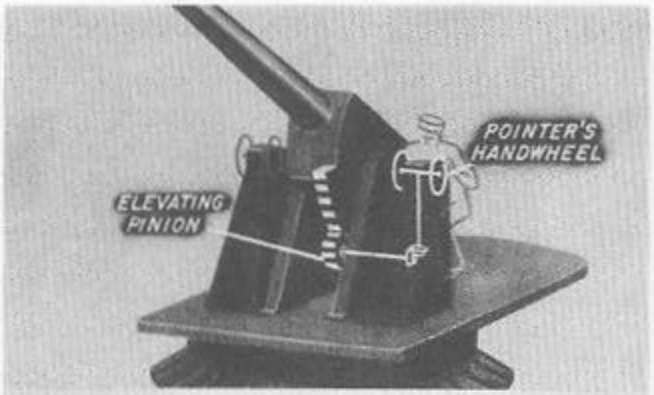
. . and then is snapped upward to close the breech so that the gun may be fired.



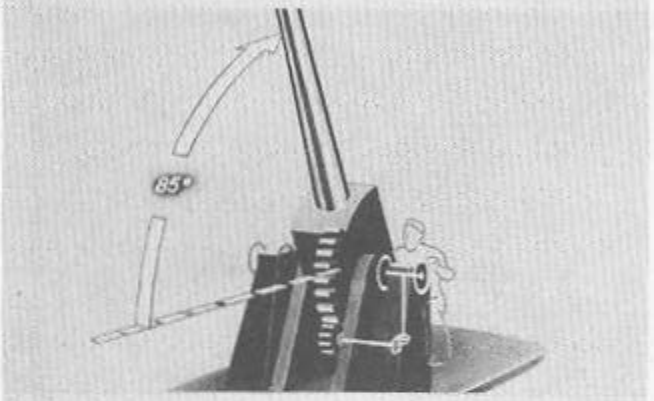
We have seen that the gun and mount may be positioned in train by means of a training mechanism.



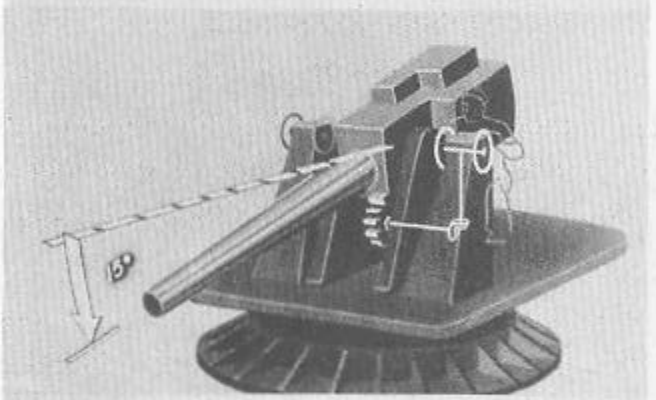
It can be elevated to the target by means of an elevating arc. . .



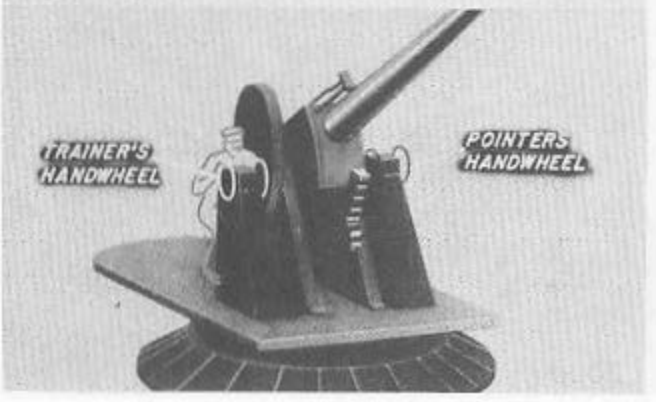
. . .that is driven by the pointer's handwheel acting through a gear train and the elevating pinion.



This elevating system together with the high carriage cheeks enables us to elevate this gun to the extremely high angle of 85°. . .

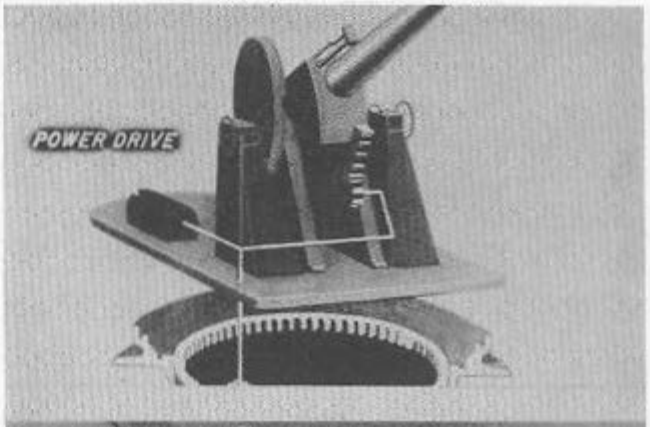


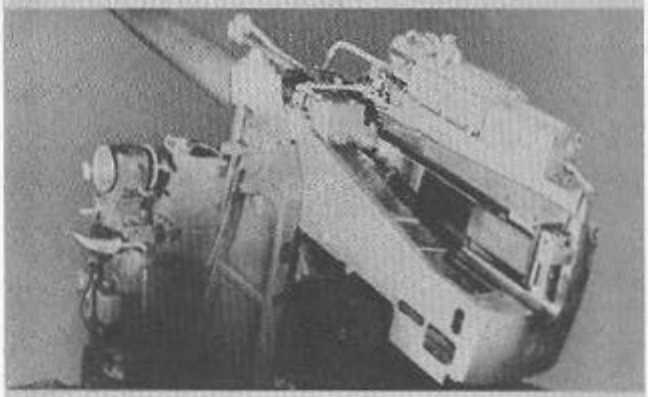
. . .and to depress it to 15° below the horizontal.

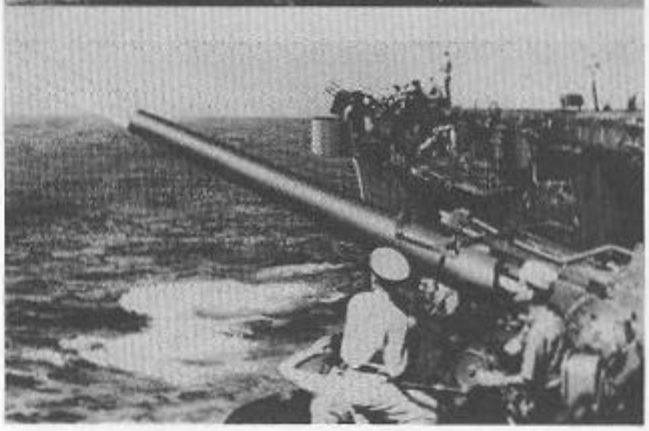


So far we have considered the gun being moved manually by the pointer's and trainer's handwheels. In many cases, on small ships particularly, the roll and pitch are so great that a man doesn't have the strength to position the gun as rapidly or accurately as is required to follow the target.

To overcome this difficulty, every 5"/38 gun is equipped with a power drive. In addition to assisting the pointer and trainer in controlling the gun this power drive can receive signals automatically from the ship's fire control system. This allows the gun to be positioned automatically and to fire at targets that are out of sight of the gun crew.



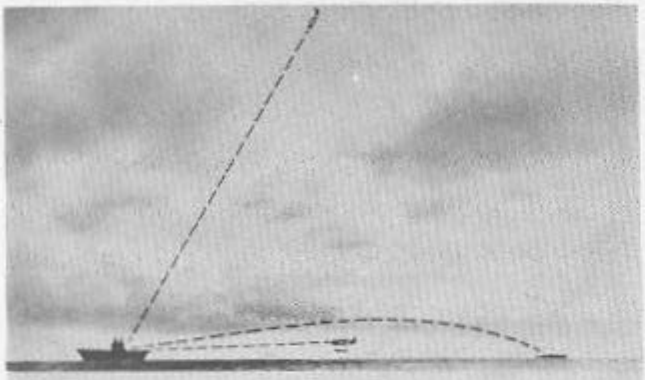




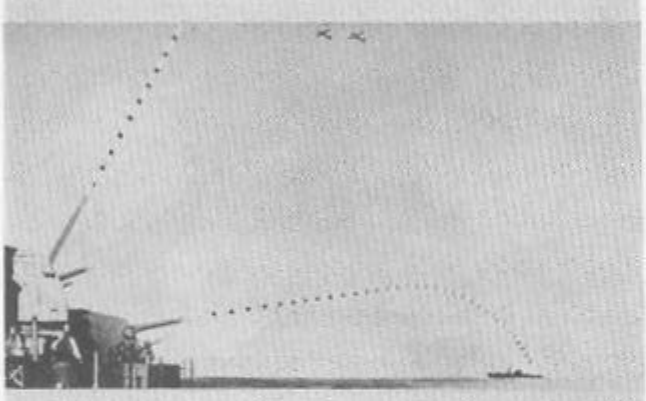
And so we see that we have in the 5"/38 gun a truly remarkable weapon, a dual purpose weapon, effective against airplanes and surface craft—a gun which can fire high explosive projectiles at a very rapid rate and which can be positioned automatically on targets not visible to the gun crew.

Maintain this gun so that it will always function to the full extent of its ability and you will have a weapon that will always be accurate, powerful, and dependable.

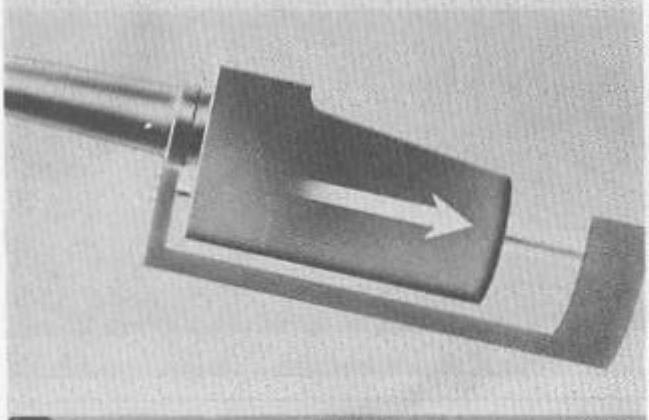
CHAPTER 2—INTRODUCTION TO THE GUN ASSEMBLIES



As a dual purpose weapon the 5"/38 gun must fire rapidly and effectively upon both enemy aircraft and enemy ships. To meet the demanding requirements of this dual purpose fire. . .



. . .the mount is designed to give a high angle of elevation to the gun and to train and elevate it rapidly and accurately. To get a rapid rate of fire. . .



. . .the mount is also designed to absorb the shock of recoil quickly and to use part of this energy to return the gun to battery, and operate the gun assemblies automatically.

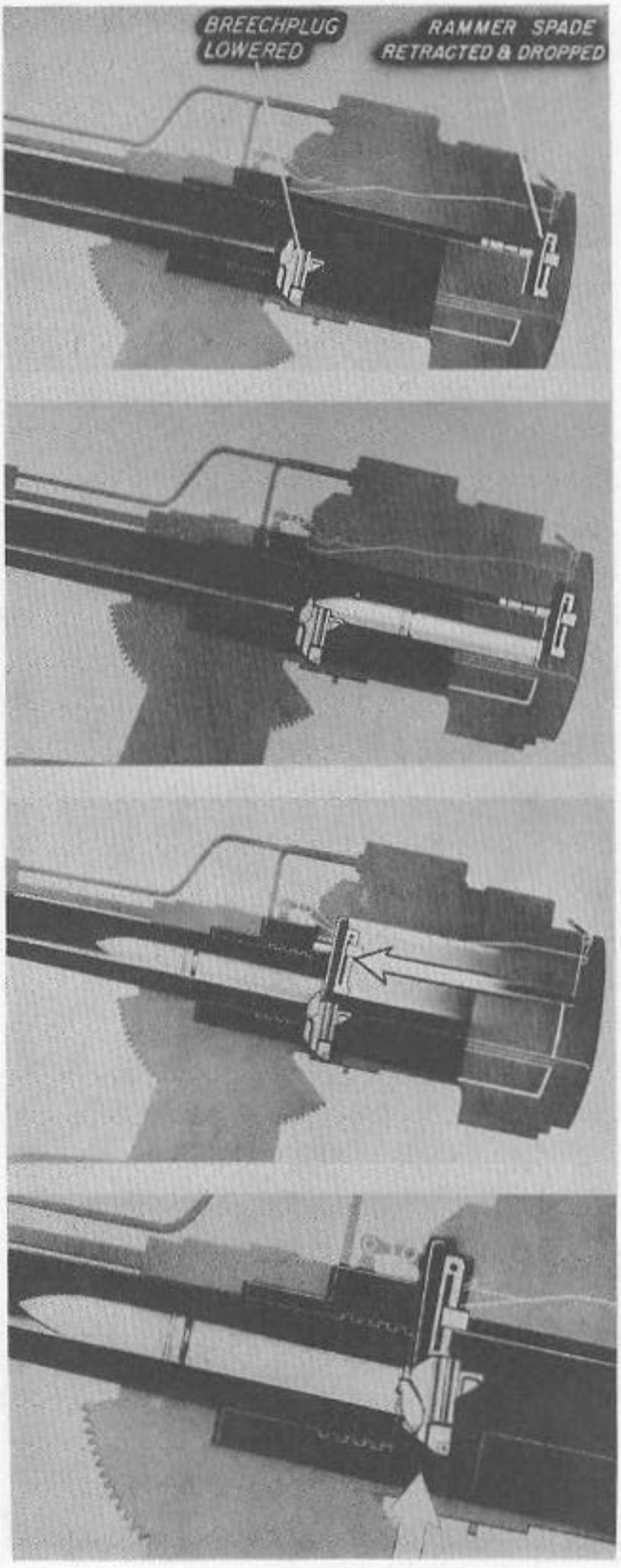
In addition, the gun itself is designed to facilitate rapid loading and firing. To load the gun a rammer spade is driven by an electrohydraulic rammer mechanism. To close the breech securely and quickly for firing, the gun is equipped with a vertical sliding wedge breechplug operated by a fully automatic breech mechanism.

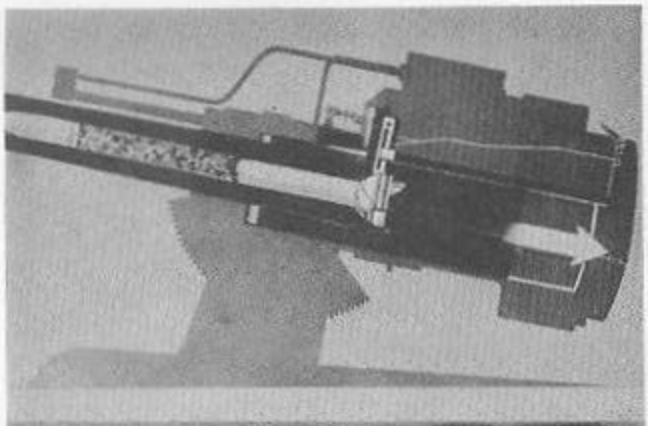
To see how the gun assemblies contribute to the rapid, accurate fire of this gun, let's trace their operation schematically in ramming, firing, and ejecting a round. To load the gun, the breechplug must be lowered to the breech open position, and the rammer spade must be retracted and dropped to its lower (or ramming) position.

The gun is entirely automatic in operation - except that the ammunition must be placed manually in the loading tray. . .

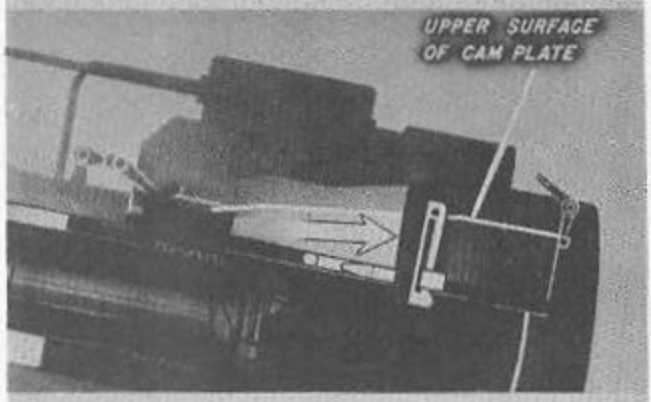
. . .and a control lever must be tripped manually to start the rammer spade forward. The spade is moved forward hydraulically pushing the round into the gun chamber over the lowered breechplug. As the round is seated, the plug is unlatched and the rammer is locked in the forward position.

When the breechplug is unlatched it springs up to close the breech by wedging the cartridge into the chamber. The plug pushes the rammer spade up out of the way so that the cartridge case can be ejected after the gun is fired.

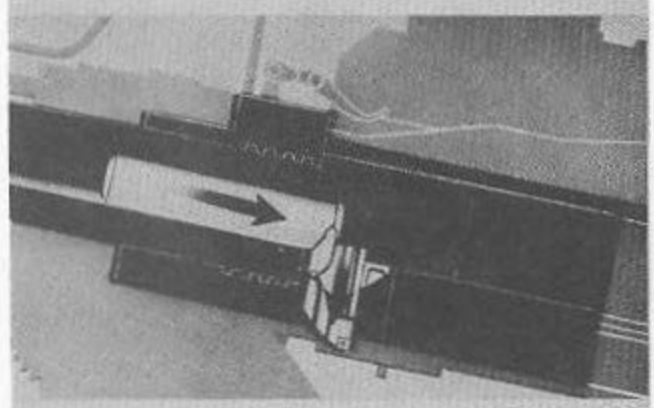




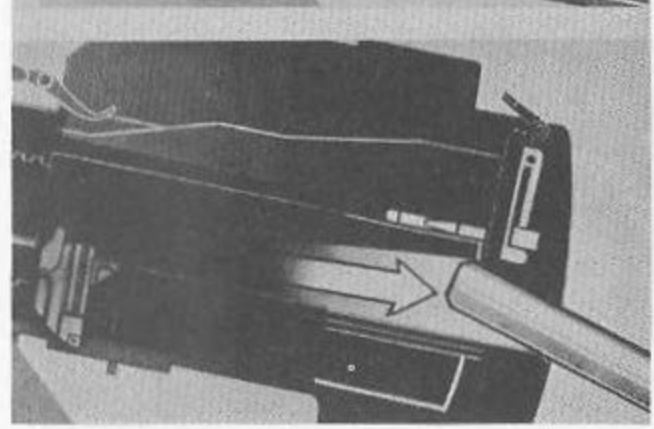
When the round is fired the breech housing the gun barrel recoil within the slide. The recoil movement is absorbed quickly and unlocks the rammer. . .



. . .causing the rammer spade to be hydraulically retracted. The spade rides aft on the upper surface of a cam plate.

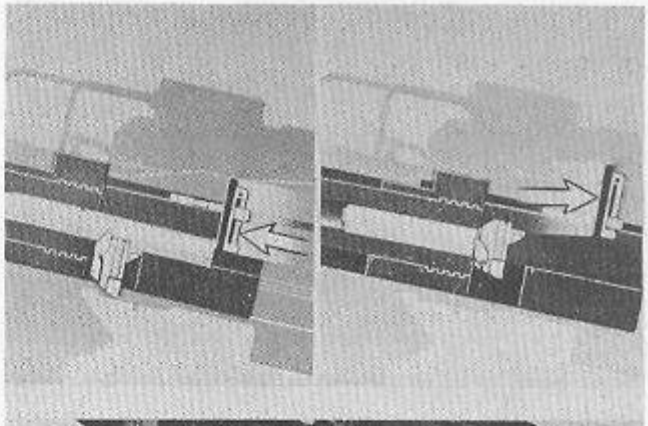


The recoil energy absorbed by the mount is then used to return the gun to battery and to lower the breechplug, automatically opening the breech and extracting the fired cartridge case.

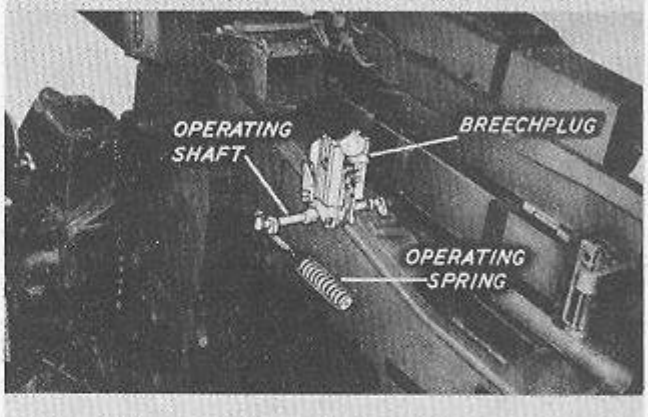


The cartridge case is extracted with such force that is is ejected aft over the loading tray. The case passes under the retracted rammer spade which is still held in the upper position. The operating cycle is thereby completed.

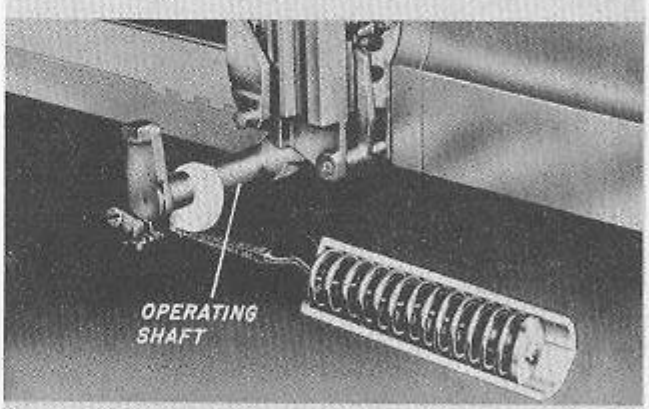
To sum up - as shown in the view at the left, the rammer spade is moved forward in the lower position to ram the round into the chamber over the lowered breechplug. The breechplug is unlatched by the cartridge case as it enters the chamber. As shown in the view at the right, the breechplug is then moved up to close the breech by wedging the cartridge into the chamber. Then as the gun recoils, the rammer spade is moved aft in the upper position. The spade is left in the upper position so that when the breechplug has been moved down to open the breech the fired case can be ejected over the loading tray.



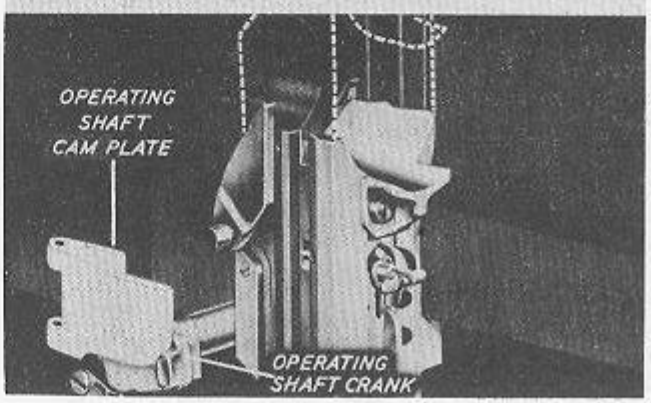
The vertical motion of the breechplug within the breech housing is accomplished by the action of an operating shaft. This shaft is rotated by an operating spring to raise the breechplug to the breech closed position.



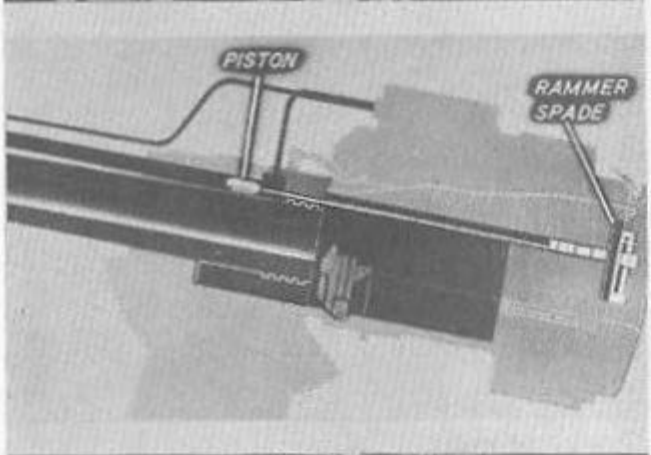
Here, we have cut away the slide and breech housing to show the action more clearly. The operating spring is attached by a flexible chain to a cam on the operating shaft. The pull of the spring on this cam cranks the operating shaft in a rotary movement. We shall investigate, later, how the rotary motion of the operating shaft is transformed to vertical movement of the breechplug.



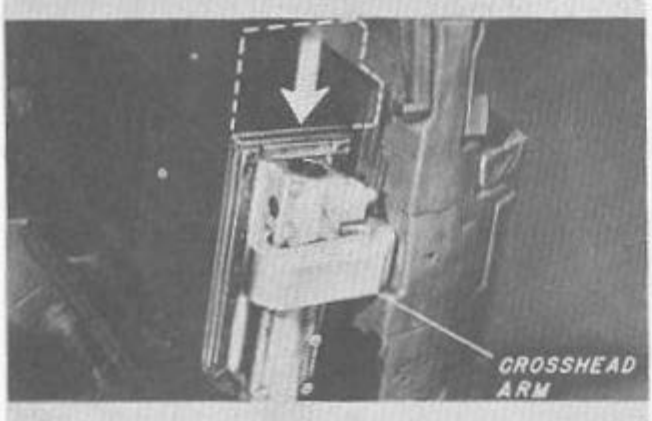
We stated that during counterrecoil the breechplug is automatically lowered to open the breech. This is accomplished by the action of the operating shaft cam plate on the operating shaft crank. As the operating shaft is carried forward by the beech housing during counterrecoil, the cam plate engages a toe on the crank rotating the shaft to pull the breechplug down.



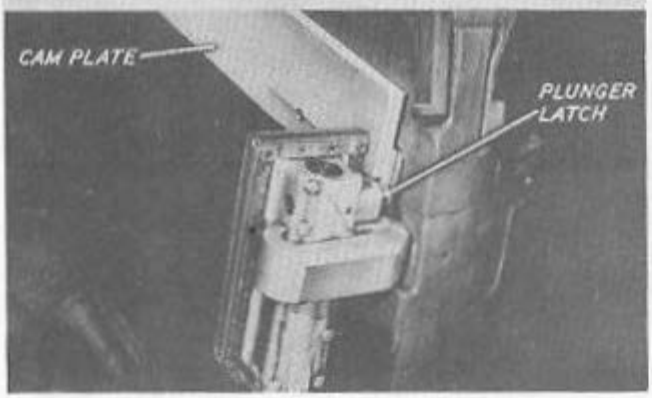
Each time the breechplug is lowered, it is latched down by the action of the extractors to keep the breech open against the force of the operating spring until the next round can be rammed into the chamber. We will examine this latching action of the extractors in greater detail later. For the present it is sufficient to remember that when the lips at the top of the extractors are aft (as shown here) the breechplug is latched in the open position. When the lips are pushed forward by the rim of a cartridge case entering the chamber the breechplug is unlatched so that it can close the breech.



Now, let's see how the motion of the rammer spade is controlled by the rammer mechanism which consists essentially of a piston contained in a closed cylinder. This piston is moved fore and aft hydraulically. The rammer spade is secured to the after end of the piston rod by a crosshead arrangement. Thus the rammer spade is moved fore and aft by the action of the hydraulic piston. In addition to this fore and aft motion. . .

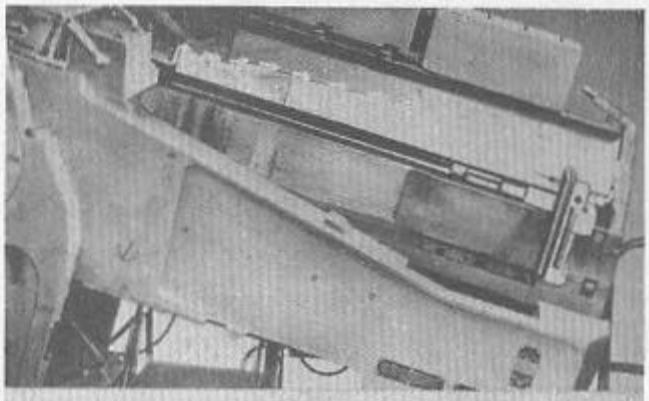


. . .the rammer spade has a limited vertical motion within the crosshead arm. It can move up and down between the position shown here and that indicated by the dotted lines.

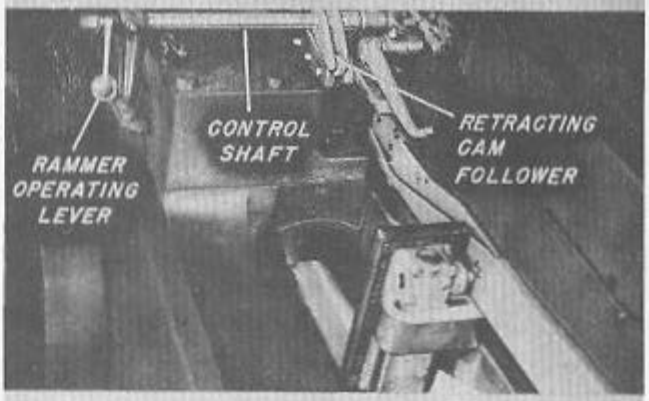


A spring-loaded plunger latch projects from the right side of the rammer spade. This plunger latch controls the vertical position of the spade by engaging the surfaces of a rammer cam plate which is secured to the slide.

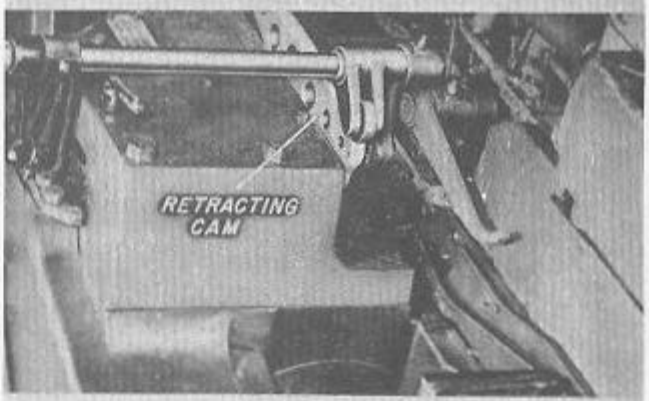
In this view the arrows indicate the path around the cam plate followed by the plunger during the operating cycle of the rammer mechanism.



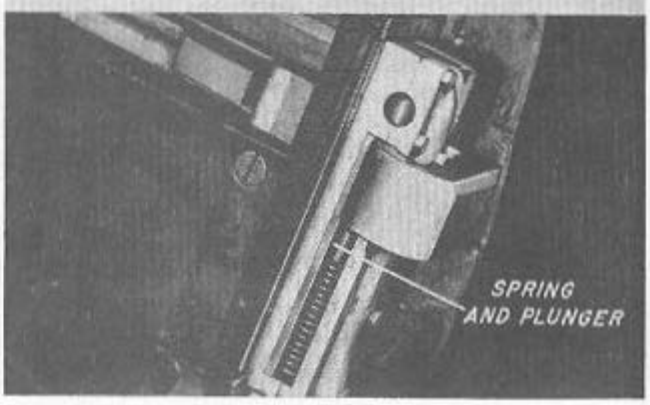
We will not study the action of the hydraulic operating mechanism in further detail here since to study the mechanical features of the rammer operation we will be interested only in the controls that operate the hydraulic mechanism. The hydraulic action is controlled by a lever known as the rammer operating lever. This lever is connected by the control shaft to the valve system. It has only two normal positions—down, to make the rammer go forward in the ram stroke, and up, to retract the rammer. The lever latches down in the ram position when it is depressed. So, to make the rammer retract automatically a retracting-cam-follower is keyed to the control shaft.

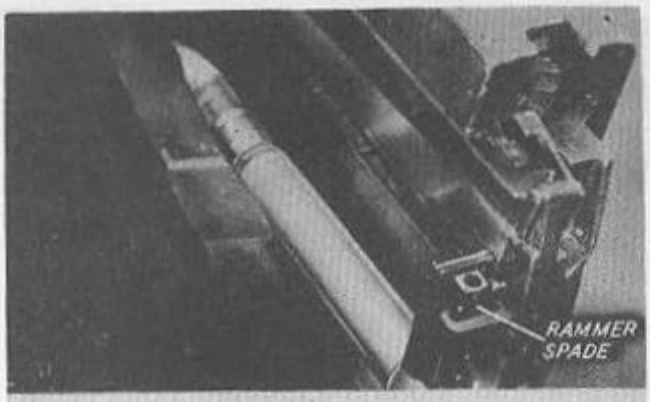


This cam follower is pushed up to the "retract" position by a "retracting cam" secured to the safety link bracket on top of the breech housing. The retracting cam engages the cam follower to retract the rammer as it is carried aft during recoil.

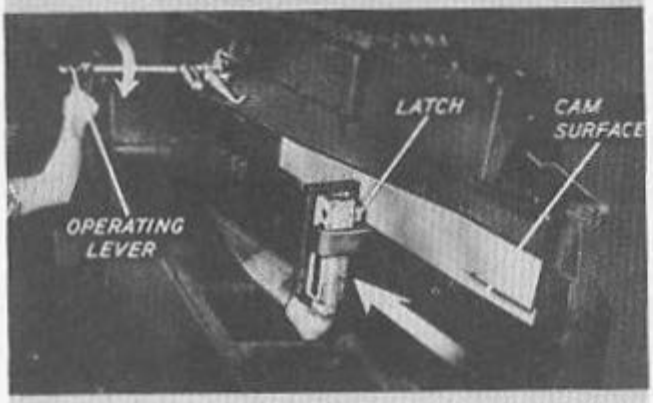


The rammer spade is normally held down in the lower position within the crosshead arm by a spring and plunger. In this position the spade is ready to ram a round into the gun chamber.

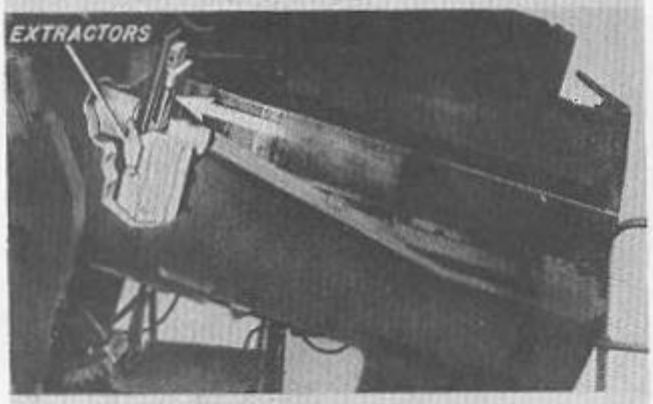




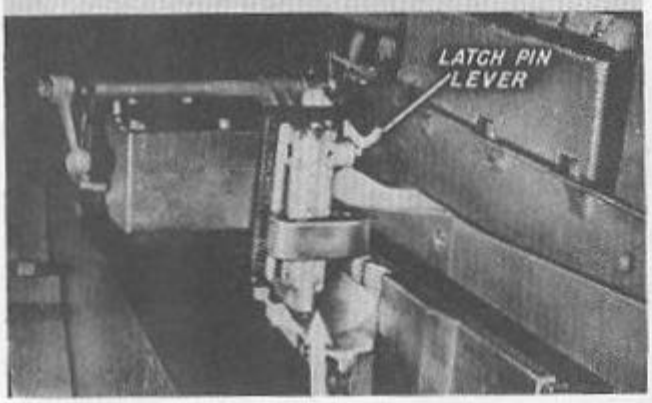
Now that we have seen how the breechplug and the rammer spade are controlled, let's review the operating cycle of the gun in further detail. We will start again with the rammer spade retracted and dropped to the lower position (and with the breechplug lowered to the breech open position). When the projectile and the cartridge have been manually placed in the loading tray. . .



. . .the rammer operating lever is pushed down to the "ram" position. This action causes the hydraulic system to move the rammer spade forward to ram the round into the gun chamber. As the spade rides forward the plunger latch is forced in against its spring by a cam surface cut in the rear of the rammer cam plate and rides on the face of the cam plate.

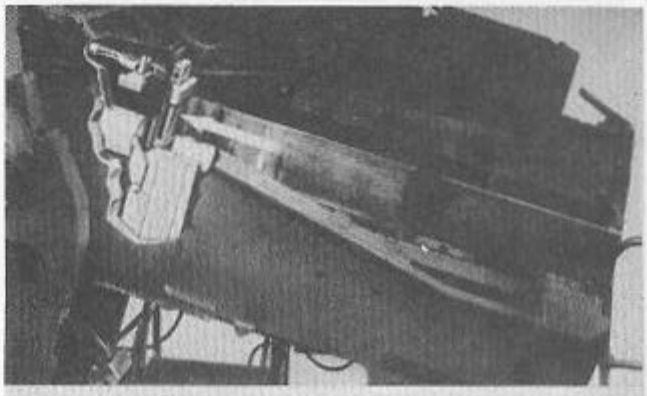


The cartridge case entering the chamber engages the lips of the extractors and pushes them forward to unlatch the breech plug.

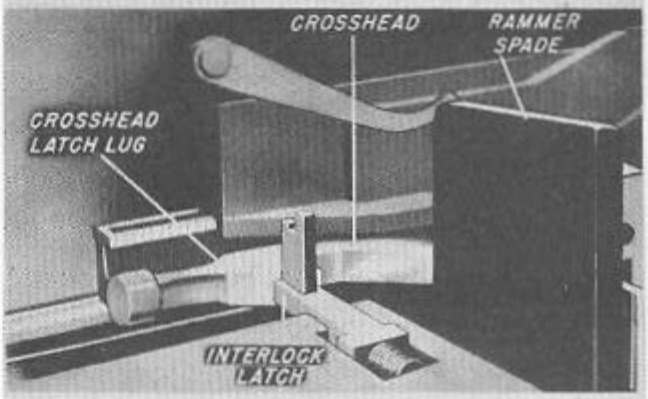


When the breechplug is raised by the operating spring, to close the breech, it pushes the rammer spade up within the crosshead arm. The plunger latch on the rammer spade rides up free of the rammer cam plate and is pushed out by its spring. The latch then engages the latch pin lever. The purpose of the latch pin lever is to cut off the hydraulic power to the rammer system.

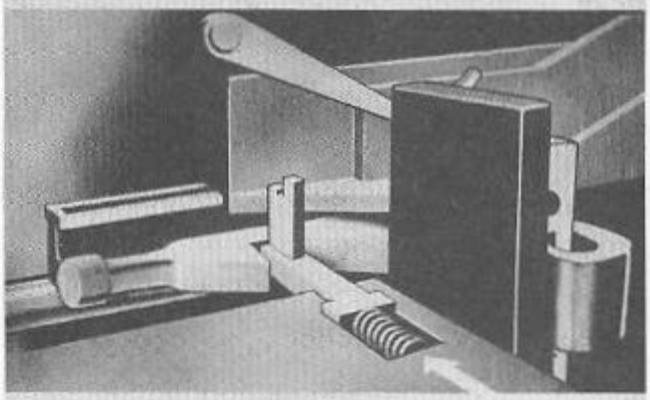
The rammer is latched in the forward position to hold the round in the chamber until the breechplug has closed the breech. To see the latch arrangement more clearly we will cut away the top of the breech housing.



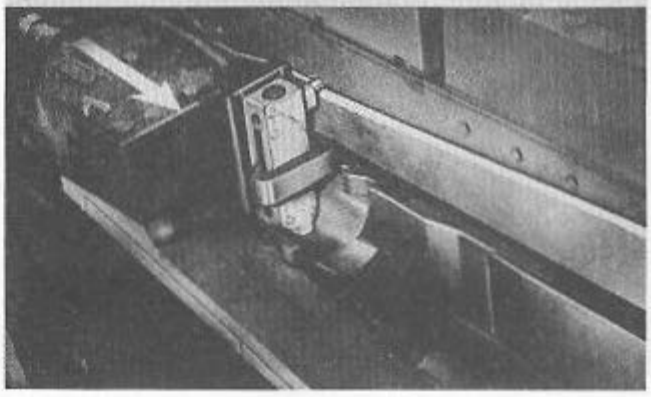
The rammer interlock latch is mounted in the top of the breech housing. It is held in the path of the rammer crosshead by a spring. As the rammer comes forward in the ram stroke the cam surface on the crosshead latch lug pushes the rammer interlock latch back into the breech housing against its spring.

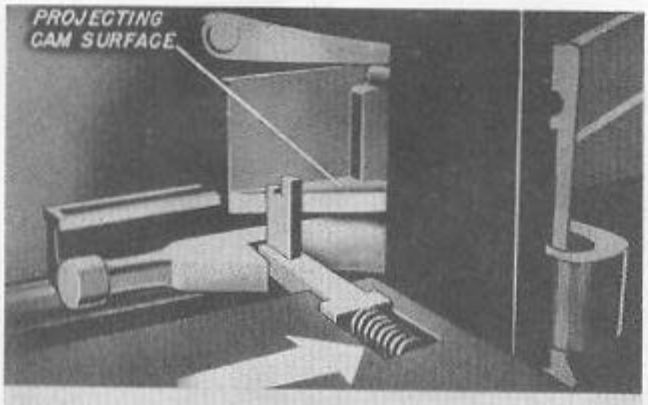


Then, when the rammer has come all the way forward the spring pushes the interlock latch into a recess in the crosshead latch lug. The rammer is thus latched securely in the forward position.

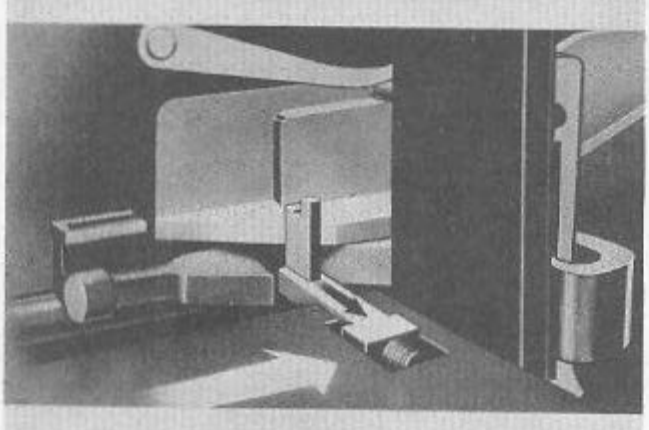


Now let's see how the rammer is unlatched and retracted when the round is fired. During the first part of the recoil movement the breech housing carries the rammer spade aft with it. It is this action, as we shall now see, that unlatches the rammer and causes it to be retracted.

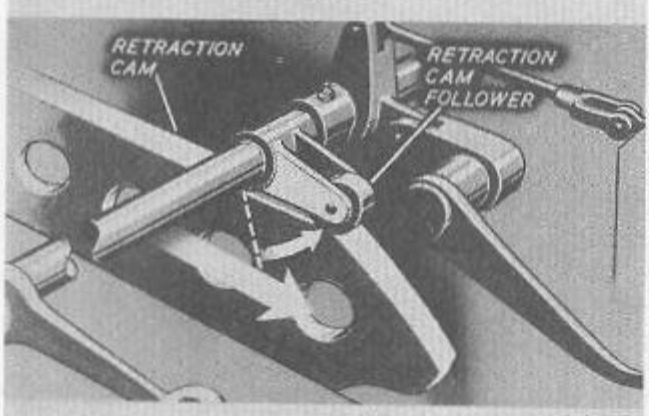




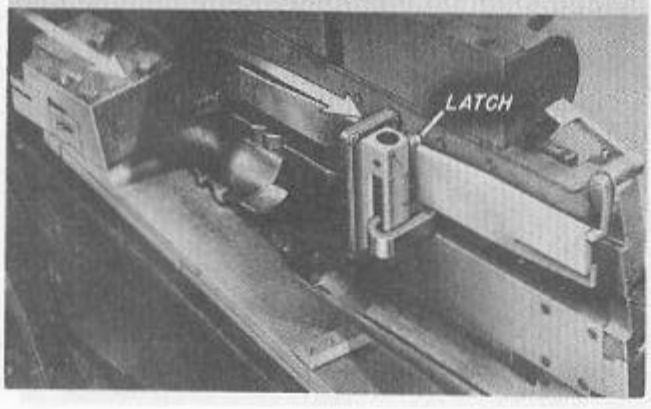
The rammer, the rammer interlock latch and the breech housing all move aft together within the slide as the gun recoils. The rammer interlock latch rides over a projecting cam surface on the rammer cam plate, which is secured to the slide so it does not move during recoil.



The interlock latch is cammed back into the breech housing compressing its spring. The latch is thus withdrawn from the recess in the crosshead latch lug and as a result the rammer is freed so that it can be retracted.

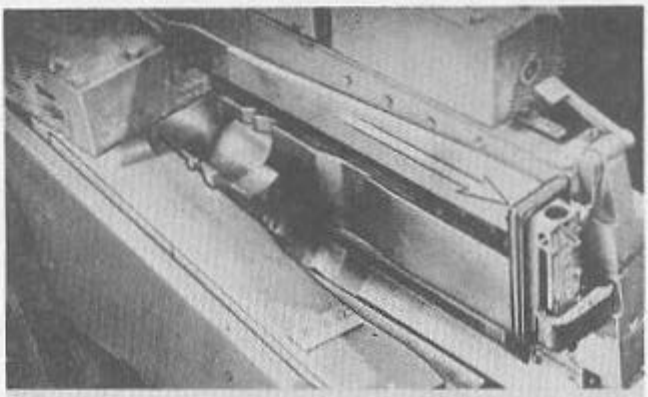


To retract the rammer automatically, the rammer control shaft is positioned by the action of retraction cam on the retraction cam follower. This retraction cam is mounted on top of the breech housing and is carried aft with the housing to engage the cam follower during recoil. The rammer control lever has only two normal positions. It can be latched down to cause the rammer to go forward hydraulically in the ram stroke or it can spring up to this position to make the rammer spade retract hydraulically. The action of the retraction cam on the cam follower unlatches the control lever from the ram position so that it can spring up to the retract position. The valve system of the hydraulic rammer operating mechanism. . .

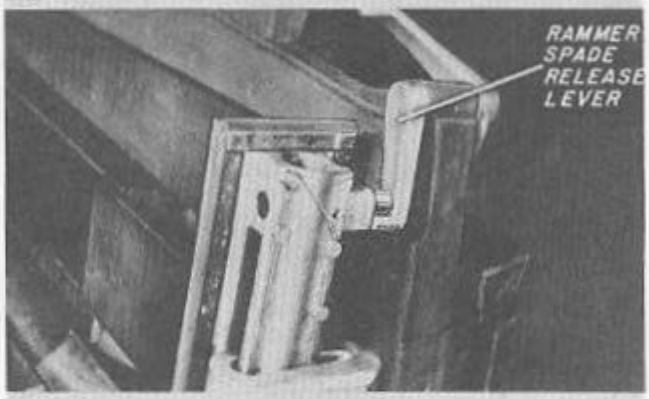


. . .is now set to retract the rammer spade. The rammer spade is moved aft in the upper position because the projecting plunger latch rides on the upper surface of the rammer cam plate.

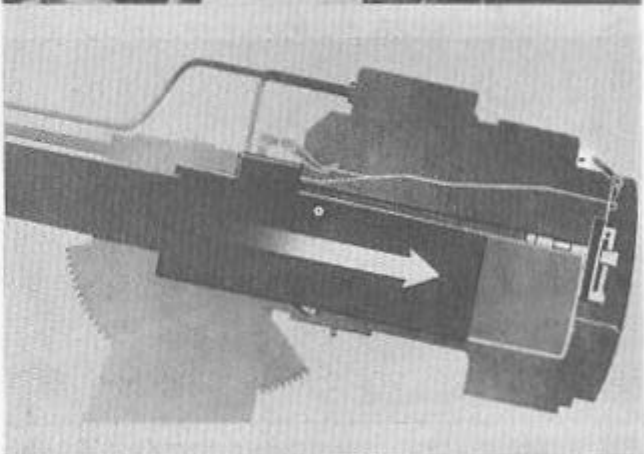
The rammer spade is thus retracted all the way aft and rests in the upper position so that (as the gun returns to battery) the fired cartridge can be extracted and ejected out of the gun under the spade.



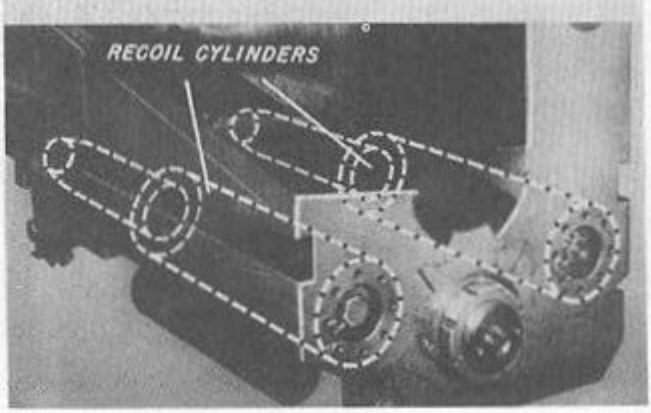
In the fully retracted position the plunger latch rests only on a lug formed on the rammer spade release lever. Thus by actuating the release lever, the spade can be dropped to the lower (or ramming) position after the cartridge has been ejected.

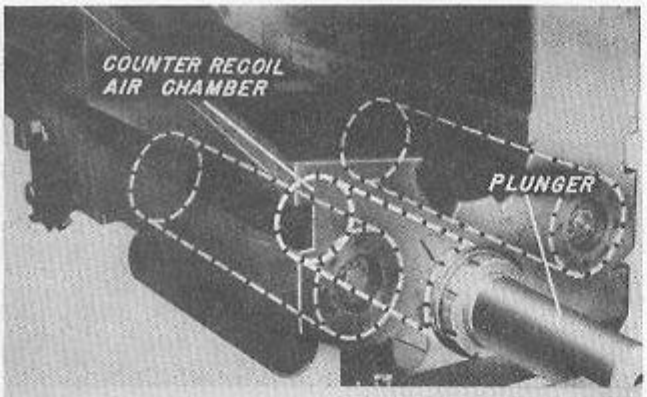


To absorb the tremendous force of the gun's recoil and to utilize part of this force to return the gun to battery and operate the gun assemblies automatically. . .

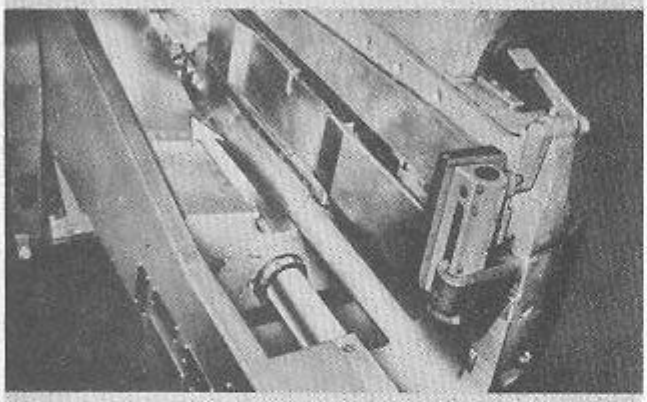


. . .a recoil and a counterrecoil system are provided. The recoil system includes two recoil cylinders whose position in the breech housing is indicated here. These cylinders are liquid filled and ride over pistons to buff the recoil and counterrecoil movements of the gun hydraulically.

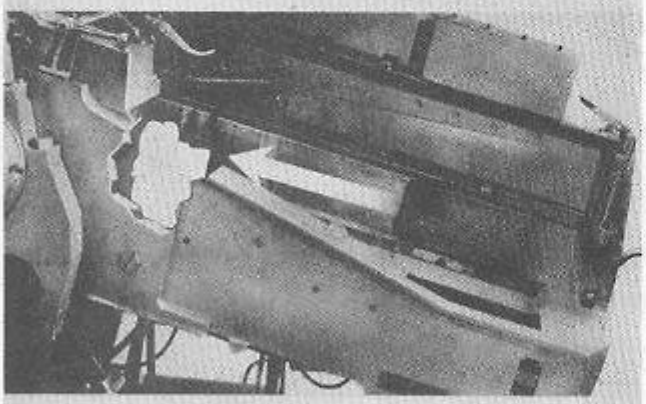




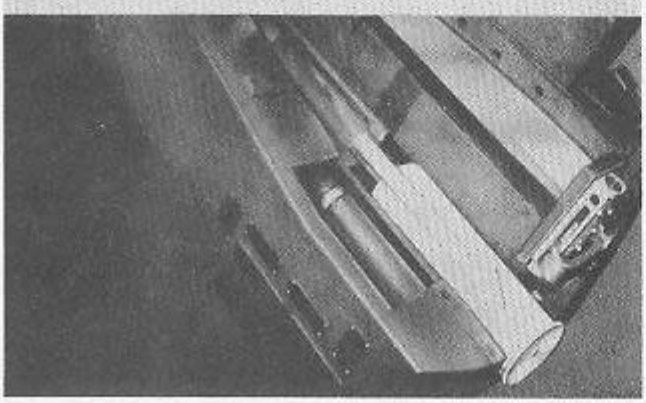
Between the recoil cylinders within the breech housing is the counterrecoil system. This system consists of a compressed air chamber in which is seated the counterrecoil plunger. The counterrecoil system has three functions; first, as the housing comes aft in recoil, the air chamber rides over the plunger further compressing the air in the chamber. This action absorbs part of the energy of the gun's recoil; second, when the recoil movement has been stopped, the compressed air returns the breech housing and gun barrel to battery operating the gun assemblies automatically; third, it holds the gun "in battery".



The compressed air tends to force the plunger out of the chamber. The plunger is secured against the slide rear plate. So - the breech housing is forced forward to battery position. The force of the compressed air against the plunger then holds the housing and gun barrel in battery position.

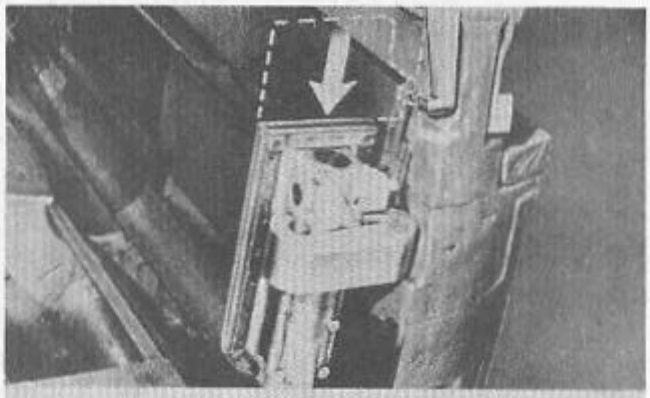


As the breech mechanism is carried forward by the housing in counterrecoil, the breechplug is automatically lowered to open the breech because the operating shaft cam plate engages a toe on the operating shaft crank to rotate the operating shaft. The extractor lips are moved aft sharply to latch the breechplug down in the open position and to extract the fired cartridge case.

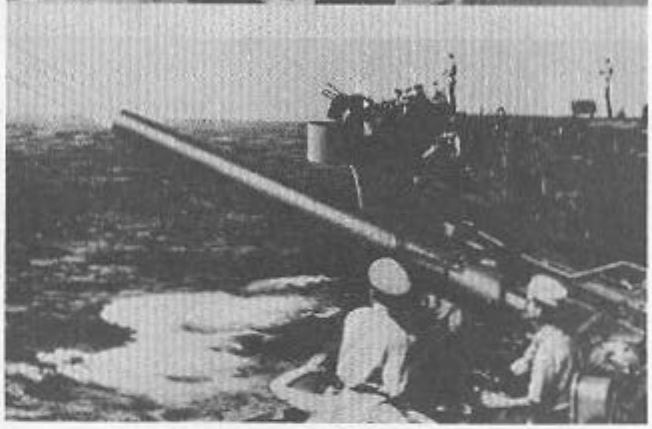


The action of the extractors is so forceful that the case is ejected back over the loading tray and passes out of the gun, riding under the rammer spade.

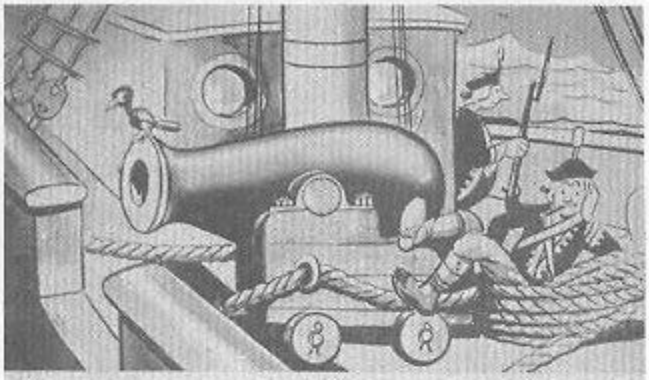
The rammer spade release lever is then tripped. The lug on the lever is withdrawn from under the plunger latch and the rammer spade is forced down to the lower position within the crosshead arm by its spring and plunger. The cycle is thus completed and the gun is ready to receive the next round.



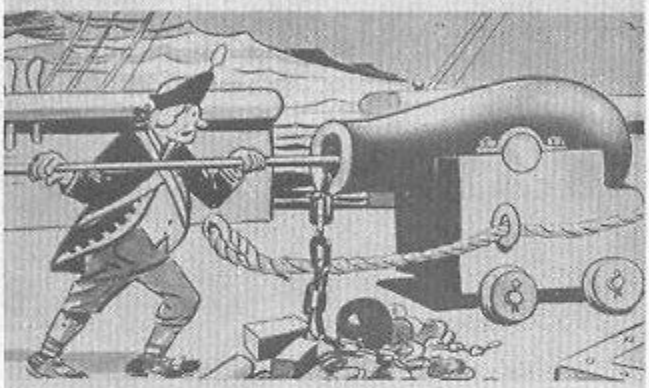
We have seen that the rapid firing rate of the 5"/38 is made possible by all of the gun assemblies working together. The gun is only as good as the sum of its parts: the breech mechanism, the rammer, the recoil system and the counterrecoil system. Each one of these gun assemblies must be kept in good working order if the gun is to fire rapidly and effectively at all times.



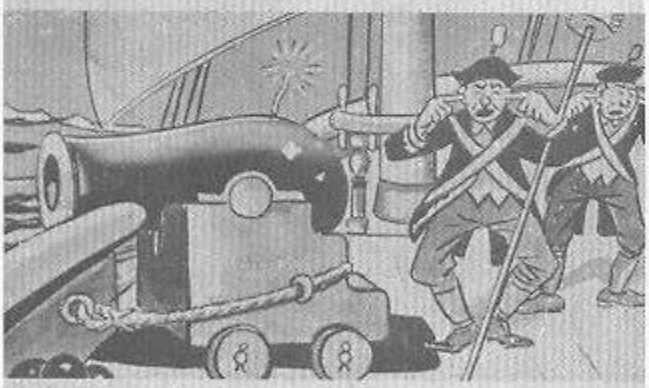
CHAPTER 3—FUNCTION OF THE BREECH MECHANISM



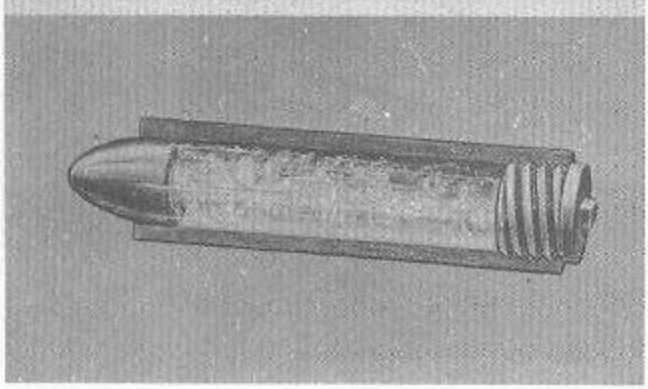
A hundred or so years ago, gunnery was a very simple matter. In those days, a gunner's mate could take life easy, with never a care about devices like breech mechanisms—for the very good reason that there weren't any.



A gun was little more than a piece of pipe that was closed at one end. To load it, you rammed some powder into the muzzle, and followed this up with a common ball or anything else that happened to be lying around.

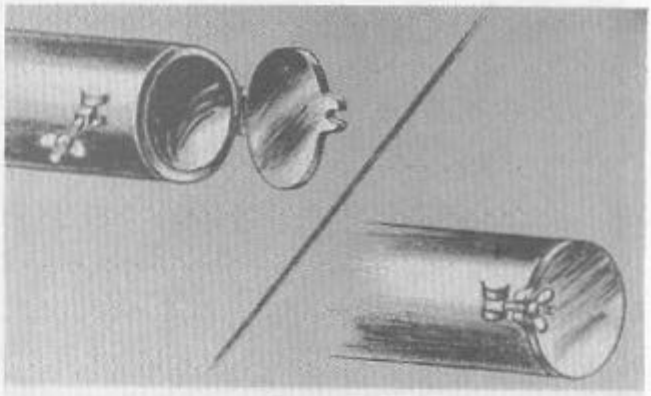


Firing involved striking a flint, lighting a fuse, and waiting until you hear a loud "BOOM"!

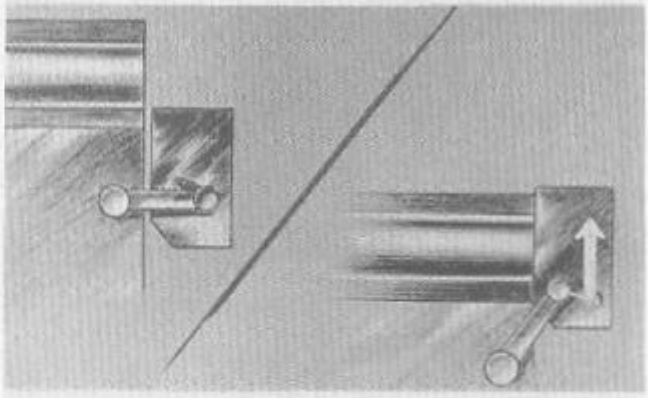


While times have changed and the science of modern gunnery is a far cry from the muzzle loader, the principle of firing is still the same: a charge exploding in a tube that is sealed at one end, so that the expanding gases can escape only by pushing the projectile out thru the open end of the tube.

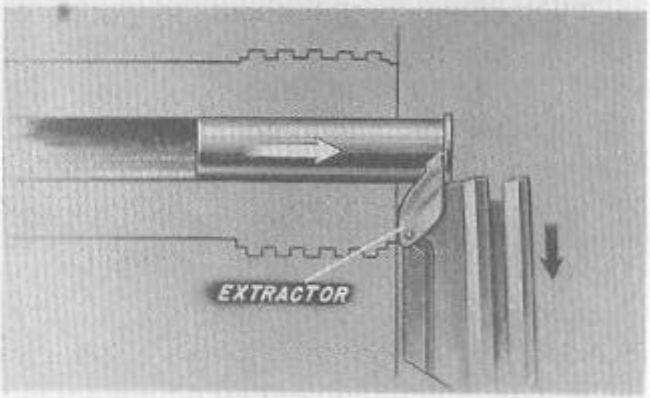
But modern guns are loaded from the after or breech end. This means that this end must be opened to allow the round to be placed in the gun chamber and closed tightly when actual firing occurs.



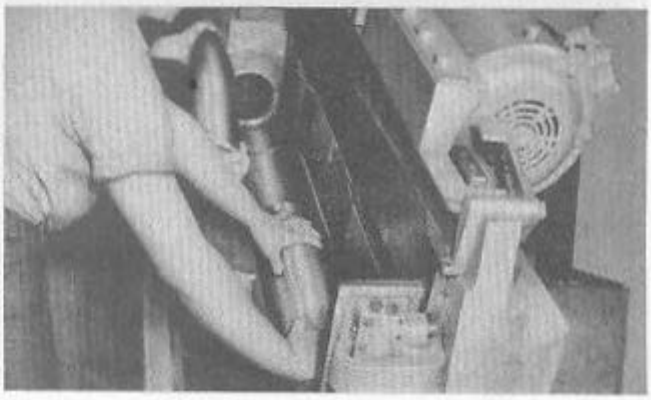
To open and close the breech, a movable plug is required. This plug, and the parts that operate it, are called the breech mechanism.

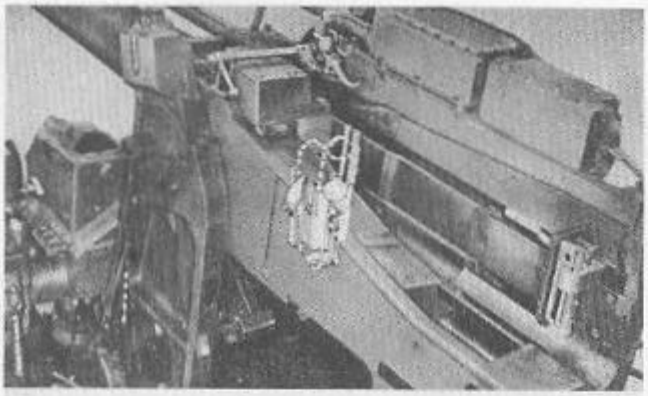


In the case of guns which fire fixed or semi-fixed ammunition, the breech mechanism usually does an additional job: that of actuating the extractors to get rid of the fired cartridge case.

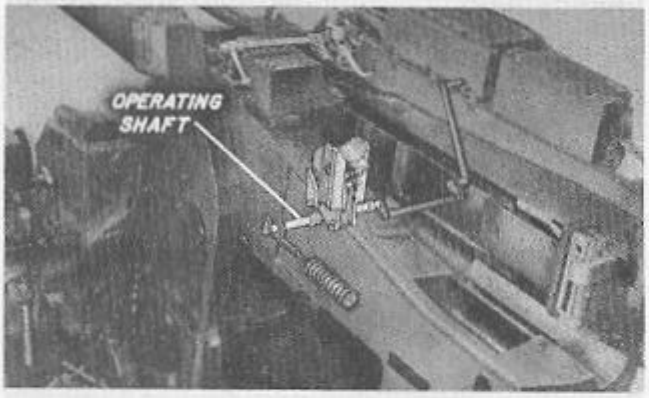


It is evident that the faster the breech plug can operate, the faster ammunition can be loaded and extracted, and the greater will be the gun's rate of fire. The 5"/38 is able to develop an extremely high rate of fire, . . .



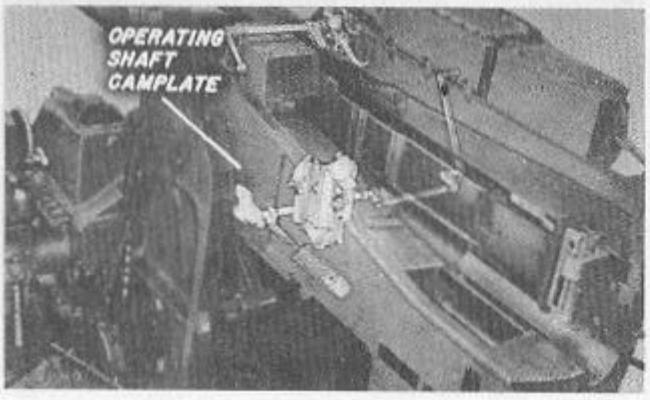


. . .largely because of the rapid and automatic action of its breech plug, which is a vertical sliding wedge that moves up to close the breech, and down to open it and eject the fired cartridge case.



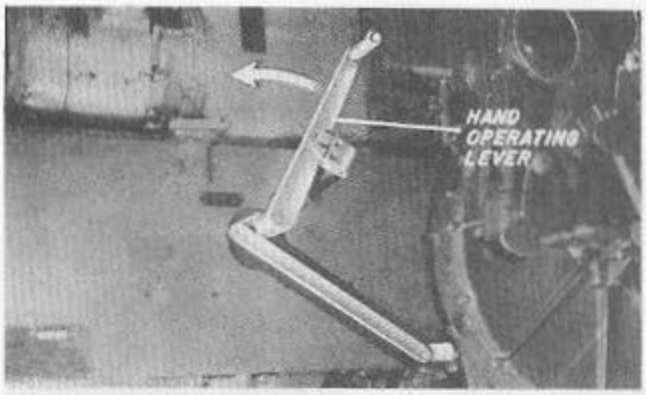
In normal operation the breech mechanism of this gun is automatic. This heart of this mechanism is an operating shaft, secured to the bottom of the breech housing just forward of the breechplug recess. This shaft controls the vertical motion of the plug.

Two parts provide automatic operation. First, an operating spring, secured to the bottom of the breech housing just aft of the operating shaft. This spring rotates the shaft to raise the plug-closing the breech.

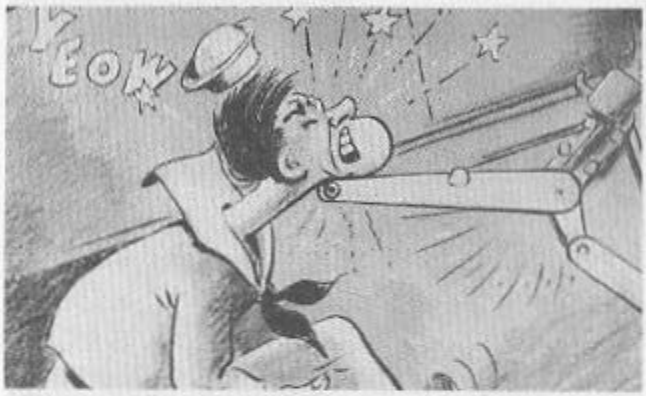


Second, an operating shaft cam plate, secured to the slide. This cam plate rotates the operating shaft to lower the breechplug—opening the breech.

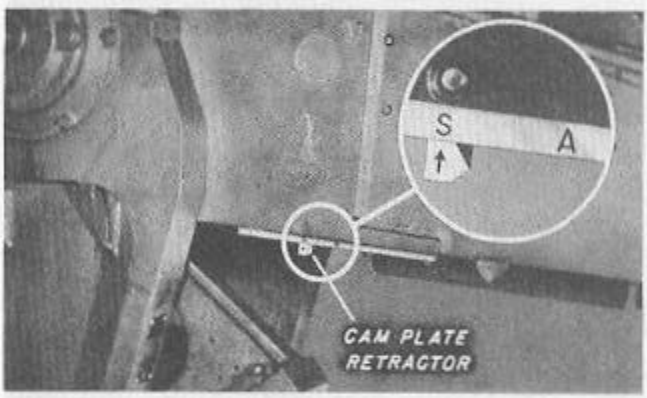
In addition, a hand-operating lever is mounted on the right side of the gun. This lever provides a standby means of rotating the operating shaft manually to open or close the breech. It is used in the event of casualty to the automatic operating parts of the breech mechanism. When the hand-operating lever is used, it is engaged to the operating shaft. Therefore, any rotation of the shaft. . .



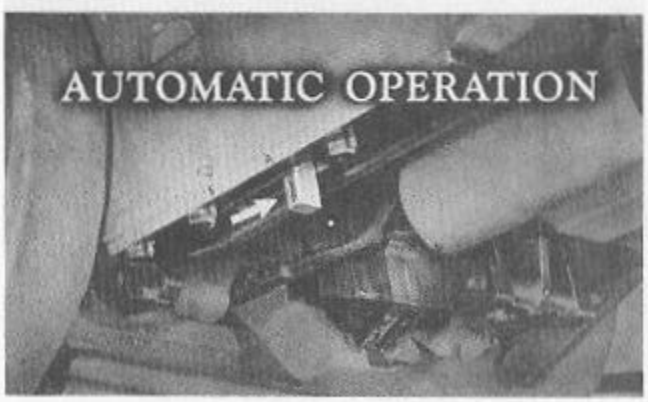
. . .will move the lever. And when this gun moves, it really means business! So - unless you have a cast iron chin, it's a good idea, before using the hand lever, to cut out the automatic features which would rotate the shaft. To prevent the shaft from rotating, . . .



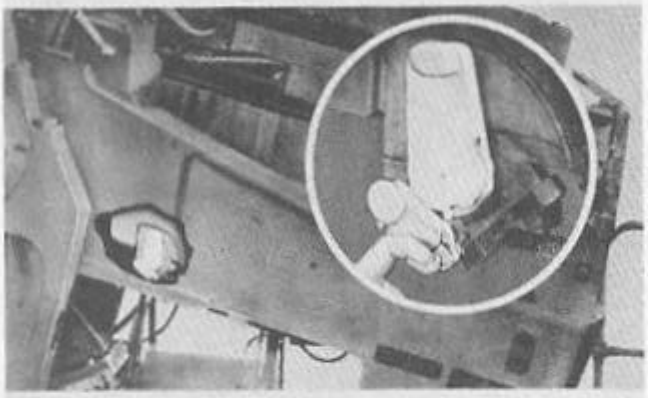
. . .a cam plate retractor is provided to cut out the operating cam plate. To operate the breechplug manually with the automatic features cut out, the retractor should be pushed forward to the "S"—or single fire—operating position. This manual operation, however, is only a standby emergency procedure. The gun will operate more rapidly. . .



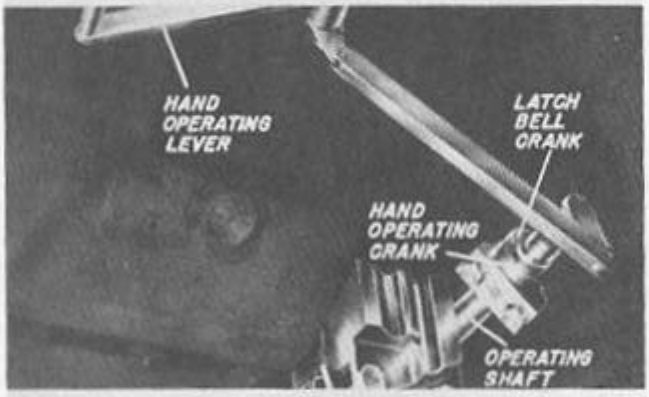
. . .when the action of the breech mechanism is automatic. To study this automatic operation in detail, we set the cam plate retractor to "A"—the automatic operating position.



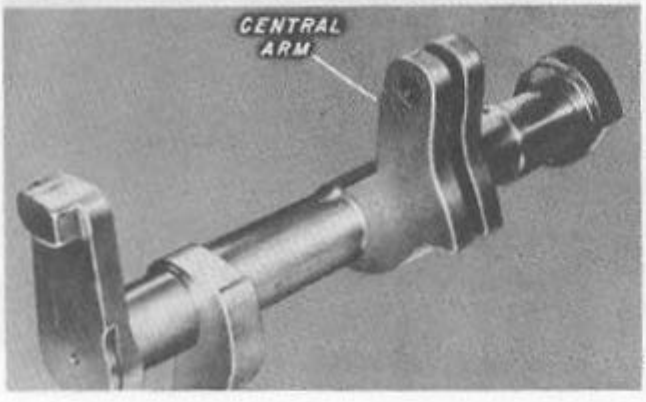
When the ship is not in a combat area—you may find the breech closed. To open the breech to load the initial round, the plug must be lowered manually with the hand-operating lever. But, when you attempt to pull aft on the lever you will find that the breech-plug is locked.



The plug is always locked to close the breech by the "salvo latch". This latch is a safety device that prevents opening of the breech while an unfired round is in the chamber. It must be tripped before the plug can be lowered. After tripping the latch. . .

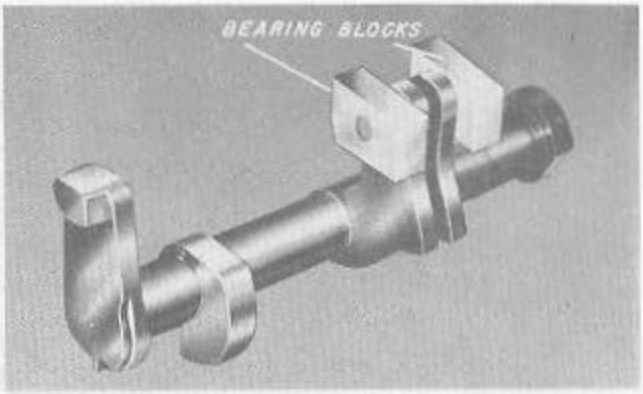


. . .the breech can be opened by the hand-operating lever. This lever, thru linkage, rotates a latch bell crank mounted in the bottom of the right sidewall of the slide. The latch bell crank, in turn, engages the hand-operating crank on the right end of the operating shaft and causes the shaft to rotate. This rotary motion of the operating shaft causes the breech plug to move down in its vertical grooves in the breech housing.

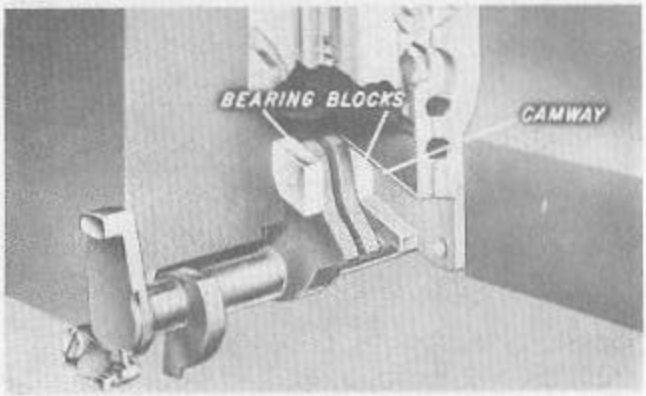


A crank on the shaft, called the "central arm", transforms the rotary motion of the shaft to vertical motion of the breechplug.

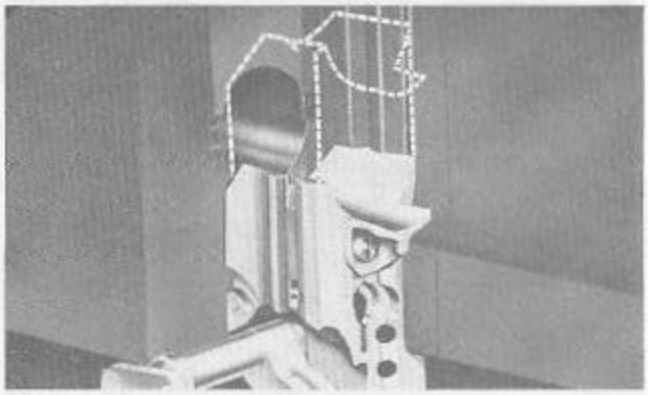
A pin, passing thru the two segments of the central arm, carries two bearing blocks. . .



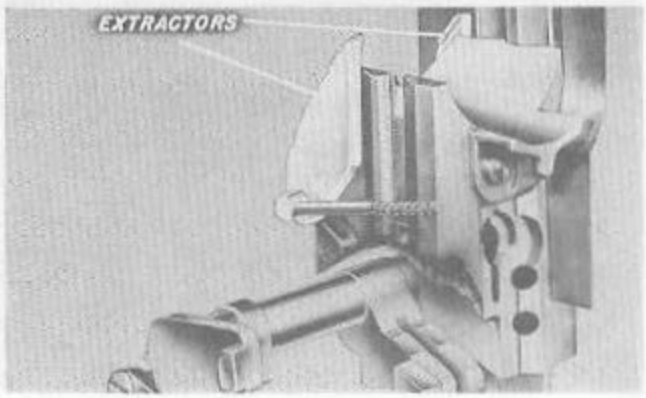
. . .which link the arm to the breechplug. These bearing blocks ride in camways cut in the inner surfaces of a recess in the bottom of the plug. As the central arm is rotated by the operating shaft, . . .

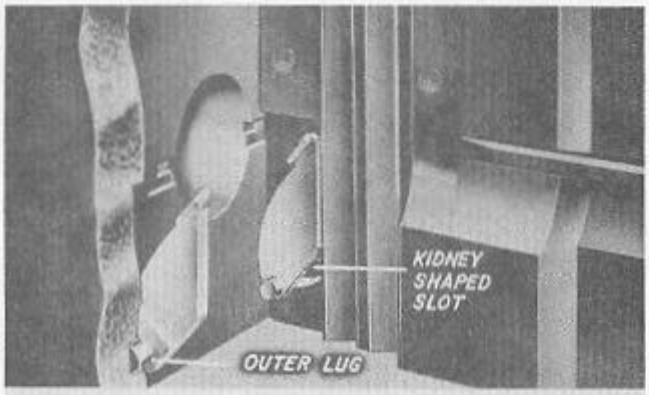


. . .the bearing blocks ride aft and down in the camways. This action cams the breechplug down from the breech closed position to the breech open position shown here. The breechplug is then held in this position. . .

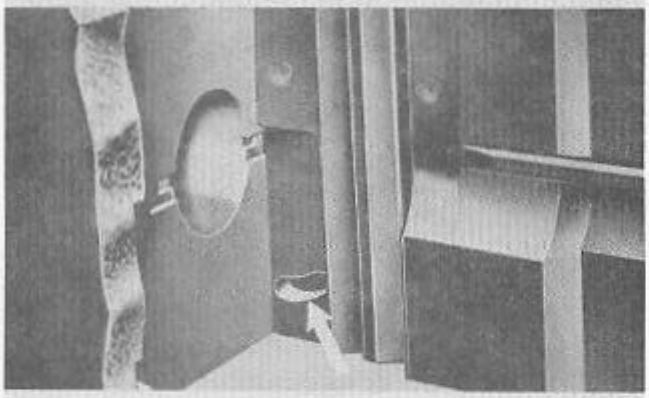


. . .by the extractors, which are located in the recesses in the breech housing at either side of the breechplug. The extractors have two functions: to hold the breechplug in the lowered position so that the round can be rammed into the chamber; and to extract and eject the fired cartridge case. Let's see how the extractors hold the breechplug.

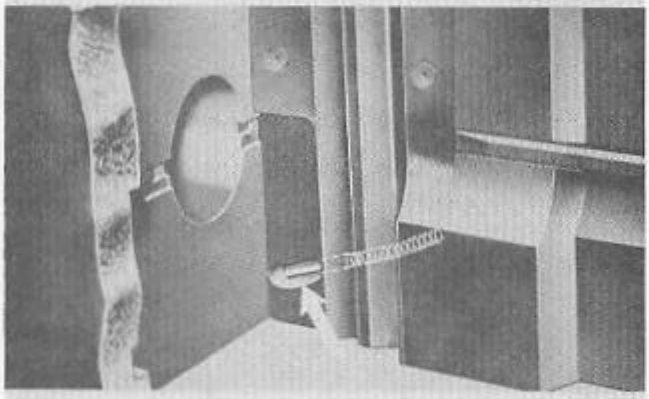




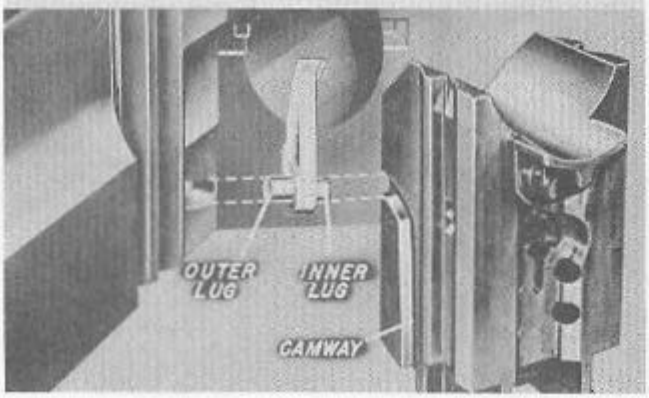
In this cutaway view we have removed the breechplug to show how the extractors are seated in recesses cut into the breechplug guide plates. An outer lug on each extractor slides in a kidney-shaped slot in the guide plate.



With the extractor removed we can see more clearly the kidney-shaped slot in the right breechplug guide plate. The extractor outer lug rides fore and aft in this slot.

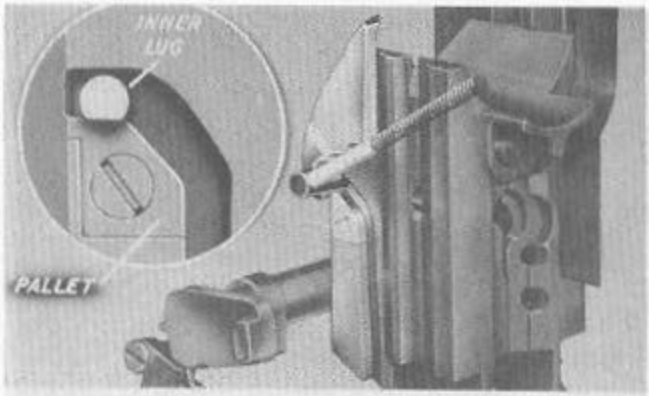


A hole is bored in each guide plate extending diagonally upward from the after end of the slot. A spring loaded plunger is mounted in this hole in order to hold the extractor outer lug in the forward position in the slot.

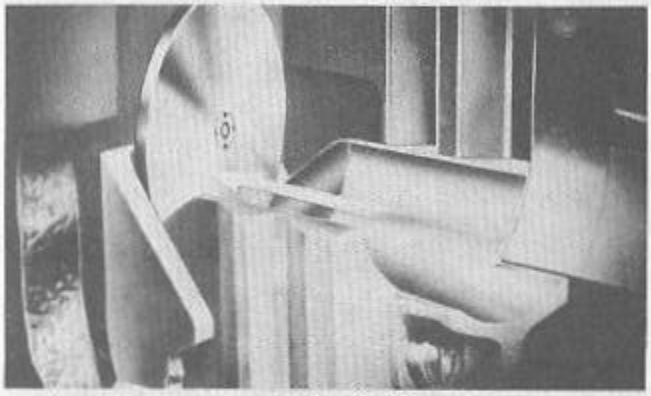


Here we can see more clearly the relation of the extractor to the breechplug. Whereas the outer lug rides in the kidney-shaped slot in the guide plate, the inner lug on the extractor rides in a camway cut in the side of the plug. When the plug is lowered, . . .

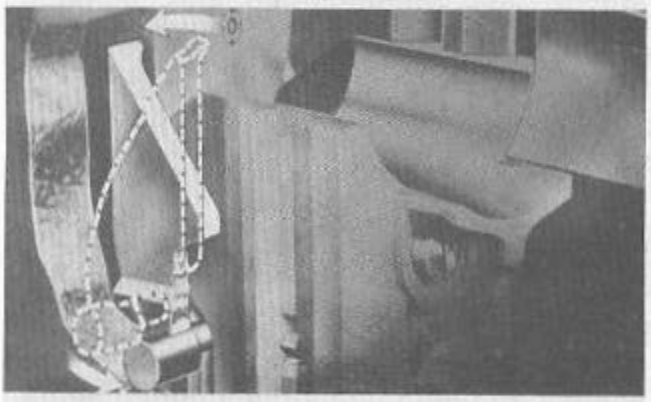
. . .the bottom of the extractor is pushed forward by the pressure of the spring on the outer lug. The inner lug is pushed forward through the horizontal portion of the camway until a flat surface on the bottom of the inner lug seats on the flat surface of the pallet which forms the bottom of the horizontal part of the camway. This contact holds the breechplug down.



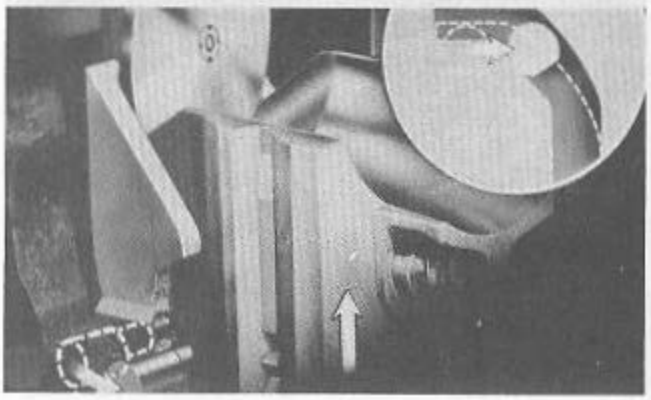
The breechplug is released when a round is rammed into the chamber, because the rim of the cartridge case engages lips at the top of the extractors. The extractor lips are thus moved forward. . .

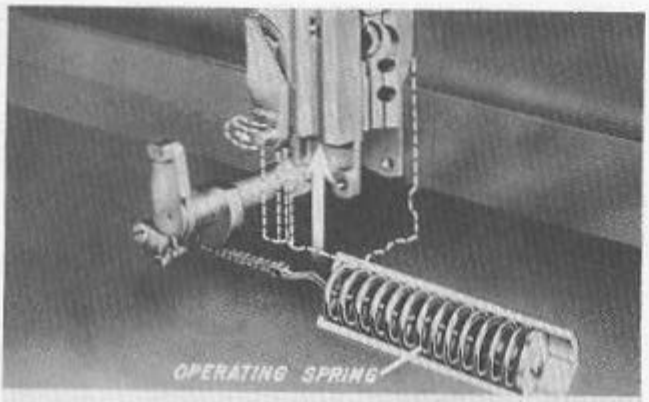


. . .and rock the extractors to unlock the breechplug so that it can be moved up by the operating spring to close the breech.

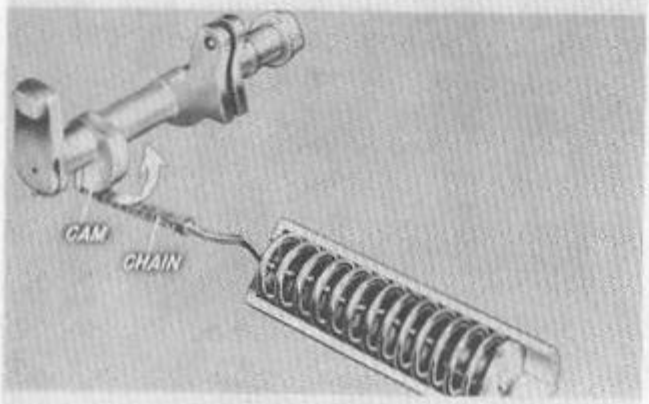


This rocking motion moves the bottom of the extractor aft. This in turn moves the inner lug aft in the breechplug camway, and the plug is released when the inner lug rides off the flat surface of the pallet.

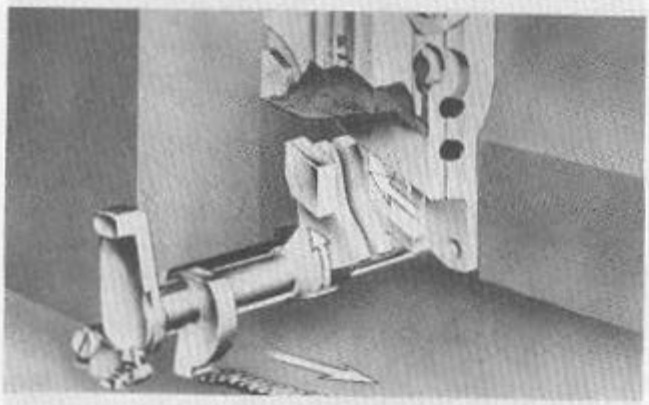




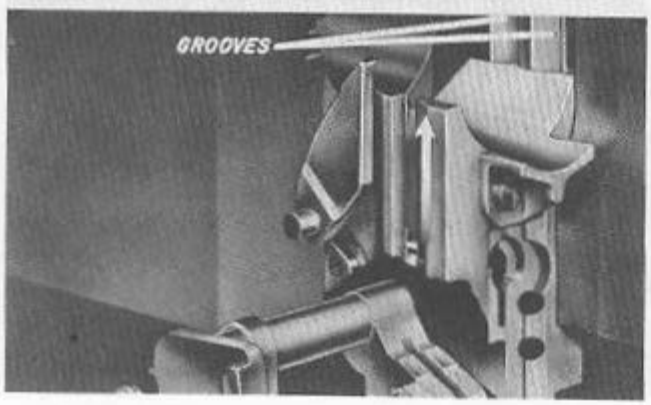
The breechplug can now be moved up by the action of the operating spring. This spring is compressed every time the breechplug is lowered.



The operating shaft is rotated because the force of the compressed spring is transmitted thru a rod and chain to a cam on the operating shaft.

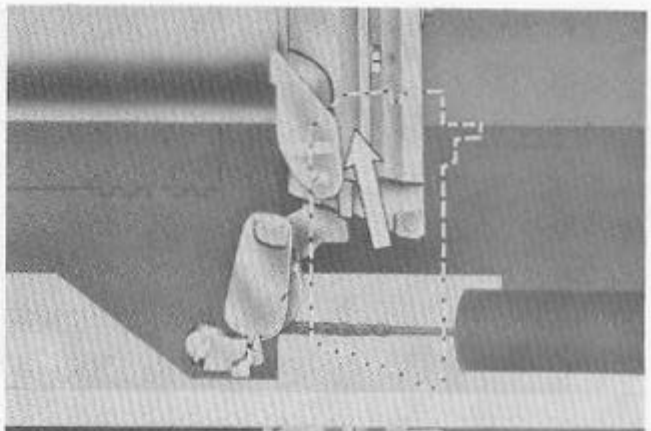


When the shaft rotates, the cam action of the bearing blocks raises the breechplug.

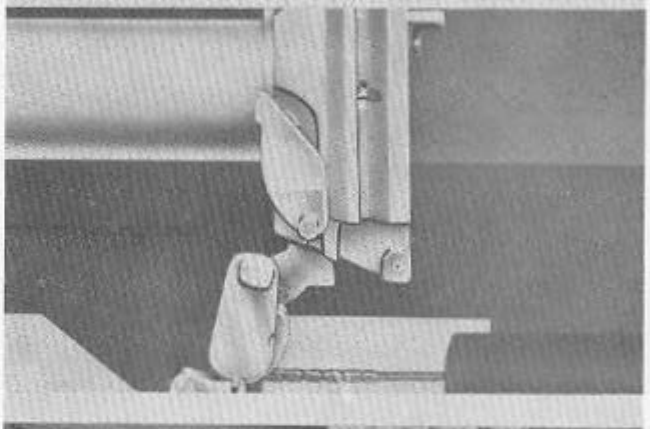


We mentioned earlier that when the gun is fired, the breech must be completely sealed. For this reason the grooves in the breech-plug guide plate have a slight forward tilt, and, as the plug is raised, . . .

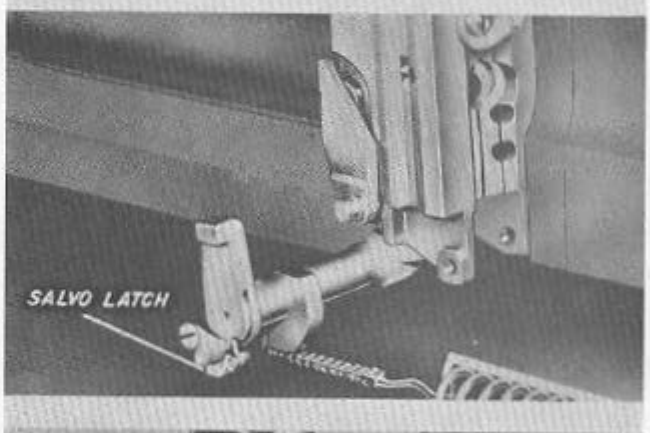
. . .the inclination of the grooves forces the plug slightly forward. This forward motion of the plug. . .



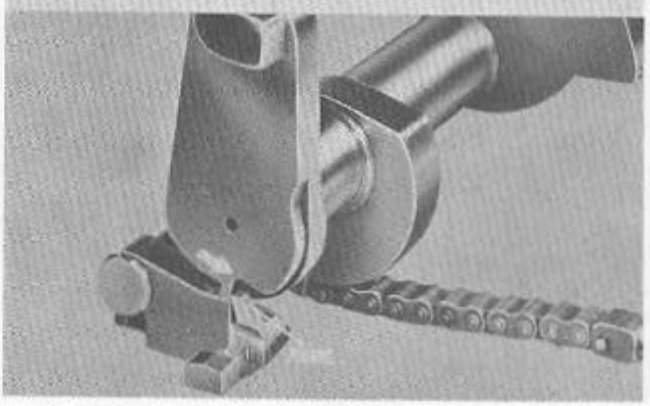
. . .wedges the cartridge tightly into its seat in the gun chamber to seal the breech. You can see now why this plug is called a "sliding wedge" type.

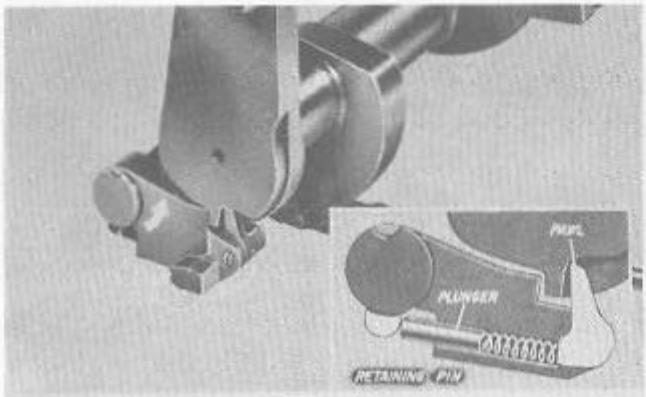


The breechplug must be securely locked to prevent the breech from being opened until the gun is fired. This locking is done by the salvo latch, which prevents rotation of the operating shaft after the breech has been closed.

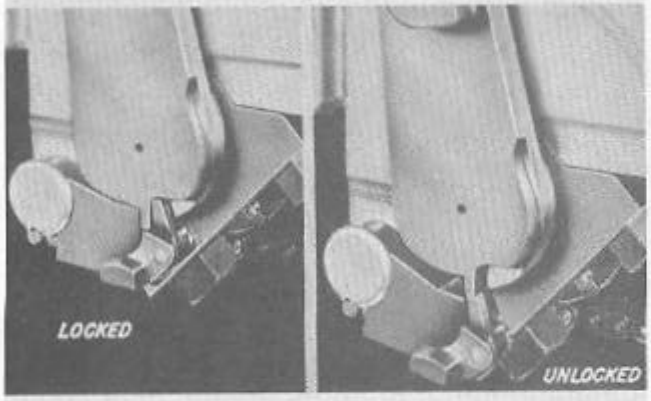


The latch locks the operating shaft by engaging a lug on the bottom of the operating shaft crank. As the operating shaft crank completes its rotation in closing the breech, this lug engages a pawl on the salvo latch. . .

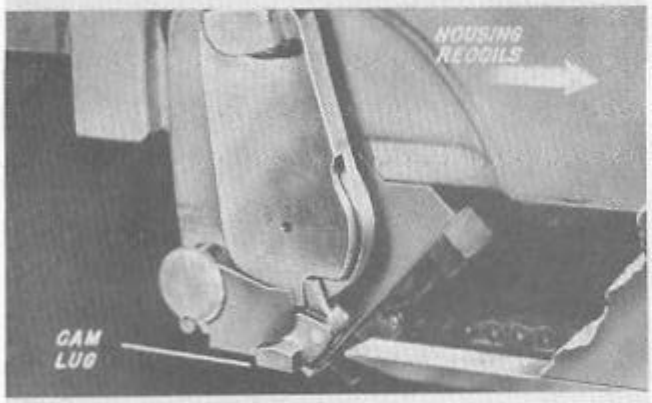




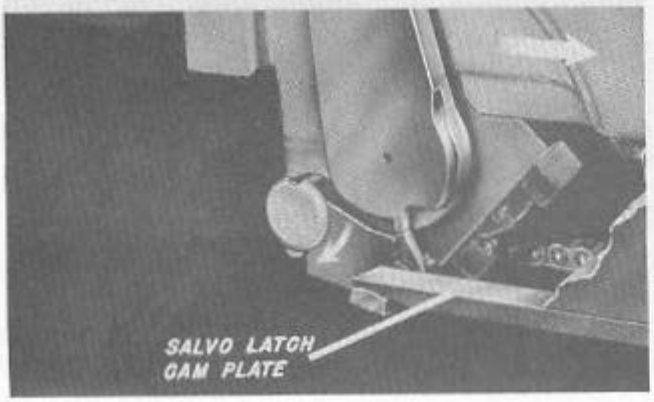
. . .and pushes it open, so that the salvo latch can spring up to engage the lug. In the insert we have cut away the salvo latch to show the spring which moves it up. This spring is held in compression between the salvo latch pawl and a plunger which bears against a retaining pin secured to the breech housing. The spring is always tending to move the salvo latch up and to close the pawl.



This pawl is provided so that the salvo latch can be disengaged to permit breech opening after the gun is fired. When the breech is locked, the pawl is pushed open, so that the salvo latch can engage the lug on the crank. But, once the salvo latch is unlocked, the pawl is snapped closed by the spring to prevent the latch from locking before the gun is again loaded.

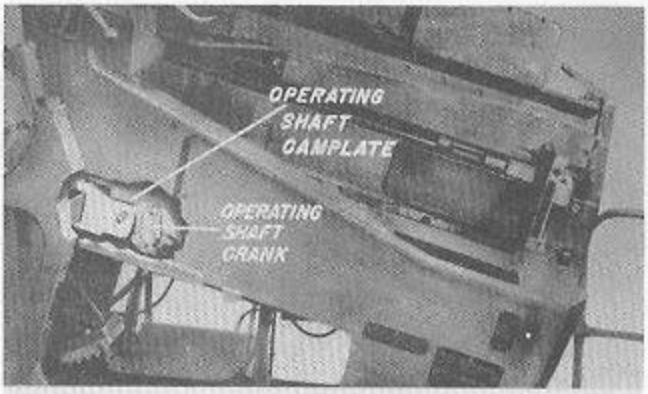


The salvo latch is unlocked after firing because the entire breech mechanism is carried aft as the housing recoils. During this motion, a cam lug, on the salvo latch. . .

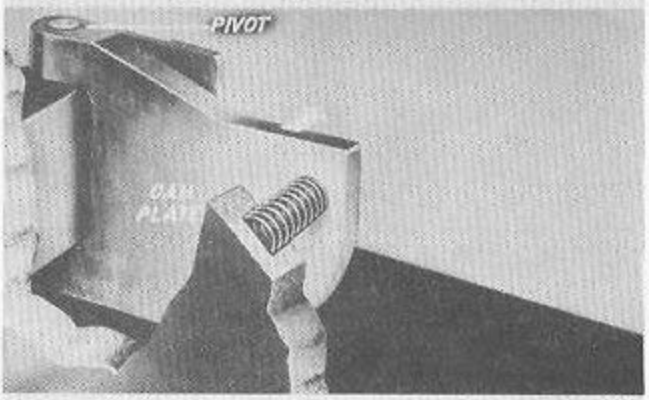


. . .rides under the salvo latch cam plate which is attached to the sidewall of the slide. The cam plate forces the salvo latch down to the unlocked position and the pawl snaps closed to keep the latch unlocked. . .

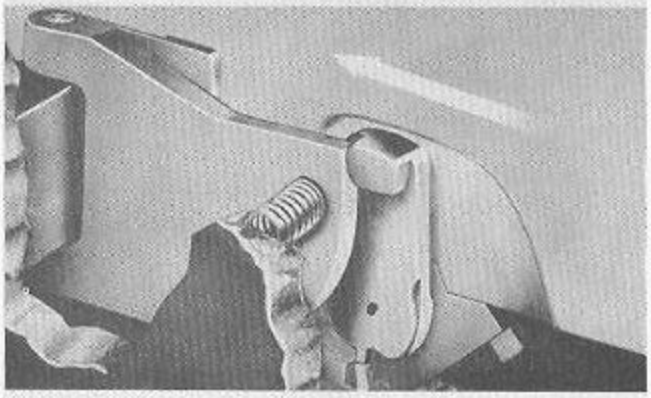
. . .so that, in automatic operation, the breech can be opened during counterrecoil and can then be locked again as soon as the gun is loaded. The opening of the breech is done by the action of the operating shaft cam plate, mounted on the slide sidewall, which rotates the operating shaft crank to lower the breech-plug.



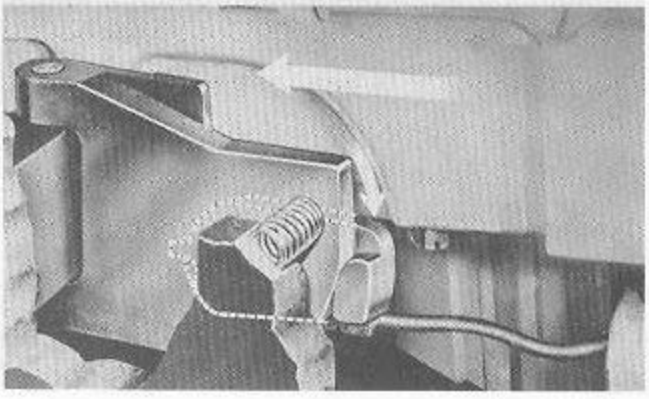
The forward end of this cam plate is pivoted on a bracket secured to the sidewall of the slide. The after end of the cam plate is normally held inboard by a spring.

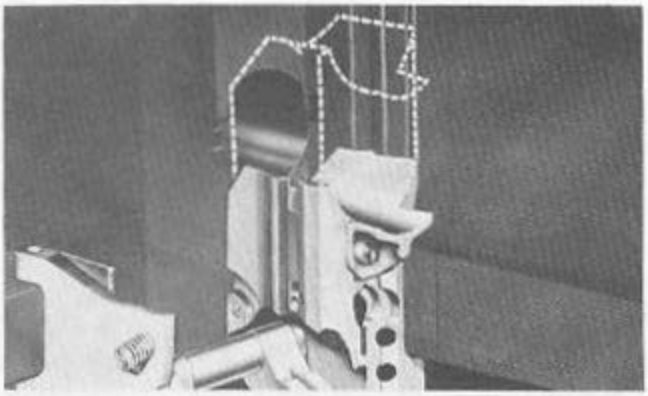


As the operating shaft crank is carried forward by the breech housing during counterrecoil, the toe on the crank is engaged by the rear surface of the operating shaft cam plate.

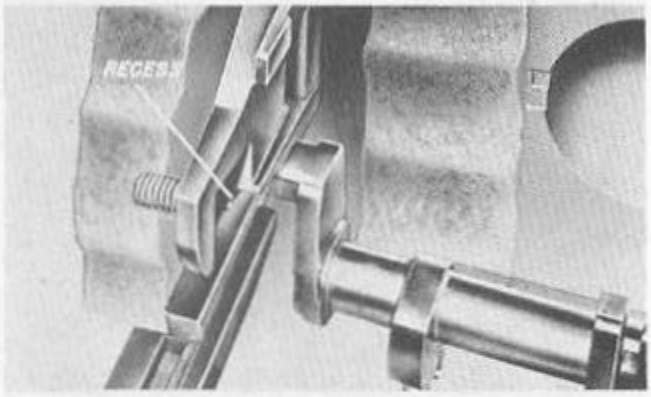


The operating shaft crank is thus rotated because its toe is cammed aft and down by the cam plate.

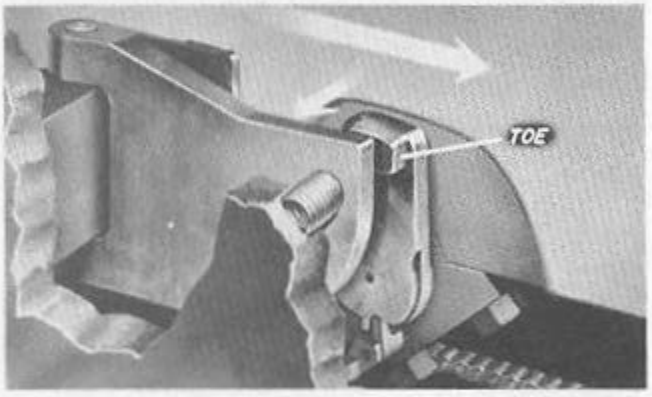




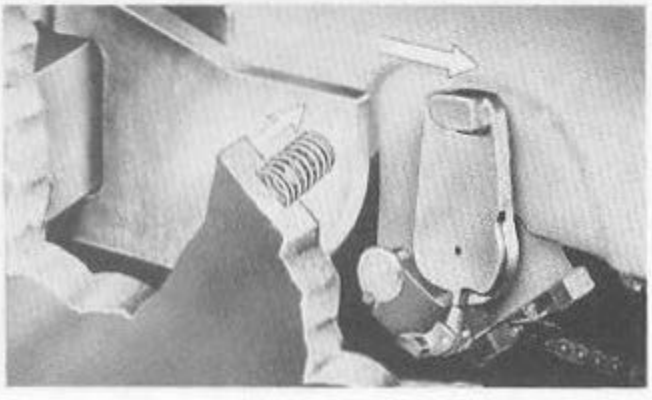
The crank in turn rotates the operating shaft and the breechplug is cammed down by the bearing blocks. For the breechplug to be raised to close the breech on the next cycle, the operating shaft and its crank must rotate. In this view, it would appear that the operating shaft crank is held down because its toe is engaged under the operating shaft cam plate.



But, actually, as we can see by looking from the rear at this expanded view, a recess is cut in the inner surface of the operating shaft cam plate. The toe on the operating shaft crank rides up through this recess as the breechplug is raised.

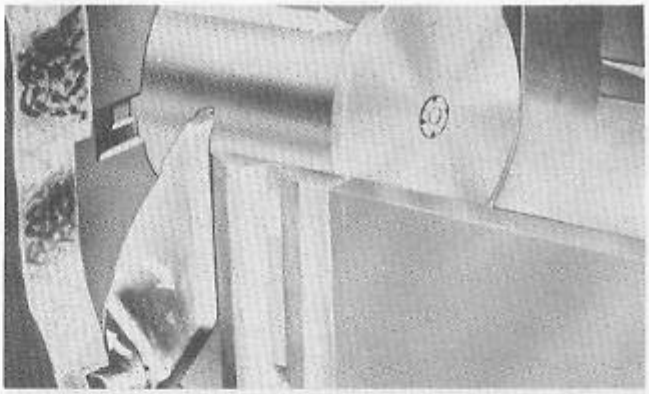


As the operating shaft is carried aft by the breech housing in recoil, the toe on the crank rides past the cam plate, forcing it outboard against the pressure of its spring.

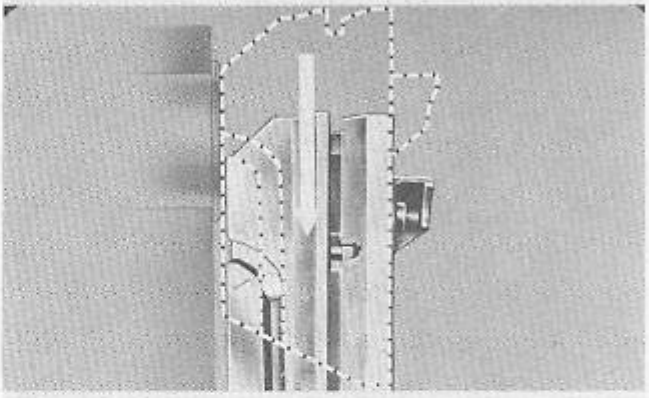


Then, after the crank has ridden past, the cam plate is returned to its normal position by the spring.

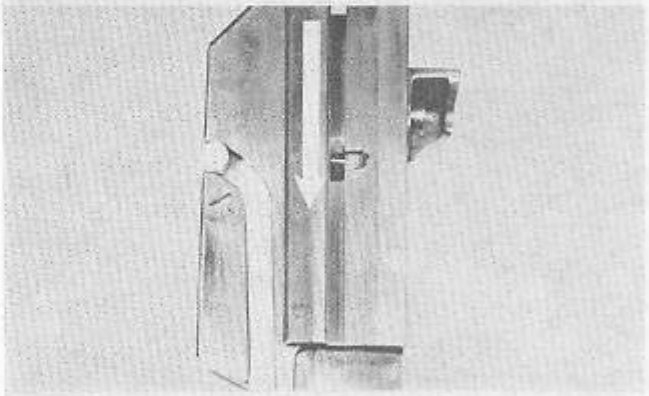
We mentioned earlier that the extractors have two functions. We have already seen how they latch the breechplug in the open position. Let's now observe how they extract and eject the fired case. As the breechplug is lowered, the extractors are rocked so that their lips are moved aft to extract and eject the fired cartridge case.



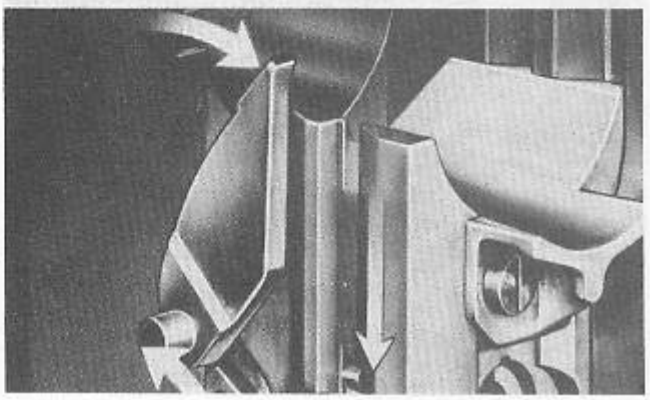
You will remember that the inner lug of each extractor rides in a camway on the breechplug. As the plug is lowered this camway is moved down, riding over the extractor inner lug.

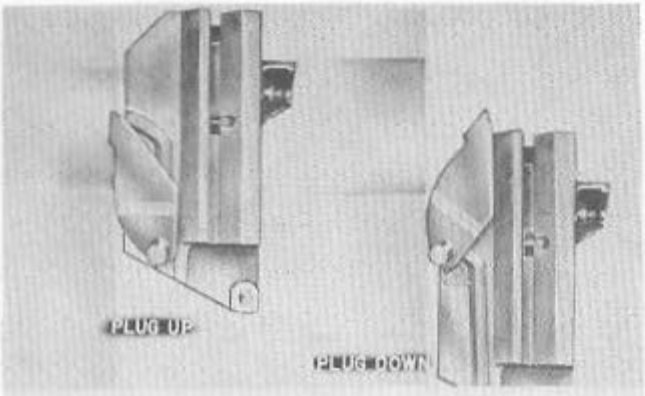


When the curved portion of the camway hits this lug, the lug is forced forward. . .

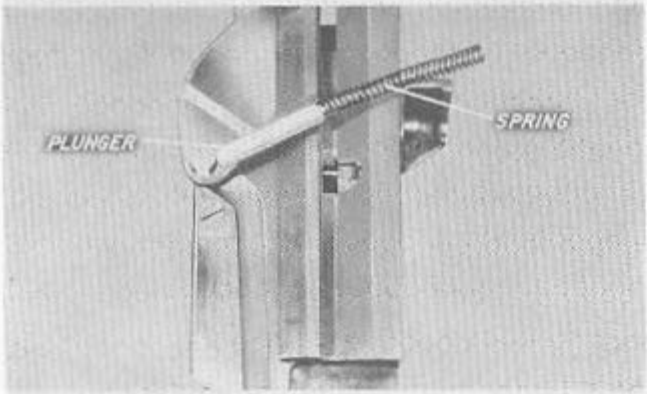


. . .and rocks the extractors on their forward curved faces so that the lips are moved aft. Note that, whereas the breechplug has vertical motion over the extractor lugs, the extractor lugs themselves have a horizontal motion only.

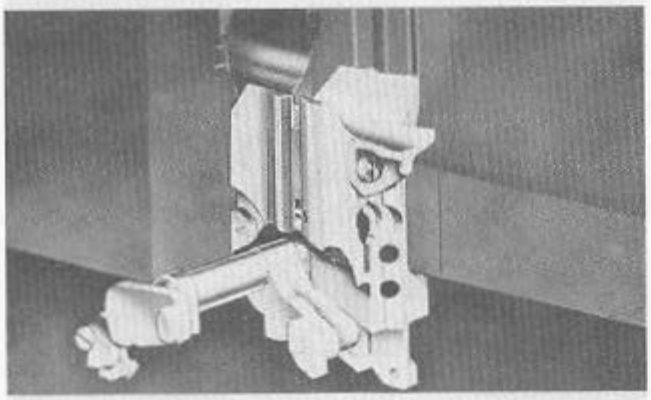




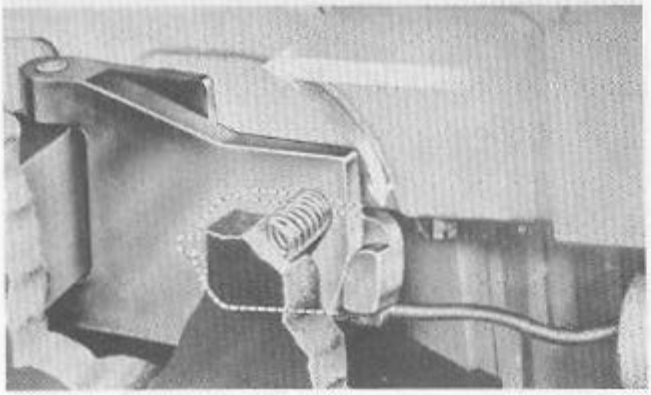
With the breechplug up, the extractor lips are forward and the extractor lugs are aft. With the breechplug down, the extractor lips have moved aft to extract and eject the fired case, and the extractor lugs are forward. The inner lugs seat on the flat surface of the pallet in the breechplug camway. The lugs are held forward in this position. . .



. . .by the extractor plunger and spring.

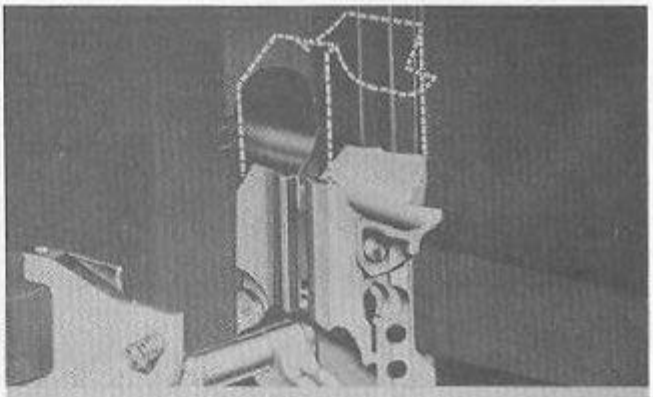


The breechplug is thereby held down in the open position. We have now extracted the fired cartridge case, and the gun is ready to be loaded to start the next cycle.

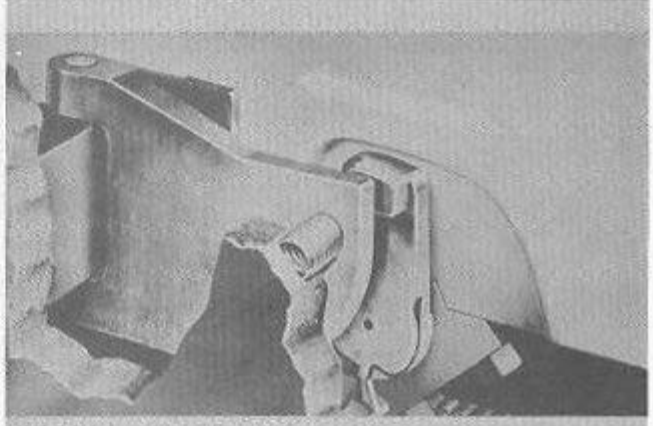


We have seen how, in automatic operation, the toe on the operating shaft crank is engaged to cam this crank down during counterrecoil.

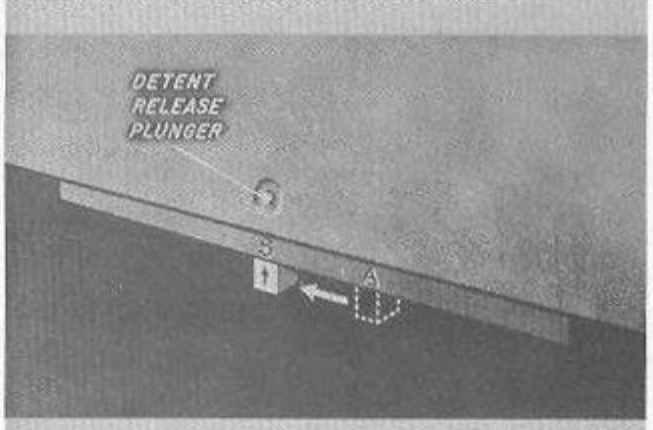
This action rotates the operating shaft to cam the breechplug down to the open position by the action of the bearing blocks.



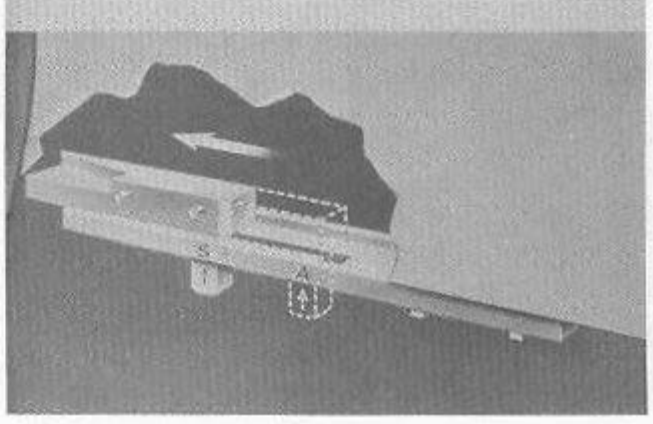
In the event of casualty to the operating spring, it is sometimes necessary to operate the breech mechanism manually. To do this, we know that all the automatic features must be cut out. In other words, the operating shaft cam plate must be held outboard to allow the crank to clear it, during counterrecoil.

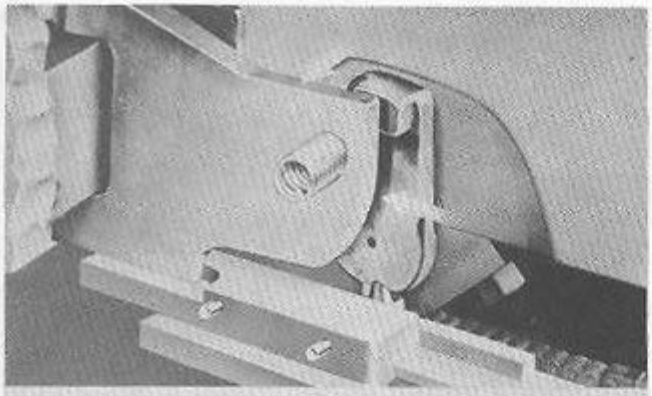


To cut out the operating shaft cam plate, first push in the detent release plunger to free the cam plate retractor.

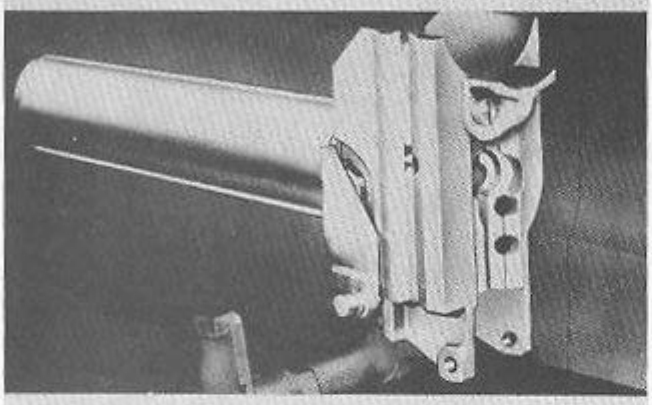


Then, set the retractor to "S"—the single fire operating position. The cam plate retractor is seated in a slot in the salvo latch cam plate. When the retractor has been pushed forward to the "S" position, . . .

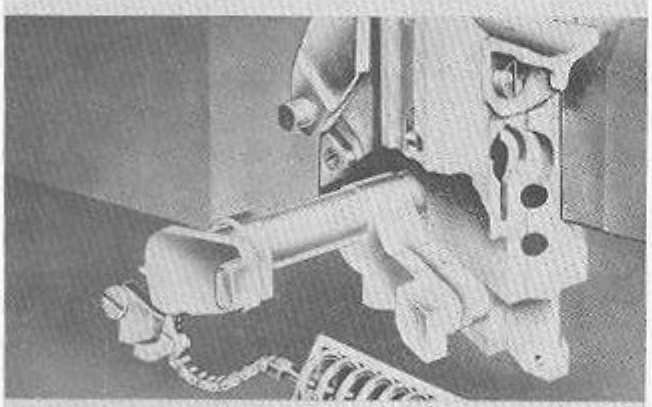




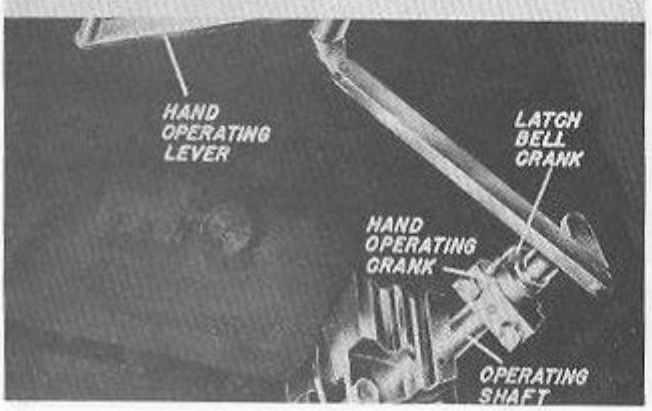
. . .a cam surface cut into the top of the retractor engages the cam plate and cams it outboard. Then as the breech housing comes forward during counterrecoil, the toe on the operating shaft crank will bypass the cam plate. The gun will thus arrive in battery. . .



. . .with the breechplug still in the closed position. Since the breech must now be opened manually, we have single fire operation.

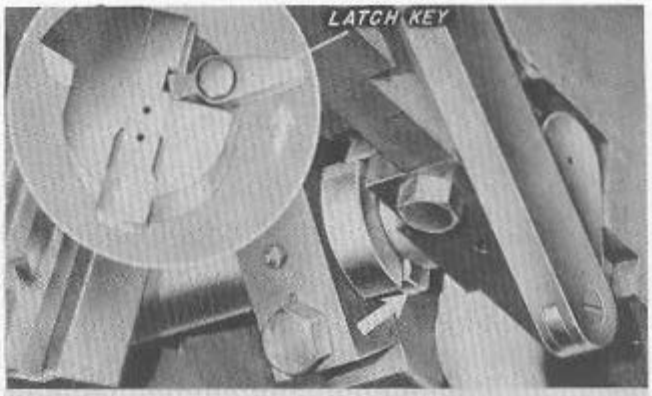


In the event of casualty to the operating spring, the breech can also be closed manually with the hand-operating lever.

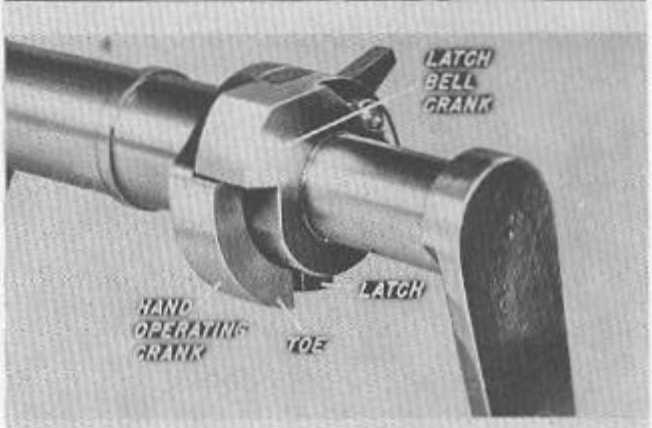


To close the breech manually, first pull the hand-operating lever all the way aft. This lever is connected by linkage to the latch bell crank. Normally, this latch bell crank can rotate the hand-operating crank on the operating shaft only to open the breech. To engage this latch bell crank so the hand-operating crank can be rotated to close the breech. . .

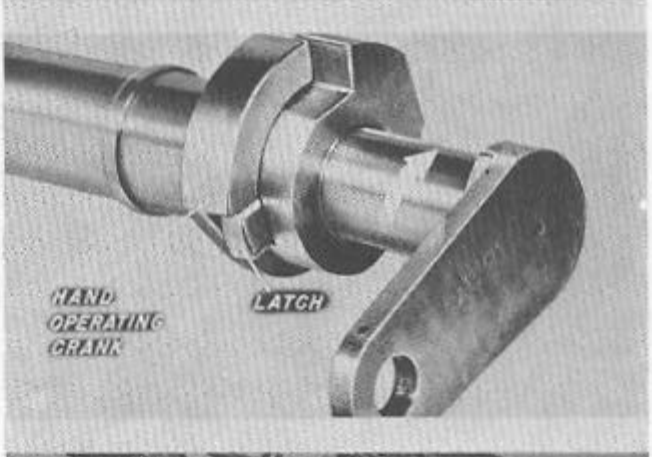
. . .the hand-closing latch key must be pushed up. This latch key is located on the latch bell crank. Pushing up the key moves the hand-closing latch down to the position we see here. The latch now projects beyond the surface of the latch bell crank.



Looking now at the hand-operating crank, we see that the projecting latch on the latch bell crank engages a toe on the hand-operating crank.

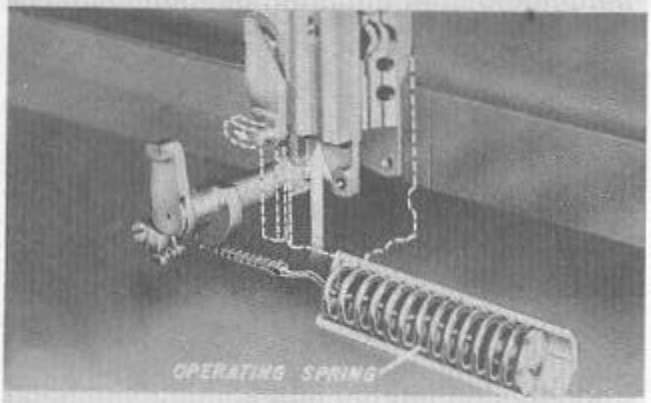


The hand-operating lever rotates the latch bell crank, as the arrow indicates. The hand-closing latch, pushing against the hand-operating crank, will rotate the operating shaft.



This, in effect, locks the hand-operating lever to the operating shaft, so that the breech may be opened and closed manually.

This breech mechanism is machined to extremely close tolerances. Dirt, burrs, or foreign matter getting into these parts can easily stop the action of the mechanism. Care should be taken to keep these surfaces clean and well lubricated, to prevent casualties.



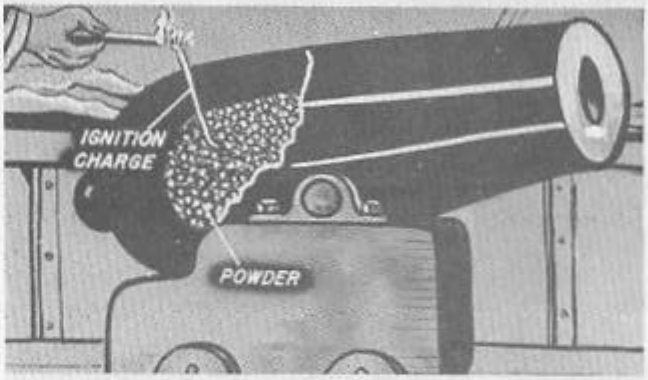
In combat areas it is common practice to keep the breech plug lowered, ready for immediate action. This may weaken the operating spring. To prevent casualties resulting from failure of the breech mechanism to close the breech by reason of a faulty operating spring, the tension of the spring should be tested and adjusted regularly.

The breech mechanism of the 5"/38 gun is designed to provide a high rate of fire. To get this high rate of fire, it is vitally important to maintain this mechanism so that it will operate without casualty. Remember, this gun can be no more efficient than its breech mechanism.

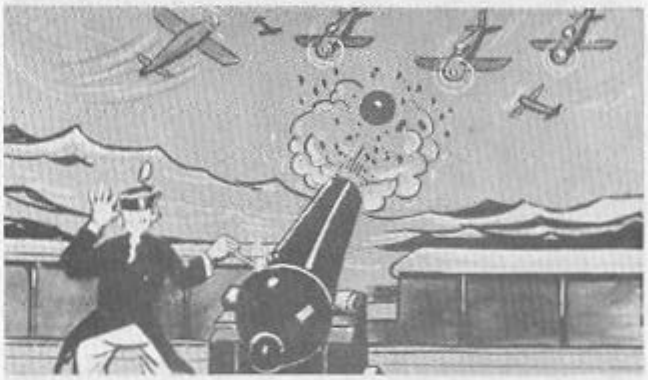
CHAPTER 4—FUNCTION OF THE FIRING MECHANISM

To fire any gun, the powder must be heated to the point where it will burn. In this distinguished ancestor of the 5"/38 an igniting charge, in the form of a powder train or fuze, was inserted through a hole at the breech end of the gun.

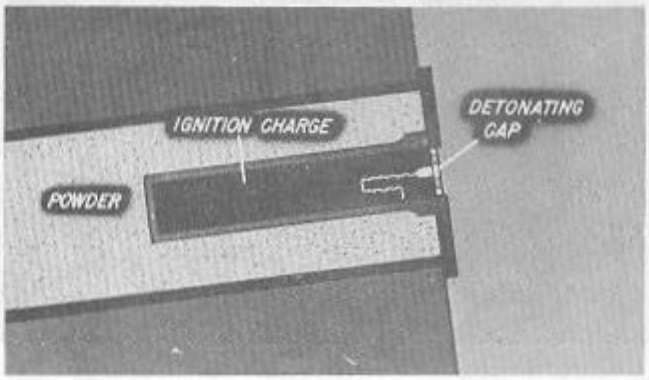
When this igniting charge was lit with a torch, it heated the powder to make it burn. Of course, waiting for the fuze to burn down took a little time, but since the enemy could move no faster than the wind in his sails would carry him, time was fairly plentiful.

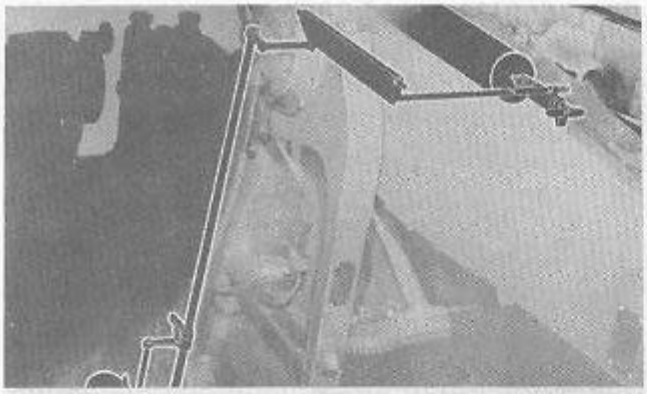


In modern war, where split seconds count, the firing system of the muzzle loader would be sadly inadequate. Today we are confronted with superspeed targets, which demand extremely rapid and accurate firing from our guns. While the principle of firing may not have changed since the days of the muzzle loader, we've certainly advanced in our application of this principle. As an example...

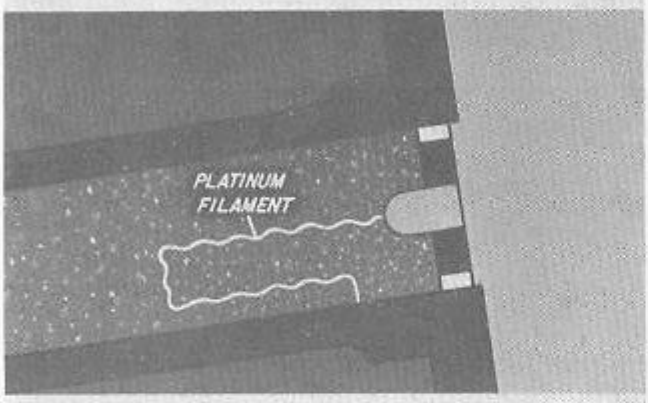


...let's look at a modern 5-inch cartridge. First, we see that the powder-igniting elements are combined in one compact unit called the primer. The primer contains a superspeed igniting charge and a detonating cap which, when struck, will explode and set off this igniting charge.

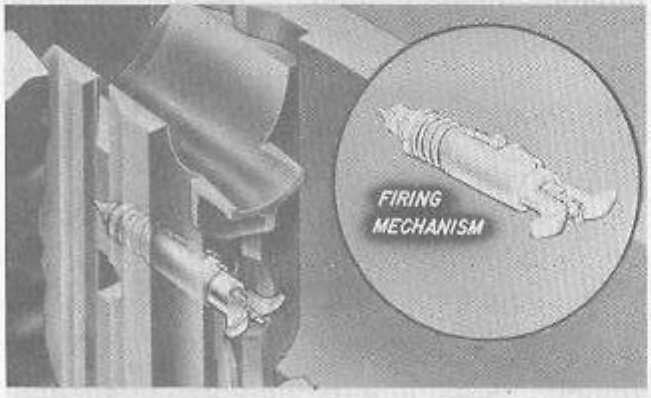




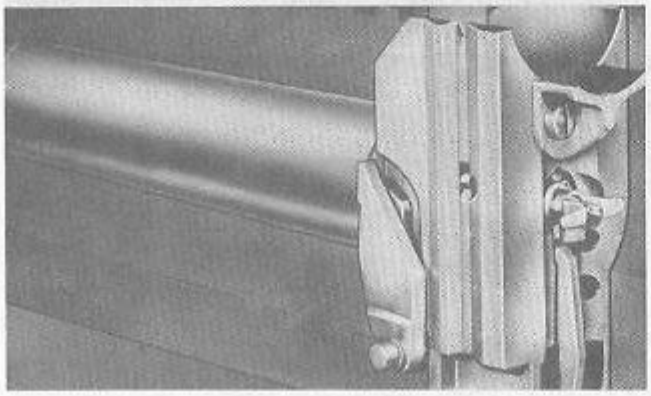
But, while the detonating cap explodes instantaneously, the mechanical action of the parts which cause this cap to be struck takes time. So, for even faster firing of this cartridge, we make use of the most rapid impulse known to man: . . .



. . .Electricity. Looking more closely at the primer, we see a thin platinum filament which, when an electric current passes through it, becomes heated to incandescence and so sets off the ignition charge.

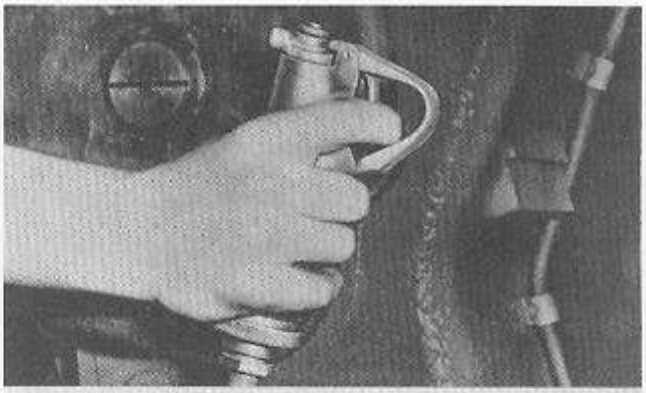


But the construction of the primer is not, by itself, responsible for the ability of the 5"/38 gun to fire rapidly. Equally important is the gun's firing mechanism, a device located within the breechplug, whose job it is to explode the primer and so fire the gun. This mechanism is equipped to fire the gun either electrically or by percussion. Because it requires no time-consuming mechanical action of parts, electrical firing is faster and hence preferable; percussion firing is used primarily as a standby.

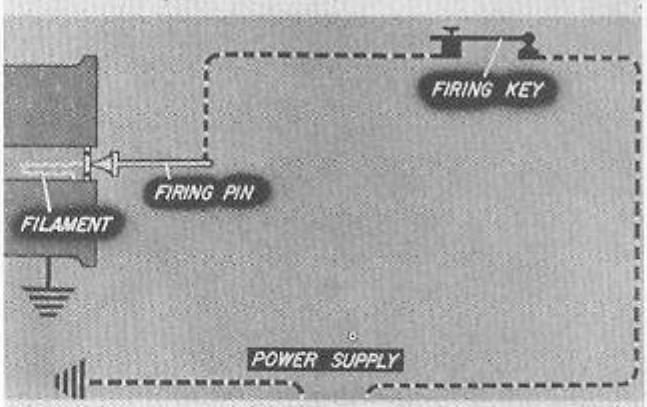


To prevent accidental firing of the gun before the breech is closed, the firing mechanism is mounted in the plug in such a manner that it will engage the primer of the cartridge only when the plug has been fully raised to close the breech securely. When the firing mechanism is in contact with the primer. . .

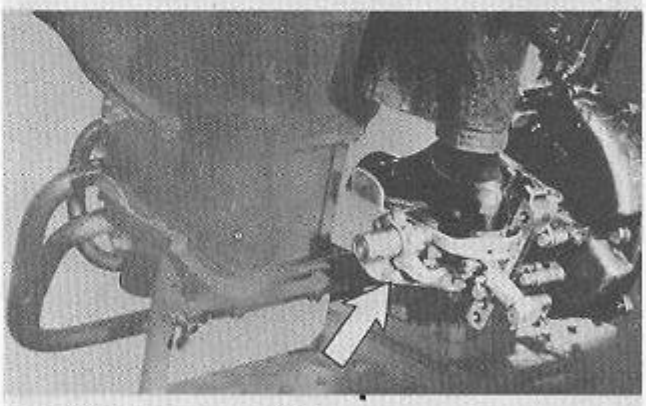
. . .the gun can be fired electrically by closing a key, conveniently located in the right handle of the pointer's handwheels. Closing this key. . .



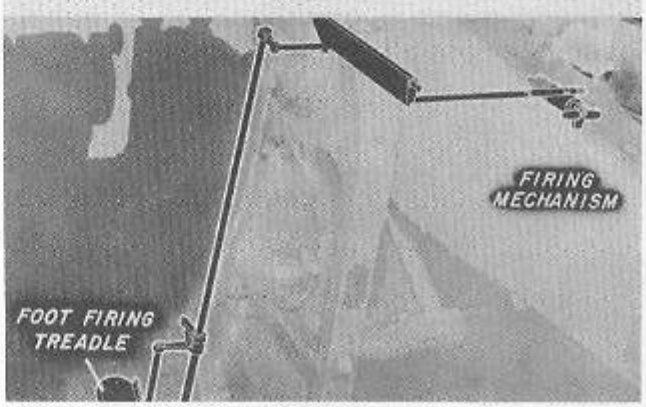
. . .completes an electric circuit. Current from a power supply flows through the firing key and firing pin and through the filament in the primer, instantly heating this filament and detonating the igniting charge. The action is as rapid as turning on a switch to light an electric light. Should the electrical power supply fail. . .

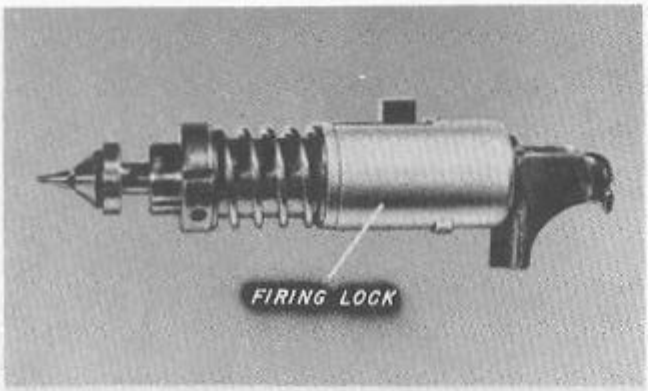


. . .the gun can be fired by the emergency method of percussion, by depressing the foot firing treadle. (It must be pointed out that most of the 5"/38 powder cartridges being supplied to the fleet today are fitted with electrical primers only. Therefore, precussion firing is impossible with these cartrides.)

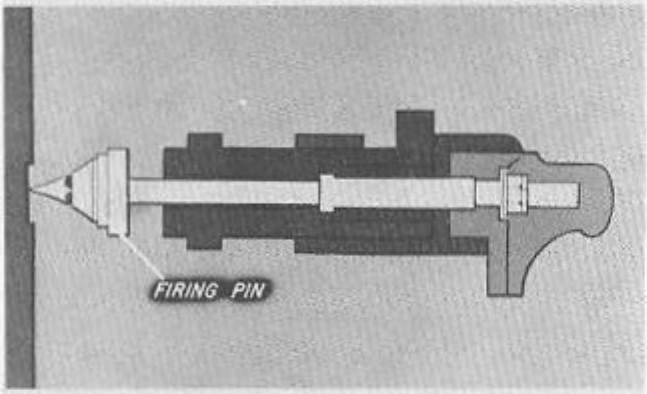


The foot firing treadle, through linkage, releases a hammer action within the firing mechanism, to explode the detonating cap and set off the primer.

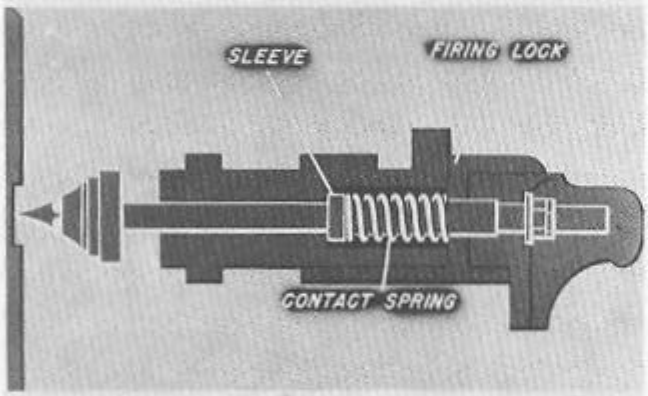




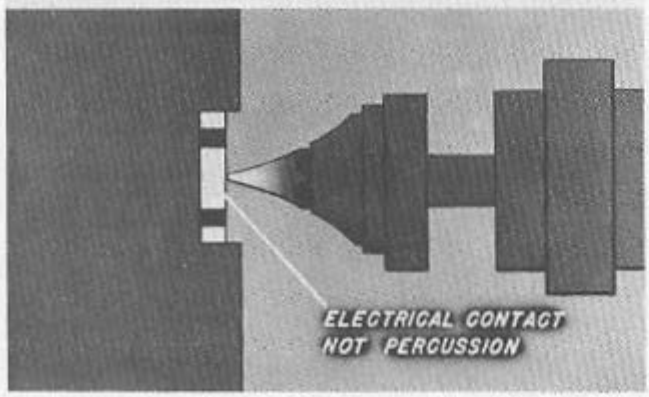
We've said that electrical firing is the preferred method because it's faster, and have shown how, in electrical firing, a filament becomes heated to detonate the primer. We are now going to study those parts of the firing mechanism which operate to make electrical firing possible. Because it serves to detonate the primer in both types of firing the construction of the firing mechanism is somewhat more complicated than the simple pin-and-spring arrangement that would suffice for percussion firing alone. The entire mechanism is contained in a casing called the firing lock. It is this lock that secures the firing mechanism in the breechplug.



Housed within the firing lock is the firing pin. With the breech closed, this pin makes electrical contact with the primer. It is important to firing that all contacts be positive so the firing pin is held in contact with the primer. . .



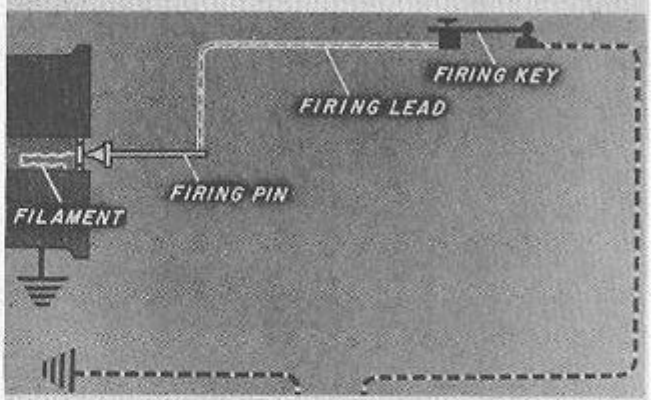
. . .by a contact spring. Because this spring is held in compression between the rear wall of the firing lock and a sleeve on the firing pin, it tends always to hold the pin forward. While the compression of this spring is sufficient to hold the firing pin in secure electrical contact with the primer, it does not push the pin forward hard enough to detonate the primer by percussion.



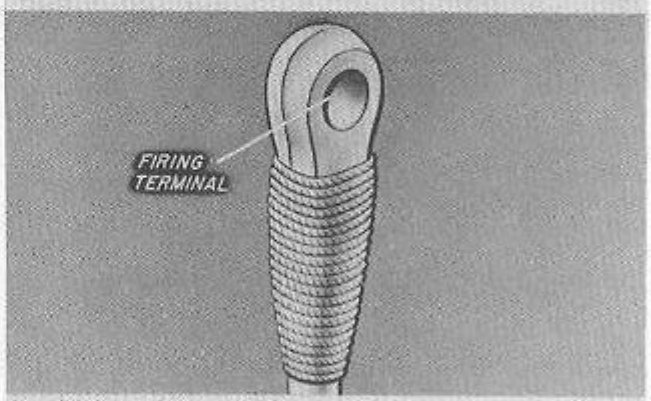
It is important to remember this point: the contact spring provides electrical contact between the firing pin and the primer, but not percussion of the firing pin on the primer. When this contact has been established. . .

. . .closing of the pointer's firing key allows current to flow. . .

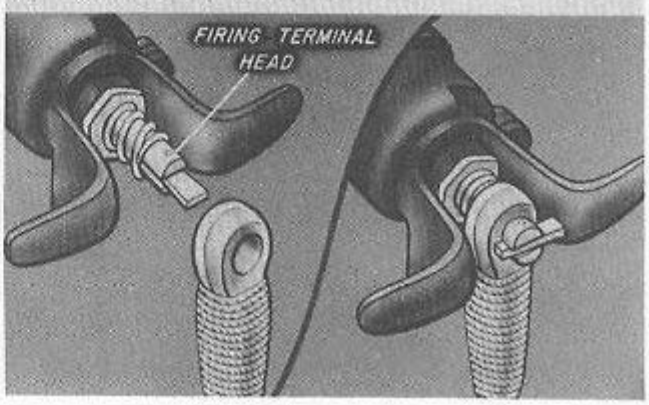
. . .through the firing pin to the filament. The firing key is connected to the after end of the firing pin by an insulated wire called the firing lead.

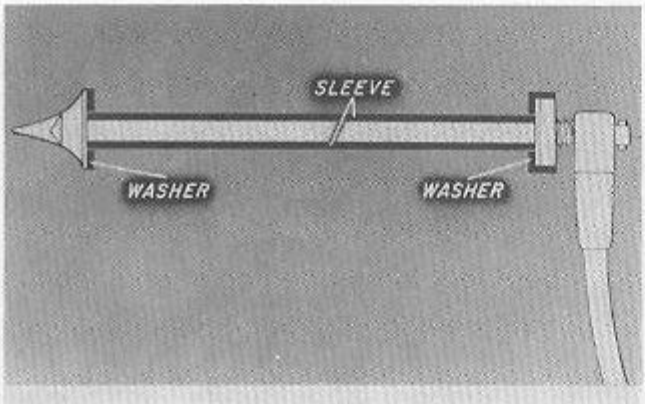


To the pin end of this firing lead is attached a special fitting called the firing terminal whose purpose. . .

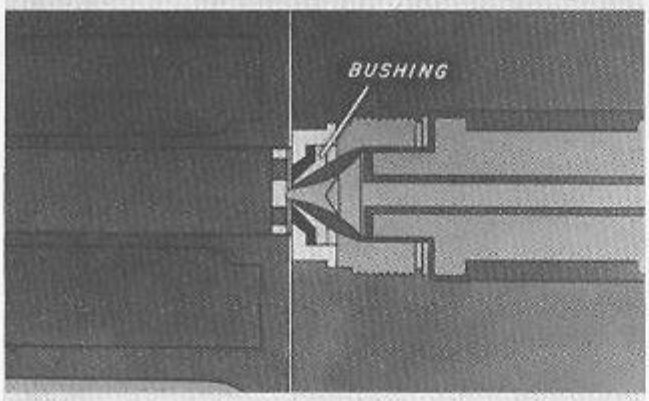


. . .is to permit easy and rapid connection to the firing terminal head on the rear of the firing pin, so that the mechanism can be quickly replaced in the event of casualty. At the right, we see how the firing terminal is secured to the terminal head, between a pivoted latch and a spring.

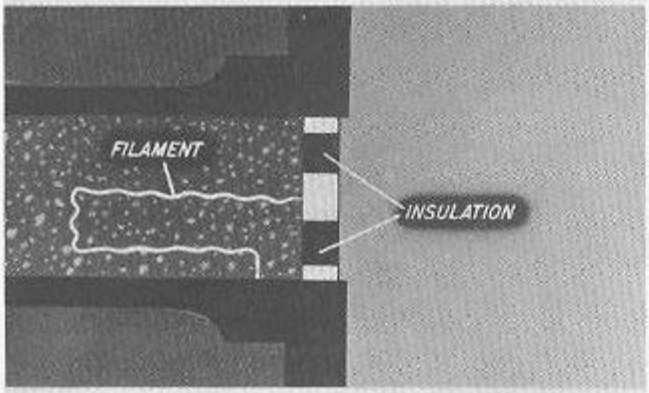




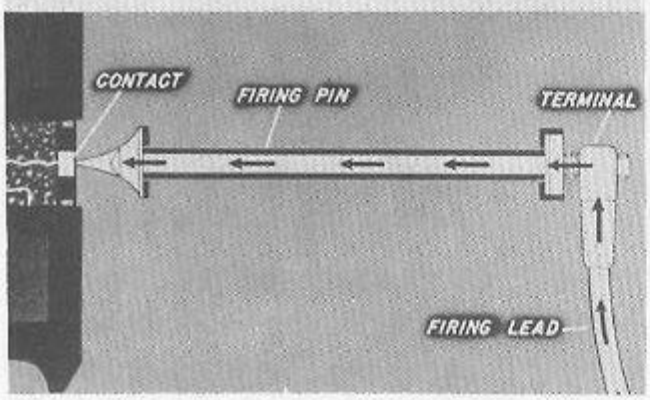
The firing pin itself is completely insulated from the rest of the firing mechanism. This insulation, indicated here by the heavy black lines, consists of a sleeve around the shank of the pin, and washers fore and aft of this sleeve.



The forward end of the firing pin passes through a bushing that is insulated from the forward face of the breechplug. So we have a completely insulated electrical circuit from the firing terminal to the contact in the base of the primer.

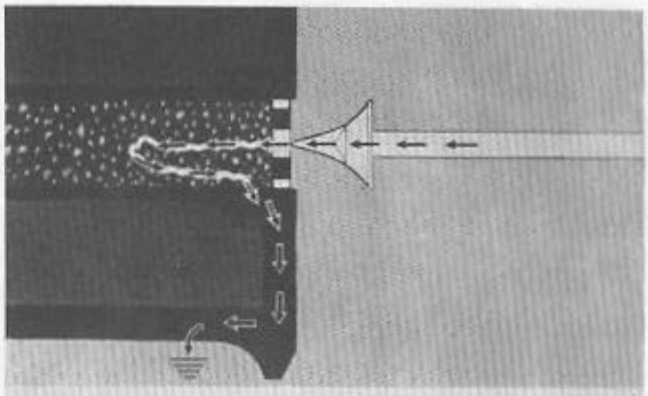


Looking at the primer more closely, we see the details of its electrical connections. The contact for the firing pin in the base of the primer is insulated from the rest of the primer. One end of the filament is connected to this contact and the other end to the primer case.

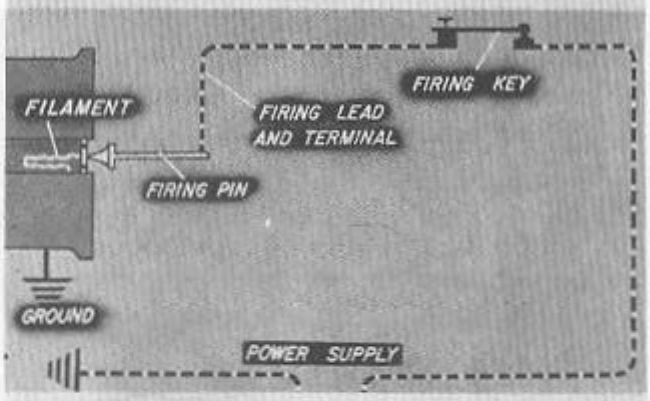


Thus we have a completely insulated electrical circuit through the firing lead and the firing lead terminal, and from there through the firing pin to the contact at the base of the primer and through the filament to the cartridge case.

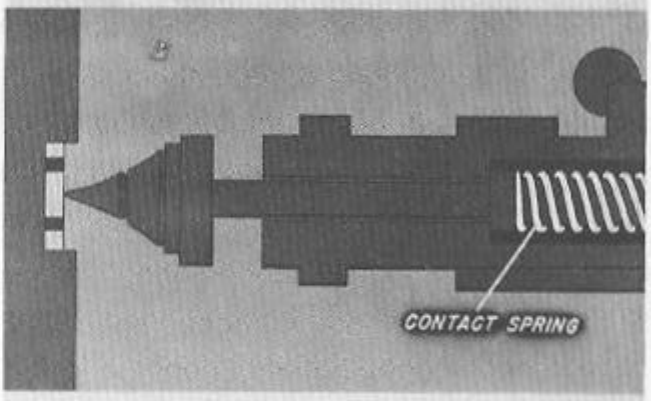
The current flows through the filament and in doing so, heats it to white heat. This filament, as we have seen, is grounded to the case, which in turn makes metal-to-metal contact with the gun chamber. Thus the circuit is completed through a ground in the gun.



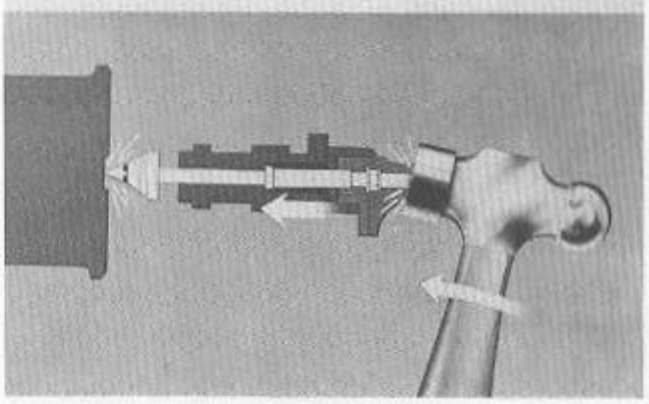
Let's sum up by tracing the complete electrical circuit. Current flows from a power supply through the firing key, the firing lead and terminal, the firing pin, and the filament in the primer, and is grounded back through the case and the gun. If any part of this circuit fails, the gun cannot be fired electrically, and we must resort to our standby method—percussion firing.

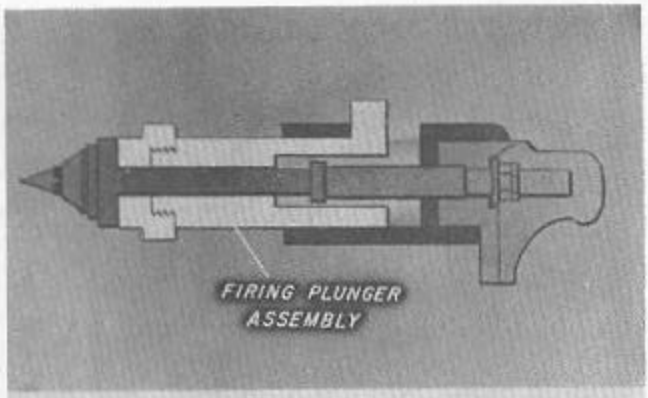


Twelve pictures ago, we showed how the contact spring always holds the firing pin in contact with the primer. This being the case, the pin cannot spring forward to strike the detonating cap. How, then, can the primer be detonated by percussion?

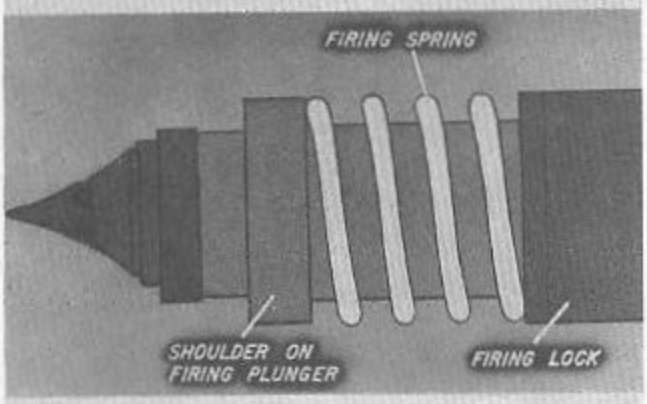


Well, here's one way we might do it: if we treated the firing pin as a drift pin and stuck the end of it with a hammer, the force of the blow would be transmitted through the pin and would detonate the primer. While this method would be almost as crude as the torch-and-fuze system in the old muzzle loaders, the hammer principle is sound.

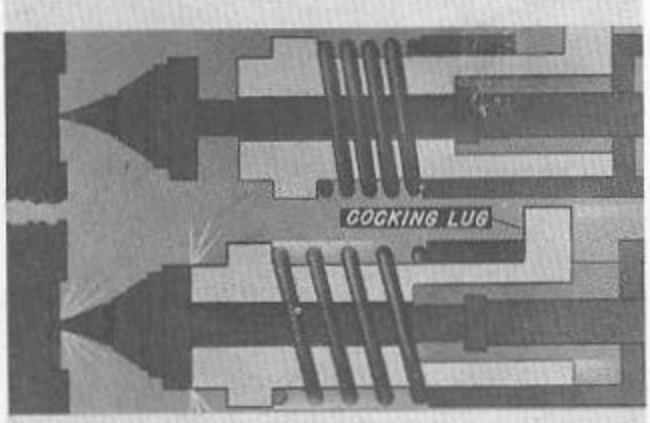




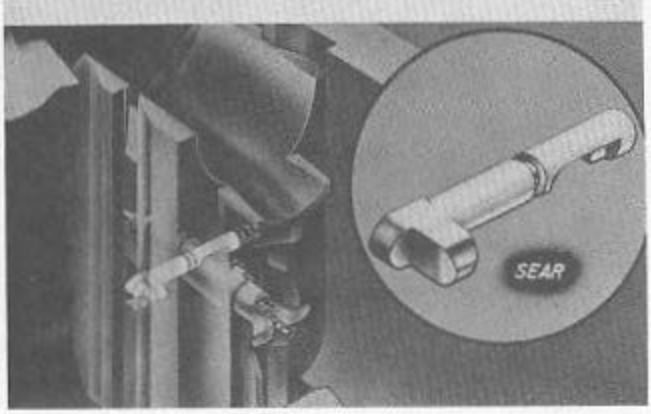
For we actually have a hammer built into the firing mechanism of this gun. The hammer is called the firing plunger assembly. Its only purpose is to strike the firing pin hard enough to detonate the primer. This assembly encircles the firing pin and is free to move fore and aft within the firing lock.



The "muscle" behind this hammer action is a powerful firing pin spring, held in compression between a shoulder on the firing plunger and the front edge of the firing lock.

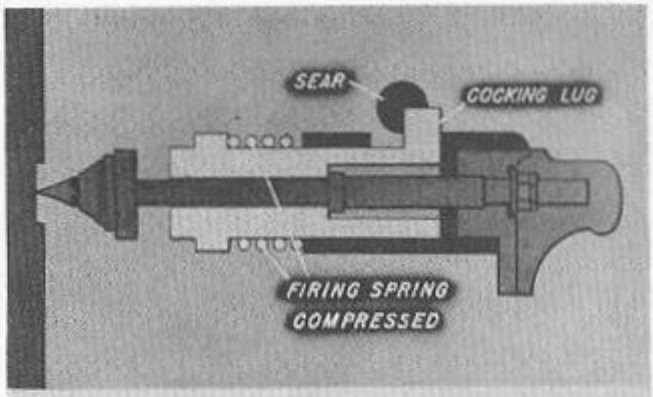


This spring snaps the firing plunger assembly forward from the position shown above to strike the firing pin a sharp blow, as shown below. This firing plunger is held aft in the cocked position shown above because a cocking lug on the assembly. . .

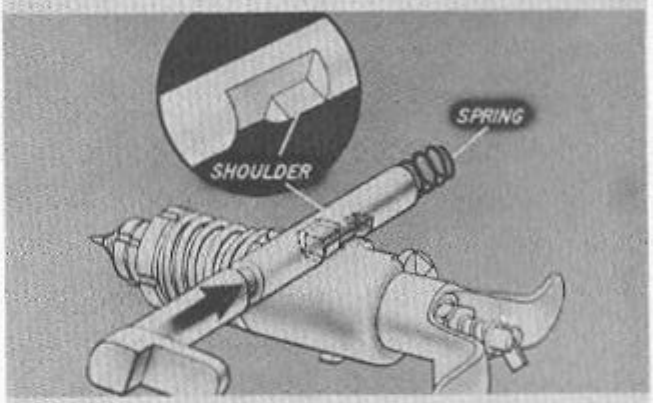


. . .is engaged by a sear, mounted in the breechplug, directly above the firing mechanism. It is the function of this sear. . .

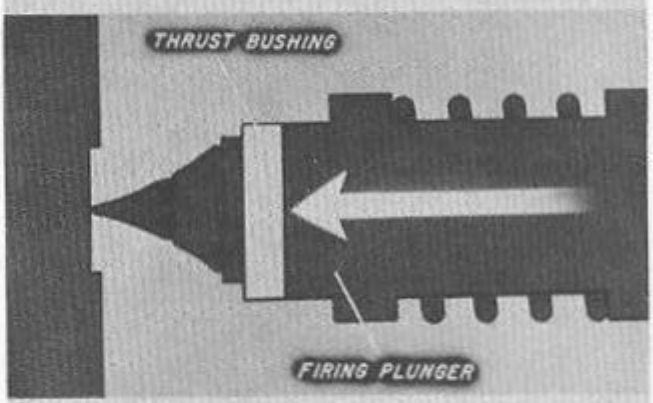
. . .to hold the firing spring compressed, by engaging the cocking lug and holding it in the aft position until we are ready to fire.



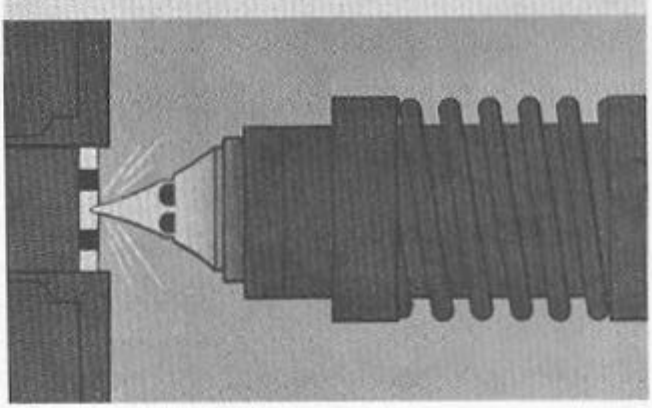
So, to fire the gun, the sear must be pushed inboard against the pressure of a spring that tends to hold it outboard. In the insert, we see more clearly the construction of the shoulder in the sear.

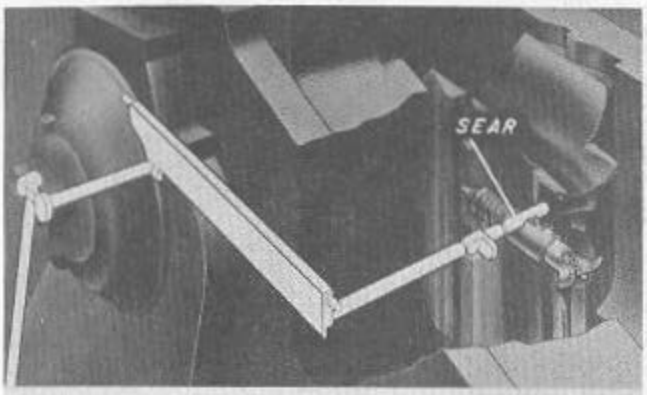


When the cocking lug is released by the sear, the firing plunger is forced forward by the firing spring and strikes sharply against a thrust bushing on the firing pin.



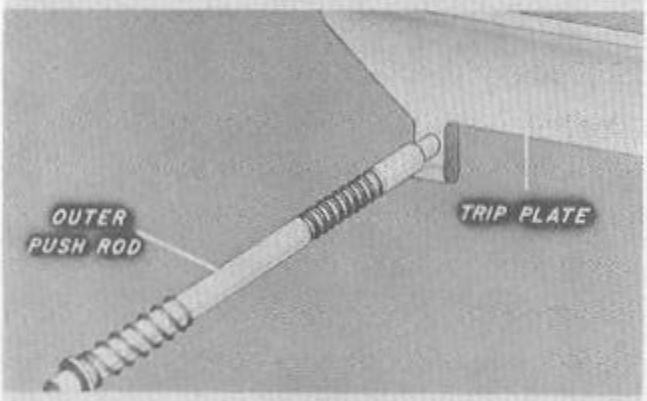
This blow is transmitted through the firing pin to detonate the primer.



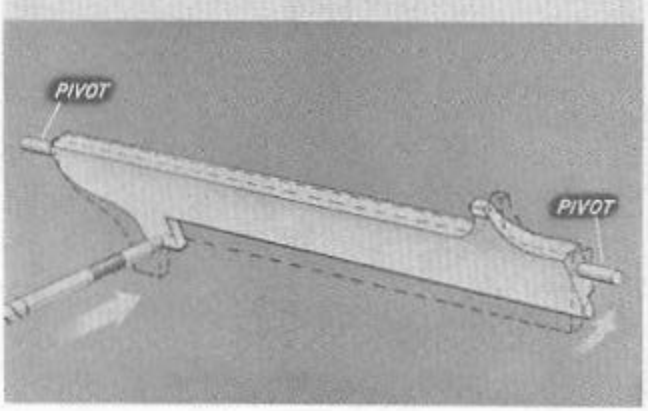


We have seen that, in order to fire the gun by percussion, the sear must be pushed inboard. This is done by the foot firing treadle acting through linkage. Let's see now what this linkage is, and how it operates.

The linkage extends from the foot firing treadle, outside the gun, to the sear inside the gun. The simplest and most direct connection between these two points must pass through the gun at the only point where it does not move in elevation and depression. This point is at the center of the trunnion. For this reason, a direct linkage from the foot firing treadle acts upon an outer push rod mounted in the center of the trunnion.

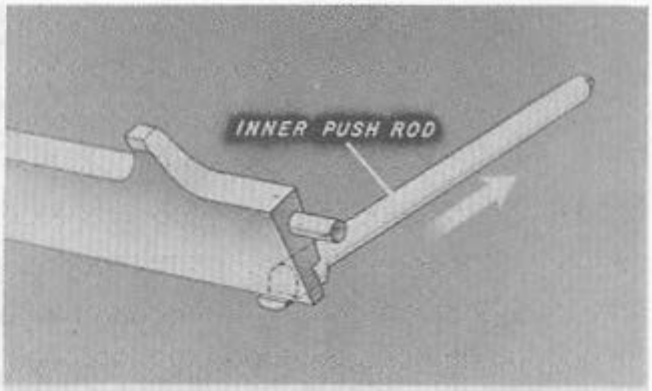


This outer push rod is normally held outboard in its nonfiring position, by the spring at its left end. The spring at the right end acts only as a shock absorber to prevent damage to the linkage in the event of casualty. This outer push rod engages the forward end of a trip plate. . .

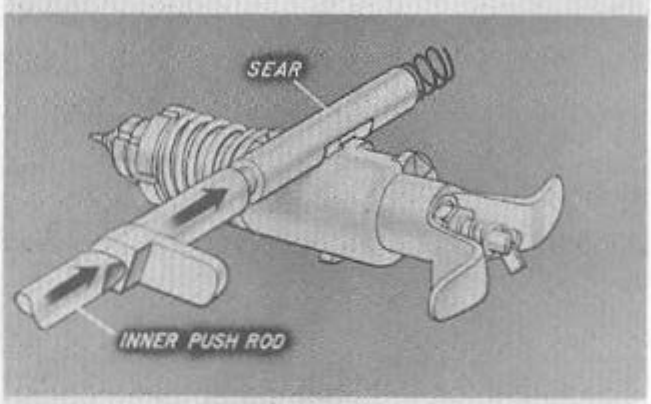


. . .which is mounted on pivots inside the slide. When the outer push rod is forced in by the foot firing linkage, it swings the trip plate inboard on these pivots. . .

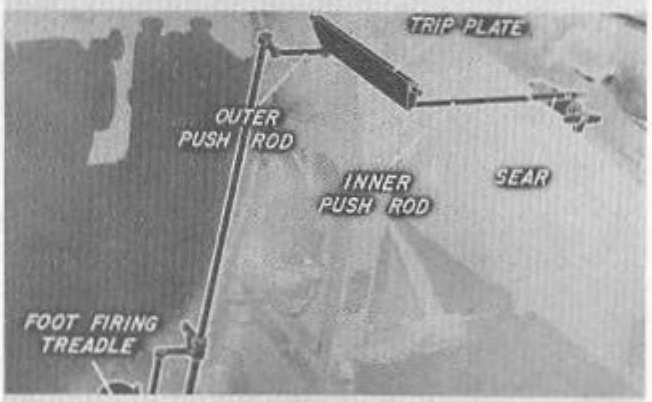
. . .causing the after end of the trip plate to force in an inner push rod, which is mounted in the breech housing. This inner push rod engages the trip plate only when the gun is in battery. You can see now why this linkage is not injured when the gun recoils, and also why the gun can fire only when in full battery position.



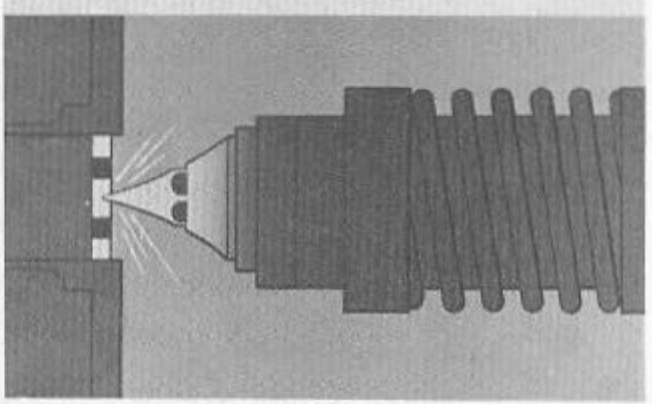
When the inner push rod is forced inboard, it pushes in the sear and releases the cocking lug to permit the firing plunger assembly to spring forward and strike the firing pin. There is another safety feature evident here: the sear, which is mounted in the breechplug is lined up with the inner push rod only when the breechplug is up to seal the breech. And so we see how, in percussion firing, the gun cannot be fired unless the breech is closed.

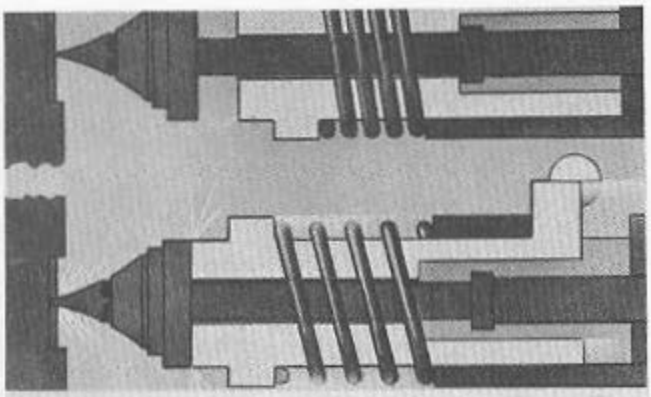


Now let's review the percussion firing action. The motion of the foot firing treadle is transmitted through linkage to the outer push rod. The outer push rod is pushed inboard, rotating the trip plate. The trip plate in turn pushes the inner push rod into the breech housing, thus forcing the sear inboard against the pressure of the sear spring. The sear, in turn, frees the cocking lug so that the firing spring can force the plunger assembly forward.

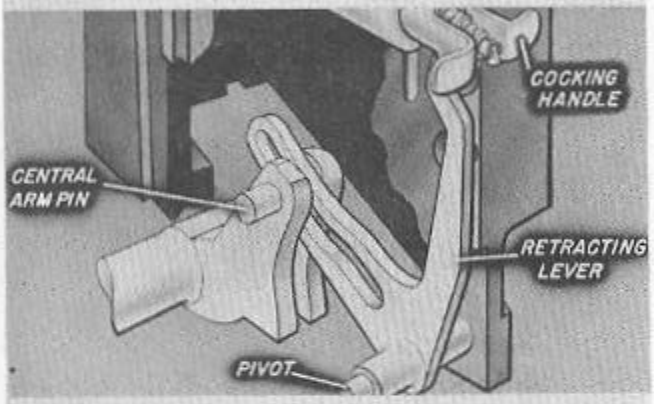


The firing plunger assembly then raps the thrust bushing on the firing pin, which transmits the blow to the detonating cap and sets off the primer.

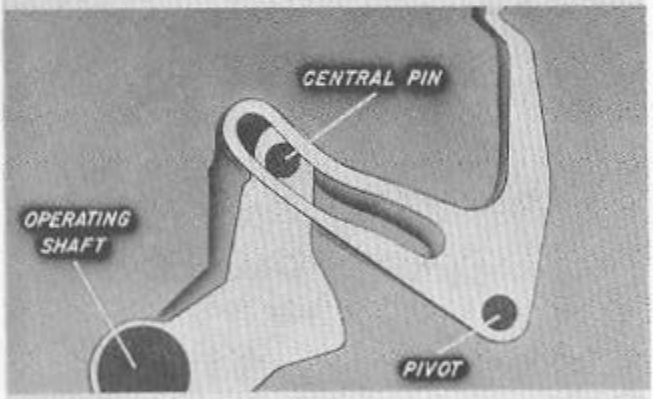




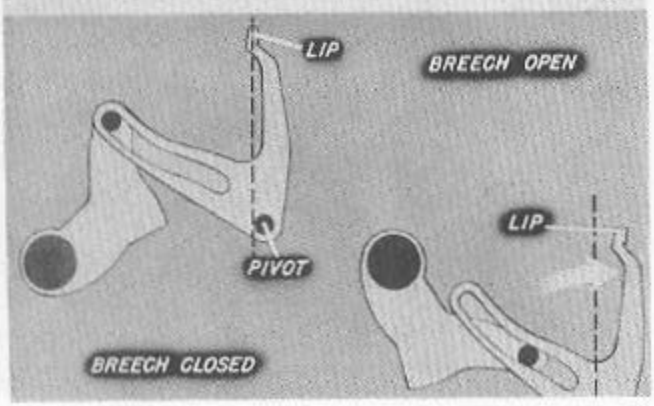
We have seen how the firing plunger assembly is held in the cocked position, as shown in the top view, and how it is released by the sear, as indicated in the bottom view, to fire the gun. Now let's see how the assembly is cocked again after the gun is fired.



You will remember that the central arm moved the breechplug. Since the cocking action must by synchronized with the motion of the breechplug, it is logical that we should use the movement of the central arm to cock the firing mechanism. Here we have cut away part of the breechplug to show how a bell crank, called the "retracting lever" is mounted by a pivot pin, directly under the firing mechanism. This lever transmits the motion of the central arm pin to the cocking handle.



As the operating shaft rotates, the central pin rides in an S-shaped groove in the retracting lever and so rotates this lever about its pivot.



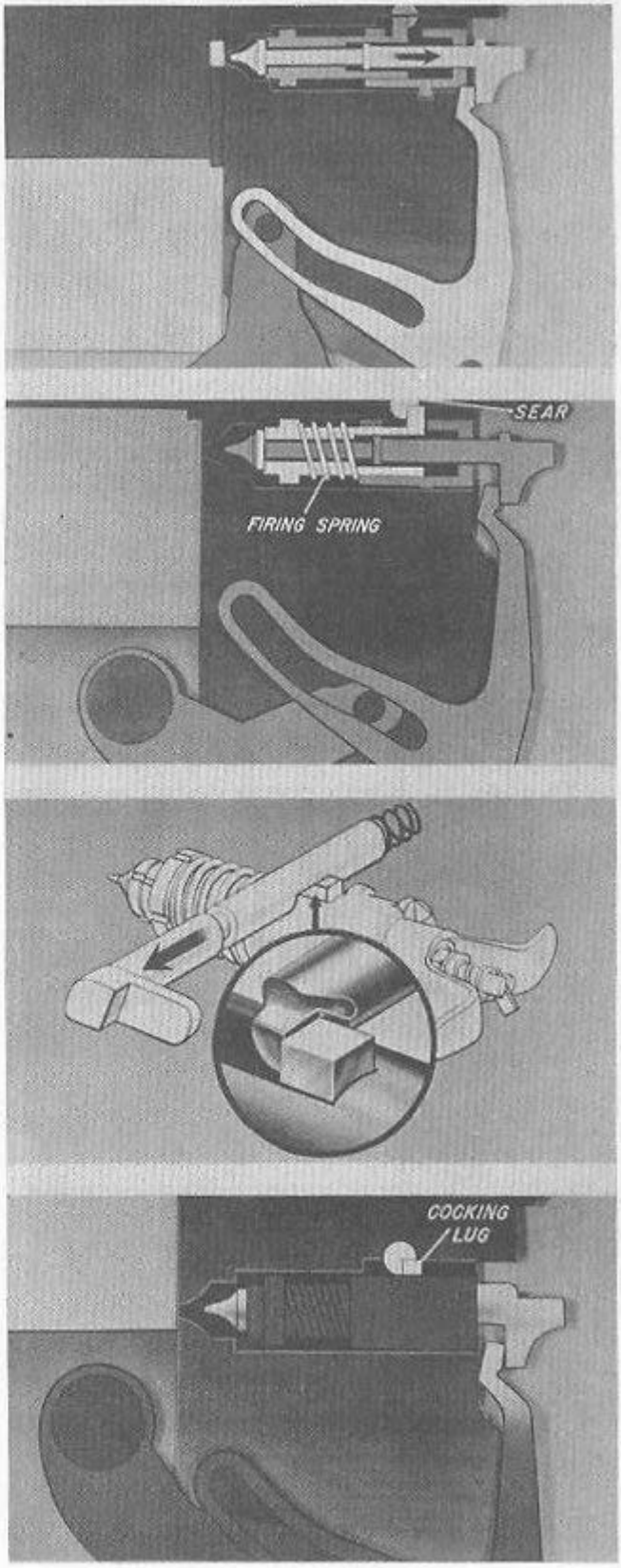
As the operating shaft rotates to lower the breechplug from the breech closed position to the breech open position, the resulting rotation of the retracting lever causes a lip at its upper end to move aft.

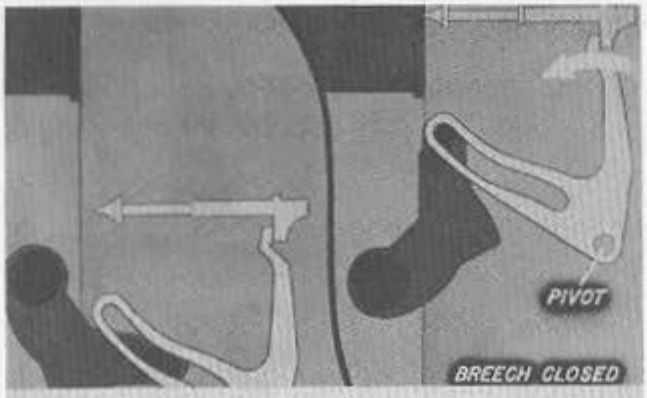
This lip, in moving aft, does two things: first, it pulls the firing pin back away from the primer. This prevents damage to the pin as the breechplug is lowered.

Second, when the breechplug is almost fully lowered, the lip pulls the firing pin all the way aft, causing it to retract the firing plunger assembly, compressing the firing spring until the sear engages the cocking lug to hold the firing assembly in the cocked position.

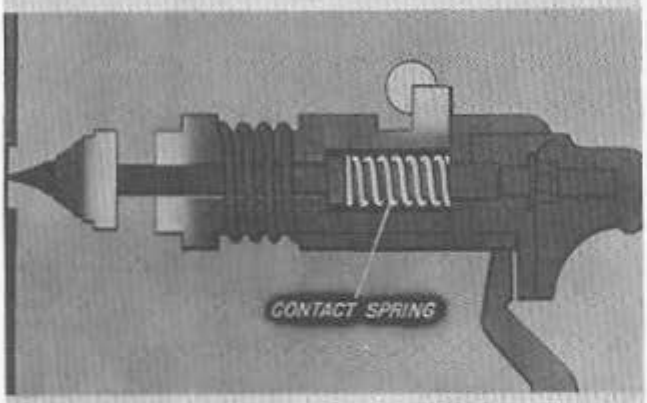
You will remember that, to engage the cocking lug, the sear is pushed outboard by its spring until, as we see in the inset, the shoulder in the sear slot engages the front face of the cocking lug.

So we see that, with the breechplug down, the firing assembly is cocked. To prevent firing until the breech is closed again, the assembly is locked by the retracted firing pin.

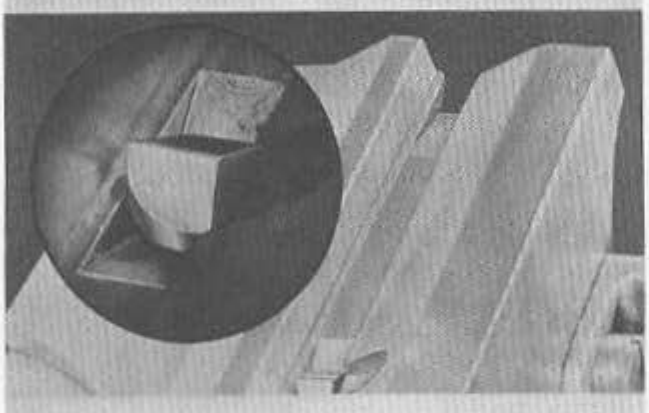




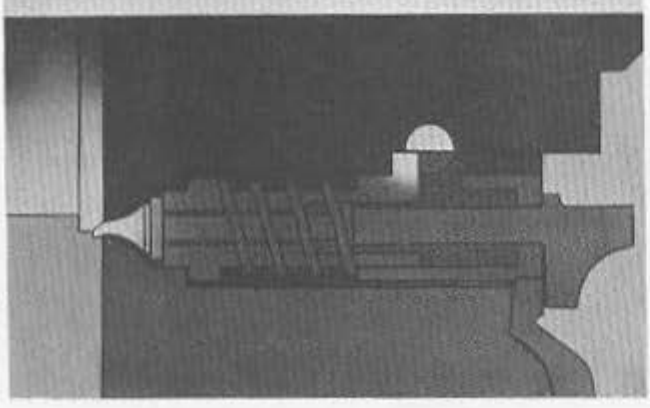
Then, as the breechplug moves up again to the breech closed position, the lip on the retracting lever is moved forward, releasing the firing pin. . .



. . .so that the contact spring can push the pin forward to make contact with the primer. This contact, you'll recall, is necessary for electrical firing. Since the firing plunger assembly is now held only by the sear engaging the cocking lug, the gun is ready to be fired by percussion whenever the sear is released.

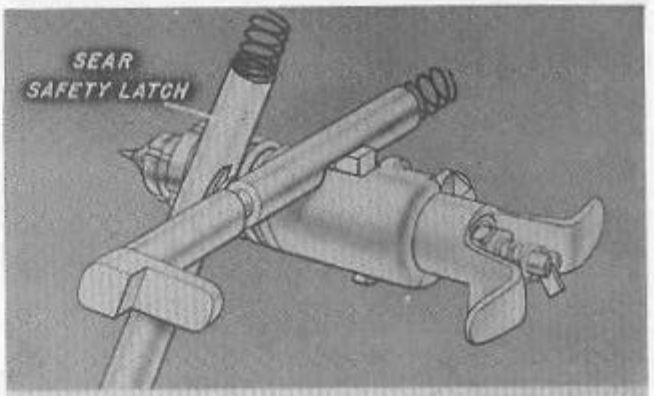


However, the sear projects out from the side of the breechplug to allow the linkage from the foot treadle to engage it readily to fire the gun. While this is fine as far as the firing linkage is concerned, it presents a problem. There is danger that, as the breechplug is raised, the sear can be pushed in prematurely by burrs or foreign matter on the breechplug guide plate. If the sear is pushed in, in this manner. . .

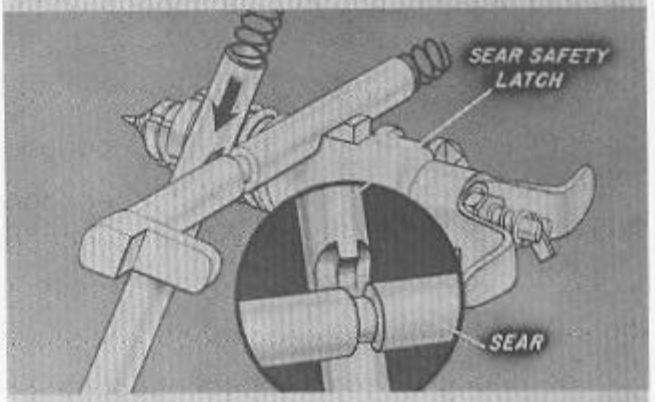


. . .it will release the firing plunger assembly, causing it to spring forward too early. This will result in failure of the gun to fire and can also cause serious damage to the firing mechanism. However, to prevent this from happening. . .

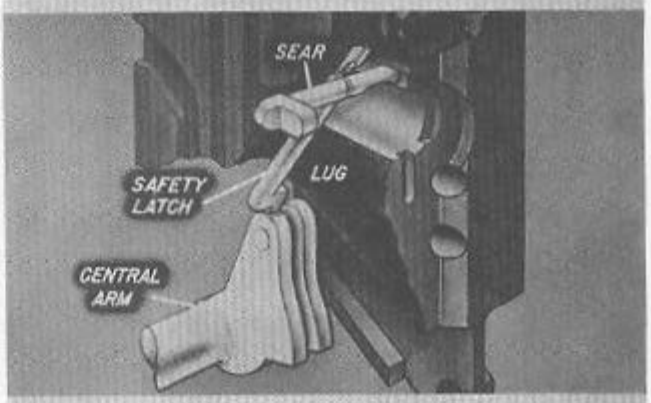
. . .the breechplug contains a part called the sear safety latch. This latch locks the sear in the cocked position until the breechplug is closed to seal the breech.



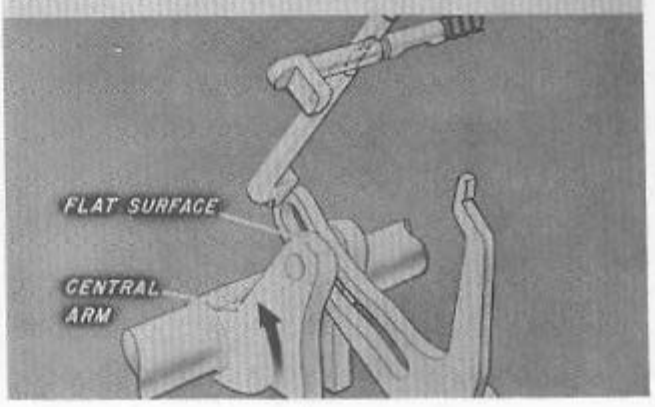
This locking is accomplished by a lug on the sear safety latch engaging a groove in the sear. The latch engages the sear in this manner only when the sear is pushed outboard to cock the firing mechanism.

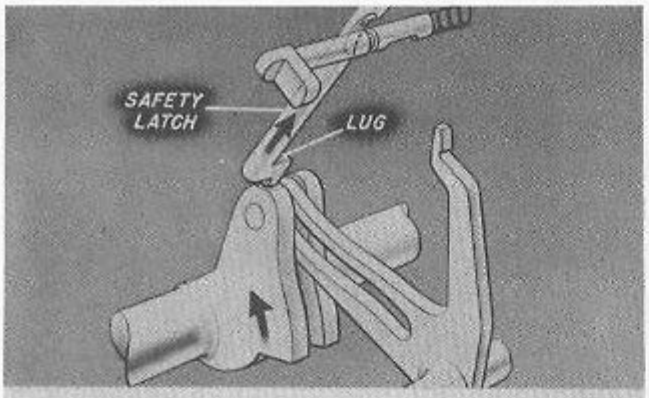


Here we have cut away the breechplug to show how the safety latch is mounted. It seats in a hole bored diagonally upward through the plug. The upper end of the latch is just forward of the sear. To disengage the latch from the sear when the plug has closed the breech, a lug on the lower end of the latch projects into the path of one segment of the central arm.

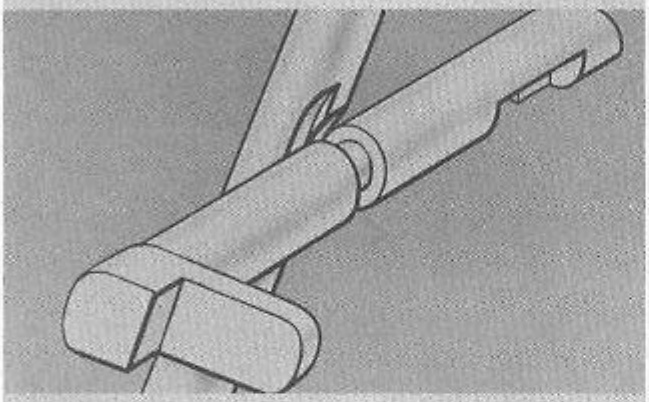


And, as the central arm is rotated to close the plug, a flat surface on the central arm segment. . .

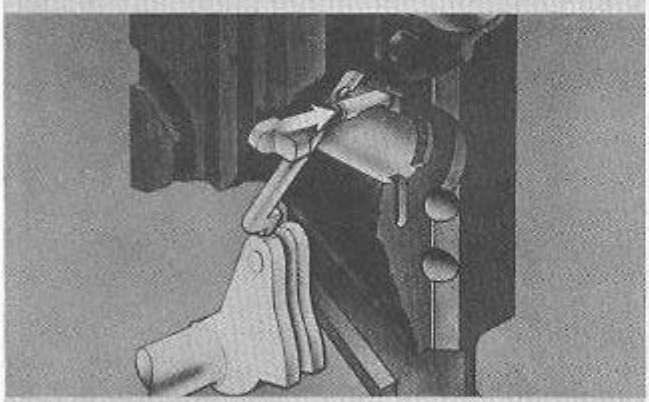




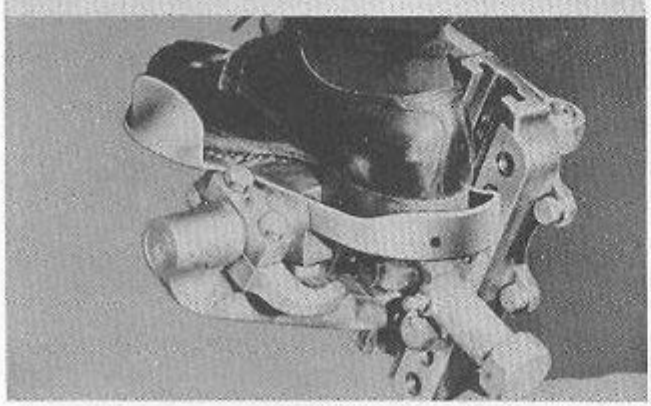
. . .rides under the lug on the safety latch, forcing the latch up against the pressure of its spring. . .



. . .to disengage the lug from the groove in the sear. . .

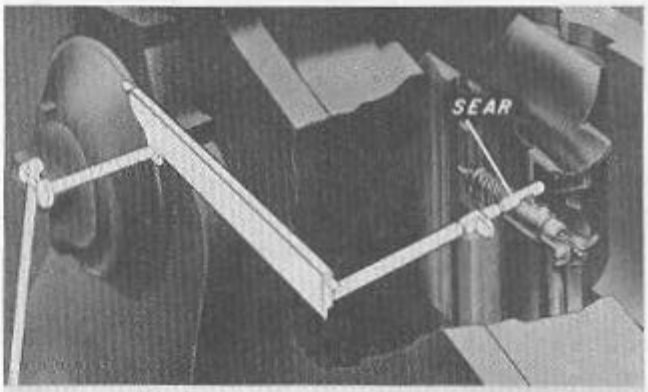


. . .and permit the sear to be pushed inboard by the linkage, when the breech is closed and the gun is ready to be fired.

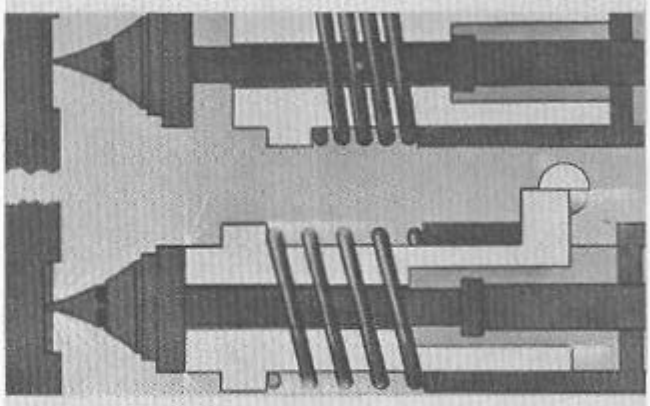


And so we've seen how the gun operates in percussion firing. The pointer depresses the foot firing treadle. . .

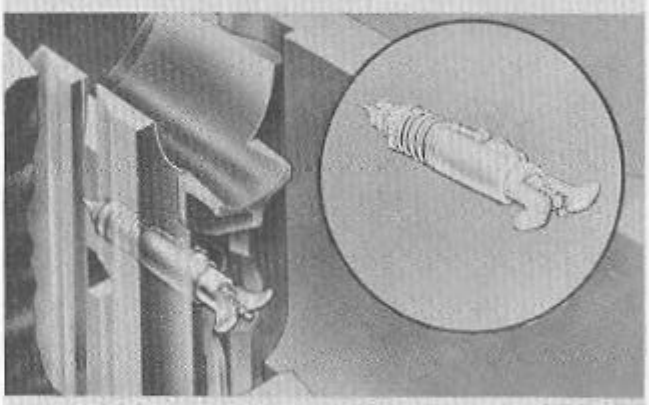
. . .and sets into motion a linkage that causes the inner push rod to push in the sear.



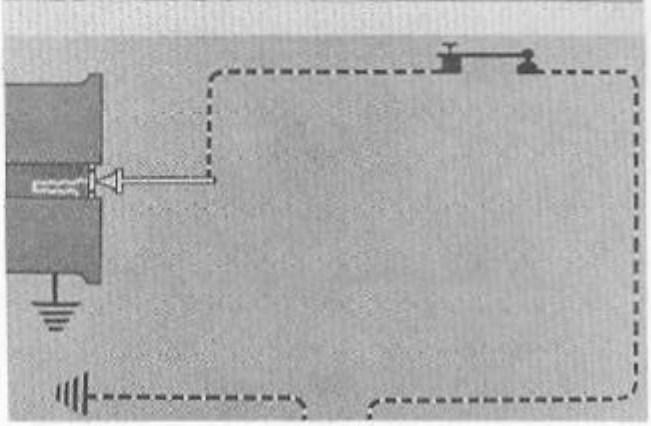
The sear, when pushed in, releases the cocking lug and the firing spring rams the firing plunger assembly sharply forward against the firing pin, to detonate the primer and fire the gun.

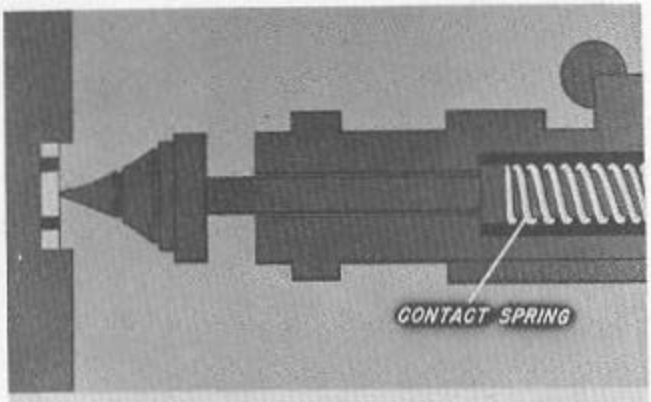


Since the purpose of any gun is to fire projectiles at the enemy, it is obvious that the firing mechanism is vitally important and must be kept in perfect working order at all times.

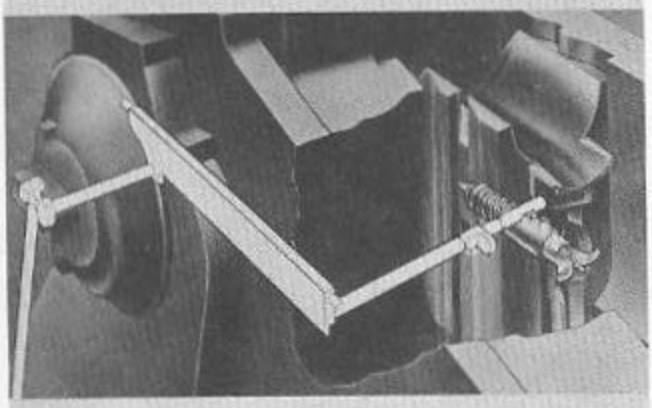


Electrical firing being the preferred and more rapid method, the electrical circuit must remain unbroken. All contacts, leads, and insulation must be kept clean and free of breaks.

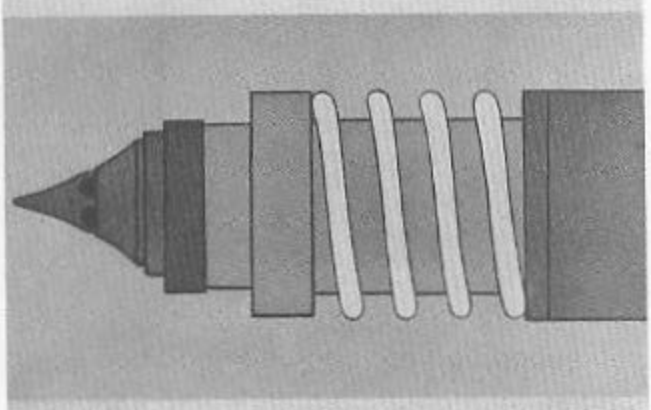




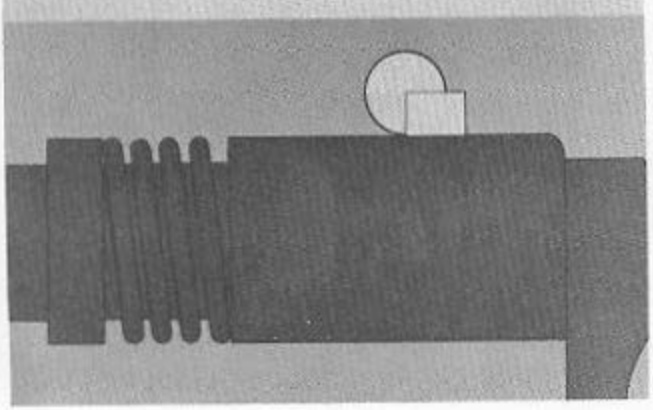
To make certain that the firing pin makes secure contact with the primer, the contact spring should be inspected frequently.



Percussion firing is provided as a standby method for emergency operation. This standby must be ready at all times to go into action. The linkage from the foot firing treadle should be exercised frequently to prevent freezing.

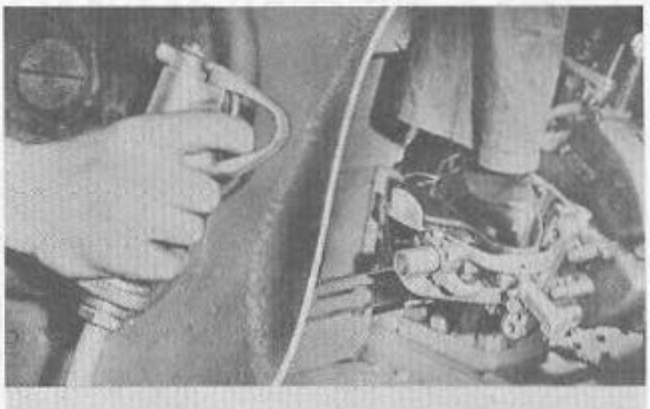


Other checks to keep this mechanism always in good working condition include inspection and testing of the firing spring, . . .

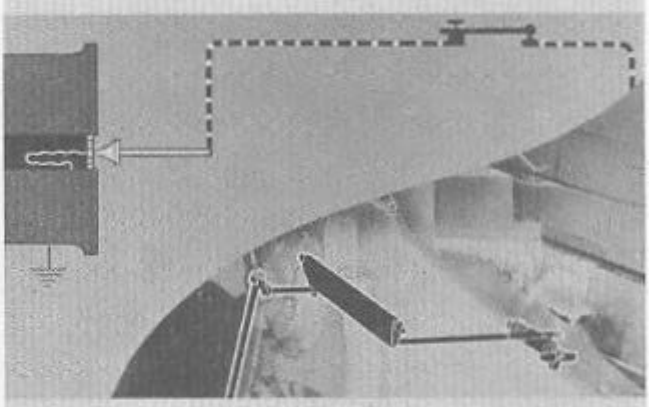


. . .the sear, and the cocking lug. Only proper maintenance and frequent testing will guarantee this mechanism being ready at a moment's notice when it is needed.

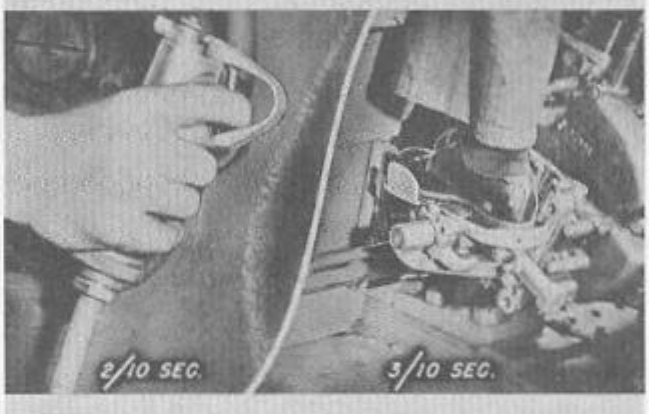
And speaking of a moment's notice, we have emphasized the fact that the preferred firing method is electrical firing because it is faster than percussion.



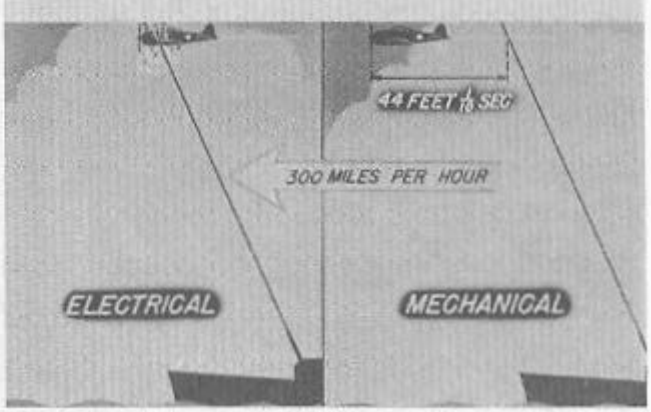
One of the reasons for the greater speed of electrical firing is that closing a circuit to allow a current to flow takes less time than activating gear linkage to operate a sear. The actual time difference may seem to you to be hair-splitting. To see what this difference amounts to, let's consider an example.

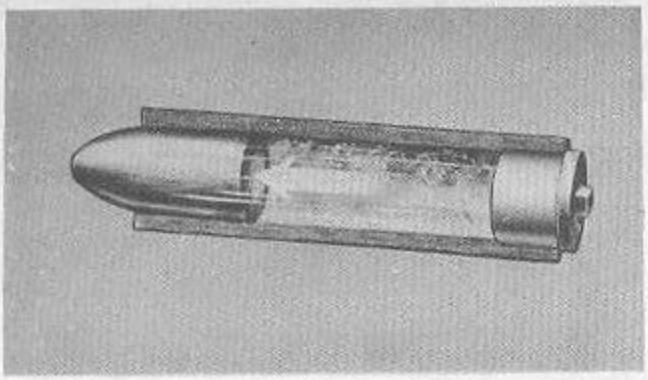


In mechanical firing, the time interval between the pointer's desire to fire and the projectile leaving the muzzle is about three-tenths of a second. Let's suppose that this same interval in electrical firing, where no linkage must be actuated, is two-tenths of a second—one-tenth of a second less than mechanical. These figures are well within reason.

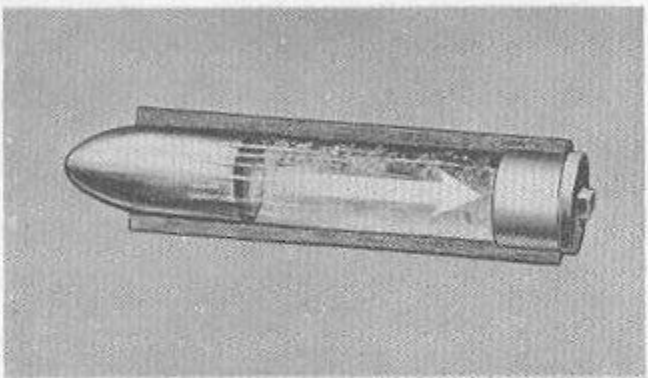


If we were firing at a plane moving at the rate of 300 miles per hour, and the electrically fired shot were dead on the target, the mechanically fired shot, coming a tenth of a second later, would be 44 feet behind the target. This example shows that, in combat, split seconds count! This is why the firing mechanism of an effective combat weapon like the 5"/38 is designed for split-second firing!

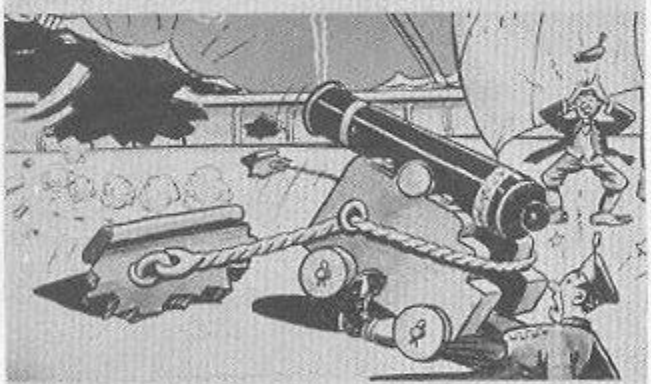




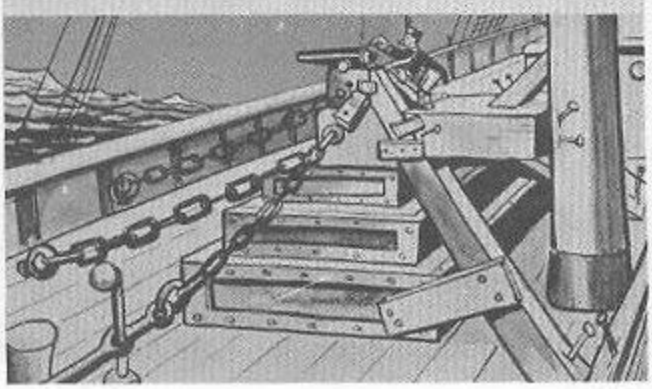
We have already seen that when any gun is fired the force of the expanding gases drives the projectile out through the muzzle. This force, however, pushes not only against the projectile,. . .



. . .but also against the gun itself causing it, when fired, . . .

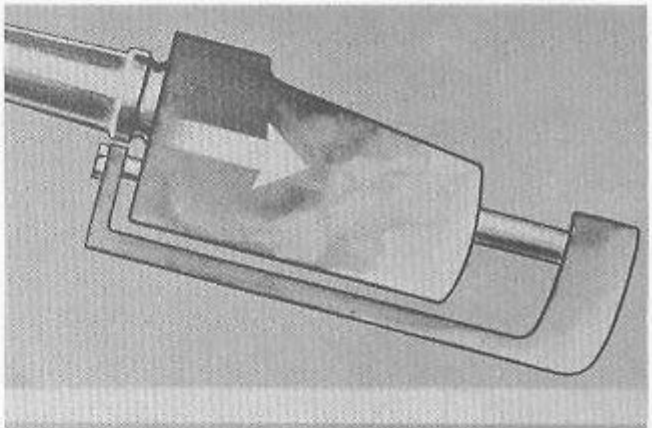


. . .to kick back—or recoil. To prevent damage to the gun or the ship, the force of this recoil must be absorbed. One way to solve this problem. . .

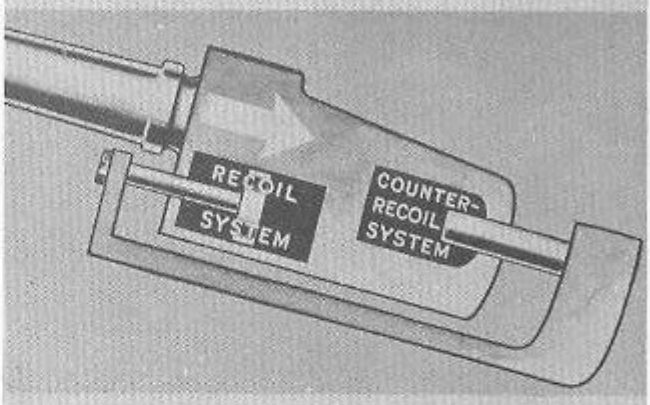


. . .would be to construct the mount large enough so that it would absorb the recoil force safely. This method is obviously impractical, since it would make necessary a mount that was too cumbersome to handle, and too large and heavy for use aboard ship.

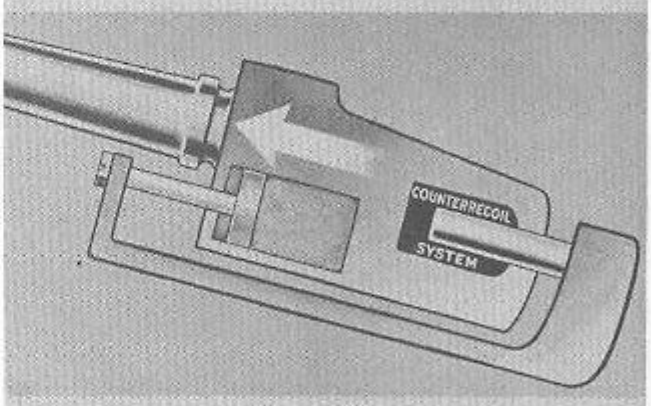
For large caliber guns like the 5"/38 which recoils with a force of 748 thousand pounds, a more practical method of absorbing this force has been worked out. The barrel and breech housing are permitted to recoil together within the slide. By permitting them to recoil a short distance, the forces which would otherwise act on the mount are greatly reduced. This allows us to use larger guns aboard ship than would otherwise be practicable. Absorbing and controlling the recoil force. . .



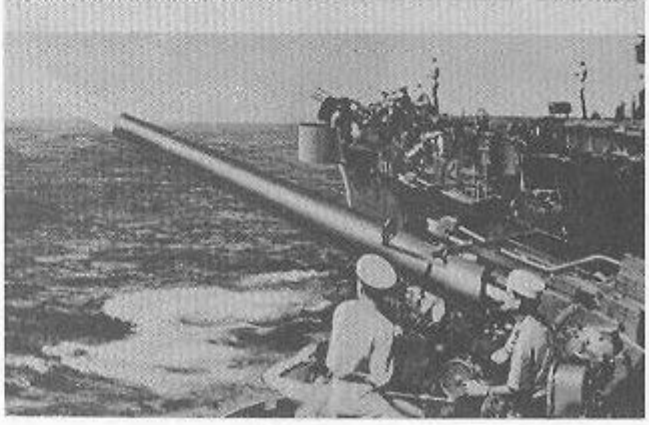
. . .is the job assigned to the gun's recoil system and counterrecoil system, which we are about to study. During recoil these systems work together to stop the gun's recoil movement smoothly, evenly, and rapidly, without shock or damage to the gun or mount. Once stopped, the gun is returned to battery. . .

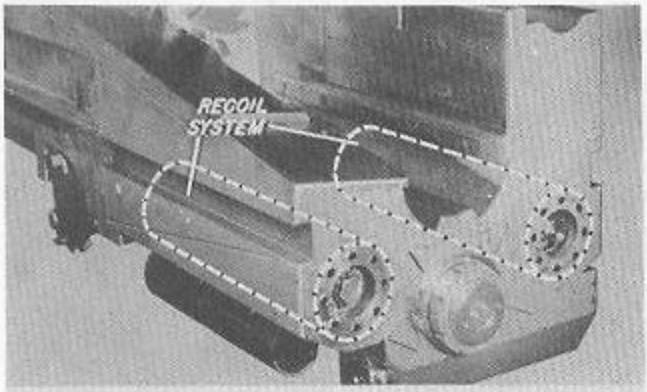


. . .by the counterrecoil system. Speed in both recoil and counterrecoil is important, because the gun's high rate of fire depends on how fast, after being fired, the gun can be returned to battery so that the next round may be loaded.

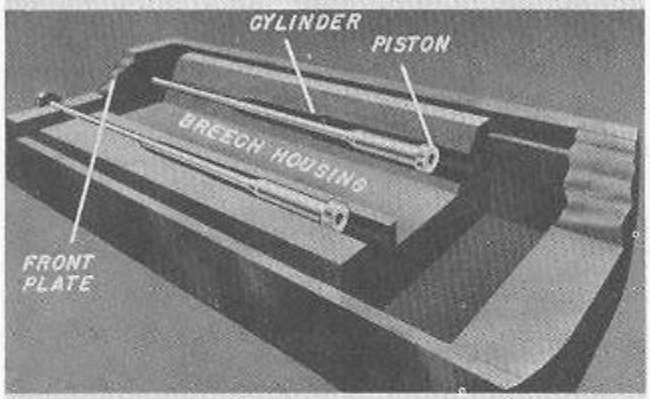


Evidence of the fact that the recoil and counterrecoil systems of the 5"/38 do their job efficiently may be found in the fact that after firing, the gun recoils and counterrecoils in a fraction of a second. Let's examine, first, the gun's recoil system to see how it is constructed and how it operates.

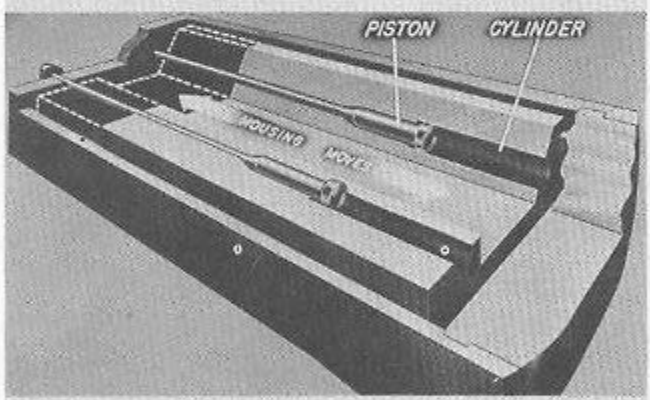




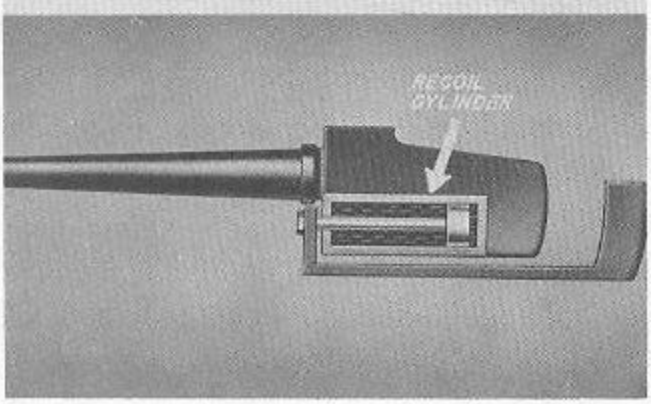
The recoil system is hydraulic in its operation. It is located in the breech housing. It consists of two cylinders which are filled with recoil liquid.



Cutting away part of the breech housing we see that each recoil cylinder contains a piston secured to the slide front plate. Since the slide remains fixed during recoil. . .

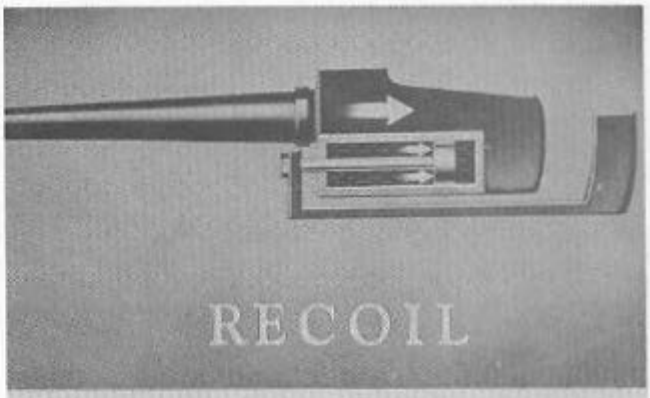


. . .and the housing moves, it is the recoil cylinders in the housing that move over the recoil pistons. The cylinders move. The pistons remain fixed to the slide front plate. With this in mind let's trace schematically, the action of the recoil system during recoil.

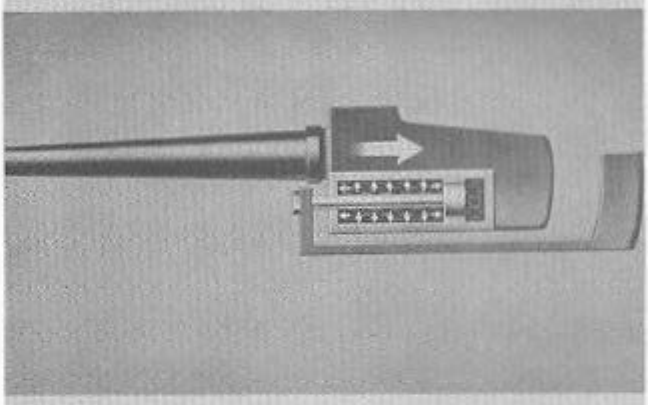


Since the action of both recoil cylinders and pistons is identical we shall consider in our schematic only one of them. Each recoil cylinder is filled with recoil liquid.

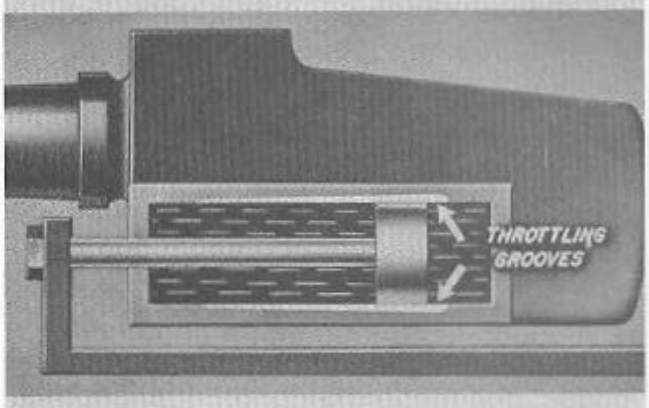
And, as the gun is fired and starts to recoil, this liquid in the cylinder opposes the motion of the cylinder over the piston, . . .



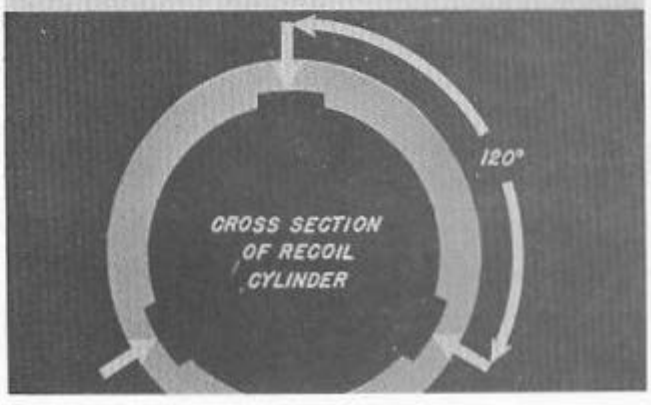
. . .because, as the cylinder starts to move back, a large pressure is built up in the liquid that is trapped in the forward end of the recoil cylinder. Liquids cannot be compressed. And so, in order for the recoil cylinder to be able to move over the recoil piston, there must be some means for this recoil liquid in the forward end of the cylinder to escape.

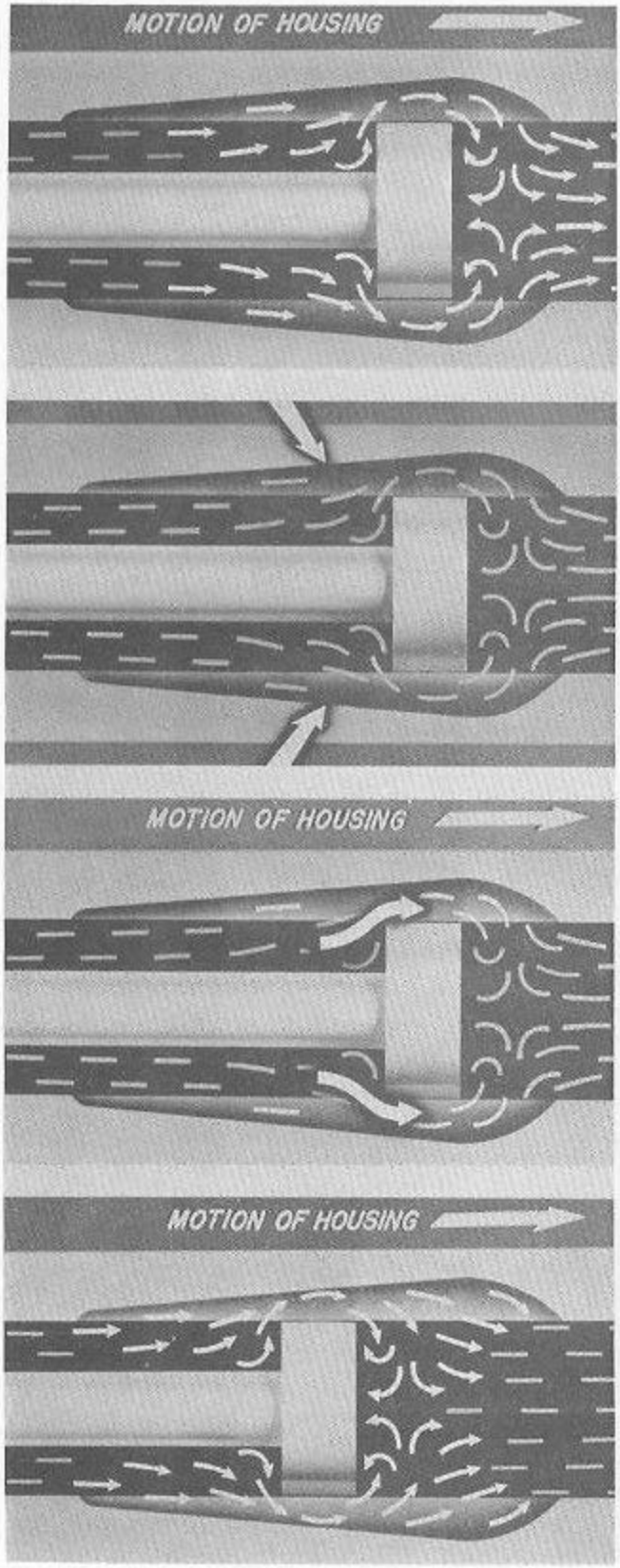


The escape for the recoil liquid is provided by means of long grooves cut in the liner of the recoil cylinder. These are called throttling grooves, because they serve to throttle the action of the recoil.



As we can see in this cross section of the recoil cylinder, there are three throttling grooves spaced 120 degrees apart.





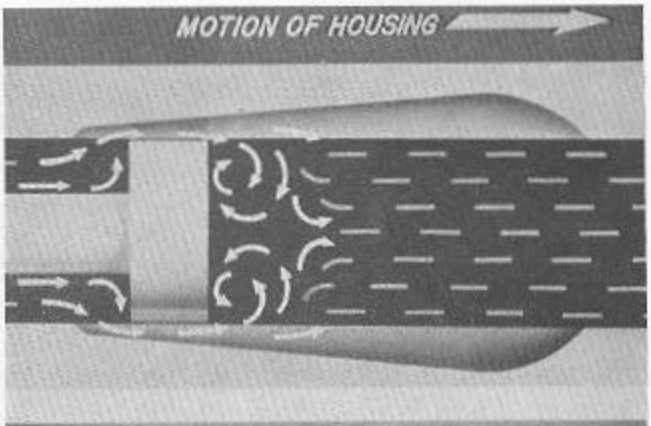
These grooves allow the liquid to escape during recoil, from the forward end of the recoil cylinder, around the piston head, to the after end. The resistance which the liquid in the recoil cylinder offers to being moved helps to stop the recoil movement of the gun. To make this resistance uniform throughout recoil so as to provide a smooth and even buffing action. . .

. . .these throttling grooves are tapered. They are deepest at the after end. When the gun is fired the force of its recoil almost instantly builds up to a maximum.

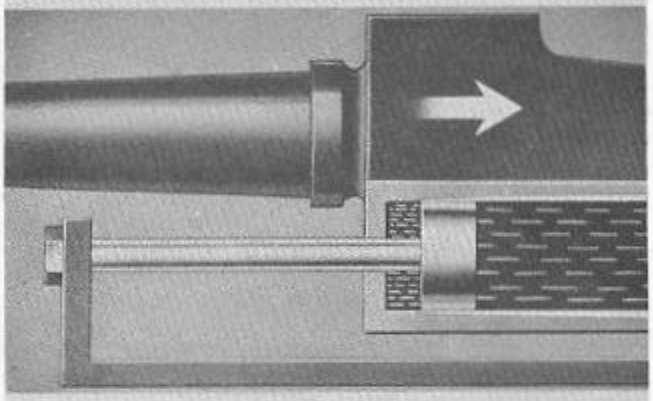
To permit the release of this liquid under the sudden impact of recoil, the grooves being deeper, allow more liquid to pass through them where the recoil action begins.

In order for the gun to fire rapidly, the force of its recoil must be absorbed in a very short time. Moreover, this must be done without damage to the gun. The tapered throttling grooves accomplish this by gradually reducing the size of the bypass as the force of the recoil diminishes. Thus, the grooves provide a smooth, even, stopping action throughout recoil.

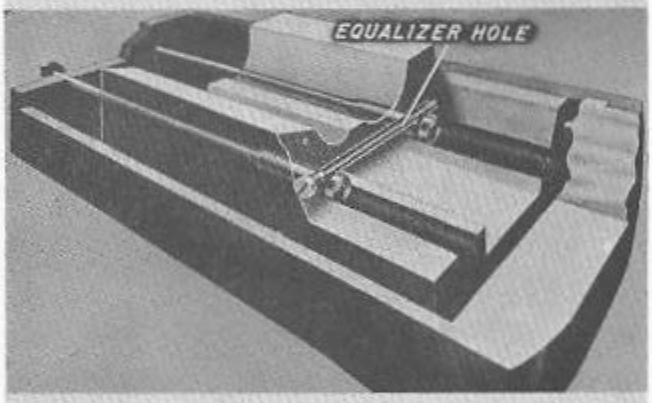
As the recoil cylinder moves back toward the position of extreme recoil the throttling grooves become very shallow and very little recoil liquid is allowed to pass through them.



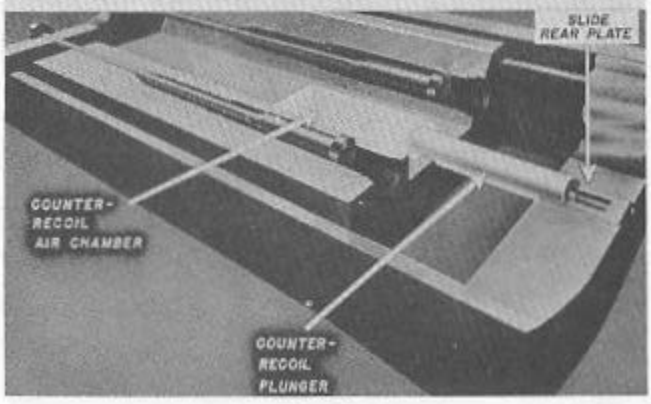
The recoil movement stops just short of the point where the recoil piston head would completely close off the ends of the throttling grooves.

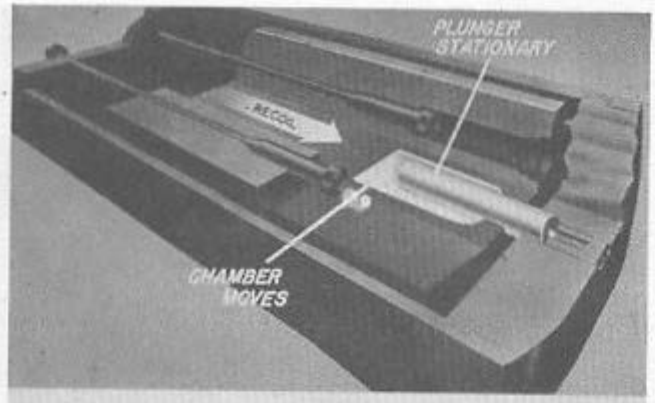


To equalize the buffing action of the two recoil pistons, the pressure of the liquid in the forward end of each recoil cylinder must be kept the same. This is done by connecting the two cylinders by a passage called the "equalizer hole". The recoil system does not, by itself, stop the recoil movement of the gun. Also acting during recoil. , .

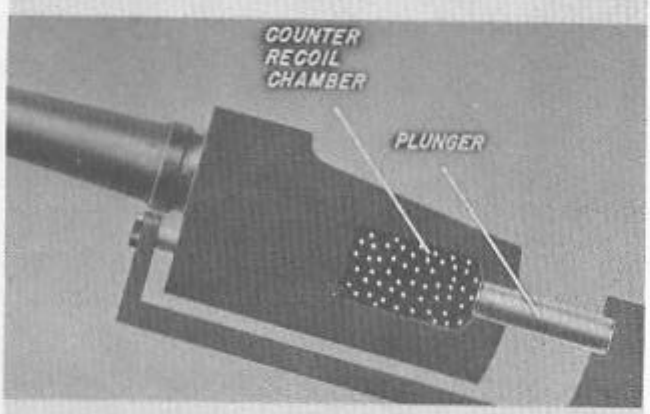


. . .is the gun's counterrecoil system. This is located in the breech housing between the recoil cylinders and consists of the counterrecoil air chamber, which contains air under high pressure, and the counterrecoil plunger, which fits into an opening in the chamber. The after end of this plunger is seated in a recess in the slide rear plate. The chamber and plunger are shown in battery position.

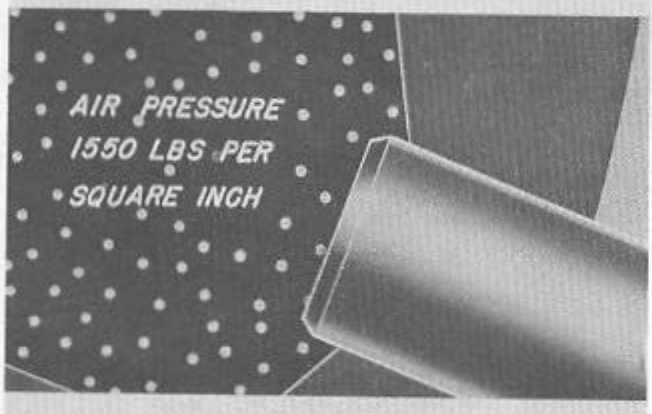




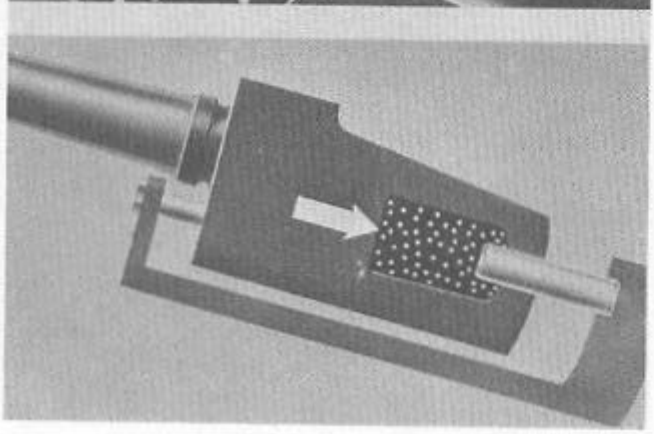
During recoil, as the housing is forced back within the slide, the counterrecoil air chamber moves over the counterrecoil plunger. The chamber moves. The plunger remains stationary.



The counterrecoil system, we have said, works with the recoil system to stop the recoil movement of the gun. Let's observe now just how this happens. Here is the gun held in battery by the compressed air in the counterrecoil chamber, pushing against the counterrecoil plunger.



This air pressure is maintained at approximately 1550 pounds per square inch when the gun is in battery position. This pressure is sufficient to hold the gun in battery at any elevation.



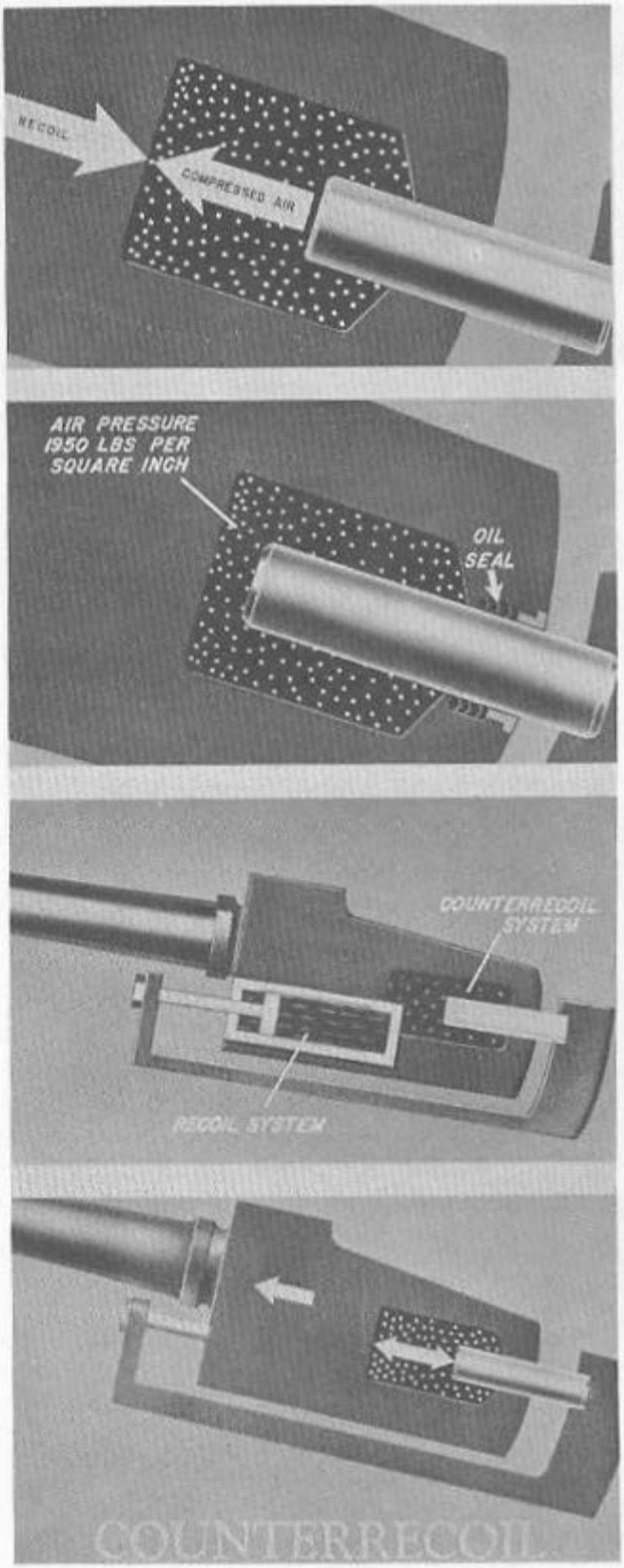
During recoil, as the air chamber moves back over the plunger, the air in the chamber is compressed still further. This air, however, offers a resistance to being compressed. And this resistance opposes the force of recoil and so slows down the recoil action.

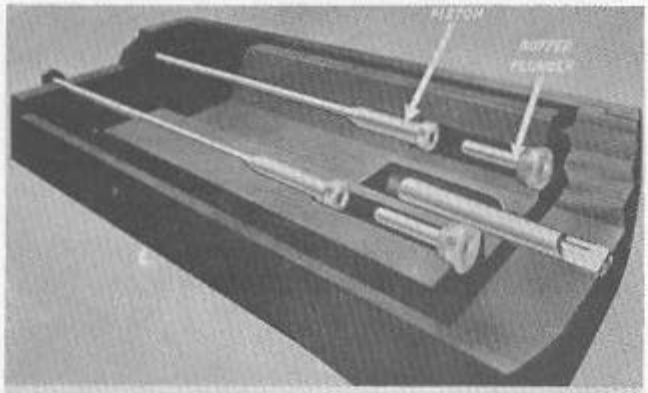
The recoil force acts to push the counter-recoil chamber over the plunger. And the force of the compressed air acts in the opposite direction to push the chamber away from the plunger. As recoil continues, the force of the recoil diminishes and that of the compressed air increases.

When the recoil movement ends, the pressure of the air in the counterrecoil chamber has increased to 1950 pounds per square inch. To hold this highly compressed air in the chamber there is, at its after end, an oil seal packing assembly of special design. We shall explain the action of this assembly in greater detail later.

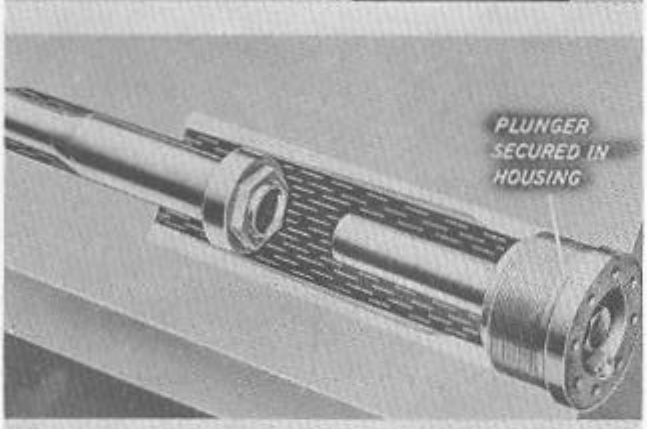
The gun's recoil action is stopped by the combined resistance of the two systems. The liquid in the recoil system resists displacement and the air in the counterrecoil system resists compression. Together these two forces opposing recoil, stop it.

After the recoil motion has been stopped the gun is returned to battery by the action of the counterrecoil system. The air pressure in the chamber acts on the plunger which thrusts against the slide read plate. As the high pressure air expands it pushes the barrel and breech housing forward toward battery position. If the extremely large force resulting from this high air pressure were allowed to act unchecked, it might return the gun to battery with a speed and impact that would damage it. For this reason the counterrecoil movement must also be controlled.

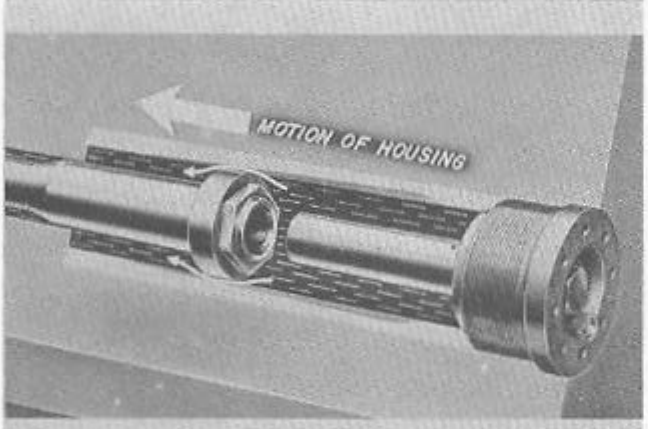




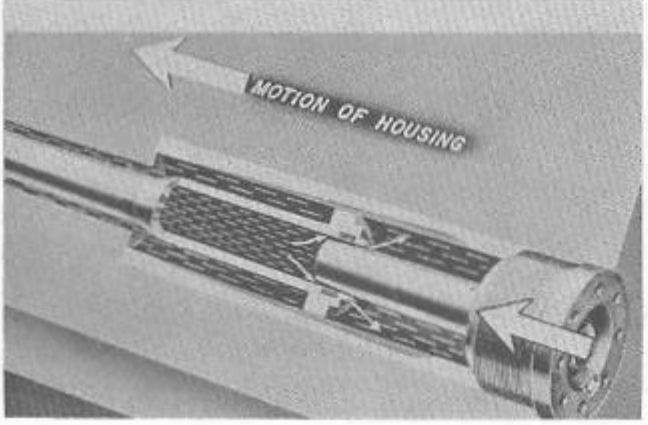
The buffing and controlling of the counterrecoil movement is done by the recoil system. Thus, in counterrecoil as in recoil, the two systems work together. You will recall that the recoil system consists of two cylinders and pistons located in the breech housing. To accomplish the buffing action a buffer plunger is fitted in the end of each recoil cylinder.



The buffer plungers are secured in the after end of the breech housing. Each buffer plunger is set so that it can move into an opening in the end of the recoil piston. Since the recoil cylinders are exactly alike, we shall again observe the action of only one of them.

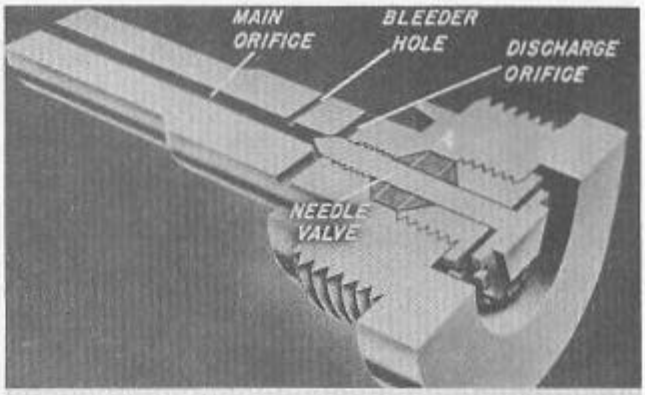


As the counterrecoil movement begins, the housing and recoil cylinder move forward over the recoil piston. This forces the recoil liquid to pass from the after end of the cylinder through the throttling grooves and into the forward end. The resistance of the recoil liquid to being moved helps to buff the counterrecoil movement.

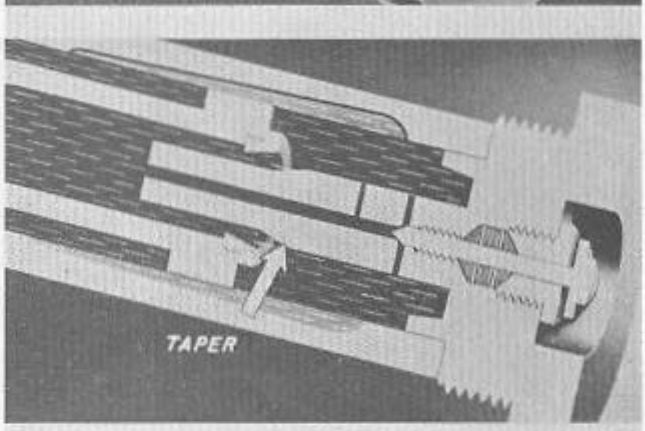


As this movement continues, the recoil buffer plunger enters the opening in the piston creating a dashpot effect. The recoil liquid inside the piston head is partially trapped and is allowed to flow out only through the small space around the buffer plunger. This dashpot effect partially resists the counterrecoil movement. To see how this movement is resisted and controlled further, . . .

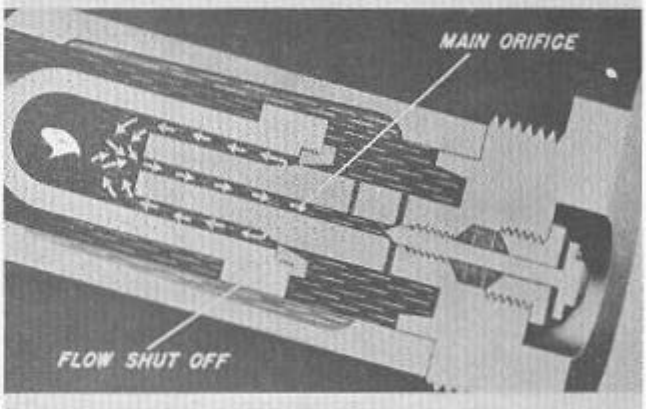
. . .we must examine the buffer plunger in greater detail. A main orifice runs through the center of the plunger. Near the base of the plunger is a bleeder hole and, just past it, a discharge orifice, both of which intersect the main orifice. Liquid flow through the discharge orifice is controlled by a needle valve.



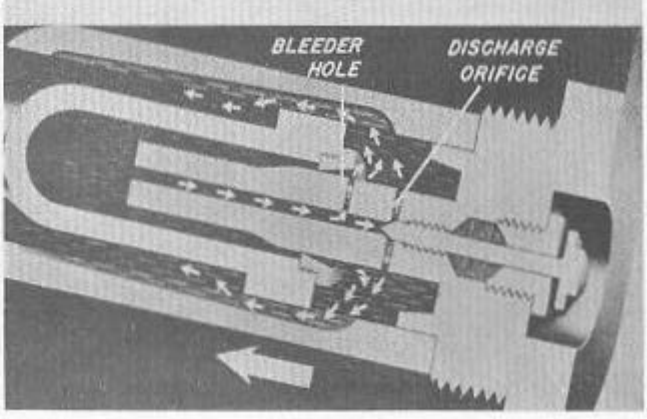
Notice, also, that this buffer plunger is tapered a few inches from its after end. So that we may better observe its action, we have exaggerated the taper.

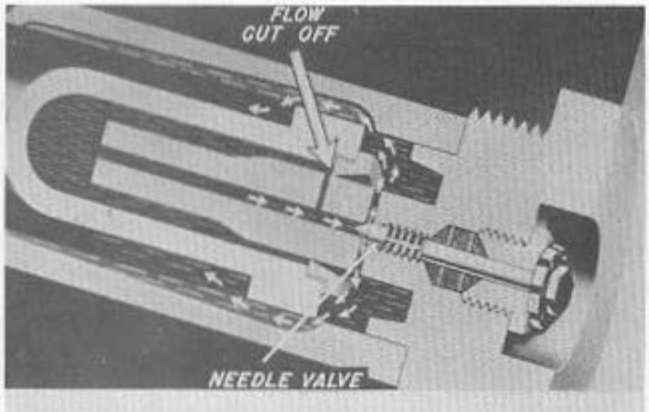


As counterrecoil continues and the recoil cylinder moves further over the piston the tapered section of the buffer plunger enters the opening in the piston completely shutting off the flow of liquid around the plunger. The recoil liquid is trapped in the piston head and is now forced to flow through the main orifice in the center of the plunger. . .

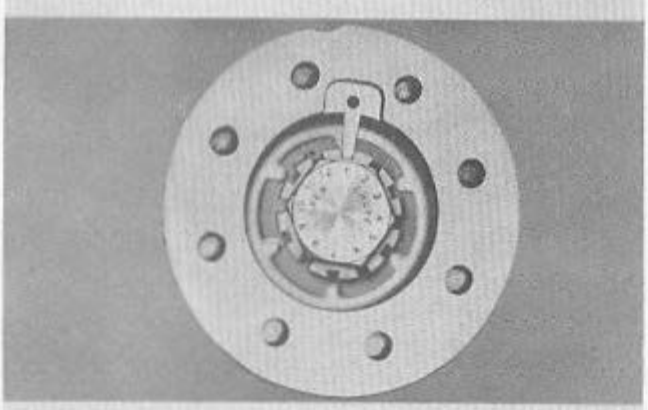


. . .and from there out through the bleeder hole and discharge orifices. This extremely restricted flow offers a large resistance to the counterrecoil movement which is, by this time, almost entirely stopped.

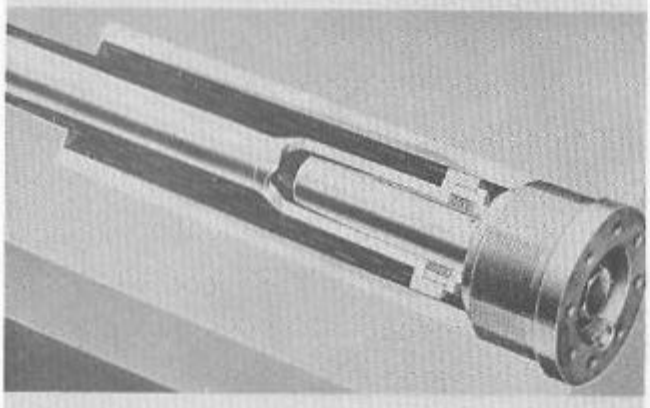




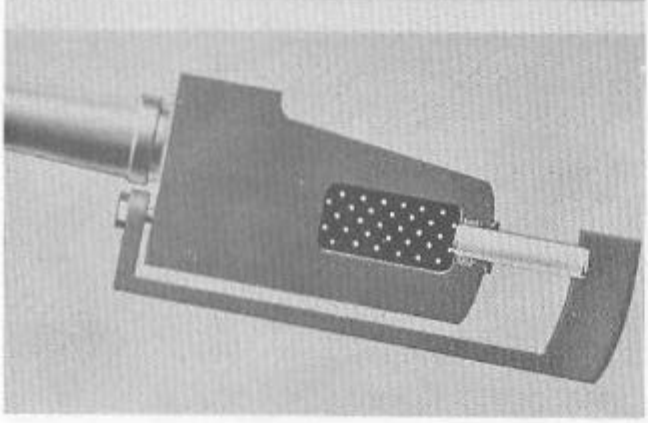
Counter recoil is stopped completely when, as the recoil cylinder moves further over the recoil piston, the flow of liquid through the bleeder hole is cut off and the liquid is forced around the needle valve and out through the discharge orifices. By controlling the amount of liquid flowing through the discharge orifices the needle valve controls the speed of counterrecoil.



The setting for each valve is made by means of a calibrated nut in the recoil cylinder head. Each valve is set at the proving ground to obtain proper functioning. Do NOT disturb the setting.

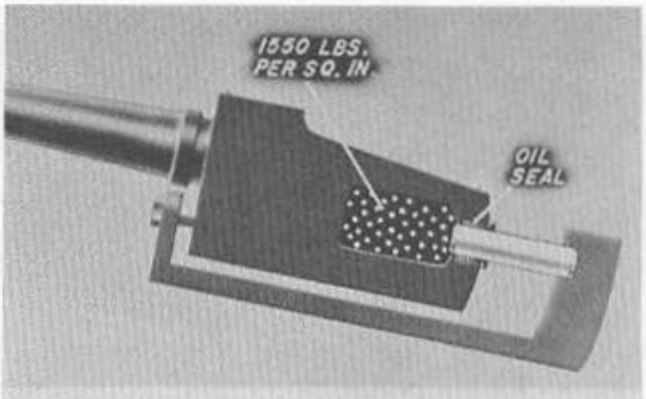


Thus, we have seen how the recoil cylinders, pistons, and buffer plungers control, buff, and finally stop the counterrecoil movement.

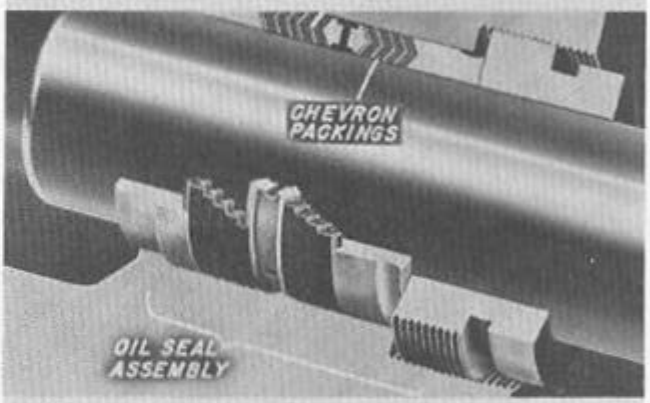


When the counterrecoil movement ends, the gun is in battery position. It is held in battery by the compressed air in the counterrecoil air chamber pushing against the counterrecoil plunger.

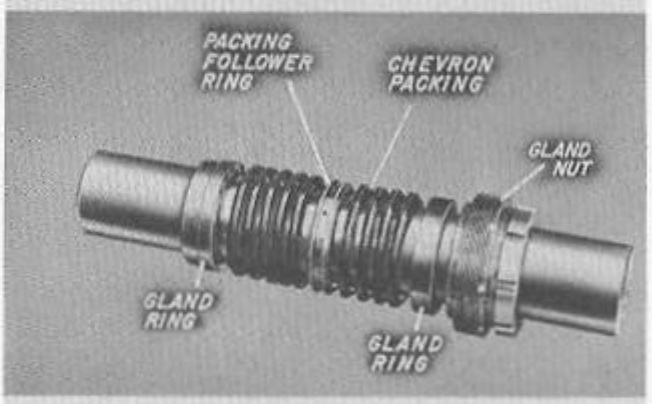
During counterrecoil the pressure of this air has decreased until, in battery position, it is again approximately 1550 pounds per square inch. So long as this air pressure is maintained the counterrecoil system will function properly. However, we are dealing here not only with high pressure, but also with a pressure that is constantly changing as the gun recoils and counterrecoils. To hold this changing high pressure in the chamber, we have, as we mentioned earlier, a specially designed oil seal. An oil seal is needed because packing alone would not suffice.



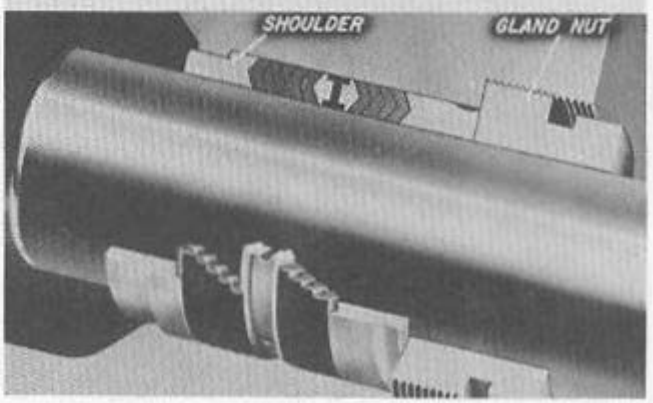
In this oil seal assembly are two opposed sets of chevron packings.

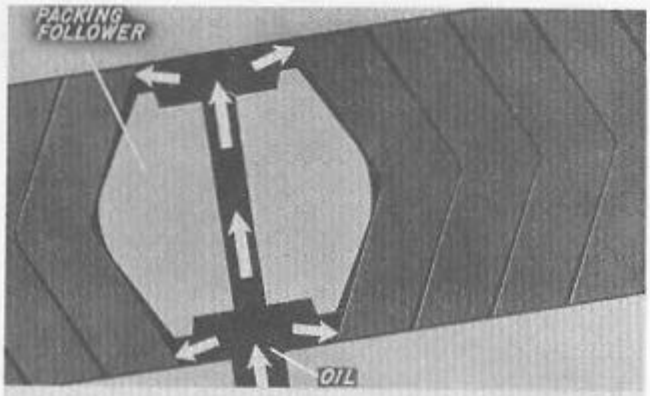


With the assembly spread out we can see in the center a packing follower ring through which oil under pressure can pass. This ring is flanked by the two opposed sets of chevron packings, which are in turn held in place by packing gland rings. At the after end of this assembly is a packing gland nut.

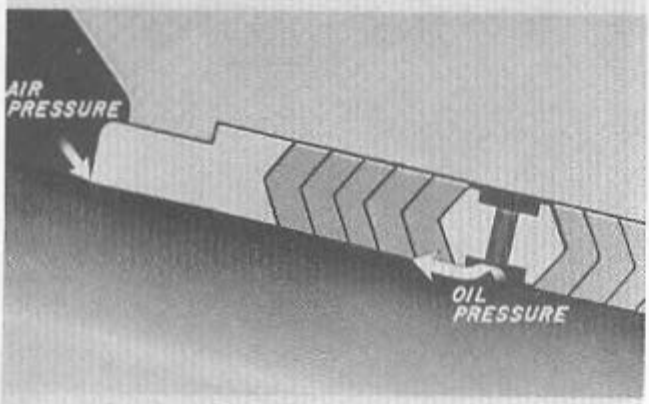


The whole packing assembly fits into a recess cut in the breech housing and is held in place between the shoulder of this recess and the packing nut which screws into the rear of the breech housing.

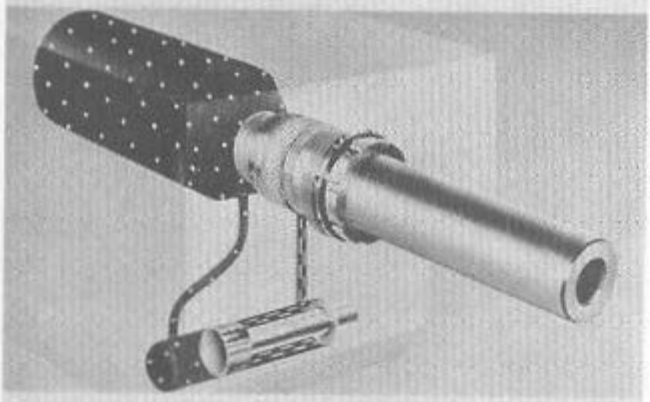




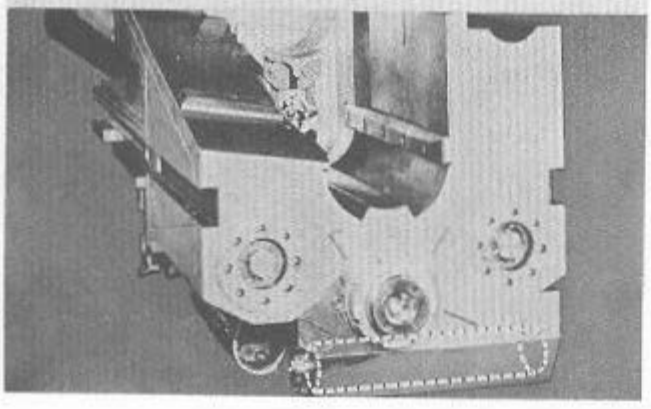
In this enlarged cross section we can see how oil under pressure is forced through the packing follower and against the chevron packings, expanding them so that they hold the high pressure oil to form a seal.



This oil seal will be effective only when the oil pressure in the seal is greater than the air pressure in the chamber. An oil pressure higher than that of the air will ensure that if any leaks are present the oil will leak into the air chamber, and loss of air from the chamber will be prevented.

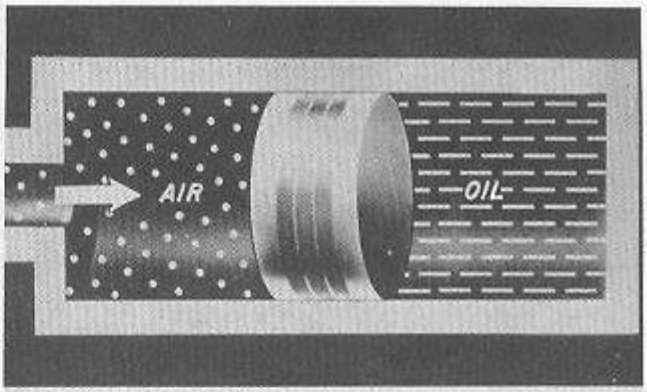


The necessary difference in pressure, or pressure differential, between the oil in the seal and the air in the chamber is maintained by an ingenious differential cylinder and piston arrangement which we shall now explain.

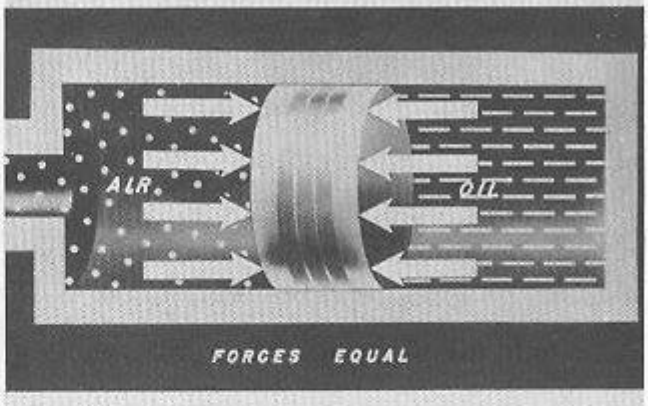


This differential cylinder is located underneath the breech housing at right angles to the counterrecoil air chamber.

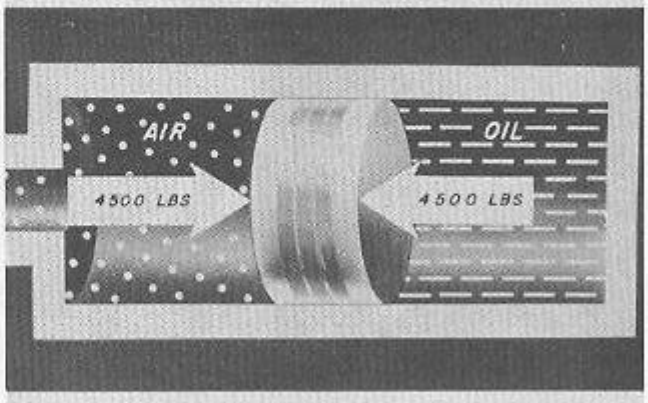
The principle of this differential pressure system can be explained briefly by a simple illustration. Suppose we have a cylinder closed at one end and containing a close fitting piston that is free to move within the cylinder. In the closed end of this cylinder we have a body of oil. The open end leads to a supply of air under high pressure.



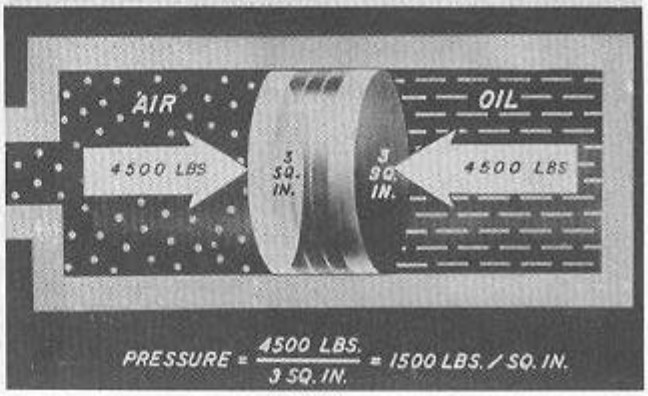
Any force exerted by the air will be transmitted through the piston to the oil. Because this is a closed system, and because liquids are not compressible, the oil will push back on the piston with the same force that the air is exerting on the piston. Thus, the total force exerted by the air must be equal to and opposite the total force exerted by the oil.

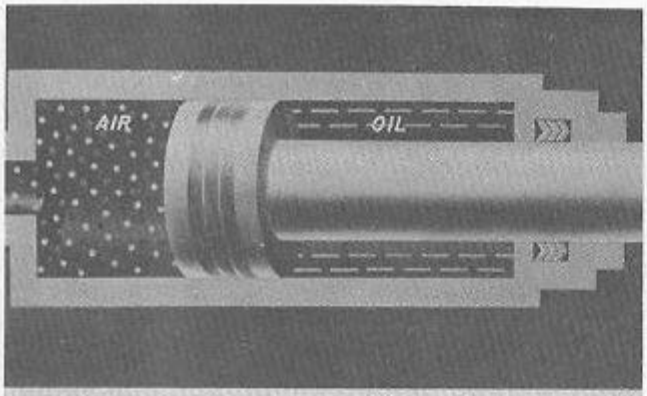


For example, suppose that the total force the air exerts on the piston is 4500 pounds. This force is transmitted through the piston to the closed body of oil which pushes back with an equal force, also 4500 pounds.

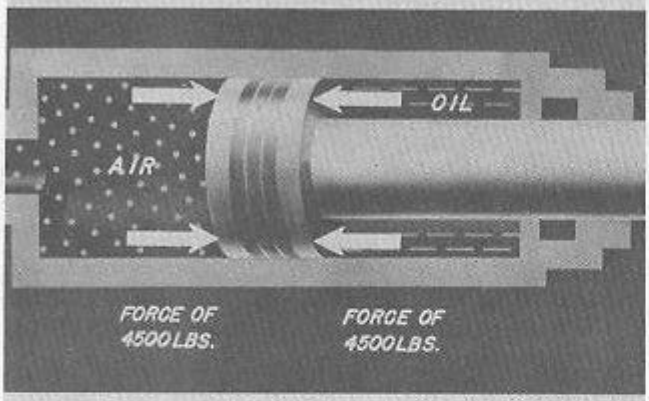


We have considered the total force of the air and the oil on the piston. Let's now consider the pressure. Assume the area of the end surfaces of this piston to be 3 square inches. If a total force of 4500 pounds acts on an area of 3 square inches the pressure, which is the force per square inch, will be 4500 pounds divided by 3 square inches or 1500 pounds per square inch.

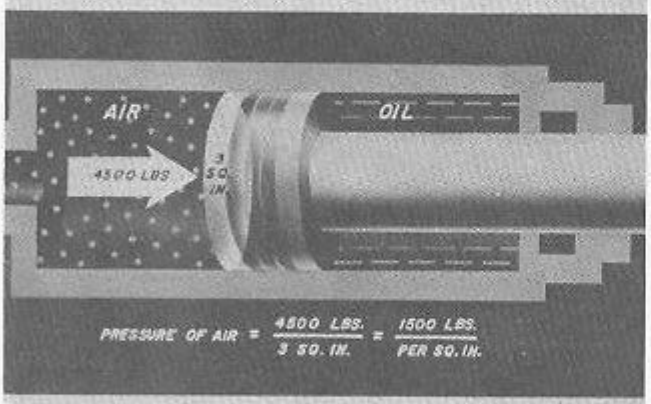




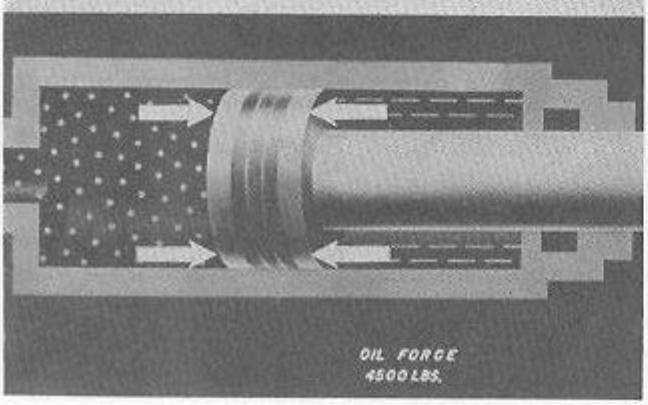
Now, let's change our system slightly. To the right end of the piston we attach a piston rod which extends through the cylinder out into the open air. This rod is fitted closely with chevron packings to ensure that the oil will remain locked in the cylinder.



With the piston rod present let's again consider the forces exerted by the air and oil. We have seen that these forces are equal and opposite. The presence of the piston rod does not alter this fact. If the force with which the air pushes against the piston is 4500 pounds, the force of the oil must also be 4500 pounds.

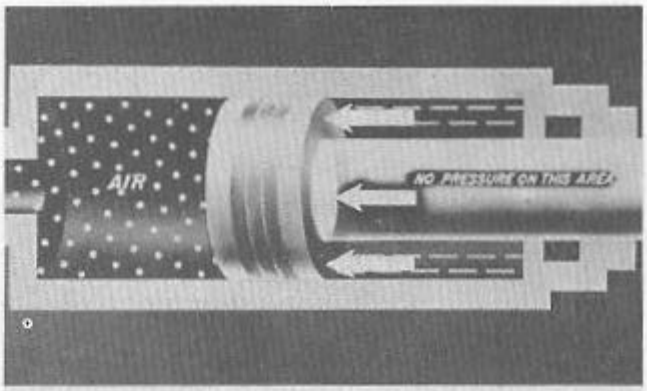


Now let's again investigate the air pressure, which we have seen is the force the air exerts on a square inch of the face of the piston. The air still acts on a piston area of 3 square inches. So its pressure remains 4500 pounds divided by 3 square inches, or 1500 pounds per square inch.

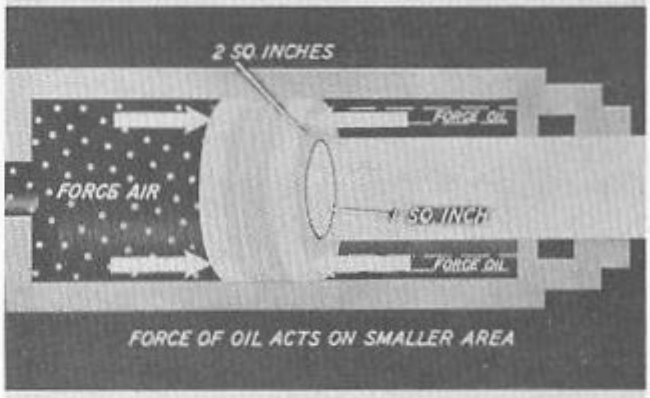


Now for the pressure of the oil. We have shown that the force of the oil must be the same as that of the air—4500 pounds. But some of the area of the piston face on which the oil presses has now been taken up by the piston rod.

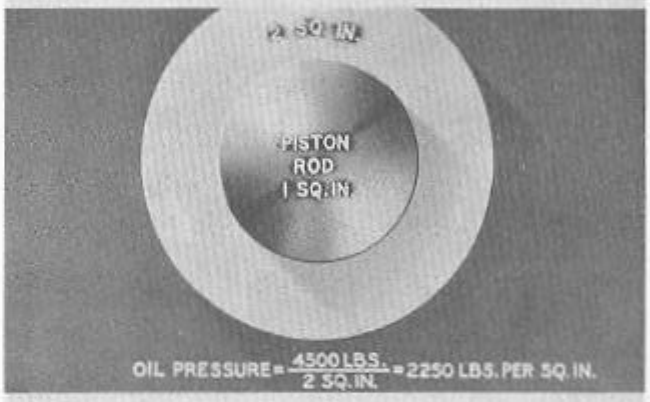
On this area of the piston face which is occupied by the piston rod, no oil is pressing. Thus, there is no pressure on this area of the piston.



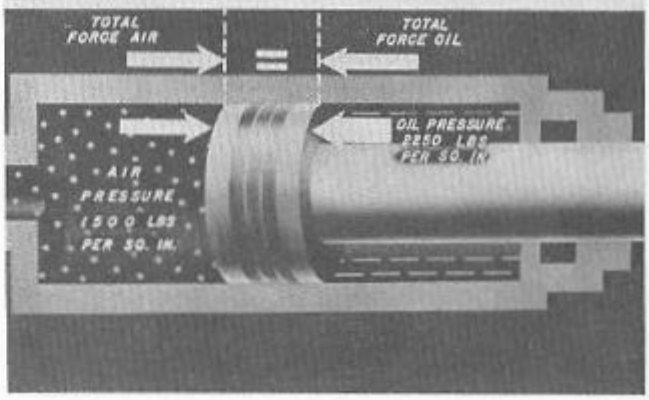
And so, while the force of the oil is still equal to the force of the air, the oil is now pressing on a smaller area. If the area of end surface of the piston rod is 1 square inch, then the area on which the oil now acts must be 2 square inches instead of 3 as before.

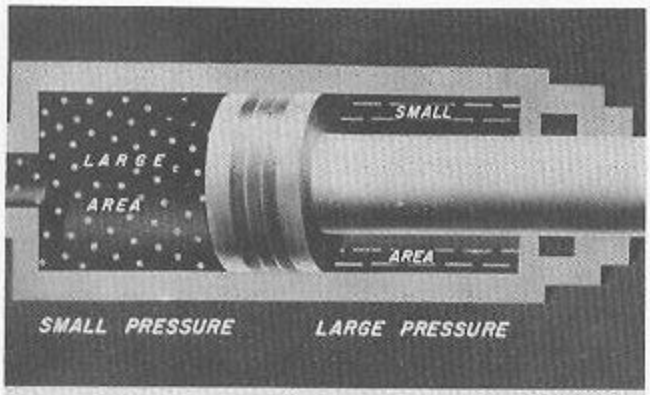


This is even more clear when we look at the end of the piston and piston rod. The rod occupies 1 square inch of the piston area, leaving 2 square inches for the oil to press against. The pressure of the oil, the force it exerts on 1 square inch of surface, is now the force of 4500 pounds divided by the 2 square inches on which the oil acts, a pressure of 2250 pounds per square inch.



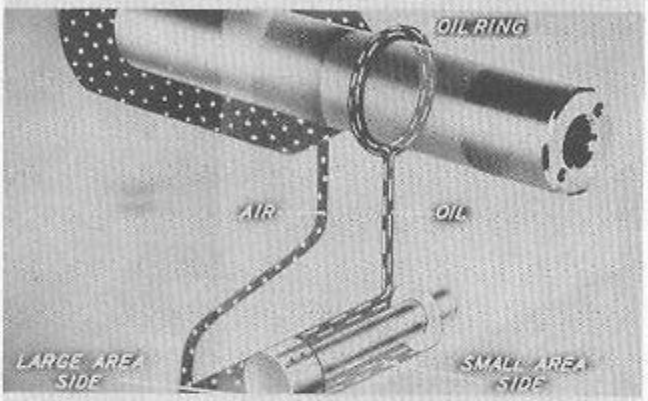
Thus, we see that while the total force of the air is still the same as and equal to that of the oil, the oil pressure, 2250 pounds per square inch, is greater than the air pressure, 1500 pounds per square inch. Thus, a difference in pressure, or pressure differential, has been created.



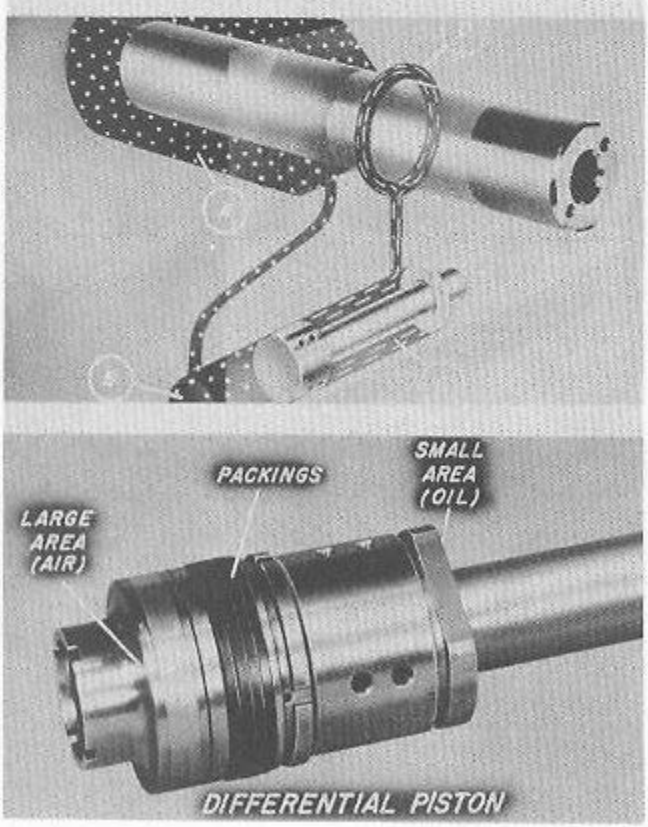


You can see now that the pressure of the oil will always be greater than that of the air, no matter what the pressure of the air is. This is true because the area on which the oil acts is smaller than that on which the air acts. This is the principle of the differential piston used in the 5"/38 gun.

Let's see now how this differential in pressure is used to seal the air in the counterrecoil air chamber of this gun. Compressed air from the chamber is channeled to the large area side of the differential piston. Oil in the small area side of the piston is channeled to a closed oil ring. The oil circuit is completely closed. Because the oil is incompressible, the pressure at the piston head is transmitted through the liquid and is for this reason the same in the oil ring as in the cylinder itself. This oil ring fits closely around the counterrecoil plunger. The oil is held in by the chevron packings and packing followers which were mentioned earlier.

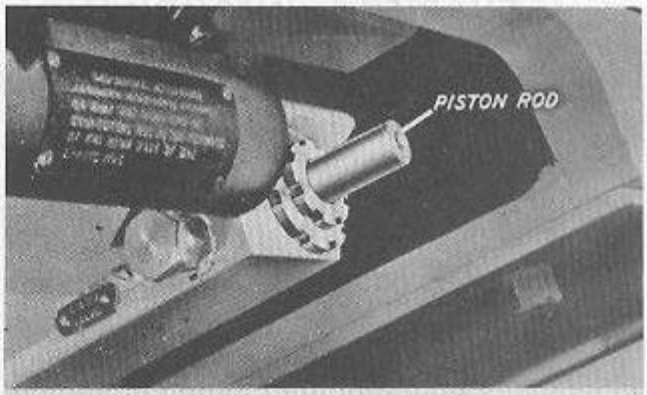


The air pressure in the counterrecoil chamber, at A, is transmitted to one side of the differential piston at B, where the resulting total force of the air on the piston is balanced by an equal force which the oil exerts against the piston. While the total force of the air and the oil are the same, the pressure of the oil is greater, because its force acts on a smaller area. This oil pressure at C is transmitted undiminished through a closed oil ring circuit around the counterrecoil plunger at D. The oil pressure in this ring is always greater than that of the air in the chamber. If there are leaks in the seal, it will be the oil that escapes into the air chamber. As the air pressure increases, as it does during recoil, oil pressure will also increase proportionally and will still effectively seal the air in.

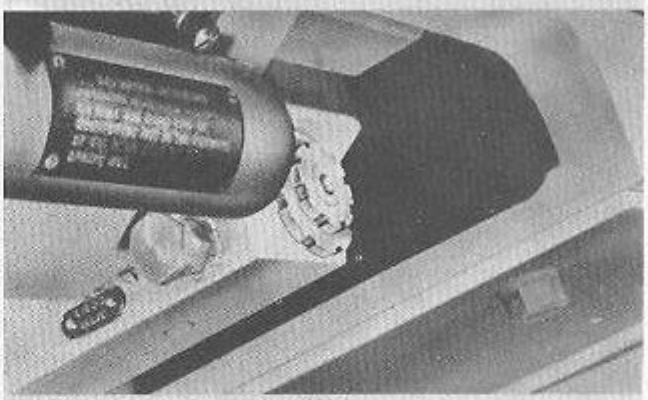


Here, in a photograph of a differential piston, we may see how it actually looks. In this view, we can see the large area side of the piston head against which the air presses, the small area side against which the oil presses, and packings in between which prevent air leaking out at this point. The piston is housed. . .

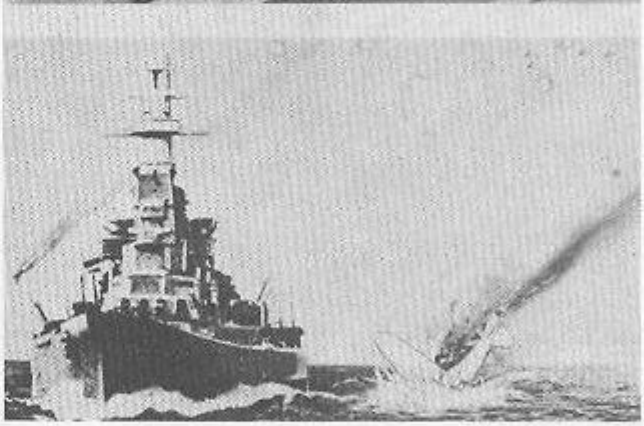
. . .in the differential cylinder located underneath the breech housing. Extending through the cylinder into the open air is the piston rod. The position of the piston rod indicates the extent of the oil supply within the cylinder. When the piston rod is extended (as shown here) the supply of oil in the cylinder is low. In this case, oil should be added. . .

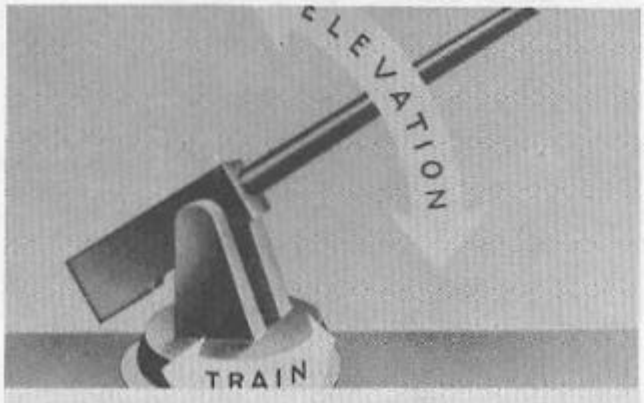


. . .until the end of the piston rod is flush with the gland nut at the end of the cylinder, through which the rod passes. This position of the piston rod indicates that the correct amount of oil is being maintained within the cylinder.



If the recoil and counterrecoil systems are properly maintained, the gun will recoil and return to battery in less than 1 second. So you can see why a thorough understanding of how these systems work is essential if you are to keep this gun punching, and punching fast, against the enemy.

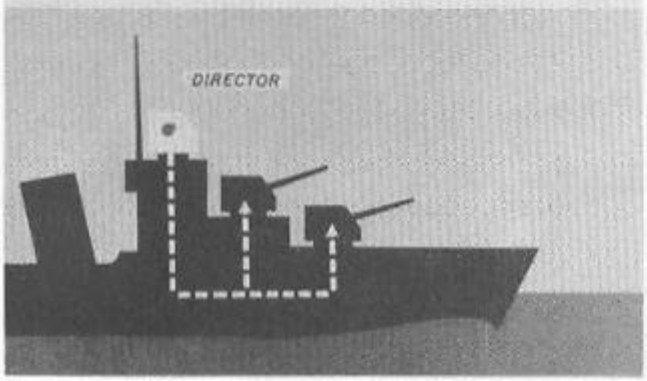




One of the most important jobs that any gun mount must do is that of providing for the movements of the gun in train and elevation. Effective firepower demands that these movements be rapid, accurate, and smooth. In order for any gun to be moved so that it may be brought onto and allowed to follow a target, two requirements must be met.

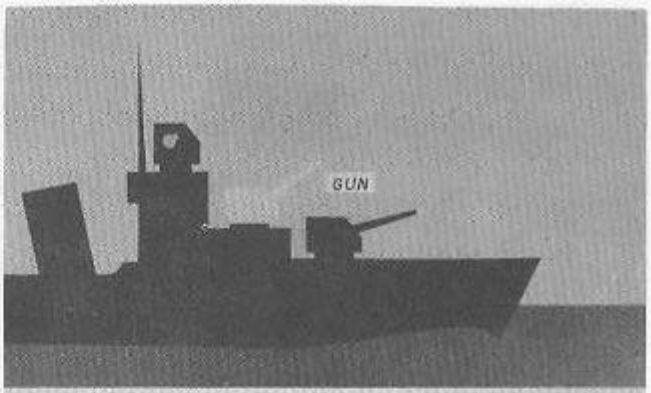
First, there must be a signal to move the gun in a given direction.

Second, there must be a source of power to accomplish this movement.

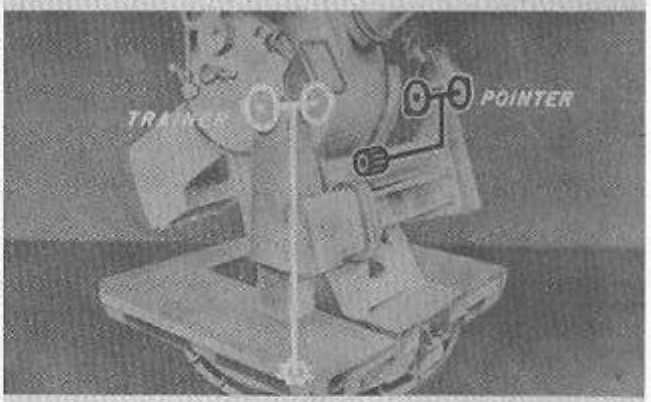


With the 5''/38, the signal to move the gun may originate in either of two places—at a director mounted high in another part of the ship,. . .

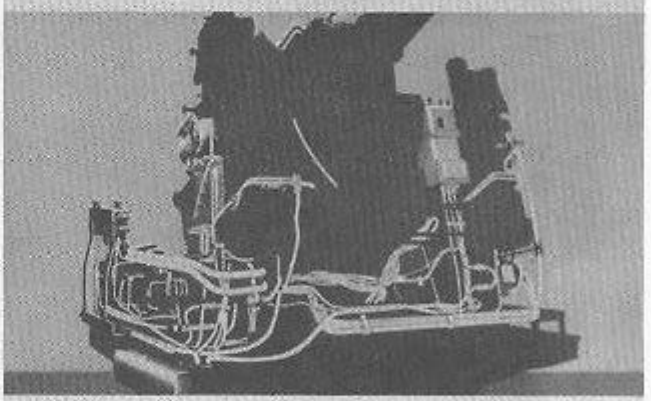
. . .or at the gun itself where, when the pointer and trainer see an enemy target, they can aim the gun so as to hit it.



The power required to move the 5"/38 gun and mount is of two kinds. First, it can be supplied manually, which is just another way of saying that the trainer and pointer, by applying some good old-fashioned elbow grease to their handwheels, can train the mount and elevate the gun by direct mechanical means.

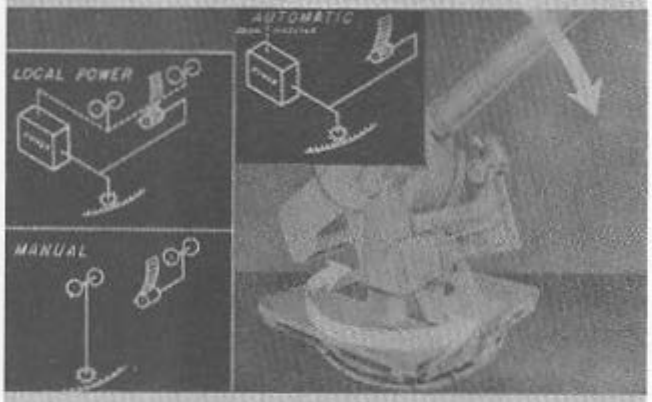


Or second, the gun and mount can be moved by ELECTROHYDRAULIC POWER DRIVE. This power drive, in turn, can be used to control the gun in two ways.

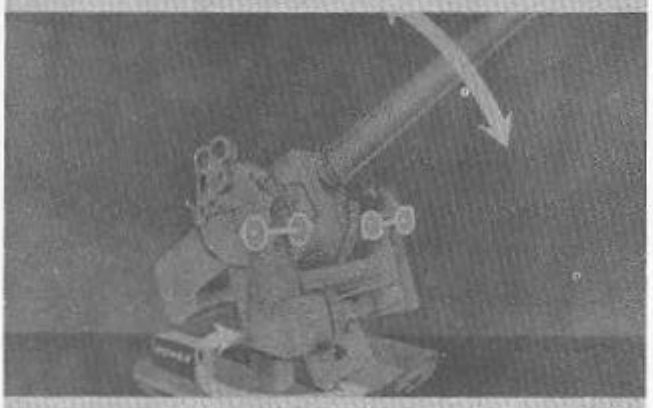


First, it can be used in local power control in which the trainer and pointer move their handwheels to give the signal which controls the power drive in training the mount and elevating the gun.

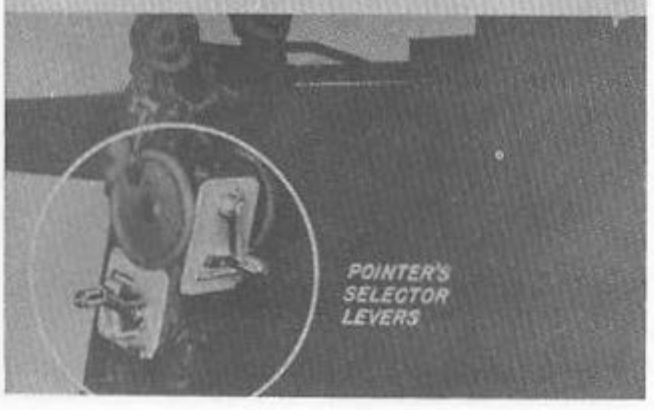
And second, the power unit can be operated by signals from a director, and so provide automatic control of train and elevation. Automatic control is the preferred method, because it is faster, easier, and more accurate.



To sum up briefly, there are three possible methods of control. First, is automatic control, which allows signals from a director to be transmitted directly to the power drive to train and elevate the gun automatically. This is the preferred method. Second, is local power control, wherein signals from the handwheels are transmitted to the power unit. Local power control is used where it is either not possible or not desirable to receive signals from a director. And third, is manual control, which allows the mount to be trained and the gun elevated only by direct mechanical means from the trainer's and pointer's handwheels. Manual control is used generally as a standby method when the power drive is not operating.

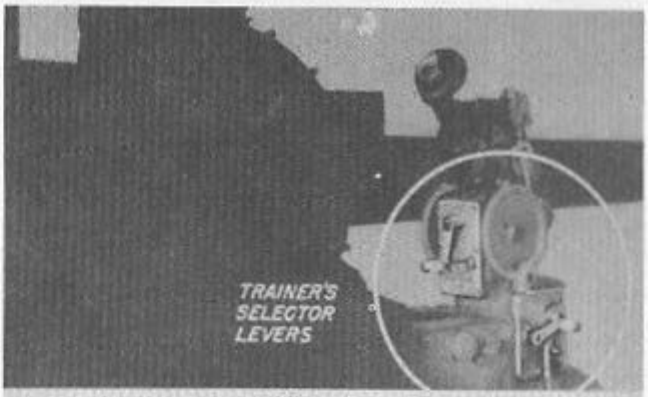


The same three methods of control, automatic, local power, and manual, operating in the same manner, are used both in train and elevation. The correct type of control to be used in any given situation depends upon conditions encountered in combat. However, once determined, the method of control to be used. . .

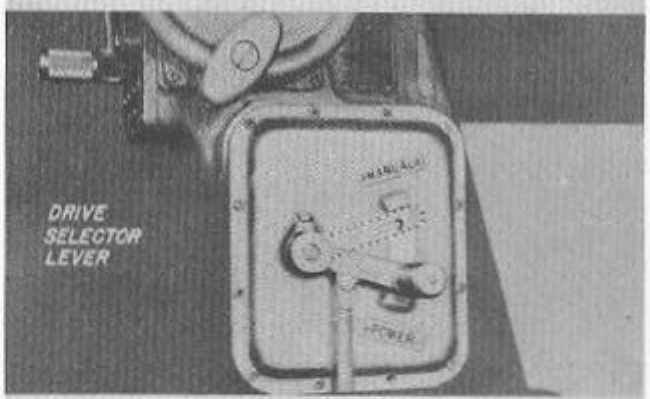


. . .is set by two pairs of selector levers– one pair, the pointer's selector levers, located on the pointer's bracket, selects the type of control to be used in elevation.

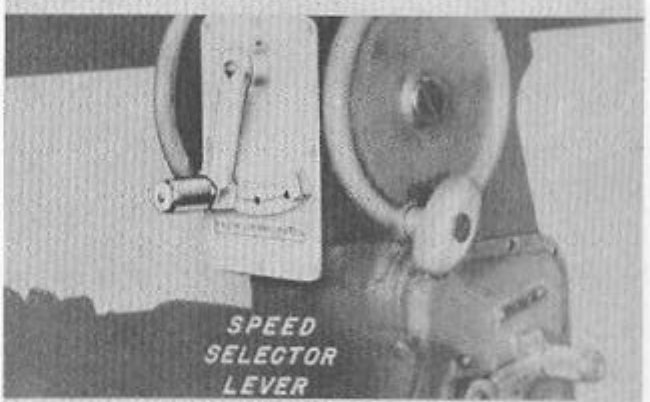
The other pair, the trainer's selector levers, on the trainer's bracket, selects the type of control to be used in train. The pairs of levers operate in the same manner. So, to show how they work, we shall discuss in detail only the setting of the select setting of the trainer's selector levers. These two levers work together jointly to select the type of control to be used in train. The lower of these two levers. . .



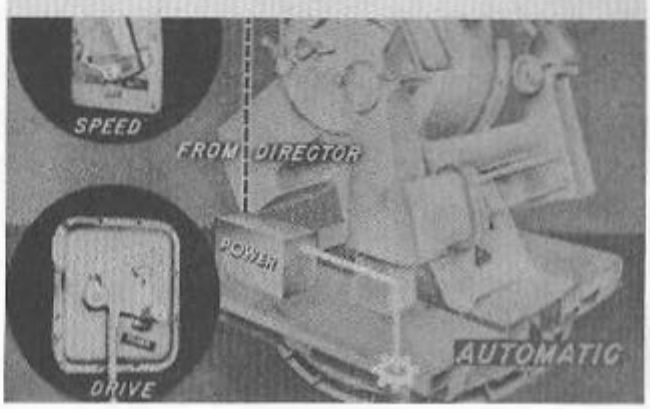
. . .is the drive-selector lever. It has two settings.—MANUAL and POWER. When set to MANUAL, it allows the mount to be trained mechanically by the handwheels. When set to POWER, it causes the hydraulic power drive to be cut in, allowing the mount to be trained under local power or automatic control. To select either one of these controls with the drive-selector lever at POWER,. . .



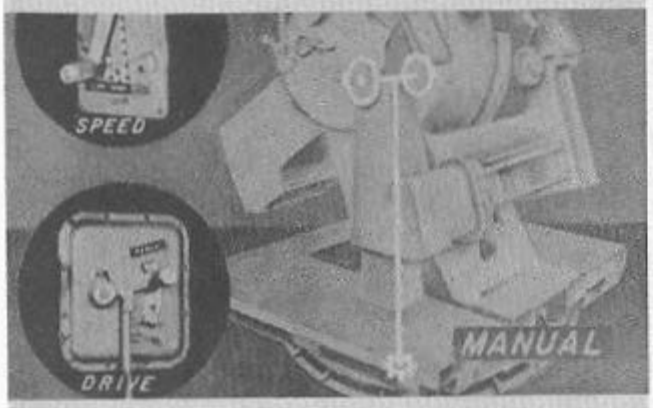
. . .we must also set the upper lever, called the speed-selector lever, to one of its three positions—AUTOMATIC, HIGH, or LOW.



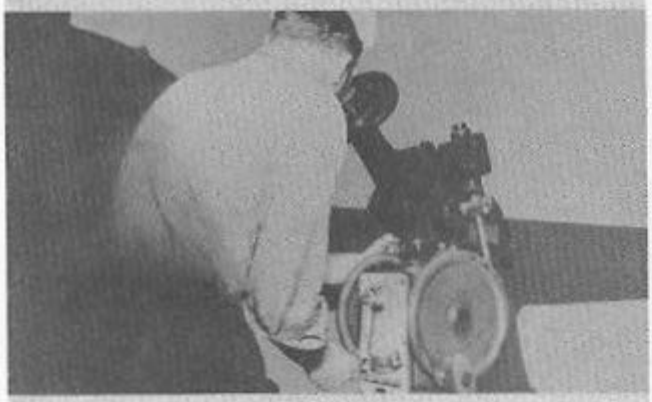
With the drive lever at POWER, the speed-selector lever is set to AUTOMATIC to cut out the handwheel control and allow the gun to be trained by the power drive entirely in response to signals from the director.



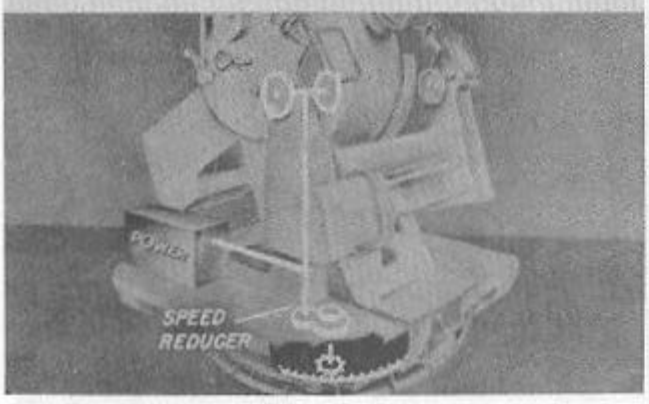
With the drive-selector lever at POWER, the speed lever must be set to HIGH or LOW to enable the mount to be trained under local power by the power drive in response to signals from the handwheels. Whether the setting is HIGH or LOW depends upon the training speed required.



For manual operation in train, the mechanical linkage from the handwheels must be cut in by setting the drive-selector lever to MANUAL and the speed-selector lever to LOW or HIGH.

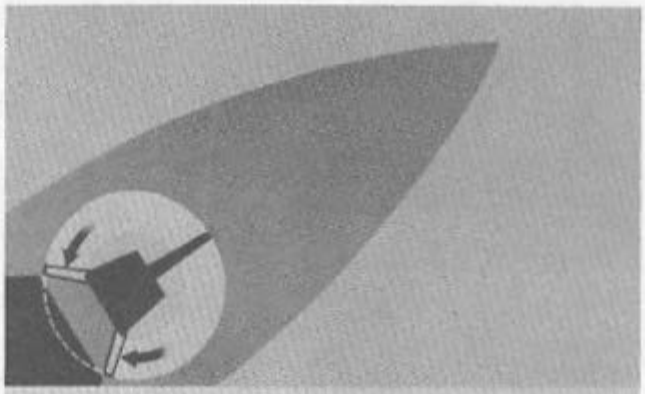


Knowing how and when to operate these selector levers is important in battle where you'll not only have to think accurately and fast in setting the levers to control the guns, but will often have to make the settings without looking. Now that we have seen how the levers operate to select the type of control to be used in train and elevation, . . .

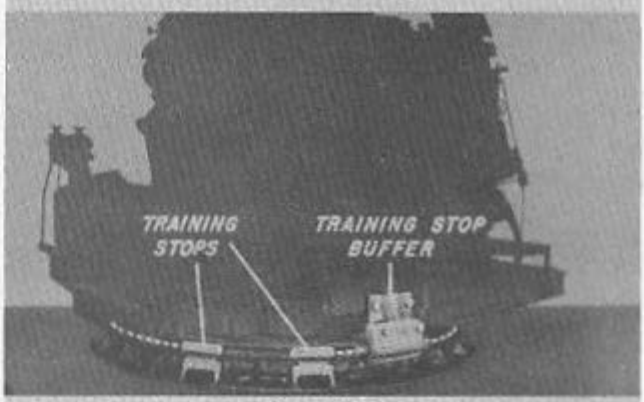


. . .let's take a look at the train and elevation gearing itself. In train, the power input from either the handwheels or the power drive acts through a speed reducer on the mount platform to rotate the train pinion which meshes with the training circle in the stand. Because the training circle is fixed, rotation of the train pinion will cause the mount to be rotated, and so move the gun in train.

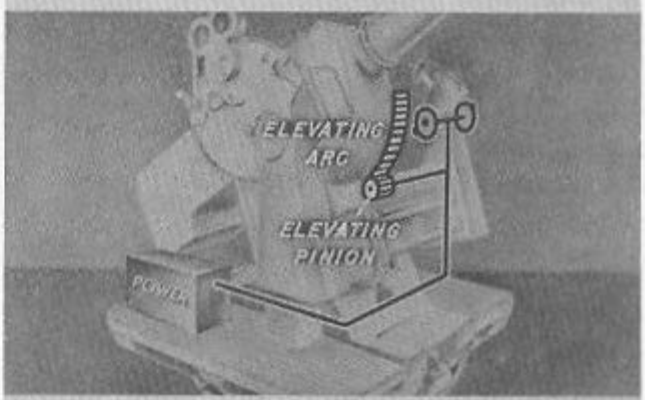
The gun is designed to permit train through 360 degrees. But, aboard ship, this train must be limited to prevent the gun from striking or firing into parts of the ship's structure. For this reason,. . .



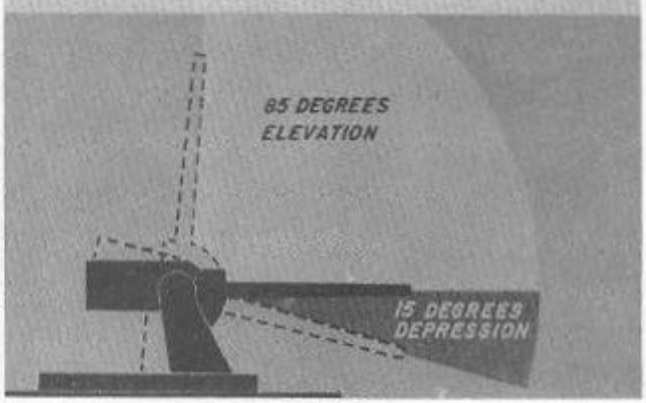
. . .a hydraulic training stop buffer is provided on the base ring. Train in either direction is stopped when the buffer strikes a training stop that is secured to the stand.

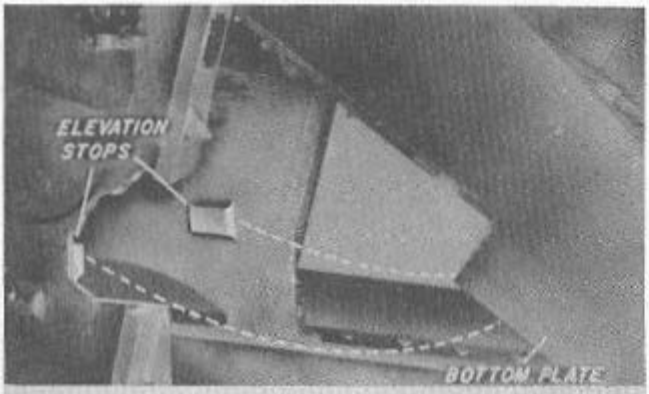


As in the case of train, the gun is elevated by rack and pinion gearing. An elevating pinion, rotated either by the power drive or the pointer's handwheels meshes with the gear segment called the elevating arc to elevate the gun. In this case, it is the gear that moves and the pinion that remains fixed.

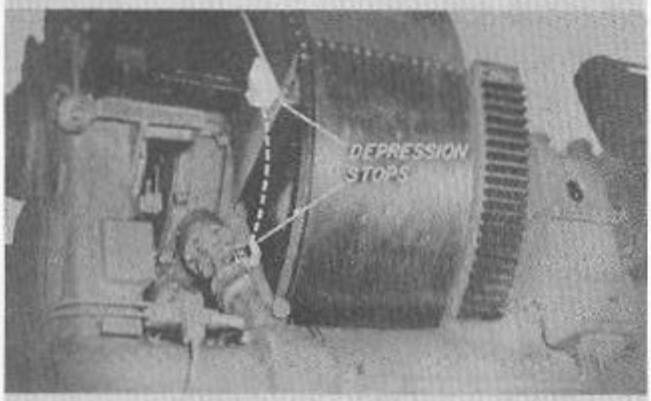


The gun can be elevated to 85 degrees above, and depressed to 15 degrees below the horizontal. To keep the movement within these limits, . . .

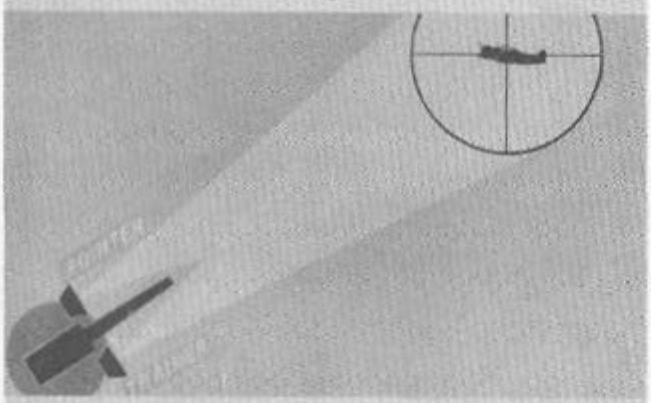




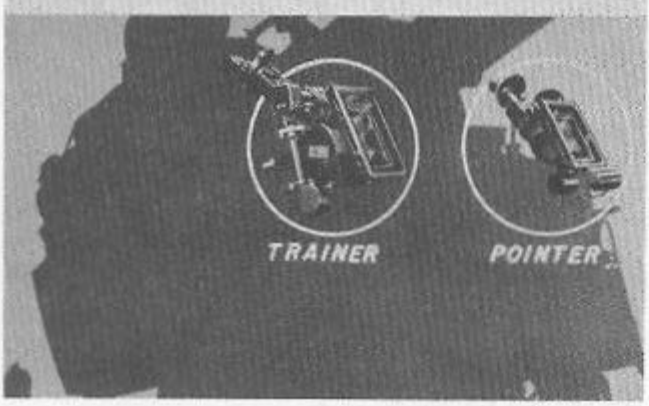
. . .positive stops are provided. When the gun reaches maximum elevation, a bottom plate at the after end of the slide strikes two elevation stops welded to the inner sides of the cheeks.



The limit of depression is reached when positive stops on the cheeks stride stops on the slide. Here we see one set of these depression stops.

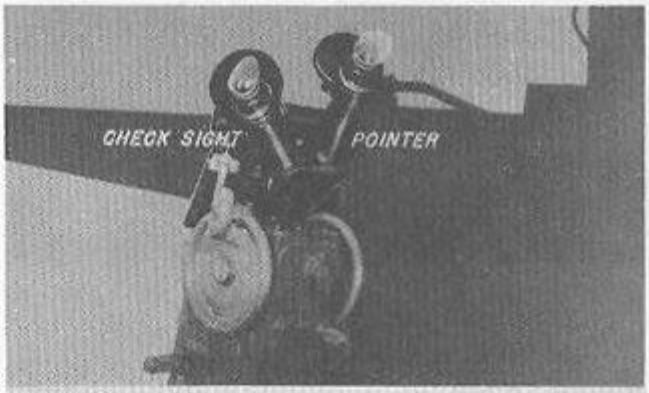


We have seen how the gun is moved in train and elevation. The purpose of these movements is to bring the line of sight on the target. The pointer and trainer do this by viewing the target through their telescopes, and turning their handwheels to keep the line of sight on the target. The sights are the eyes of the gun. They must be clear and accurate. Without sights that function properly, the gun is blind and virtually useless. Let's take a quick look at how the sights of this gun operate.

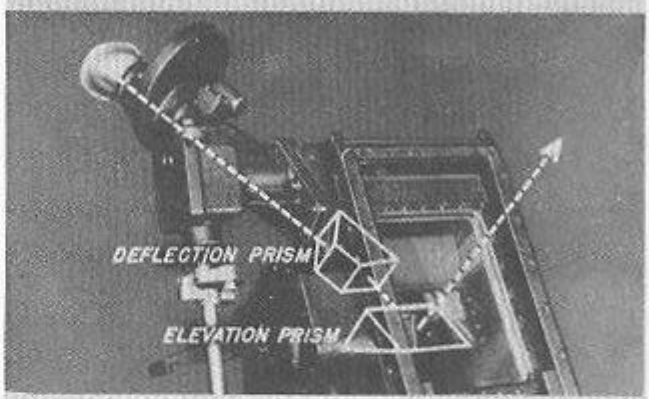


In sighting, the trainer and pointer look through telescopes mounted on their respective brackets.

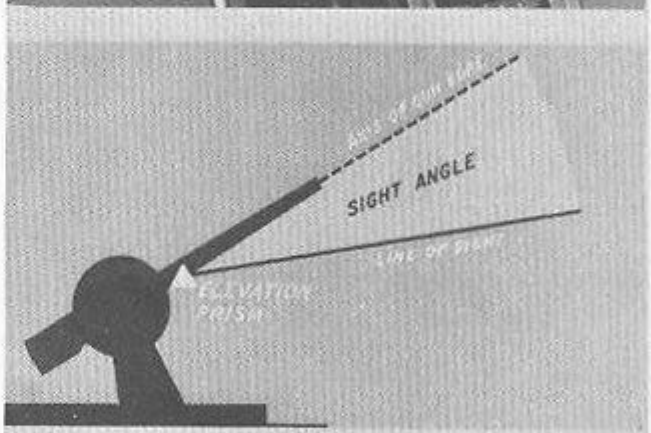
An additional telescope, used for check sighting, is included in the same housing with the pointer's telescope. Since it is not required in the operations we are about to describe, however, we shall not mention it again.



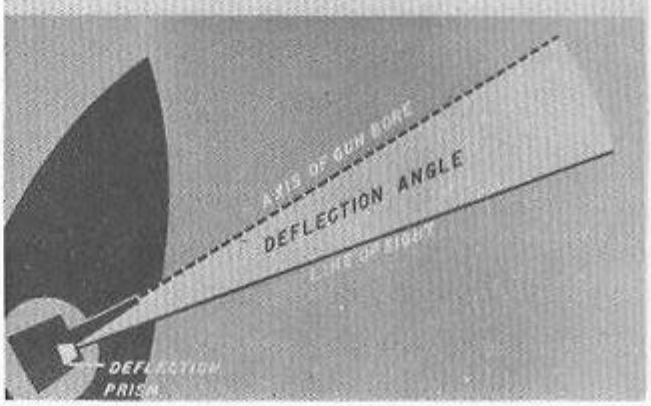
Each telescope contains a deflection prism and an elevation prism. Both prisms can be moved.

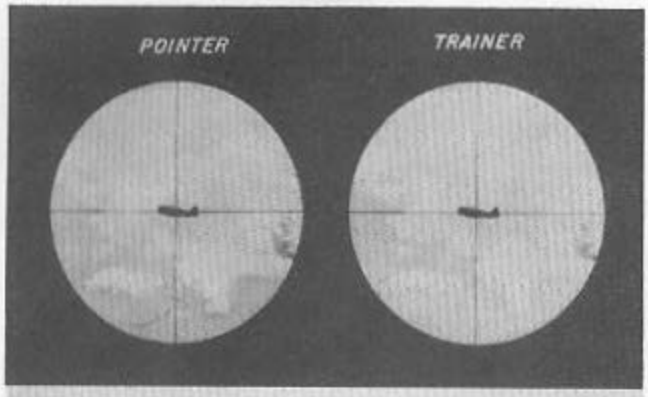


The elevation prism is moved to elevate or to depress the line of sight. This establishes a sight angle between the line of sight and the axis of the gun bore.

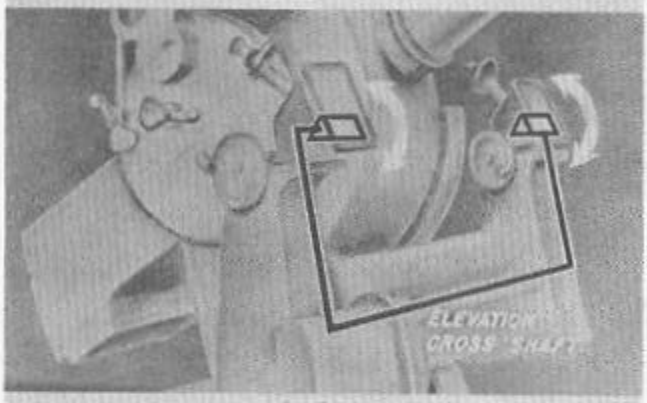


Looking down on the ship, we see that the deflection prism is moved to deflect the line of sight to the right or left. This establishes a deflection angle between the line of sight and the axis of the gun bore.



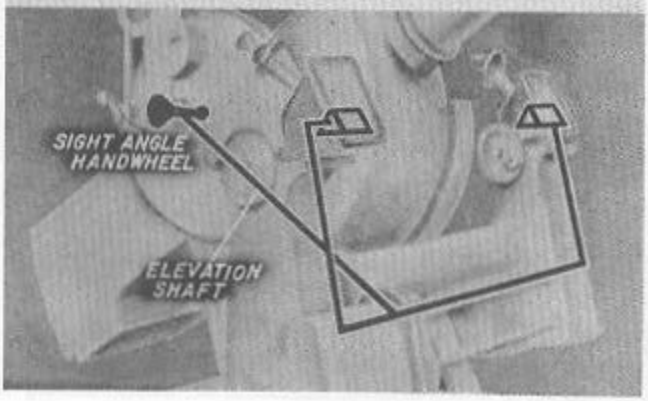


If the gun is to be aimed properly, it is obvious that the pointer and trainer must see the same image through their telescopes at the same time. To make this possible, the two elevation prisms must move together. And the two deflection prisms must also move in unison. For this reason,. . .



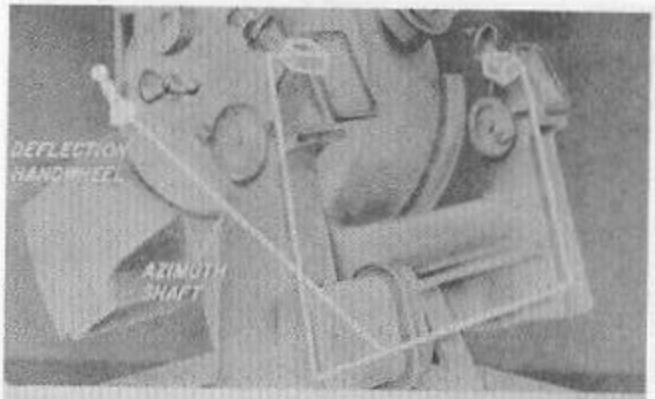
. . .the two elevation prisms (one in the pointer's telescope and one in the trainer's telescope) are connected by vertical shafts and a cross shaft.

And, in the same manner, vertical shafts and a cross shaft cause the two deflection prisms to be moved together.

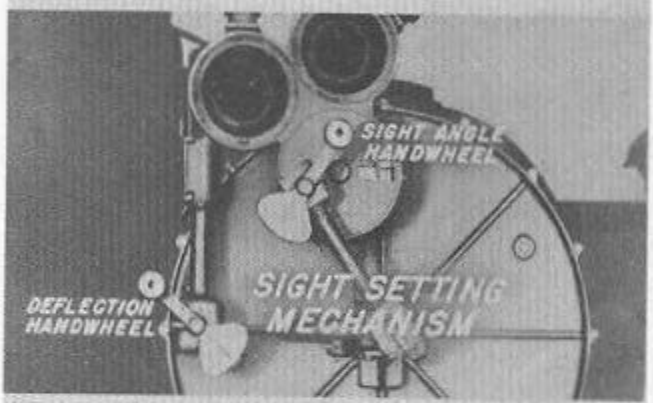


To set the sight angle, the elevation prisms must be moved. For this reason, they are connected by an elevation shaft to the sight angle handwheel.

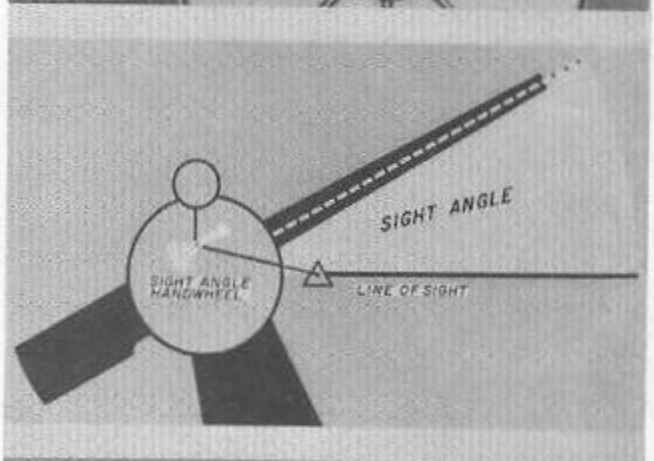
And, so that their movement may also be controlled, the two deflection prisms are connected by an azimuth shaft to the deflection handwheel.



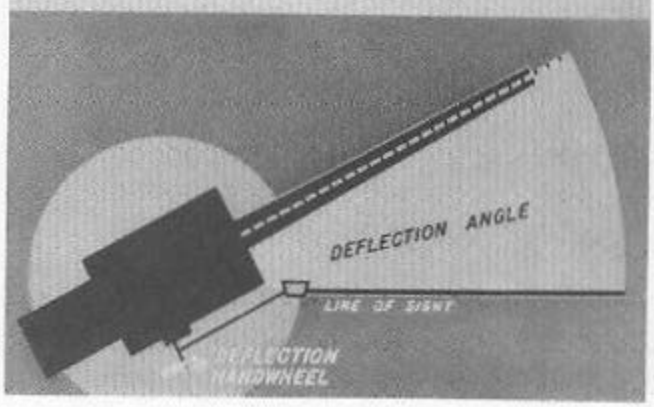
The deflection handwheel and the sight-angle handwheel are located on the housing of the sight-setting mechanism. Because it is treated in detail in a later chapter, we shall discuss here only briefly the function of the sight-setting mechanism.

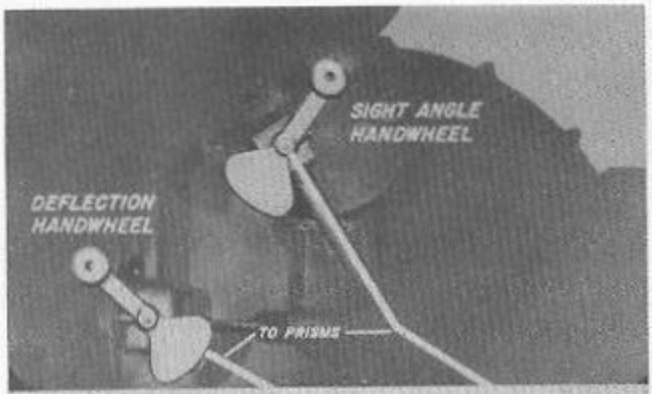


One purpose of the sight-setting mechanism is to set the prisms. Turning the sight-angle handwheel moves the elevation prisms to establish the proper sight angle. The sight angle provides an elevation of the gun above the line of sight and so compensates for the trajectory of the projectile in flight.

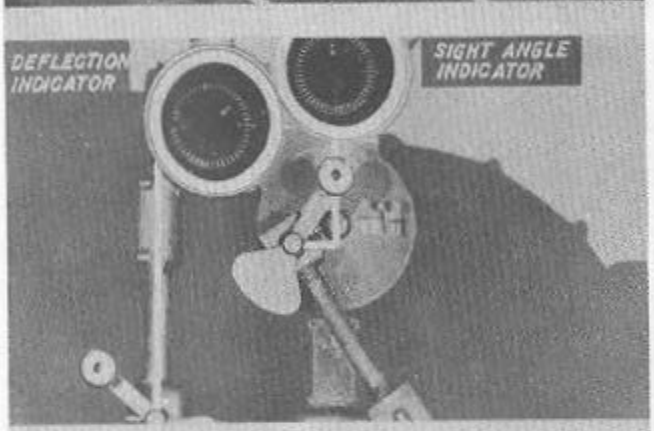


Turning the deflection handwheel moves the deflection prisms to establish the proper deflection angle. The deflection angle offsets the gun to the right or left of the line of sight. This offset compensates for movement of the target, movement of our own ship, windage, and for the drift caused by the rotation of the projectile in flight.



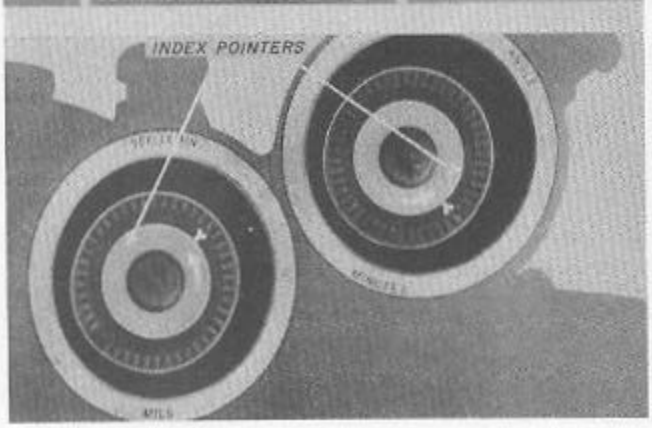


Turning the handwheels moves the prisms, because, as we observed a moment ago, the handwheels are connected to the prisms through shafting.



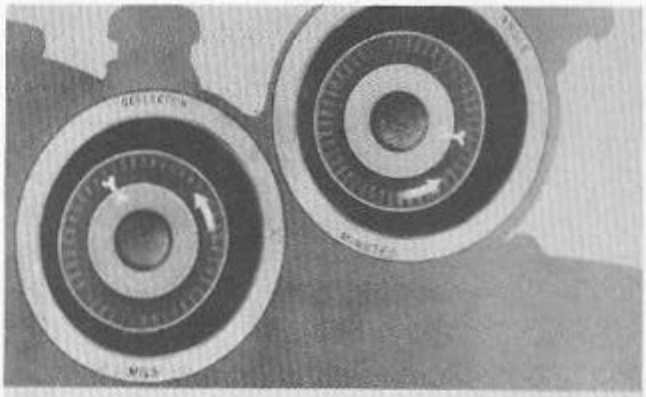
The handwheels are also connected to the sight-angle indicator and the deflection indicator.

These indicators each have an outer dial and an inner dial. It is to the outer dials that the handwheels are connected. So, we see that turning the handwheels not only moves the prisms, but also indicates the amount the prisms have been moved on the outer dial.

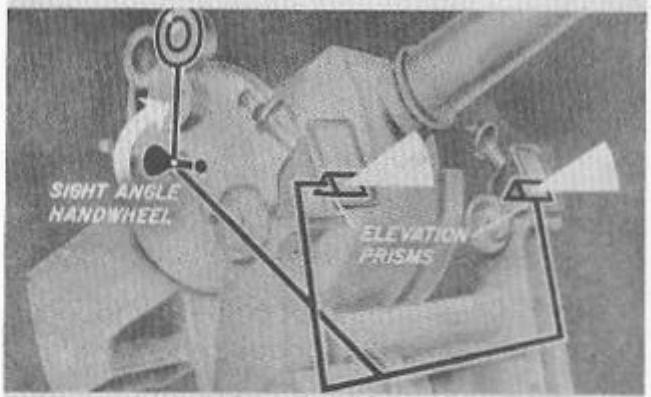


The inner dials of these indicators are controlled by a computer in another part of the ship. As signals for deflection angle and sight angle are transmitted by the computer, the inner dials rotate carrying index pointers around with them.

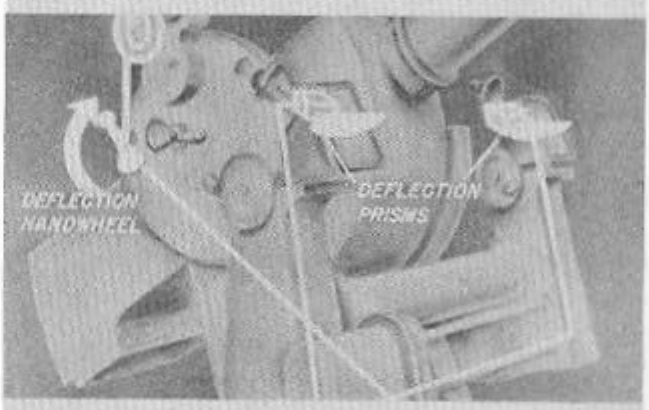
Index pointers on the outer dials are then matched up with index pointers on the inner dials by turning the deflection and sight angle handwheels. Turning the handwheels. . .



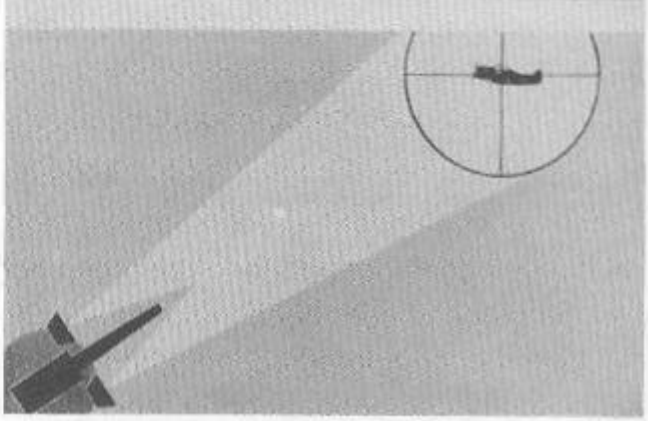
. . .also moves the prisms. Thus, turning the sight angle handwheel to match up the pointers on the sight angle indicator has moved the elevation prisms to set the sight angle determined by the computer.



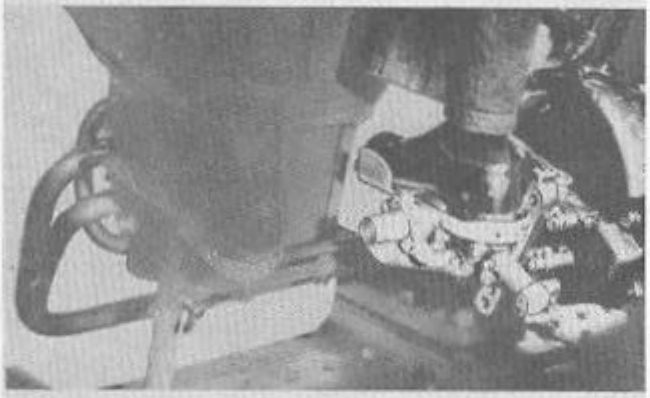
And turning the deflection handwheel to match up the pointers on the deflection indicator has moved the deflection prisms to set the deflection angle determined by the computer. In this way the computer signals for the correct sight angle and deflection angle are transmitted to the prisms in the telescopes.



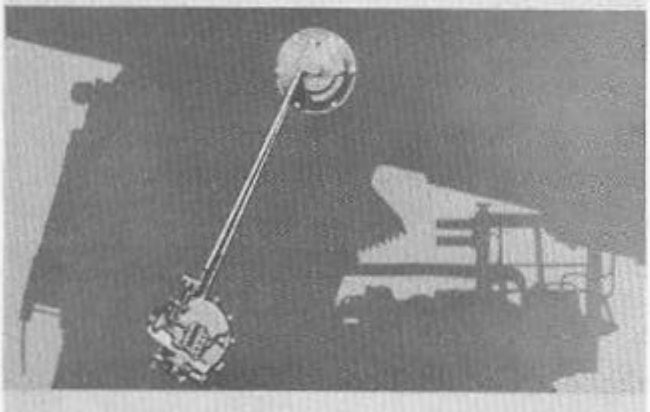
We have seen how the gun is trained, elevated, and sighted. When these operations have been completed, it is ready to be fired.



This gun can be fired in two ways. The preferred is electrical firing. To fire the gun electrically, the pointer closes a firing key on his right handwheel. If for any reason electrical firing is not possible,. . .



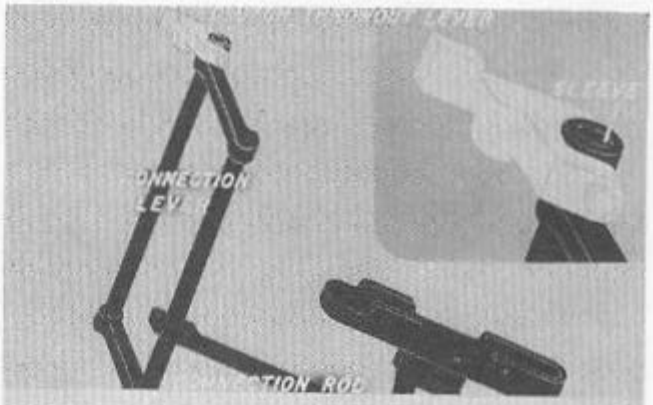
. . .the gun is fired by percussion. This is accomplished by the pointer depressing the foot-firing treadle to operate the foot firing mechanism. Because this mechanism is one of the mount assemblies, we shall review it briefly here.



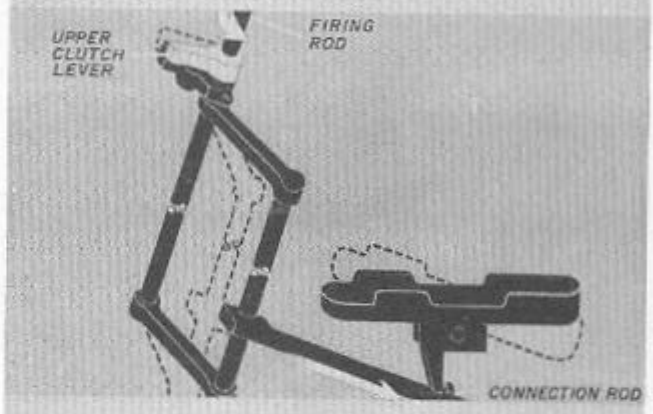
The foot firing mechanism is located on the left side of the mount. Most of its working parts are assembled in two housings—one near the platform of the mount, the other over the left trunnion.

The foot-firing treadle is connected by linkage to the gun's firing mechanism. Let's briefly trace this linkage.

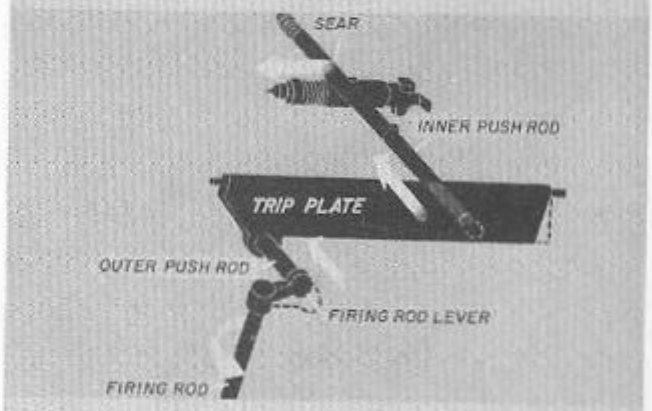
From the treadle, a connecting rod extends to one rod of a connection lever. Attached to the other rod of the connection lever is a clutch throw-out lever (shown in detail in the insert). Notice that there is a sleeve in the upper end of the rod.



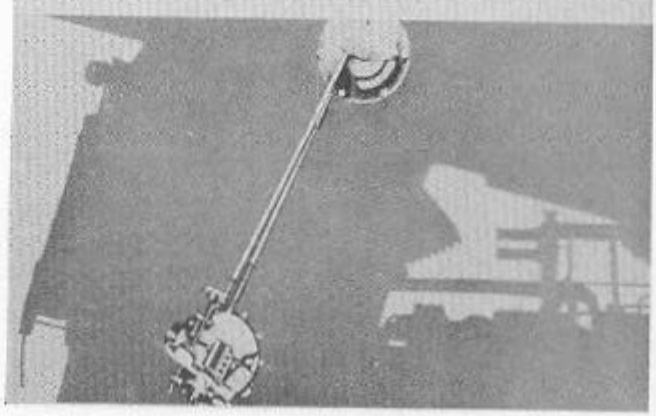
Seated in this sleeve is a firing rod. Secured to the lower end of this firing rod is an upper clutch lever which bears against the clutch throw-out lever. When the foot-firing treadle is depressed, the connection rod is pulled back, rotating the connection lever. This rotates both clutch levers and the firing rod.

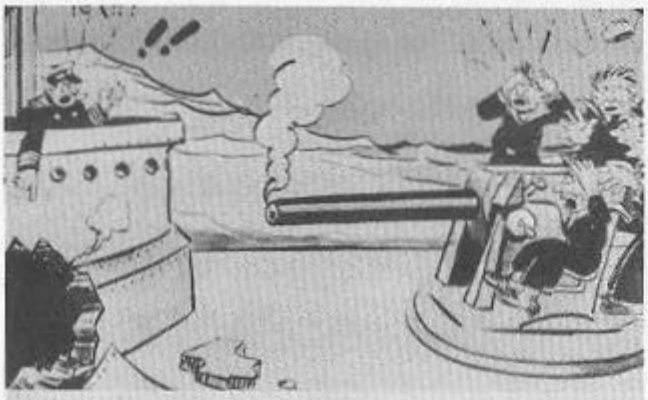


Rotation of the firing rod causes the firing rod lever to push in the outer push rod against the trip plate. The trip plate, in turn, transmits this motion to the inner push rod and to the sear which causes the firing mechanism to fire the gun.

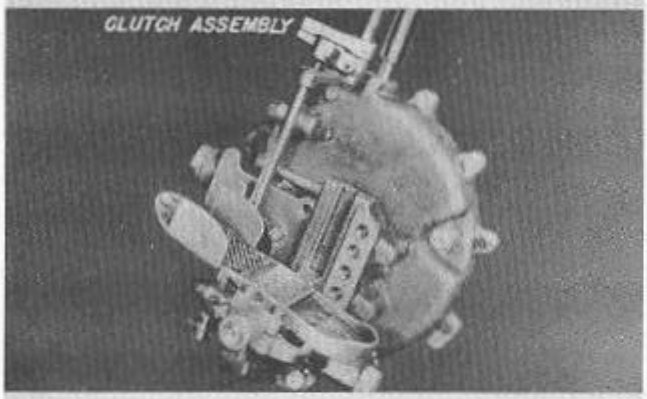


Working in conjunction with this foot firing linkage and located in the same two housings is a firing stop mechanism whose job it is to prevent the gun from being fired either electrically or by percussion.

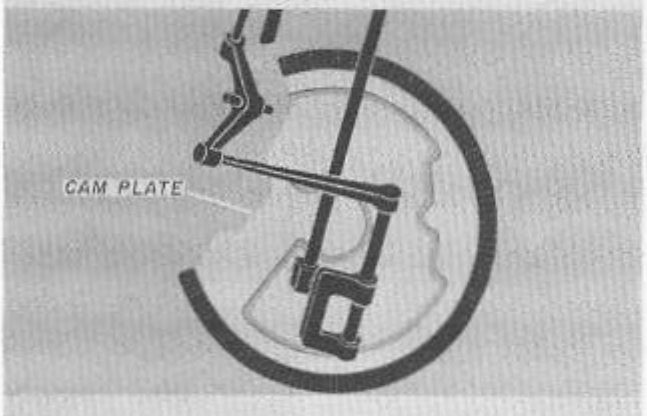




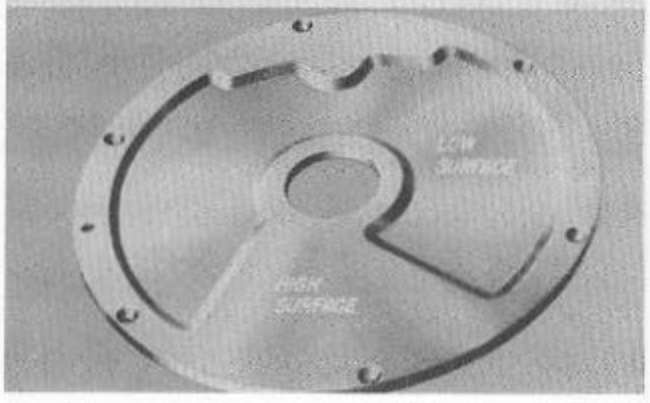
Firing into your own ship is strictly against regulations, and can prove to be extremely embarrassing. The firing stop mechanism saves you this embarrassment by preventing the gun from firing when it is bearing on the ship's structure.



The firing stop mechanism is connected to the foot firing mechanism by the clutch assembly. It is the assembly that breaks the foot firing linkage to prevent firing.

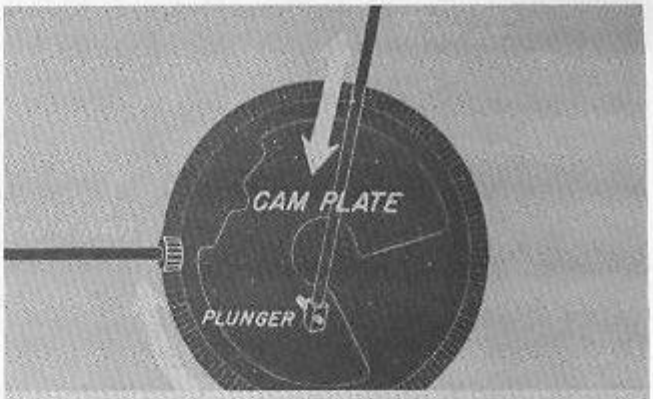


The heart of the firing stop system is a cam plate. This cam plate is mounted in the housing behind the system of levers.

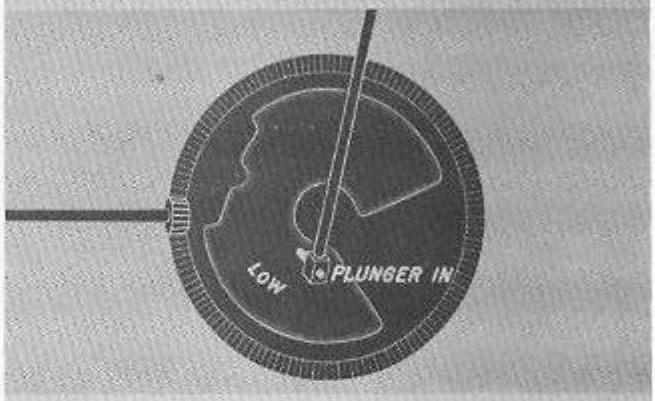


The face of this cam plate has a high surface and a low surface. It is the high surface that causes the firing linkage to be broken. Let's see how this is done.

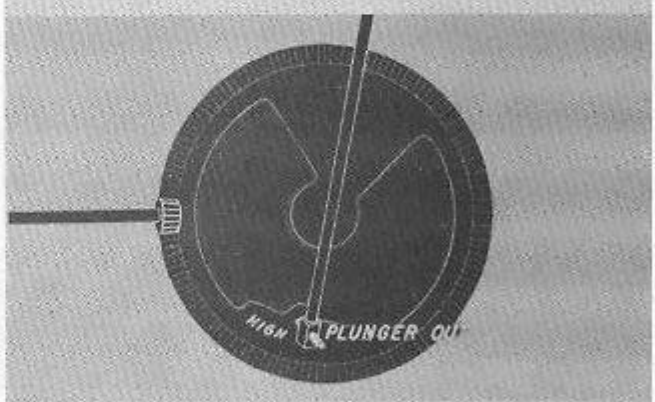
When the mount trains, it rotates a train input rod causing the cam plate to be revolved. Elevation of the gun causes an elevation input rod to be moved up and down across the face of the cam plate. A plunger in the lower end of the elevation input rod bears against the surface of the cam plate.



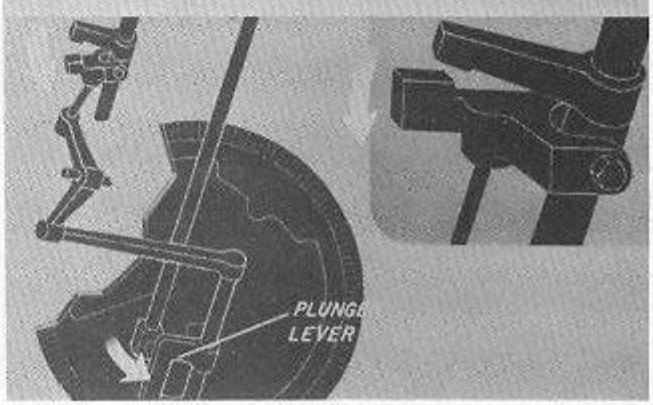
When the plunger rides over a low surface on the cam plate, it is pushed in against this surface.

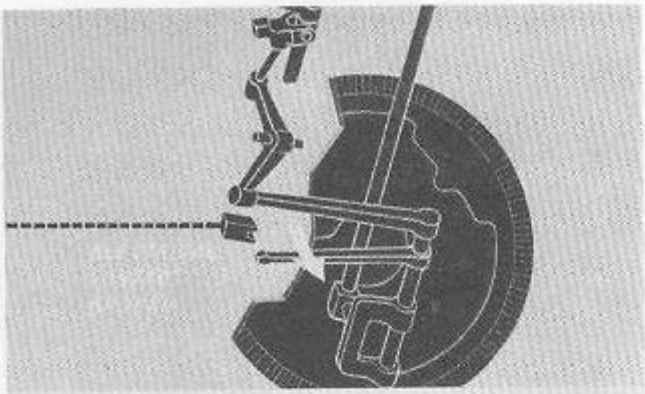


When it rides over a high surface on the cam plate, it is pushed out.

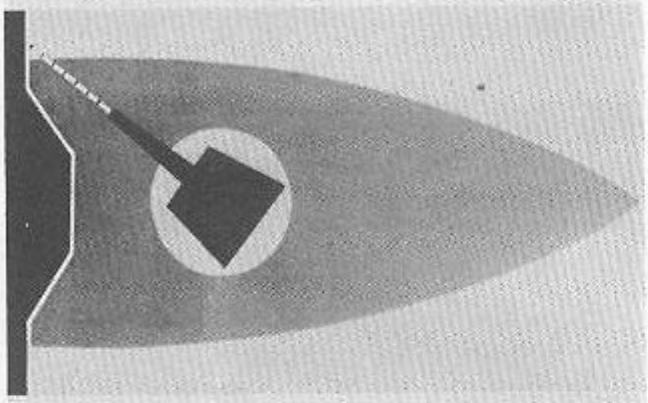


When the plunger is out, it forces the plunger lever outboard. The plunger lever, in turn, operates a linkage which pulls the clutch throw-out lever down, (as shown in the insert) the firing rod is disengaged and the gun cannot be fired by percussion.

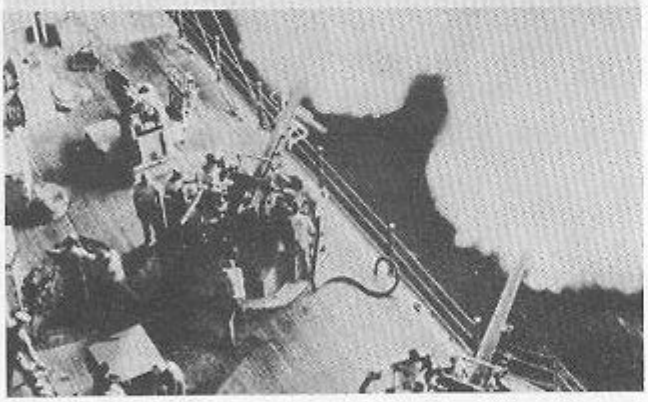




At the same time, the high surface on the cam plate cuts out percussion firing, a lever breaks an electrical contact to prevent electrical firing. Thus, while the foot firing mechanism causes the gun to be fired, by percussion only, the firing stop mechanism prevents firing by both methods—percussion and electrical.



In a later chapter (chapter 9) we shall study this firing cutout mechanism in greater detail, and shall see how the gun is prevented from firing when it bears upon any part of the ship's structure, wherever that part may be located.



Accurate train, elevation, sighting, and firing of this gun are all vitally important. Learn these operations well. Remember, you're not shooting at clay pigeons. Your targets are enemy planes and ships that may destroy you if you don't get them first.

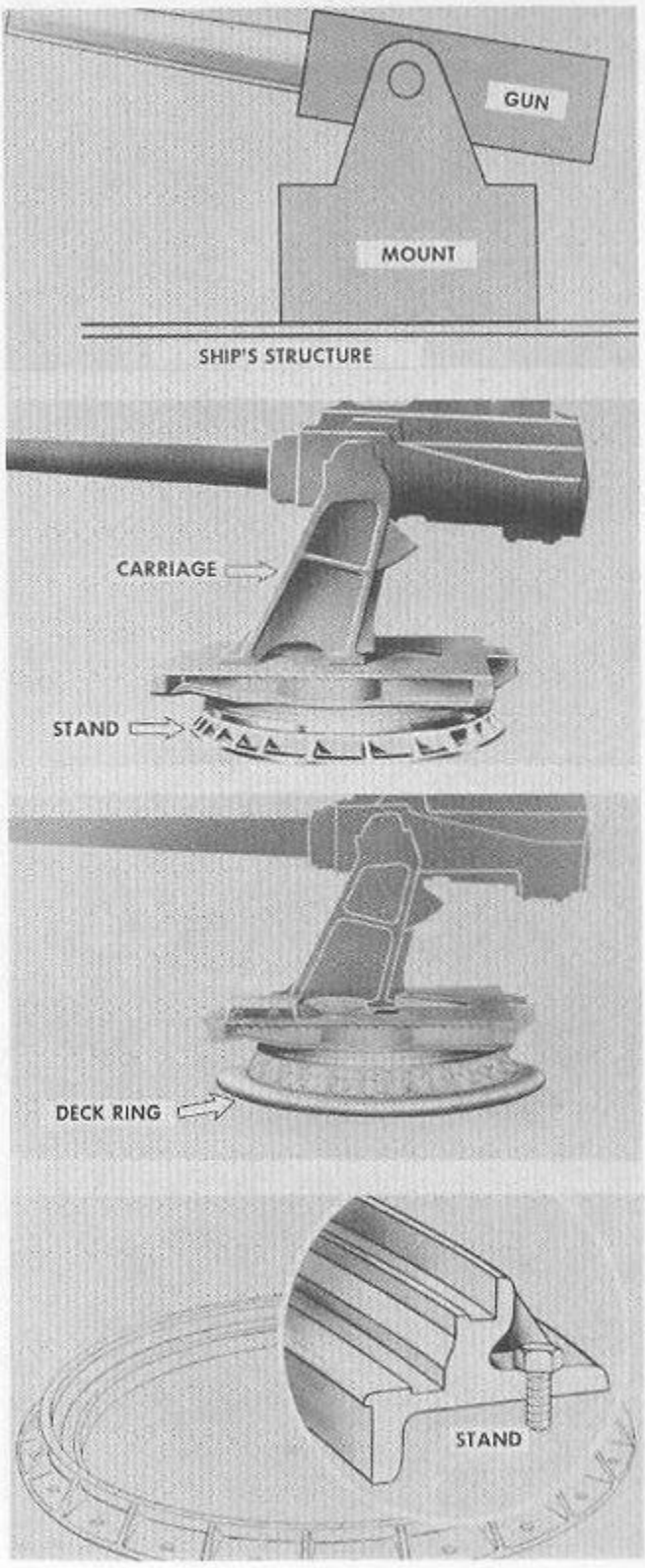
CHAPTER 7—FUNCTION OF THE STAND AND CARRIAGE ASSEMBLY

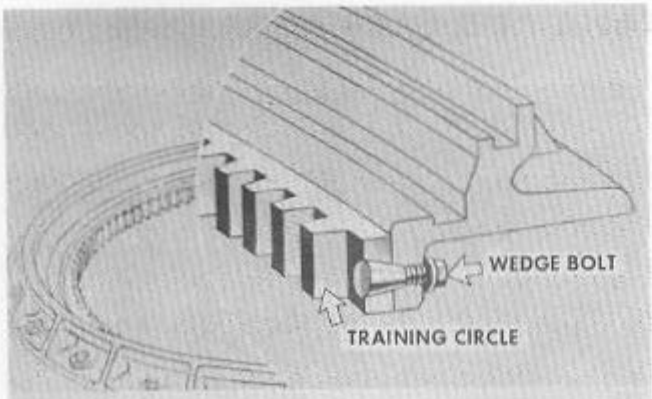
The mount is the entire system that is placed between the structure of the ship and the gun. Its construction depends upon the use for which the gun is designed. The mount of an efficient, dual purpose weapon like the 5"/38 has many jobs to do and must meet many exacting requirements. Some of these are: It must support the gun. It must provide for elevation and train, and must enable these movements to be fast, smooth, and accurate. It must provide for recoil and counterrecoil. It must provide for control of power, either hand or motor. And it must allow for high elevation of the gun and provide for rapid loading and firing.

We are about to study the stand and carriage assembly which is part of the mount. In studying this assembly we shall see how the 5"/38 mount is constructed to meet the requirements imposed upon it.

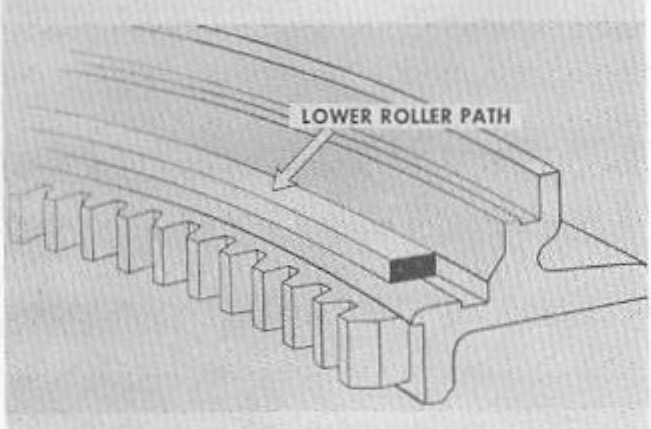
In our description of the stand and carriage of the mount, we shall work from the deck up. The mount is seated on a deck ring welded to the deck.

The stand of the mount is a heavy, cast steel ring bolted to the deck ring.

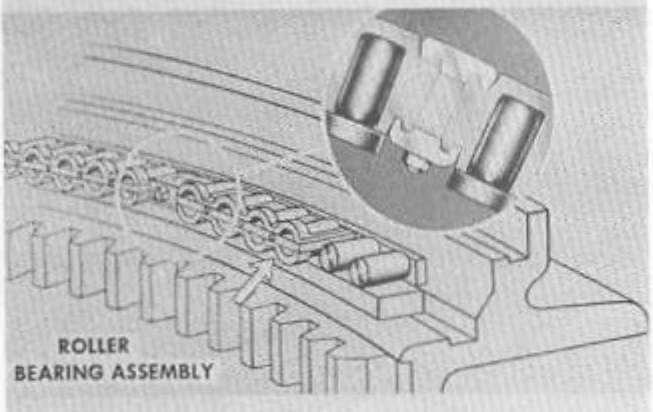




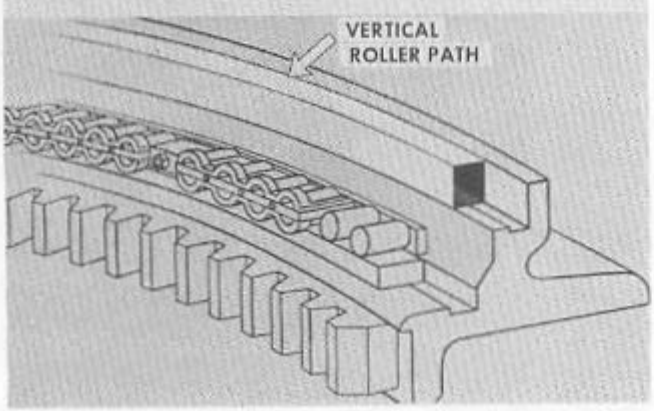
The training circle is push-fitted into the stand from the bottom and secured by wedge bolts. This training circle is a continuing circular rack in a rack and pinion system, through which the gun is trained.



Largely responsible for the ease with which the gun can be trained are two roller bearing assemblies. The first of these rides on a chrome-plated lower roller path, push-fitted into the stand from the top. This path also supports the weight of the carriage and gun, and the large downward firing thrust.

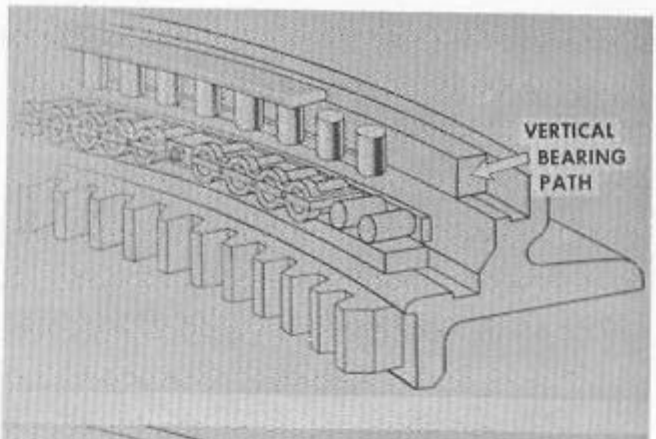


The first roller bearing assembly rides on the lower roller path. The rollers are held in a separator made up of eight identical sections. (The insert shows how the sections are clamped together.)

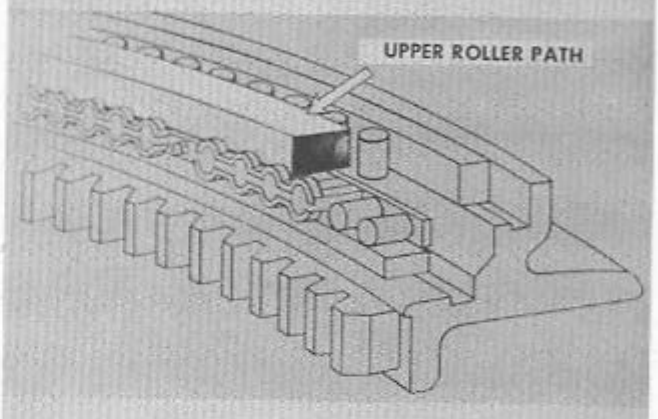


Another bearing path, also push-fitted into the stand from the top, is this vertical roller path, which provides a continuous bearing surface for the second roller bearing assembly. This assembly takes up the side thrust caused by firing and the motion of the ship.

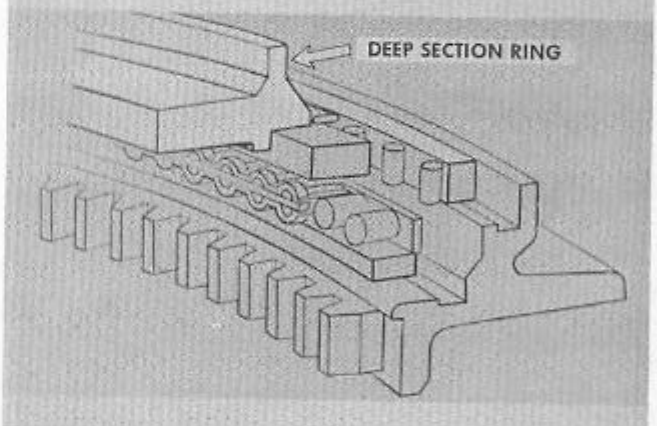
The second roller bearing assembly is also made up of chromeplated rollers assembled in separators. These rollers ride in contact with the vertical bearing path. The bearing system extends all the way around the stand. Both these roller assemblies are precision machined and fitted, so that there will be no lost motion in training the gun to follow an ever shifting target, and no play that would make it difficult to keep the gun on the target.



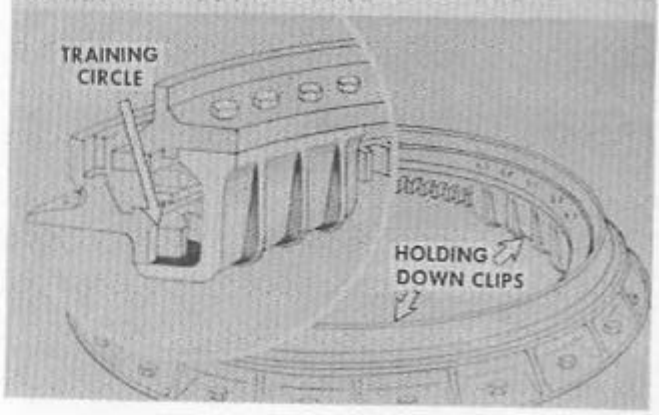
An upper roller path rides on the lower roller bearings. It also bears against the vertical rollers. Thus, it serves as an upper bearing path for the lower roller and as an inner bearing path for the vertical rollers. It is on these roller bearing assemblies, which combine toughness and precision, that the movable part of the mount is built.

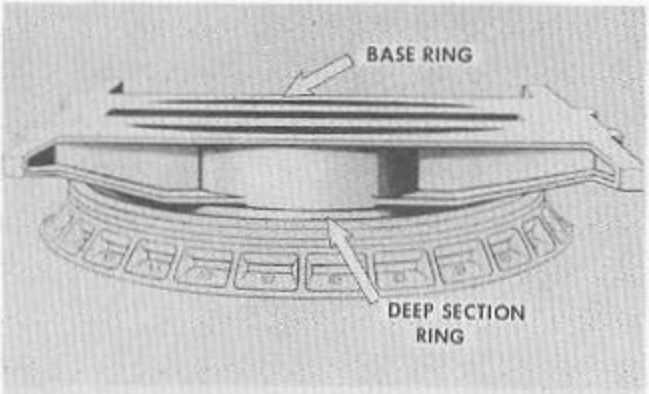


Seated on the upper roller path is a deep section ring. This deep section ring is the foundation of the movable part of the mount.

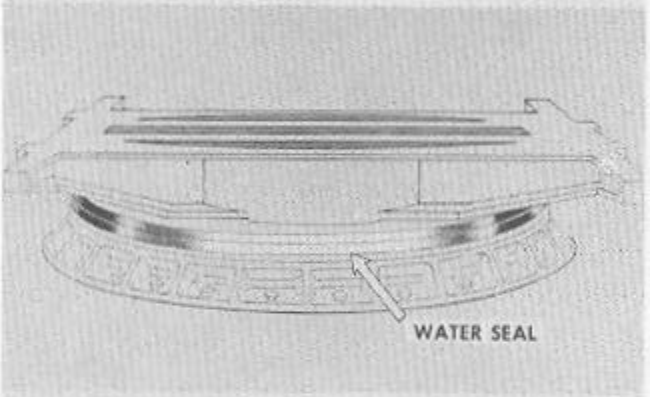


Bolted to the deep section ring are three holding-down clips which extend under the training circle and the lower edge of the stand. These clips prevent the deep section rigring and the mount itself from being jarred off the roller bearings as the ship rolls and pitches, and as the gun is fired and recoils.

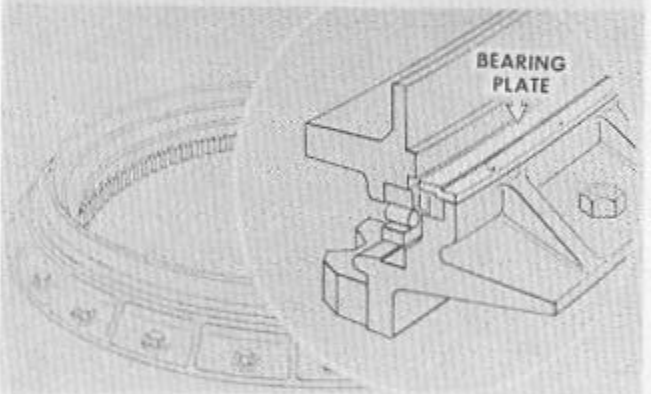




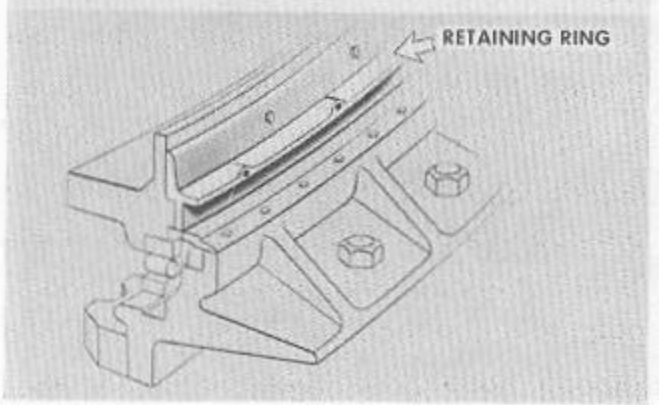
Welded to the deep section ring is a base ring. This base ring consists of heavy steel girders and cross beams welded together to form a square platform structure. This structure supports the carriage, the gun, and the control assemblies.



So that they can engage aircraft most effectively, antiaircraft guns are usually mounted on weather decks where they are subjected to heavy seas and rough weather. To protect the precision bearing systems from corrosion, a water seal is provided between the base ring and the stand.

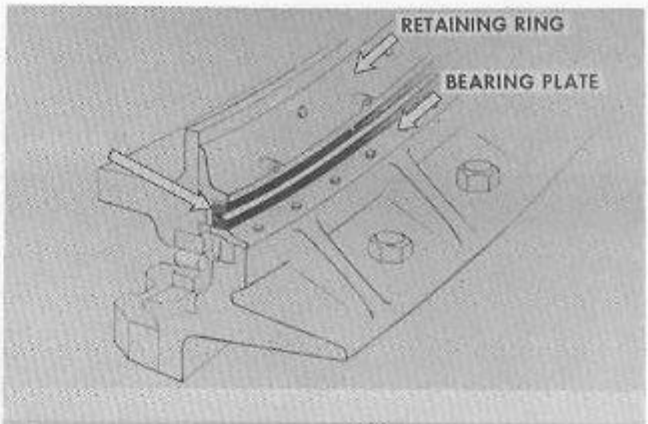


A brass, water-seal bearing plate is bolted to the top edge of the stand and extends over the top of the vertical roller bearing system.

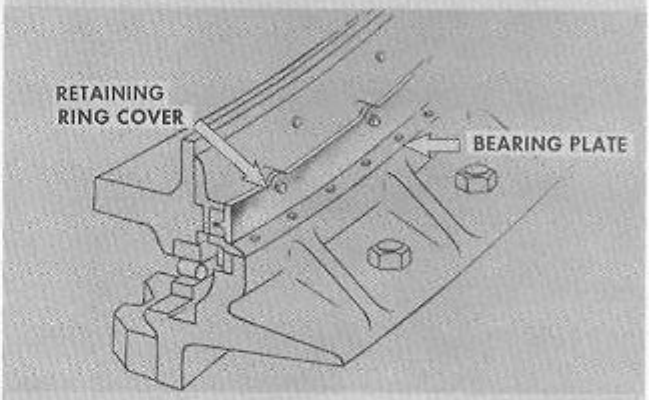


Above the bearing plate, a retaining ring is bolted in sections to the base ring and extends all the way around it.

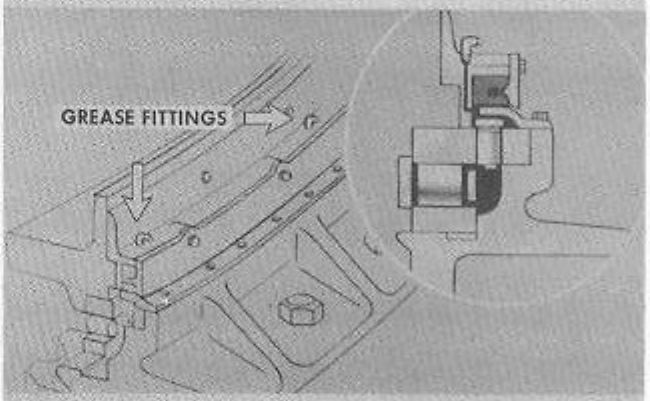
To make the water seal even more secure, a packing is inserted between the retaining ring and the bearing plate.



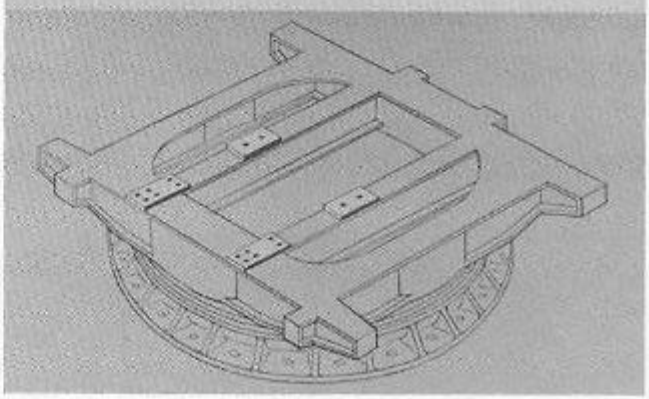
A retaining ring cover holds the packing in place. This cover is bolted, in sections, to the retaining ring making a sliding contact with the bearing plate.

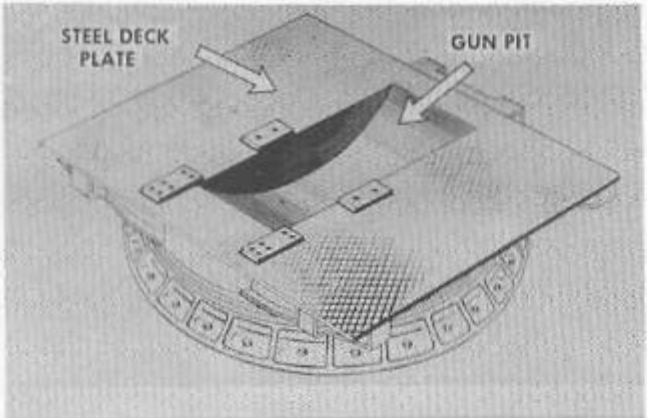


Zerk grease fittings on the retaining ring are provided for lubricating the roller bearing paths. Grease forced through these fittings serves the additional purpose of forming a seal to hold out sea water. The importance of regular and thorough lubrication here cannot be stressed too much. Thus we see how, despite the fact the base ring moves within the stand, an effective seal is provided between them.

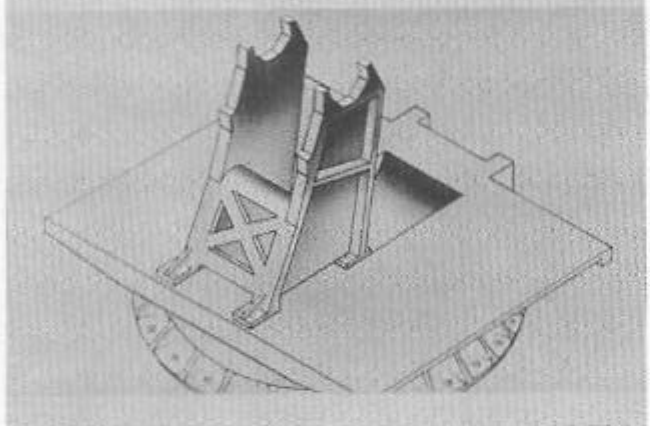


Welded to the top flanges of the base ring girders are four machine pads which provide a foundation for the gun carriage.

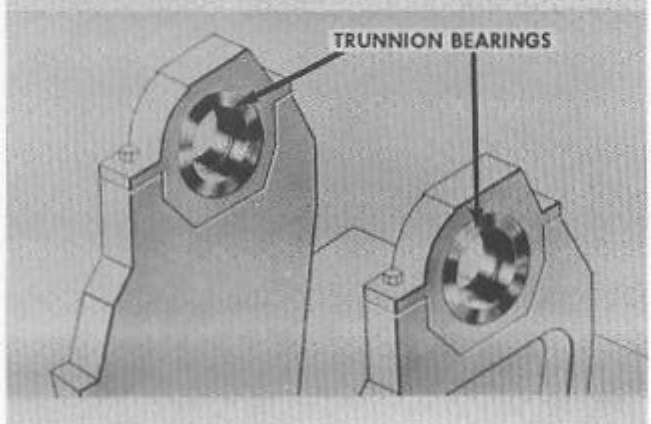




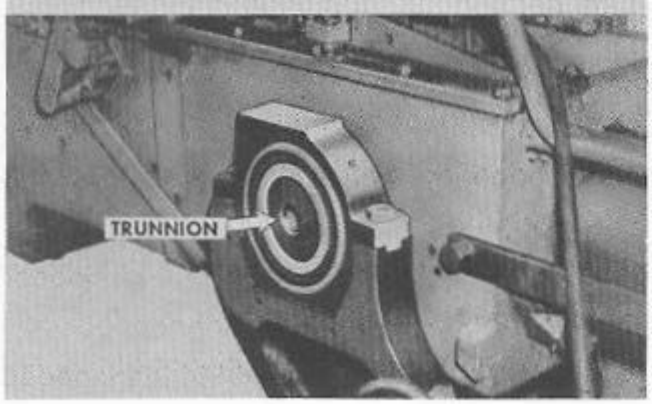
To provide a platform, steel deck plates are also secured to the girders and beams of the base ring. The bottom of the gun pit is also covered by a steel plate. This completes the assembly of the stand and base ring. Let's continue now with the assembly of the carriage.



The gun carriage, bolted to the four pads, serves as a support for the slide and the gun. It consists of two cheeks and a connecting cross piece welded together.

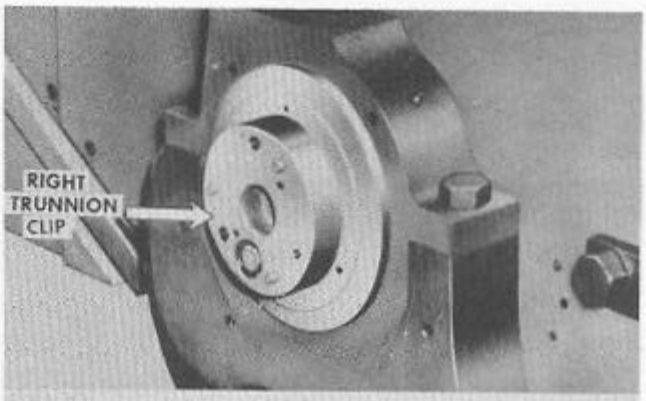


The gun must be able to elevate easily, accurately, and rapidly. To enable it to do this, trunnion bearings, fitted with roller bearing separators, are bolted to the upper ends of the cheeks.

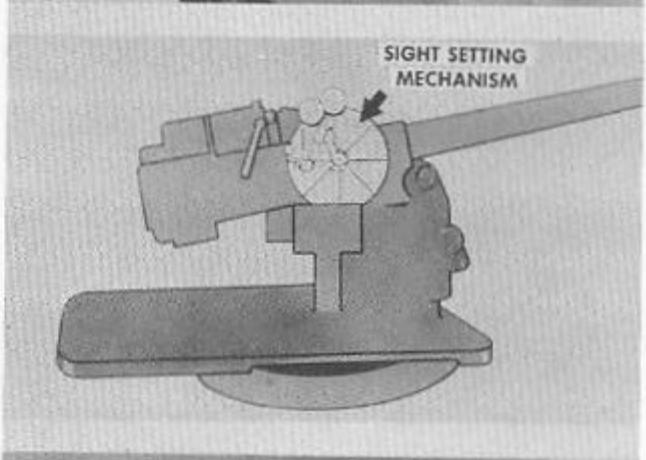


The trunnions, which are part of the slide, pivot within these bearings. We are looking, here, at the right trunnion.

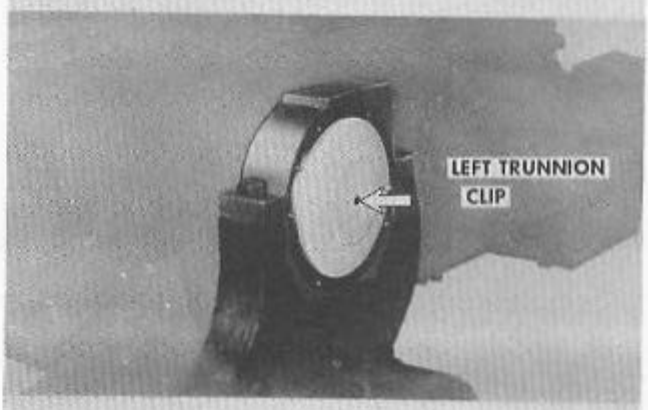
Protecting the right trunnion bearing assembly is a clip that rotates with the trunnion in elevation. This clip also serves. . .



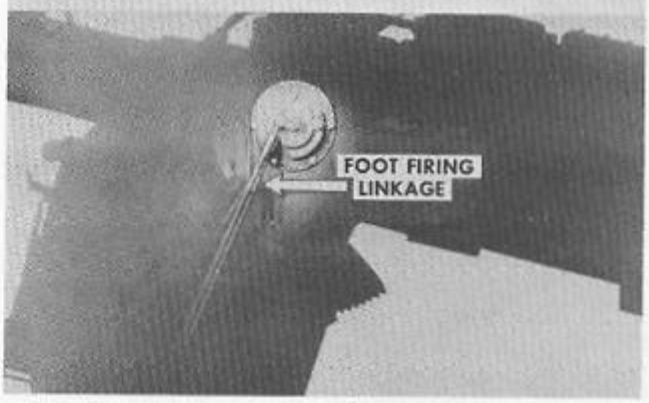
. . .as a connection for part of the slight-setting mechanism.

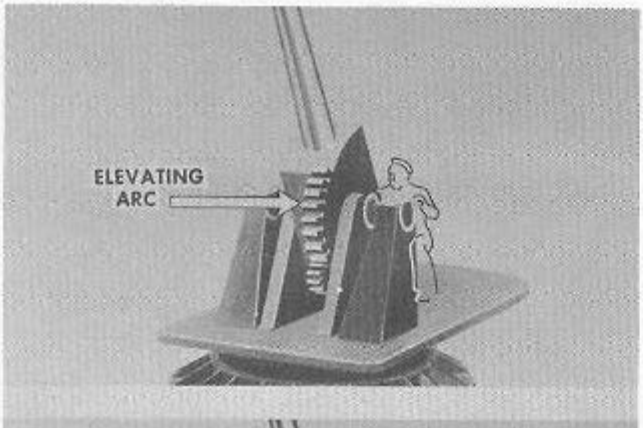


Protecting the left trunnion is another clip. A hole in its center is provided. . .

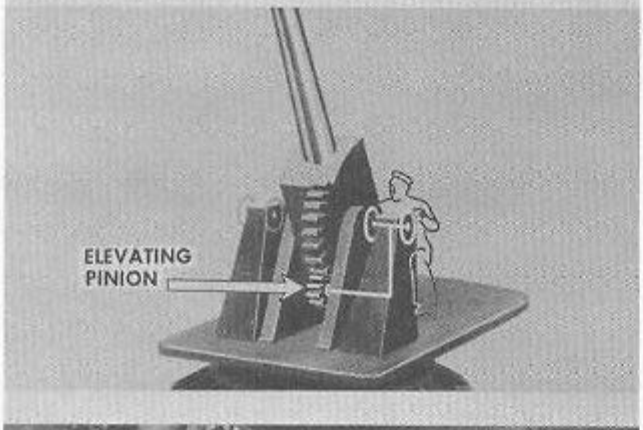


. . .to permit a connection from the foot firing linkage, part of which is located in the housing over this trunnion clip.

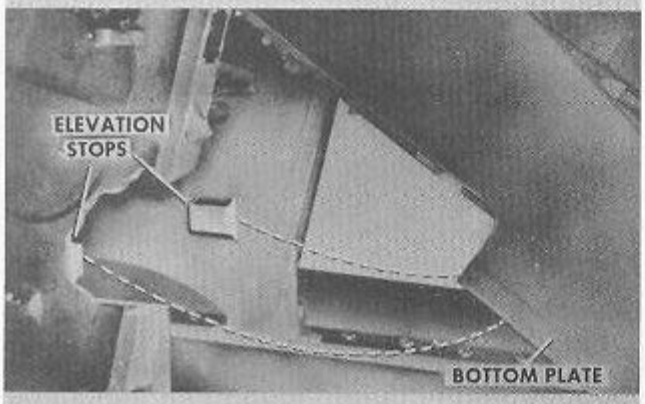




Pivoting within the trunnion bearings, the slide and gun are elevated and depressed by means of an elevating arc secured to the slide.



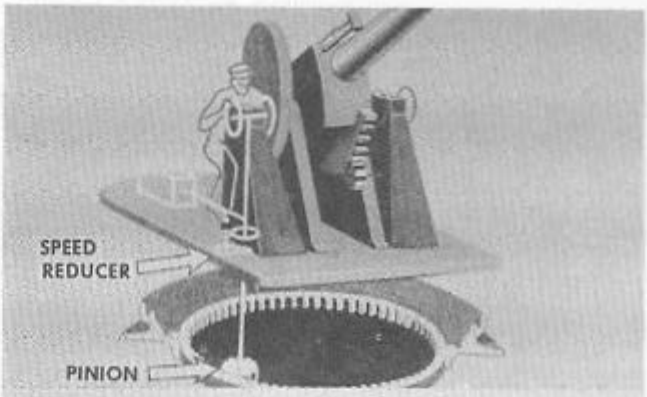
This arc is moved by an elevating pinion that can be linked either to the pointer's handwheels or to the power drive.



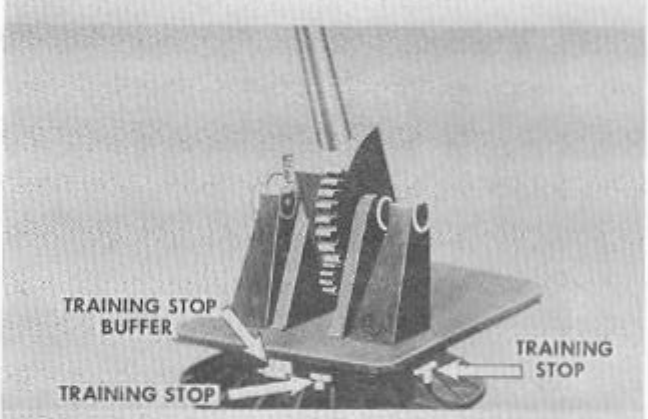
Elevation of the gun is limited when the bottom plate of the slide strikes two positive elevation stops on the inner sides of the cheeks.

The depression of the gun is limited by positive depression stops on the slide and cheeks.

We know that the mount can be trained by the power drive or by turning the trainer's hand-wheels. These are connected, through a speed reducer on the platform of the base ring, to a pinion that meshes with the training circle. While it is possible to train the mount through 360 degrees. . .

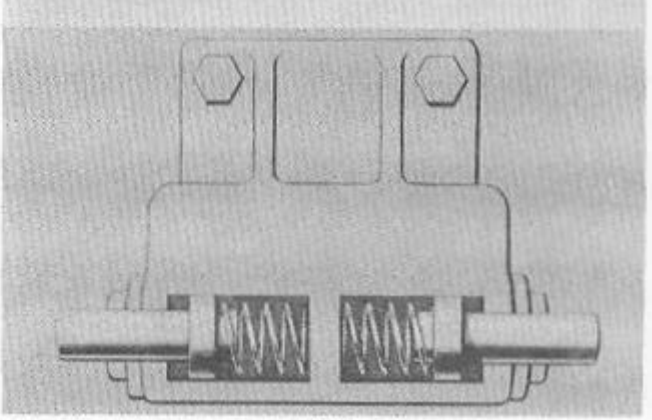


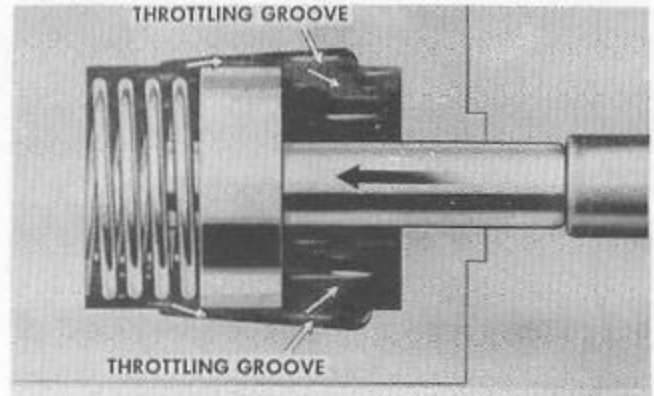
. . .this train must be limited to prevent the gun from striking or firing into parts of the ship's structure. This is done by positive training stops secured to the stand and a training stop buffer secured to the base ring.



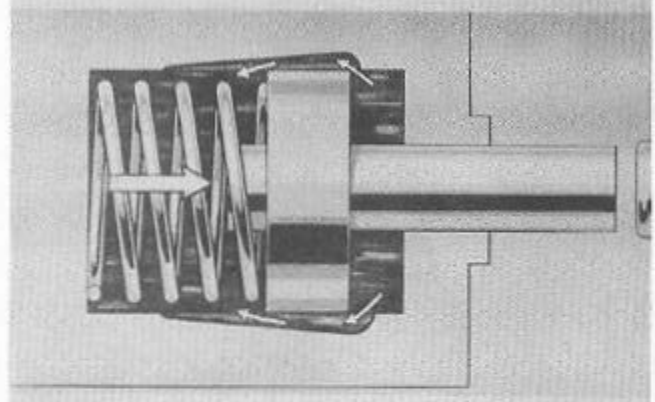
As the gun approaches its limit of train in either direction, the buffer strikes one of the training stops.

Each side of the buffer contains a piston in an oil-filled cylinder. Each piston is normally held outboard by a spring.

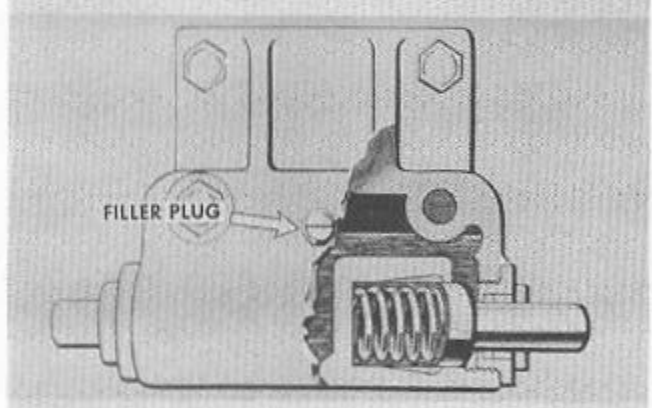




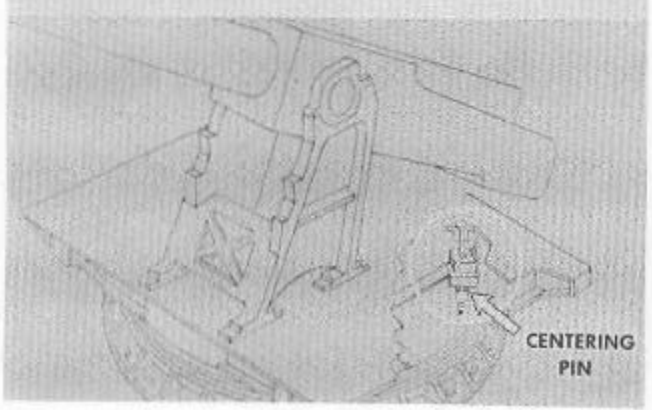
To provide suitable buffing, throttling grooves are cut in the wall of the each cylinder. When the piston rod strikes a training stop, oil is forced through the throttling grooves from one side of the piston to the other. The resistance of the oil being displaced causes the mount to come to a relatively smooth stop.



When the pressure of the training stop against the buffer piston is removed, the spring returns the piston to its normal position.

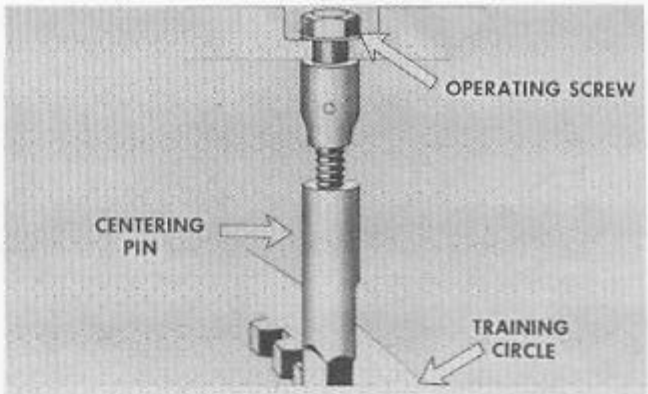


The buffer system is kept filled with ice machine oil up to the level of this filler plug.

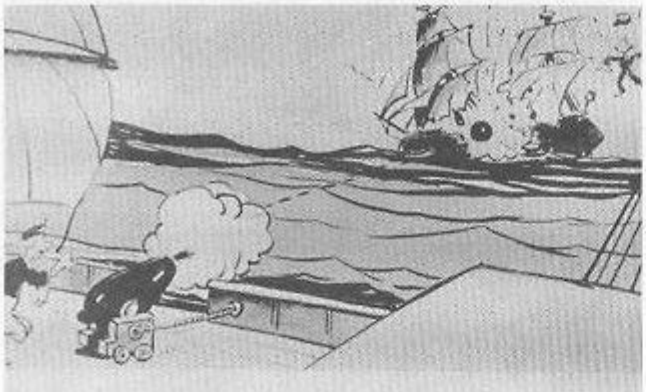


When in a heavy sea, the mount is prevented from slewing around by a centering pin in the base ring.

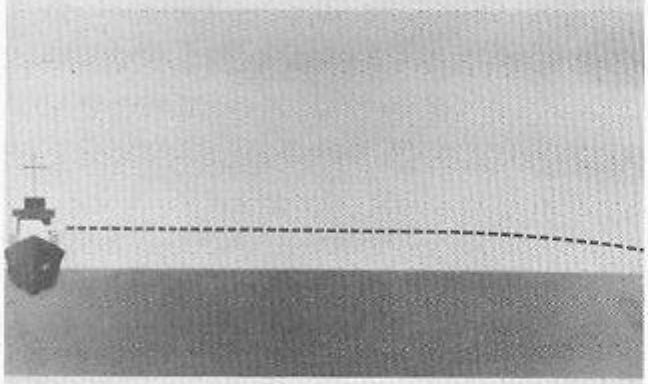
To lock the mount in the secured position the centering pin is lowered into a seat in the training circle by an operating screw. The seat for the pin is wider than the space between the teeth. Thus, it is the only point in the training circle into which the pin will fit.



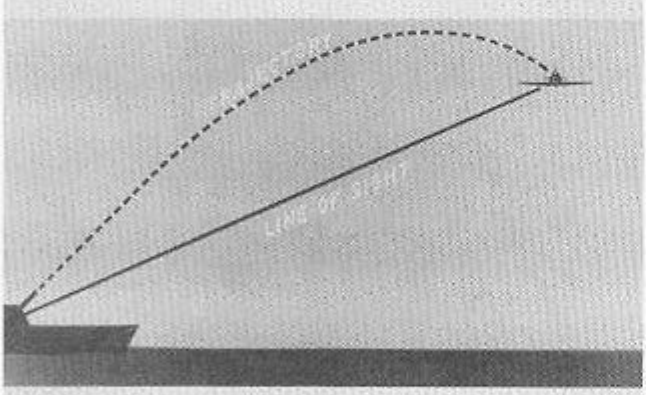
And so we have seen that mount is considerably more than a bracket to hold up the gun. In designing this mount there were many problems to overcome. That they were overcome successfully is evidenced by the fact that the mount on the 5"/38 gun today combines ruggedness and precision to produce a weapon that is one of the Navy's best. Maintain this mount properly and it will serve you well.



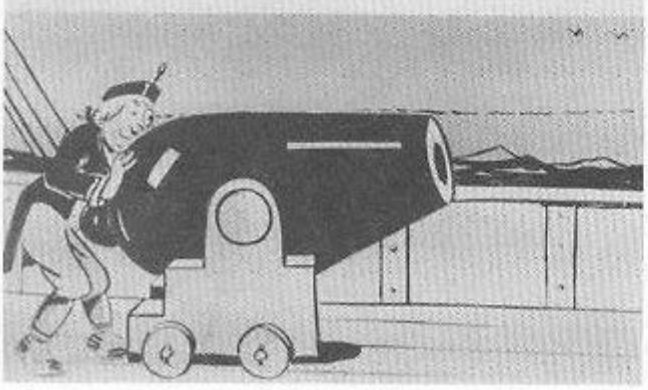
The ultimate purpose of any gun is to hit the enemy with its projectile. In order to do this the gun must, first, be properly aimed.



If aiming the gun meant only pointing the barrel directly at the target, it would be a very simple matter. This cannot be done, however, because the projectile drops during flight and, so, travels in a curved rather than a straight line.

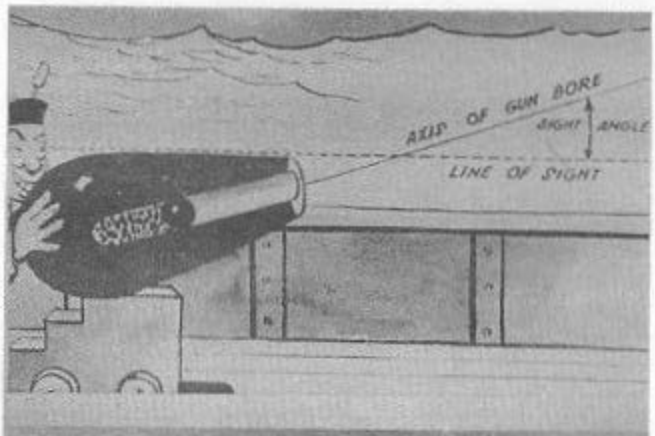


This curved path, known as the trajectory, results from the pull of gravity on the projectile. To aim the gun so that the projectile will hit the target, this trajectory must be compensated for by offsetting the gun barrel the correct amount above the straight line from the gun to the target. This line is called the line of sight.

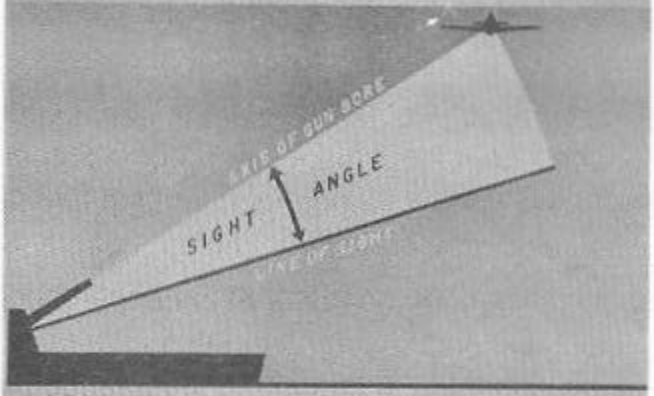


Even in the days of the muzzle loader the gunner applied this principle. He found that by sighting horizontally along the top of the barrel he would sometimes hit the target. This happened because. . .

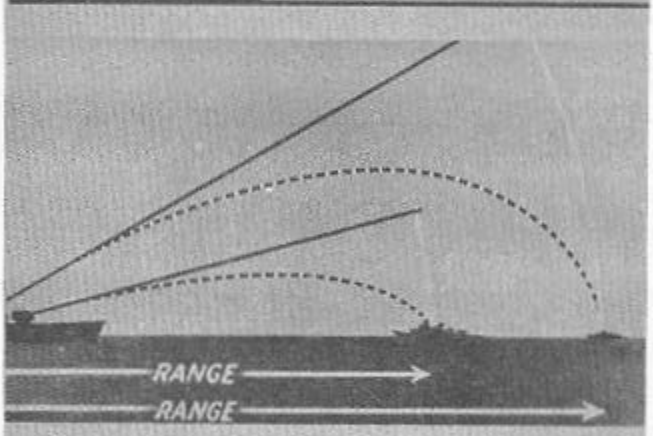
. . .the bore of his gun tilted upward to form a sight angle between the axis of the bore and the line of sight. The projectile was thus fired above the line of sight and the trajectory, in a crude way, was compensated for.



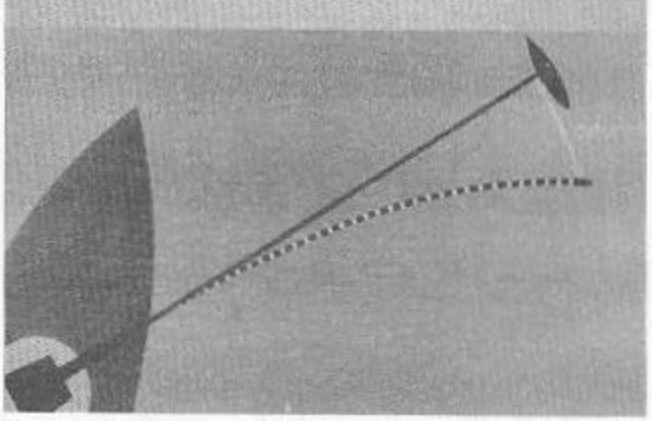
In the 5"/38 this same principle is applied. To compensate for trajectory we establish the correct sight angle between the line of sight and the axis of the gun bore. When sight angle is introduced, the line of sight is depressed below the gun so that when the line of sight is brought onto the target, the gun barrel will be elevated by the correct amount necessary to enable the projectile to hit the target.

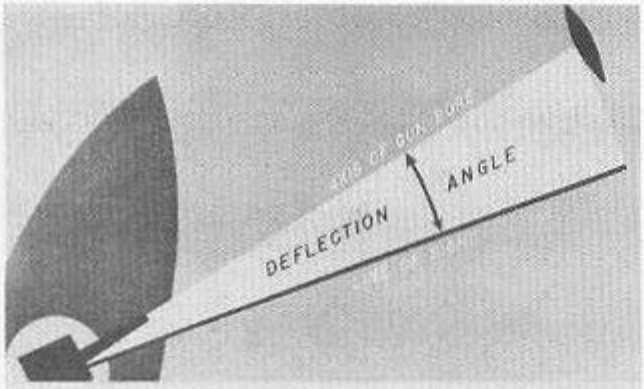


The proper sight angle depends on the range, which is the straight line distance from the gun to the target. One of the improvements that has been made since the muzzle loader, whose sight angle was fixed, is that in this gun we are able to vary this angle and so permit accurate firing within the full range of the gun. The exact value of the sight angle for any given range is determined by a computer in another part of the ship.

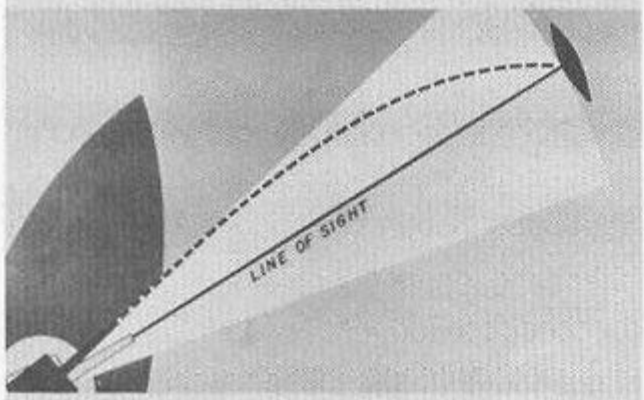


In all modern guns, accurate aiming is further complicated by the fact that the barrel is rifled and causes the projectile to spin when fired. Its spin makes the projectile drift off to the right of the target. This drift, like the trajectory, must be compensated for. Compensation is made. . .

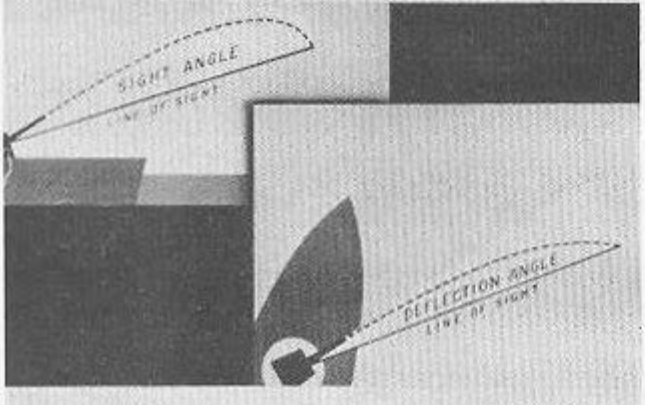




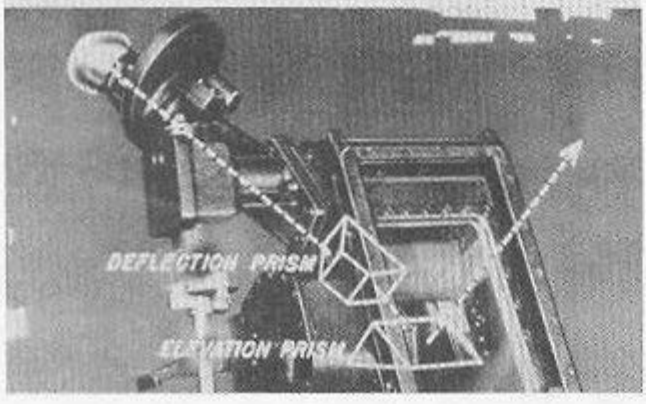
. . .by offsetting the line of sight to the right of the target to establish a deflection angle between the line of sight and the axis of the gun bore. After setting the proper deflection angle. . .



. . .bringing the line of sight onto the target will offset the gun the amount necessary to enable the projectile to hit the target.

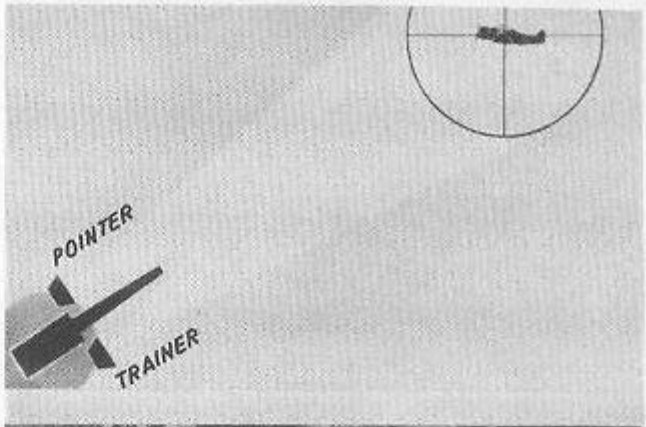


And so we see that the function of the sights is to offset the gun from the target by the amount necessary to enable the projectile to hit it. And that this is done by moving the line of sight to set the proper sight angle or deflection angle.

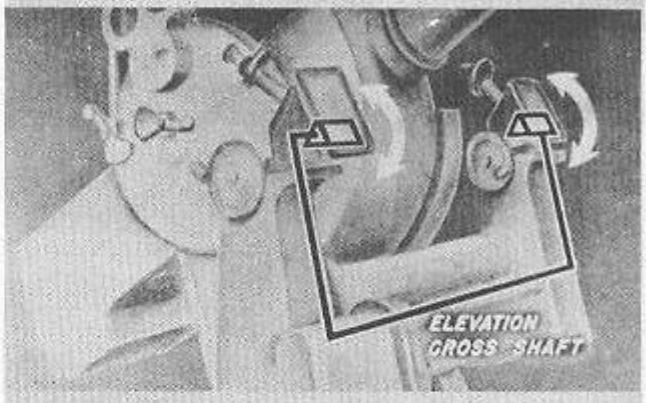


In the 5"/38 the line of sight is optically elevated and deflected to set these angles by means of movable elevation and deflection prisms mounted in each telescope.

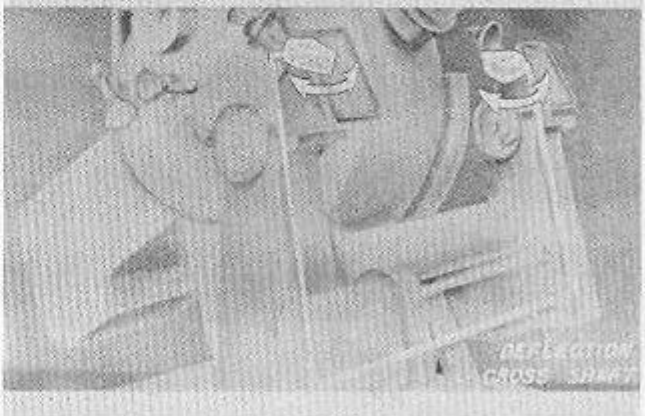
If the gun is to be aimed properly, it is obvious that the pointer and trainer must see the same image through their telescope at the same time. To make this possible the elevation prism in the pointer's telescope must move together with the elevation prism in the trainer's telescope. And the two deflection prisms must also move in unison. For this reason. . .



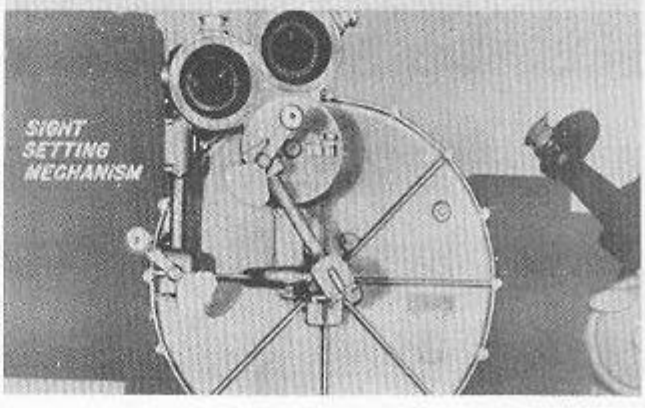
. . .the two elevation prisms, one in each telescope, are connected by vertical shafts and an elevation cross shaft.

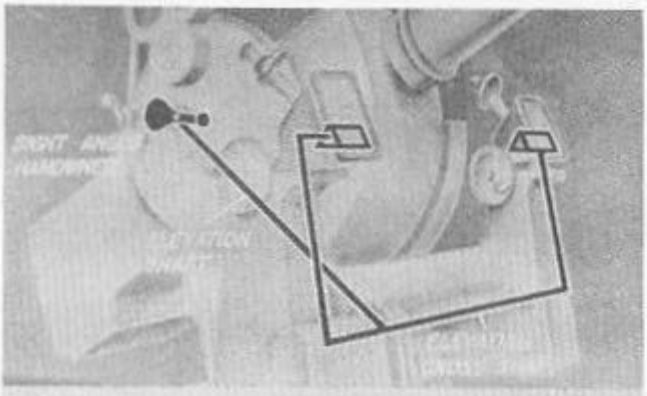


And in the same manner, vertical shafts and a deflection cross shaft cause the deflection prisms to be moved together.

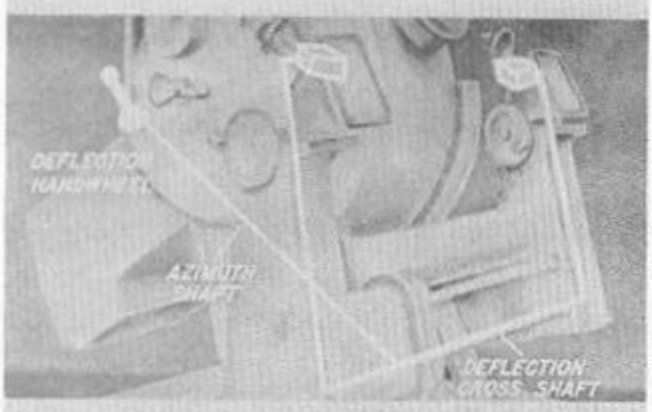


Moving the prisms to establish the correct sight and deflection angles is done by a series of gears, levers, cranks, and pointers that are known as the sight setting mechanism. This mechanism is mounted over the right trunnion just aft of the trainer's handwheel bracket. Let's see now how this mechanism operates to move the prisms.

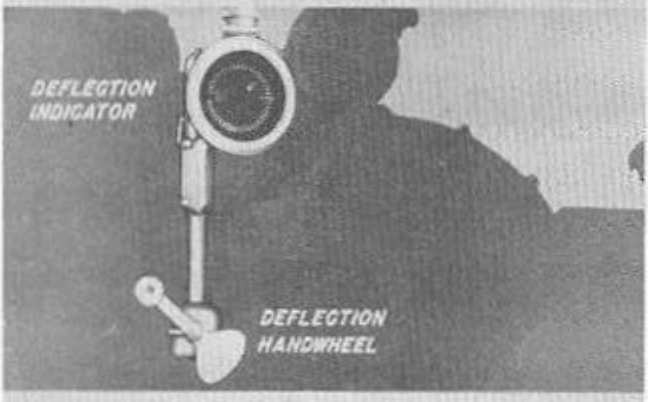




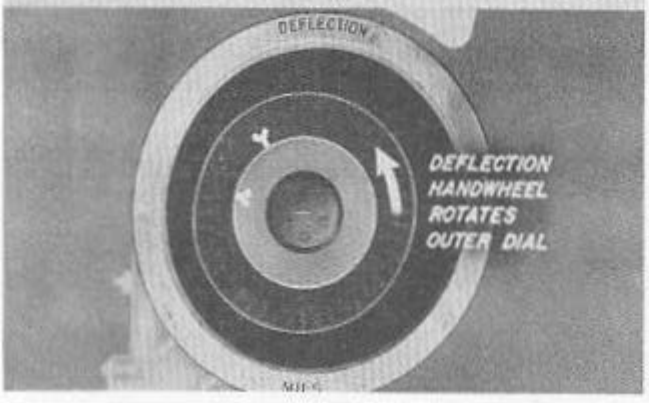
From the sight angle handwheel an elevation shaft extends to the elevation cross shaft. Turning the sight angle handwheel will thus move the elevation prisms.



In a similar manner the deflection handwheel is connected through an azimuth shaft to the deflection cross shaft. And turning the deflection handwheel will move the deflection prisms. We shall study first how the deflection prisms are operated by the sight-setting mechanism. In addition to the shafts which enable it to move the deflection prisms. . .



. . .the deflection handwheel is also connected to a deflection indicator.



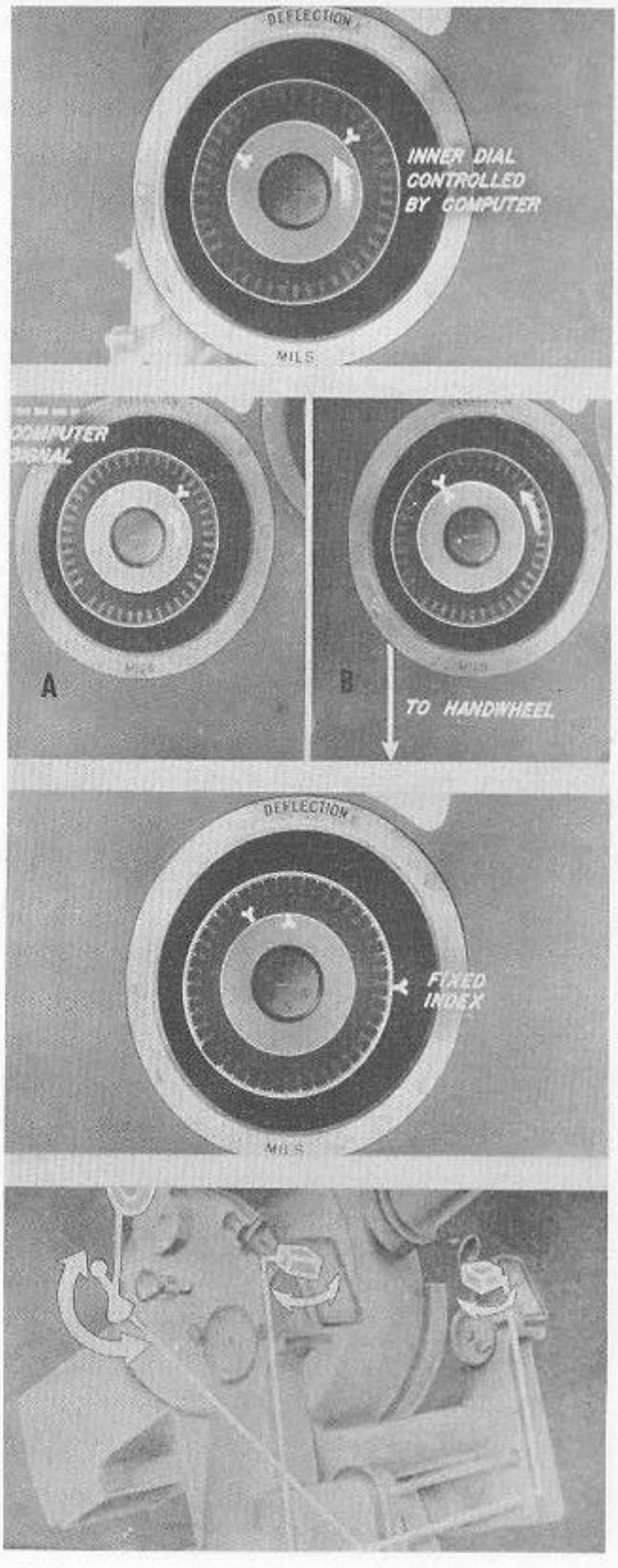
Turning the deflection handwheel rotates the outer dial of this indicator.

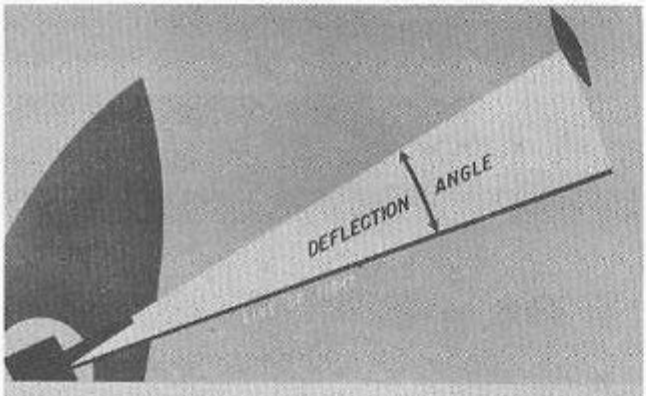
The inner dial of this indicator is controlled by a computer in another part of the ship. This computer positions the inner dial to indicate the proper deflection angle.

When the computer signal rotates the inner dial (as shown in A) the index pointer of this dial moves to set the proper deflection angle. By turning the deflection handwheel to move the outer dial (as shown in B) in order to match its index pointer to that of the inner dial, we have set the deflection prisms to the proper angle.

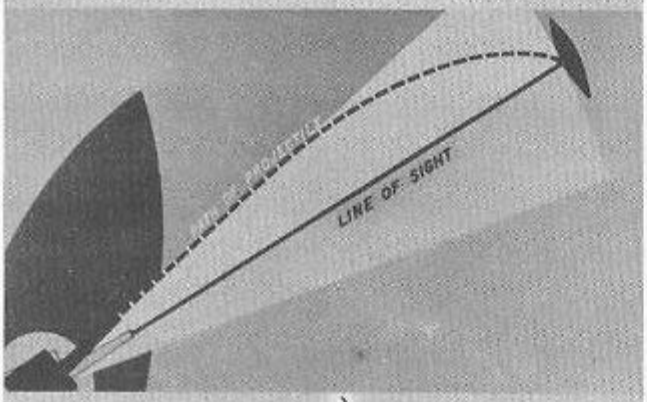
The outer dial is calibrated in mills of deflection. If the signal from the computer should fail, the deflection angle can be set directly by turning the handwheel to match the required mills of deflection to a fixed index pointer. The order specifying the mills of deflection required is transmitted to the gun by telephone. Turning the deflection handwheel, either to match the index pointers of inner and outer dials or to match mills of deflection with the fixed index sets the deflection prisms to the proper angle, because. . .

. . .the handwheel is connected both to the outer dial of the indicator and, through shafting, to the prisms. Thus, turning the handwheel moves both the dial and the prisms at the same time. When the dial has been set to match the computer signal the prisms have been moved to establish the proper deflection angle.

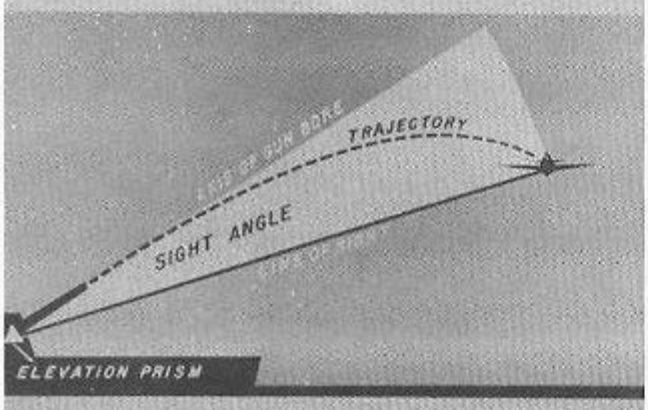




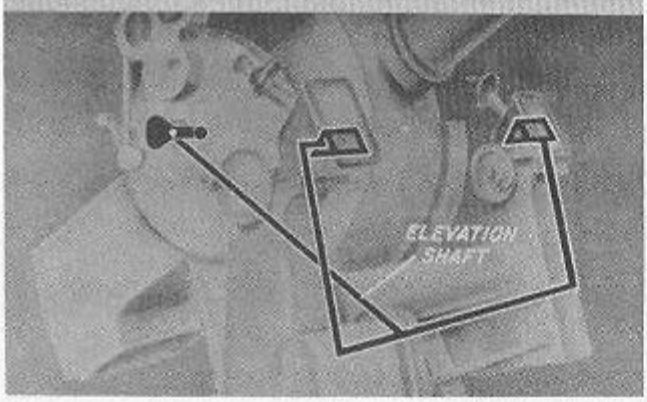
In moving the prisms to set the proper deflection angle, and so compensate for drift, we have offset the line of sight to the right of the target.



Training the gun to bring the line of sight onto the target now makes it possible for the projectile (whose path is shown dotted here) to hit the target. Thus we have seen how the sight setting mechanism enables us, in train, to aim the gun so as to hit the target.

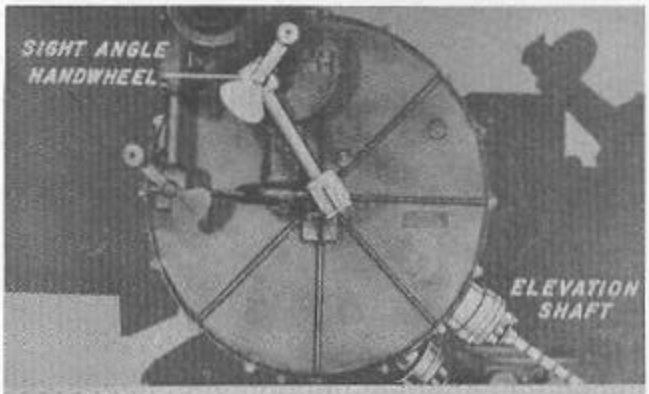


The sight setting mechanism also operates in elevation to compensate for trajectory by moving the elevation prisms to establish a sight angle between the line of sight and the axis of the gun bore. Let's see how this is done.

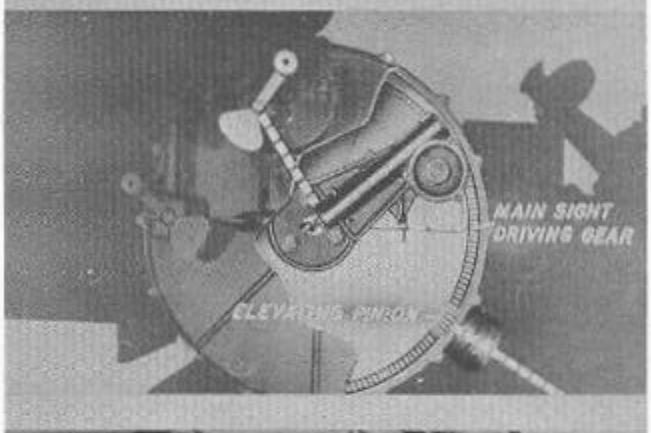


We have seen that the sight angle handwheel, when turned, acts through the elevation shaft to move the elevation prisms.

The sight angle handwheel is connected to the elevation shaft by a system of gears in the sight setting mechanism.

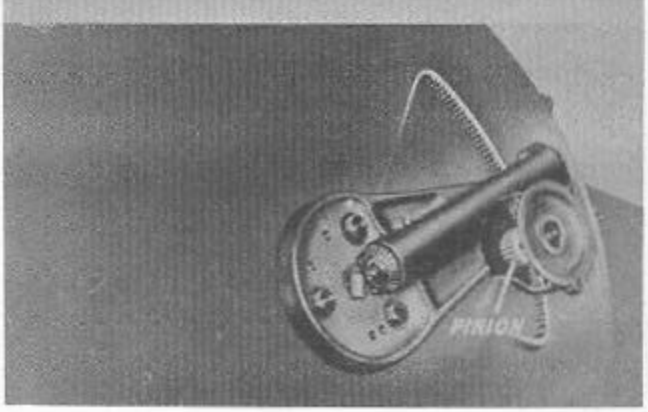


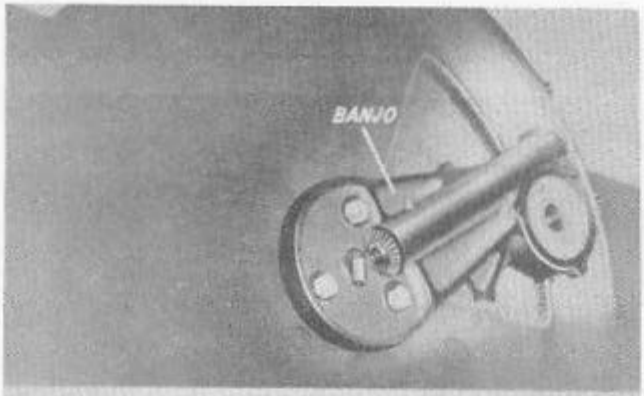
Turning the handwheel operates the gear system to rotate a large gear called the main sight driving gear. This in turn meshes with an elevating pinion which rotates the elevation shaft. The main sight driving gear is free to revolve within the housing.



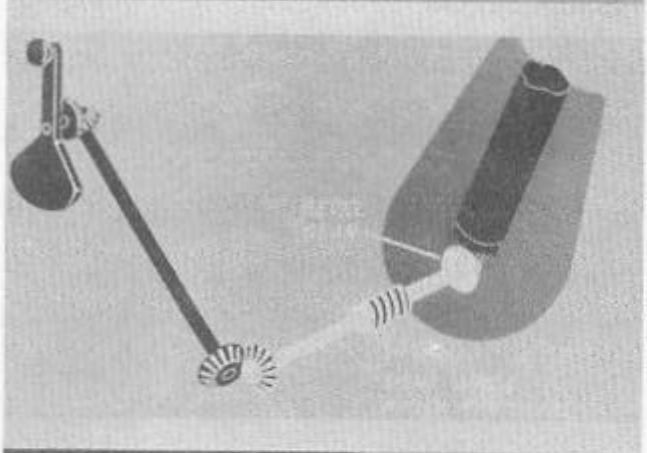
On the main sight driving gear, in addition to the outer gear path for the elevating pinion there is a 40 degree section of internal ring gear.

The internal ring gear meshes with a pinion attached to a banjo-shaped casting.

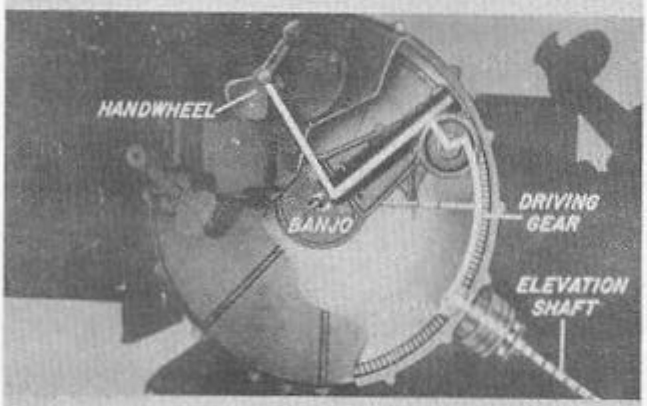




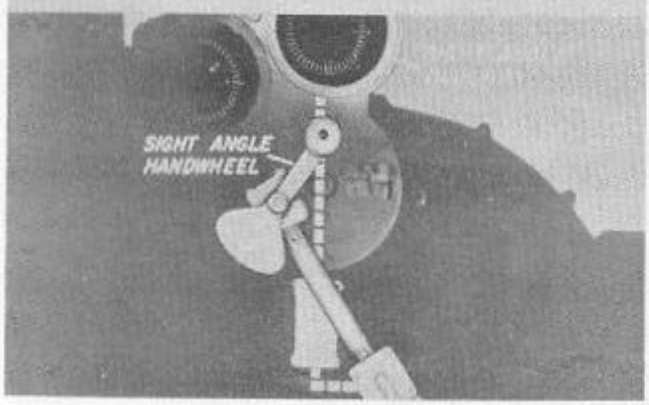
The banjo, as this casting is called, is bolted to the trunnion and serves as a housing for the gear system that links the main sight driving gear with the sight angle handwheel.



The gear system in the banjo has a bevel gear at its lower end. This bevel gear meshes at 90 degrees with another bevel gear on the sight angle handwheel shaft. This shaft, in turn, is connected to the sight angle handwheel.



The sight angle handwheel is thus linked through the banjo and the driving gear to the pinion on the elevation shaft. Turning the handwheel will rotate the elevation shaft and cause the prisms to be moved.



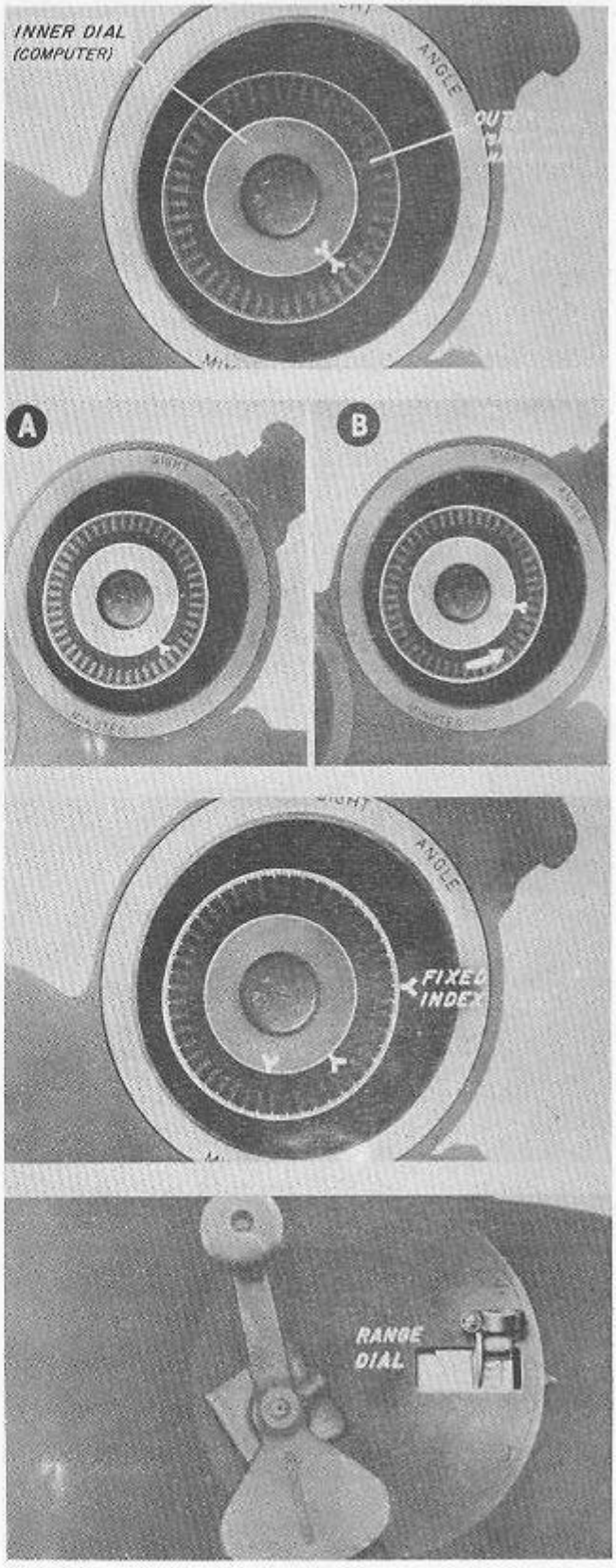
But moving the prisms is only half the story. As in the case of deflection, there must be a means of setting the elevation prisms to correspond with the proper sight angle determined by the computer. For this reason the sight angle handwheel, in addition to being connected to the linkage that moves the prisms, is also connected to the sight angle indicator.

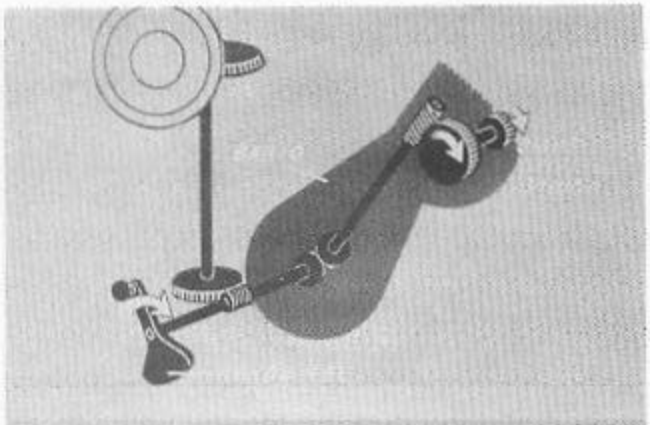
The sight angle indicator operates in the same manner as the deflection indicator that we have already described. The sight angle handwheel is connected to the outer dial. The inner dial is controlled by a computer.

The inner dial indicates the correct sight angle as signaled by the computer. When the computer signal changes the inner dial (as shown in A) moves, carrying its index pointer with it. When the inner dial moves, the outer dial must also be moved (as shown in B) by turning the sight angle handwheel until the index pointer on the outer dial is matched up with the index pointer on the inner dial. Because, turning the handwheel also moves the elevation prisms, matching up the dials sets the elevation prisms to the correct angle.

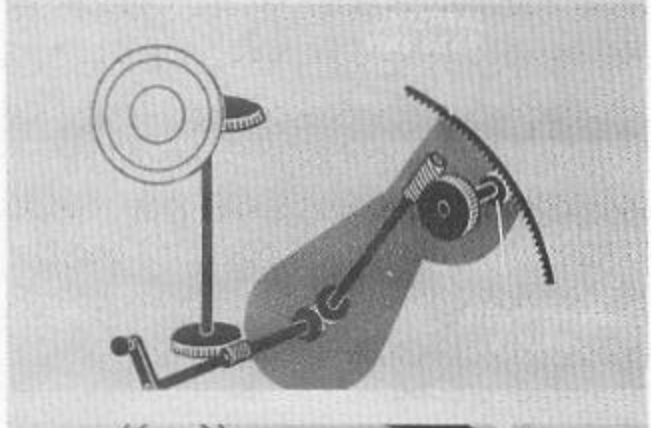
The outer dial is calibrated in minutes of sight angle. If the computer signal should fail, the sight angle can be set directly by turning the sight angle handwheel to match the required minutes of sight angle to a fixed index pointer. The order specifying the proper setting for this dial is usually telephoned to the gun.

Sometimes the sight angle order is given by specifying the range in yards. When this is done, the sight angle handwheel is turned to set the specified range opposite an index in the square opening of the range dial at the right of the handwheel, thus setting the prisms to the proper sight angle.

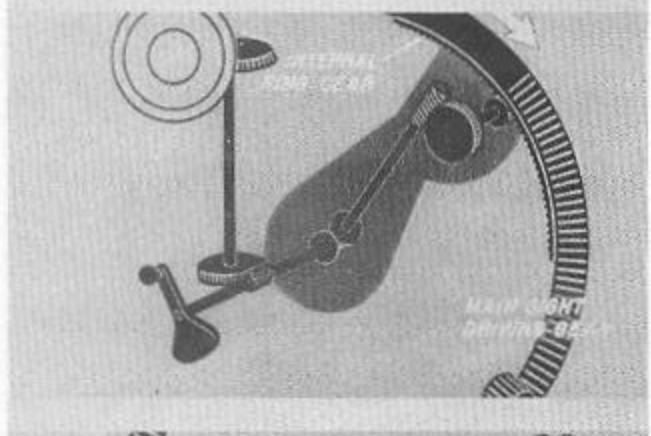




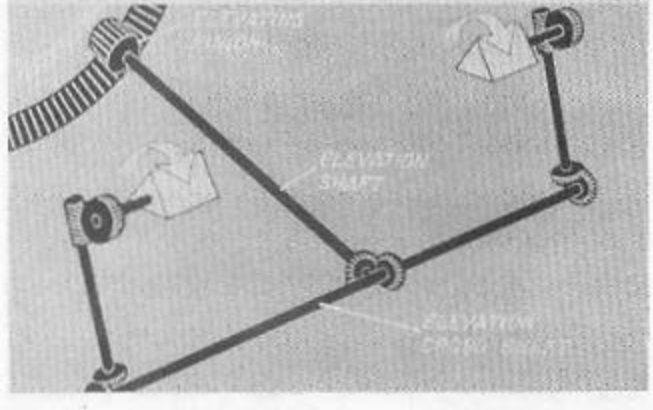
Let's review, briefly, the action of the sight setting mechanism in elevation. We have seen that no matter how the sight angle is given, the sight setter must respond by turning the sight angle handwheel. This movement of the handwheel operates the gear system in the banjo and rotates the sight driving pinion.



The sight driving pinion meshes with the internal ring gear.

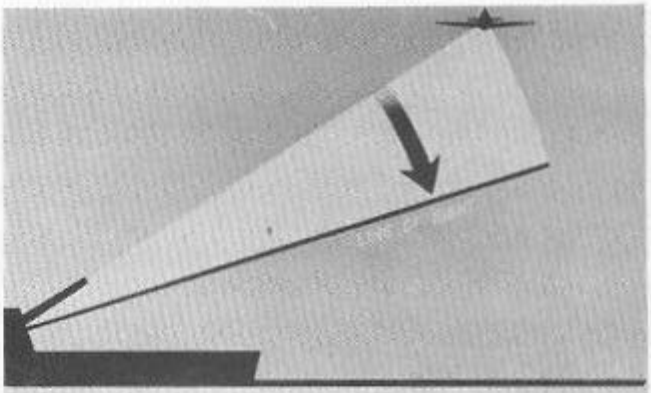


And the internal ring gear, being attached to the main sight driving gear, moves the driving gear along with it.

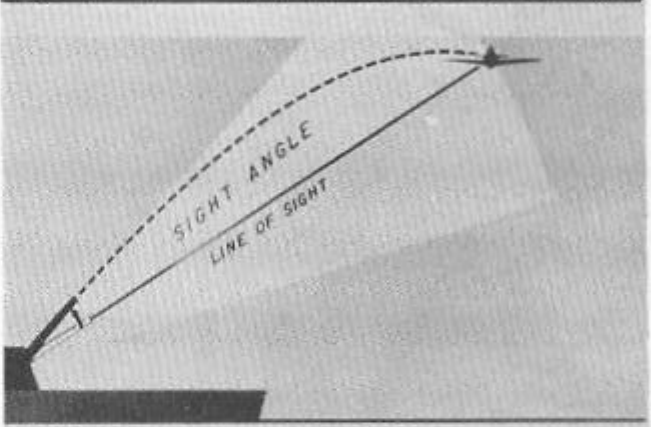


As the driving gear moves, it rotates the elevating pinion and elevation shaft. This shatt rotates the elevation cross shaft and this, in turn, moves the prisms.

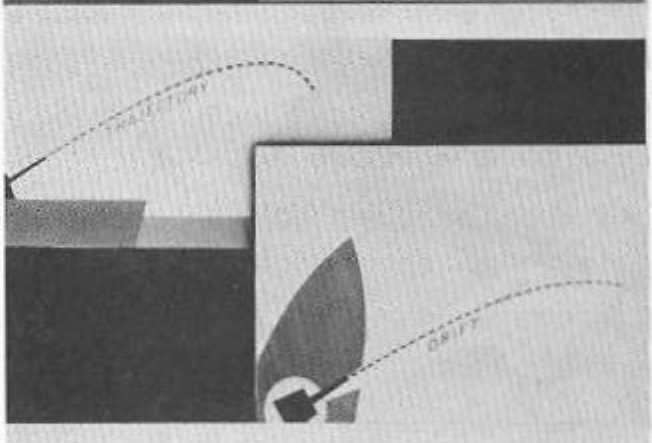
In order to elevate a gun to given angle above the line of sight, we must first set the elevation prisms to depress the line of sight at the same angle.



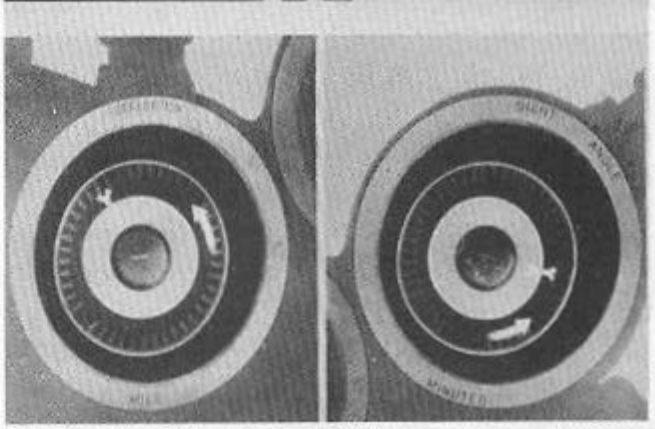
With the line of sight below the target the gun pointer operates his handwheels to elevate the gun. As the gun is elevated, the line of sight is also elevated with the sight angle remaining the same. In this way we compensate for the trajectory and enable the projectile to hit the target.

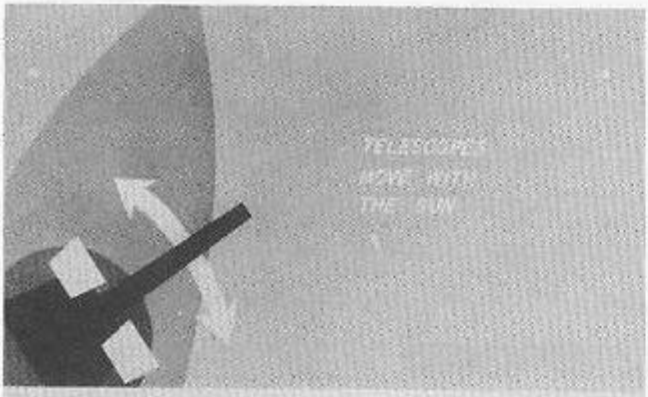


We have seen that if the gun is to fire accurately, the axis of the gun bore must be offset from the target both vertically and horizontally--vertically to compensate for the trajectory and horizontally to compensate for the drift of the projectile.

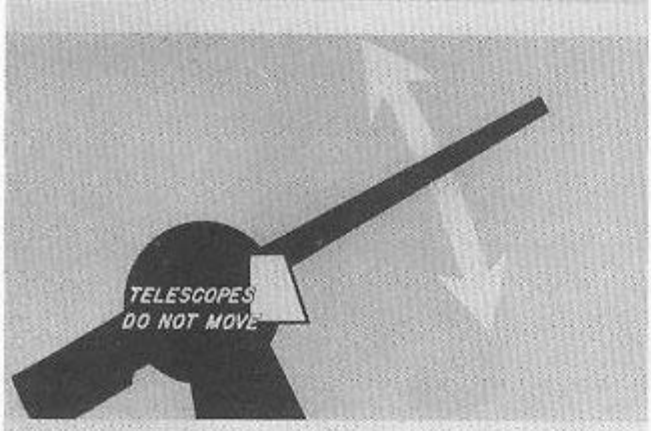


We observed also that the deflection angle for the proper horizontal offset and the sight angle for the proper vertical offset are determined by a computer. If the gun is to be able to accurately follow a moving target, it is obvious that the sight and deflection angles, once established, must remain fixed until a new angle is signaled by the computer.

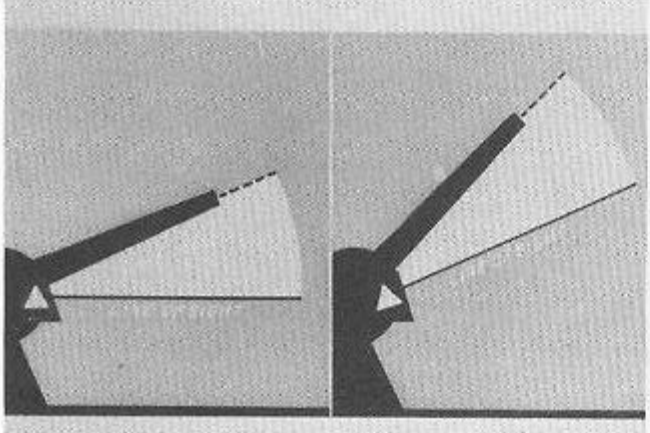




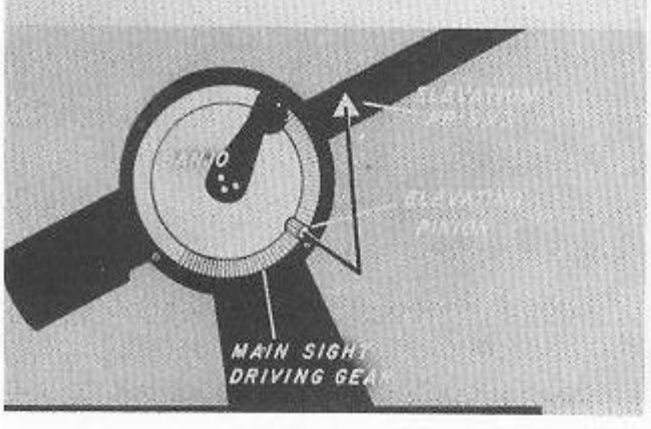
In train this is done quite easily. Here the telescopes, prisms, and the gun itself all move together with the mount. Thus, once a deflection angle is established, it can remain set. Training the mount cannot disturb it because the telescopes move with the gun.



In elevation, the problem of causing the line of sight to move with the gun is not so simple because the telescopes do not move as the gun is elevated.

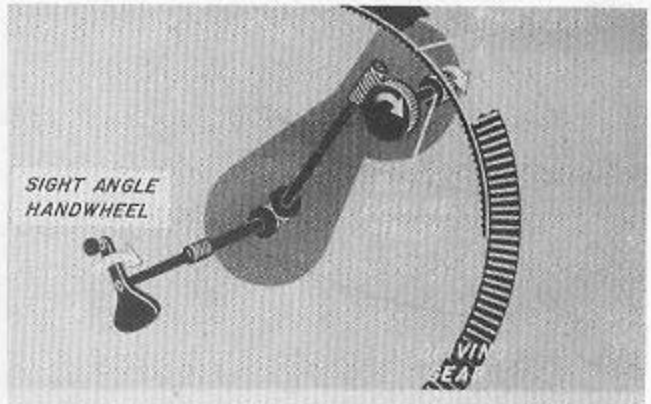


But if the gun is to compensate for trajectory, the line of sight and the gun barrel must move together as the line of sight is brought onto the target. The problem is solved by making the elevation prisms in the telescopes move with the gun in elevation. Accomplishing this is a job assigned to a part of the sight-setting mechanism which we shall now investigate.

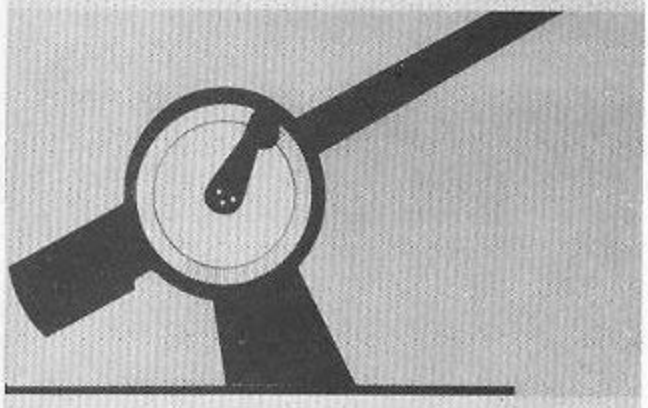


The mechanism that moves the prisms with the gun in elevation includes the banjo, the main sight driving gear, and the linkage between the elevating pinion and the elevation prisms.

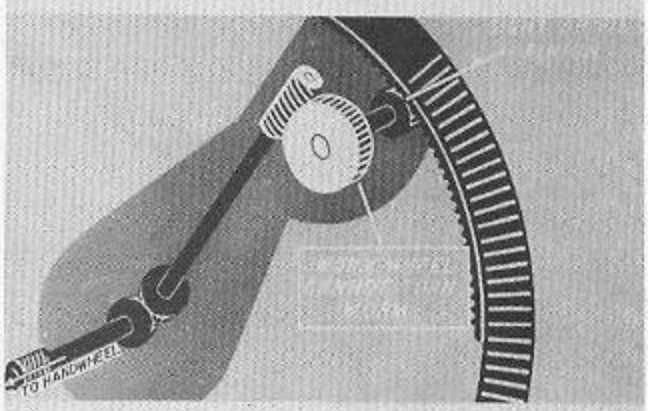
When we studied the movement of the elevation prisms, we found that the sight angle handwheel rotated the sight driving pinion to turn the internal ring gear and the driving gear.



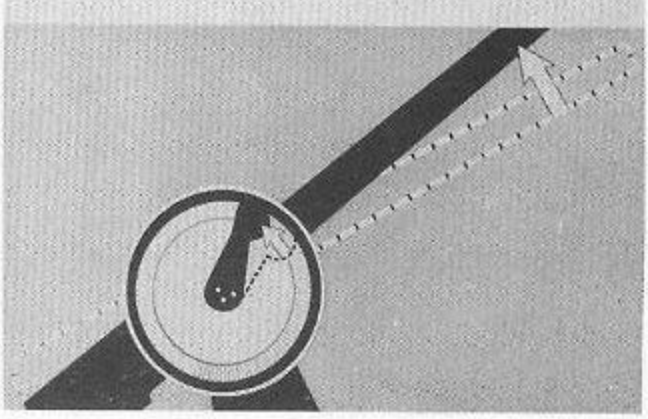
We assume that the gun itself was not being moved in elevation. The only movement with which we were concerned was that of gears and shafts within the banjo. The banjo itself, being bolted to the trunnion, did not move.

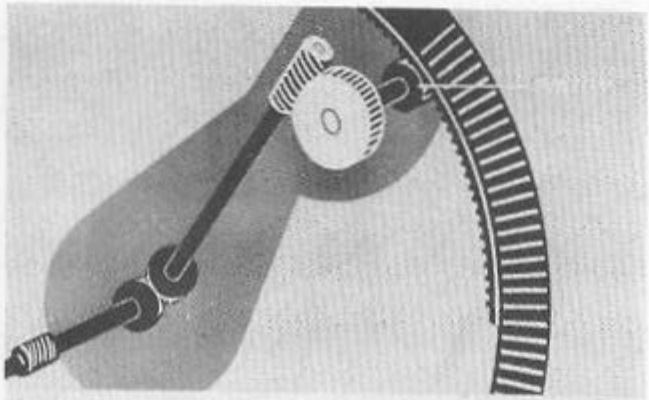


The sight driving pinion cannot be moved unless the sight angle handwheel is turned, because the worm wheel that is connected to the sight driving pinion cannot turn the worm. This pinion may be here regarded simply as a fixed attachment that connects the main sight driving gear to the banjo.

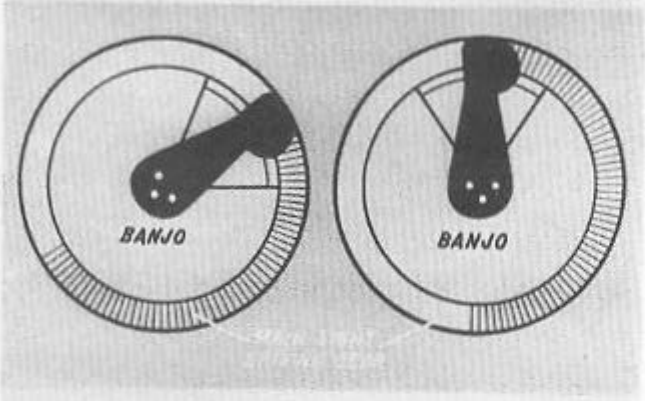


When the gun is elevated the banjo, being bolted to the trunnion, moves with it.

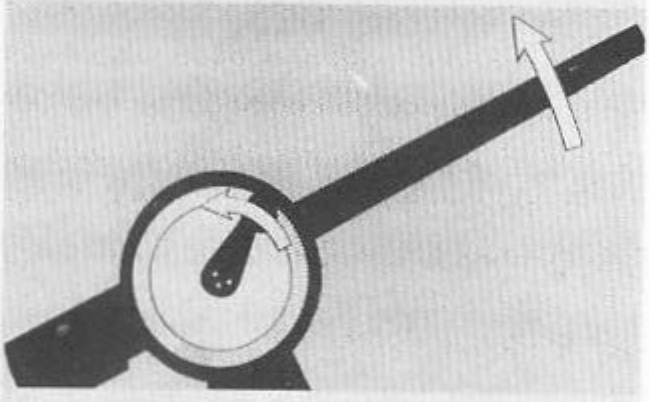




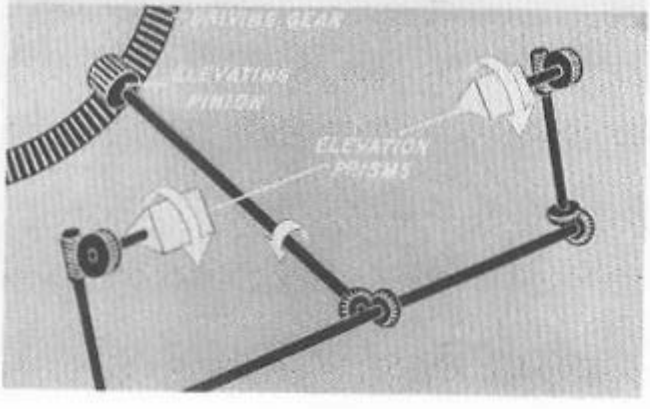
And, since the sight driving pinion now acts as a fixed attachment connecting the banjo to the main sight driving gear,. . .



. . .we can see that as the banjo moves with the gun in elevation the main sight driving gear will also move.

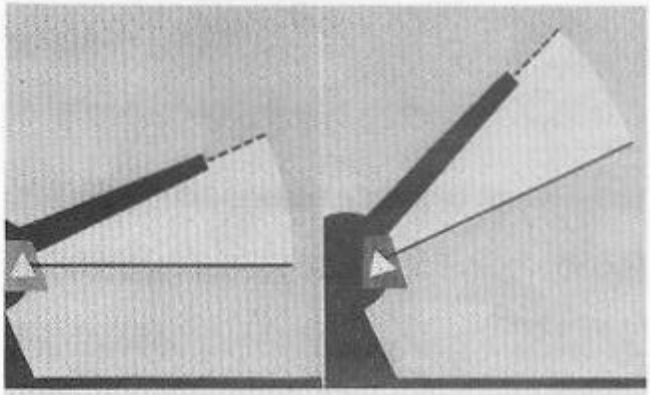


So, as the gun is elevated or depressed, the driving gear will be rotated.

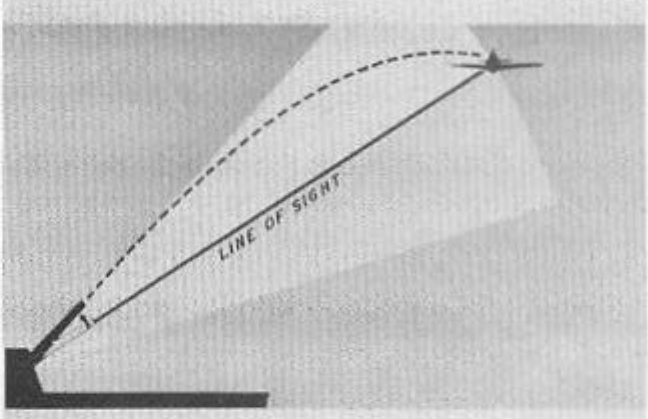


This rotation of the driving gear with the gun causes the elevating pinion to rotate. When this pinion rotates it acts through shafting and gearing to move the elevation prisms.

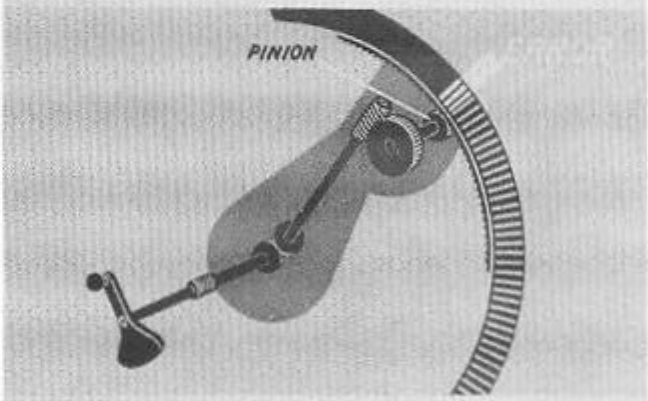
And so we can see how the elevation prisms move with the gun as the gun is elevated or depressed. We see also that this enables us to compensate for trajectory, because. . .



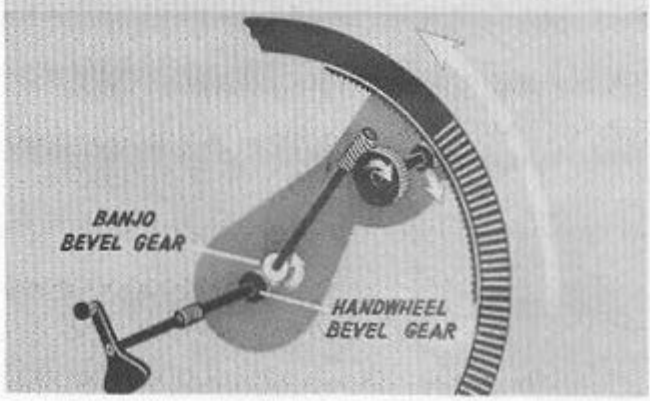
. . .both the gun and the line of sight are elevated together with the sight angle between the two remaining the same. To ensure the accuracy of the sight angle setting and, hence, the precision aiming of the gun , we must consider and compensate for a small error that occurs when the elevation prisms are elevated with the gun. To see how this error occurs. . .

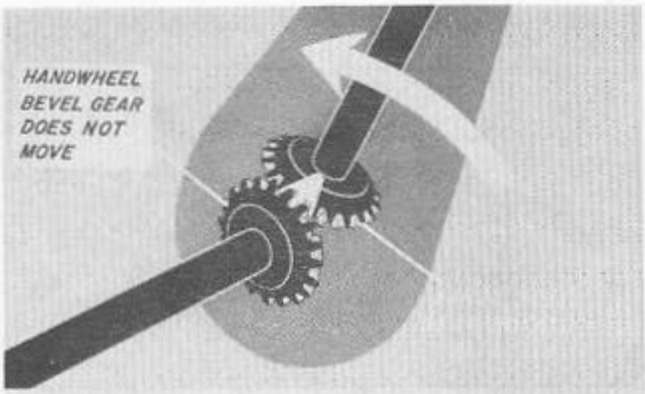


. . .let's go back to the point where we compared the sight driving pinion to a fixed attachment between the banjo and the driving gear. It was necessary, when we first explained this gearing to ignore a slight motion that creeps into the banjo gear assembly as the banjo moves and causes an error in the movement of the driving gear.

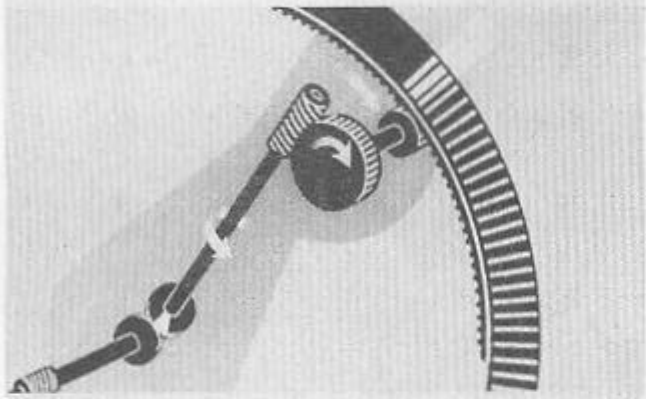


When the banjo moves with the gun in elevation it causes the teeth of the banjo bevel gear to roll over the teeth of the handwheel bevel gear.

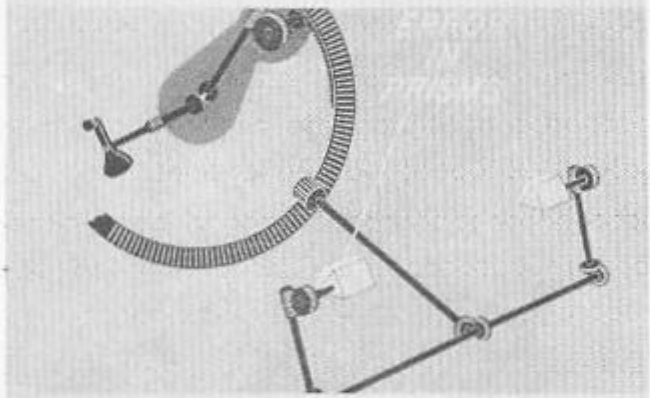




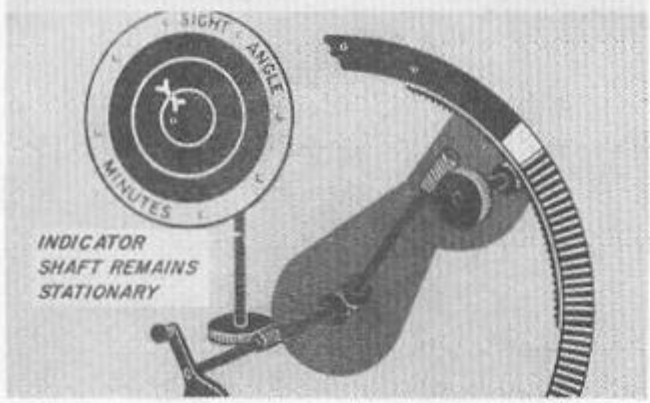
The handwheel bevel gear does not move. But, in rolling over this gear the banjo gear rotates slightly. It is this small amount of rotation (indicated by the white area on the gear) that causes the error. This error is transmitted through the gearing, because. . .



. . .the small amount of rotation in the banjo bevel gear shaft moves the worm and worm wheel and causes the sight driving pinion to move on the internal ring gear section. This results in lost motion between the banjo and the main sight driving gear. In other words, the banjo has not carried the driving gear around as far as it should have carried it.

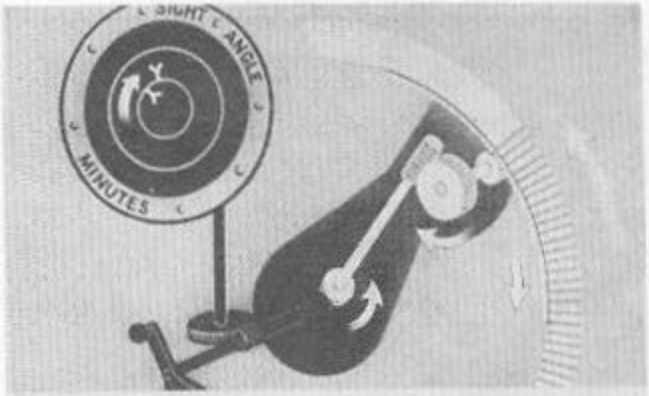


If allowed to go unchecked, this would result in an error in the setting of the elevation prisms, since they would not have been moved as far as they should have been. This would, in turn, result in an inaccurate sight angle setting and might cause the projectile to miss the target.

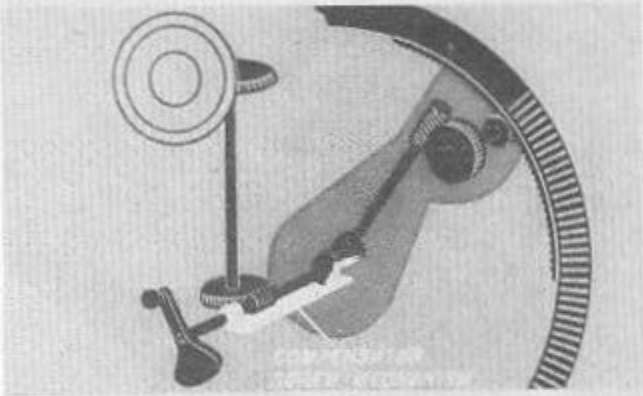


This error would not show on the sight angle indicator dial, because the sight angle indicator shaft that operates this dial remains stationary as the banjo rotates. The error must, of course, be corrected. Correction is made. . .

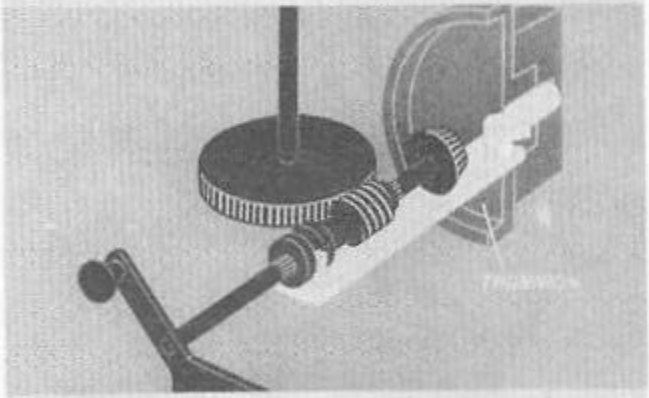
. . .by providing a means of causing the error to show on the sight angle indicator dial and then compensating for the error by turning the sight angle handwheel to match up the pointers. Doing this sets the prisms at the correct angle.



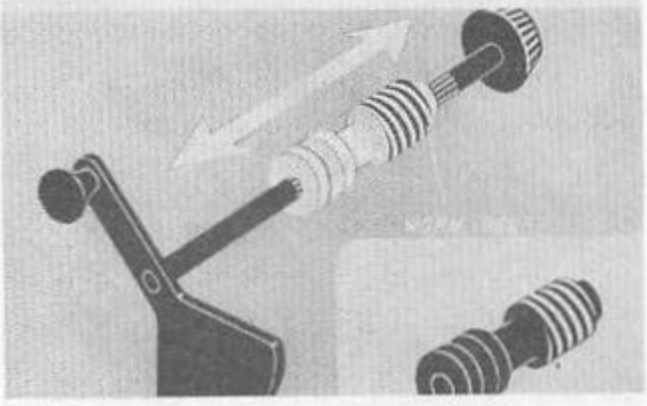
The means of causing the error to show on the sight angle dial is provided by a compensator screw mechanism.

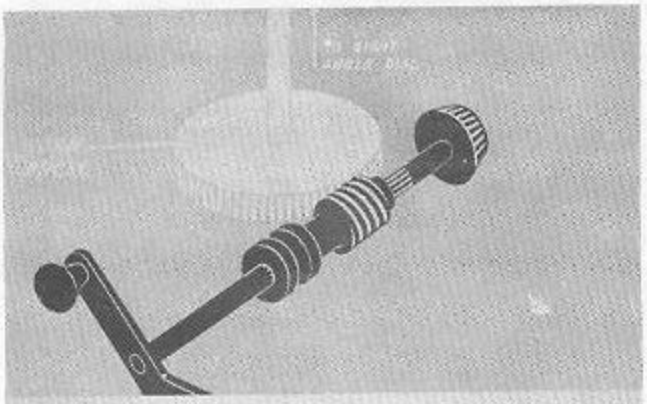


This mechanism is installed in the banjo in line with the axis of the trunnion. Let's see how it works.

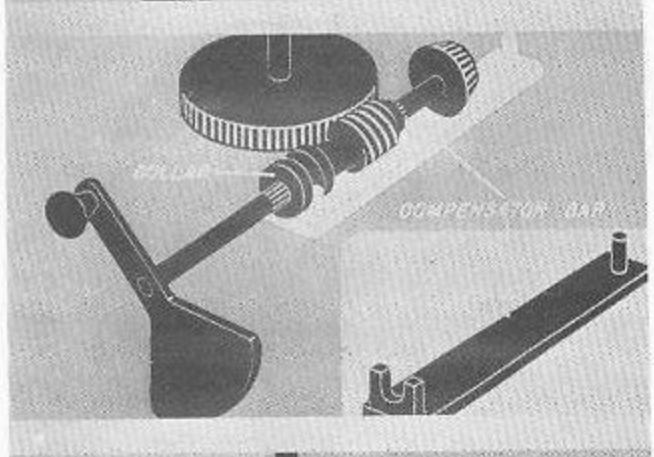


Mounted on a splined section of the sight angle handwheel shaft is a worm gear with a slotted collar attached to its outer end. This gear can slide along the splined shaft but cannot rotate on it.

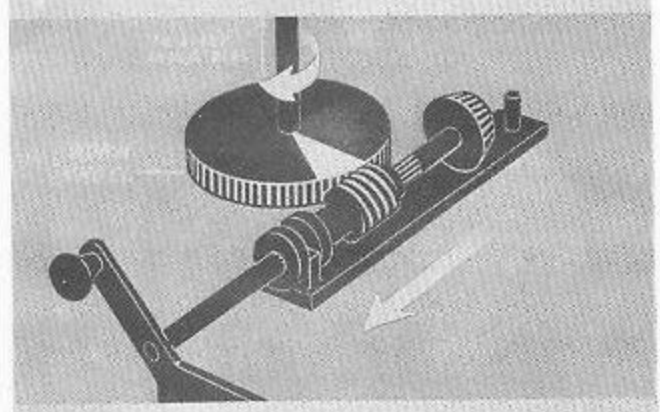




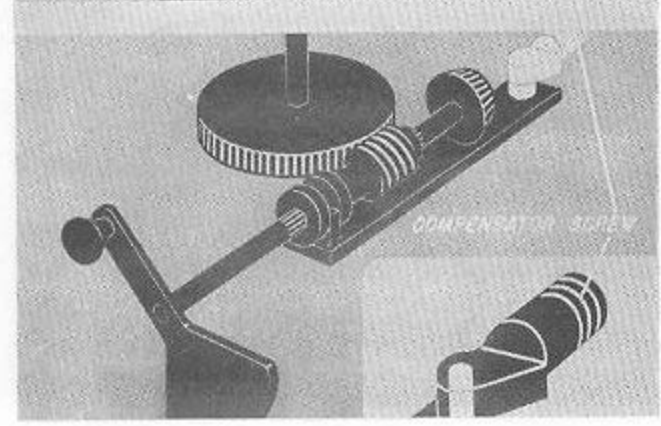
This worm gear meshes with the worm wheel which drives the shaft of the sight angle dial.



A compensator bar fits into the slotted collar. The purpose of this bar. . .

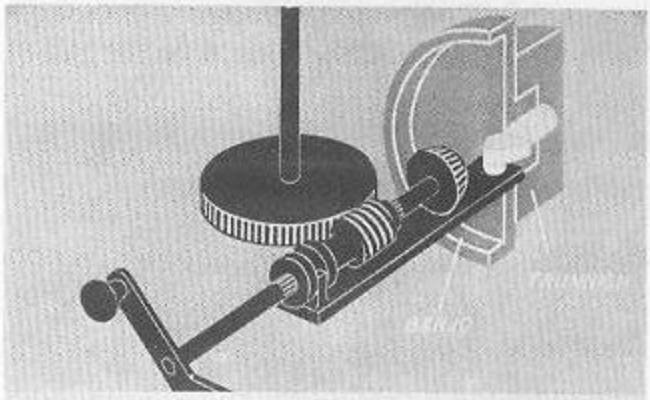


. . .is to carry the worm gear along on the spline and, so, to move the worm wheel and the shaft to the sight angle dial in the manner of a rack and pinion. To move the bar. . .

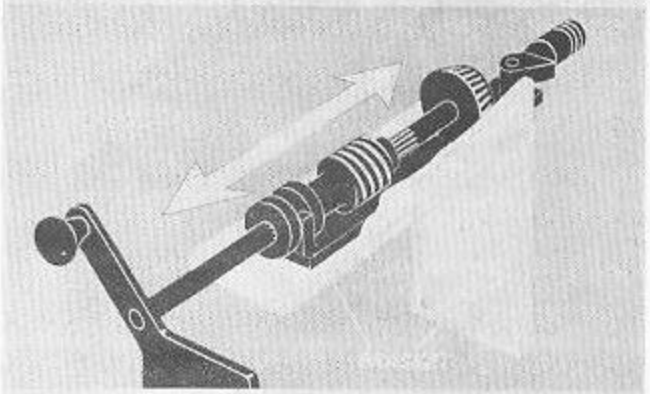


. . .a compensator screw is attached to it by a pin. The screw is fitted with an elbow which receives the pin.

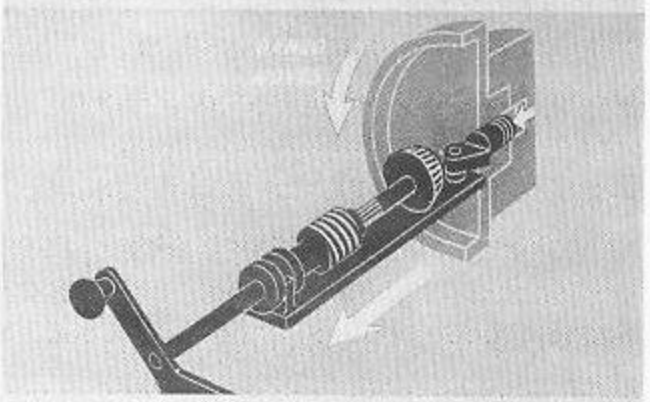
This compensator screw is threaded into a hole in the banjo at the exact center line of the trunnion. The screw has a left-hand thread.



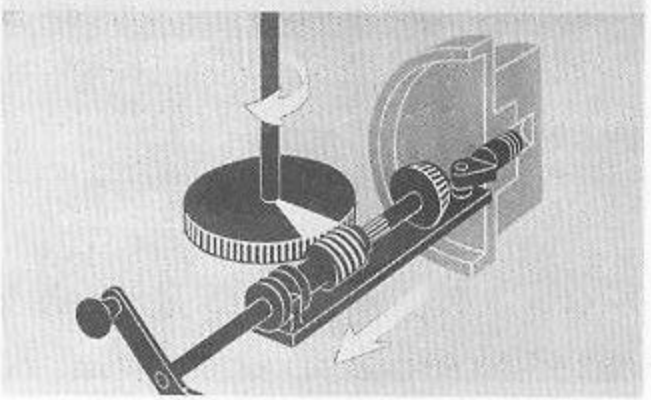
The compensator screw assembly is mounted in a bracket which allows it to slide in and out.

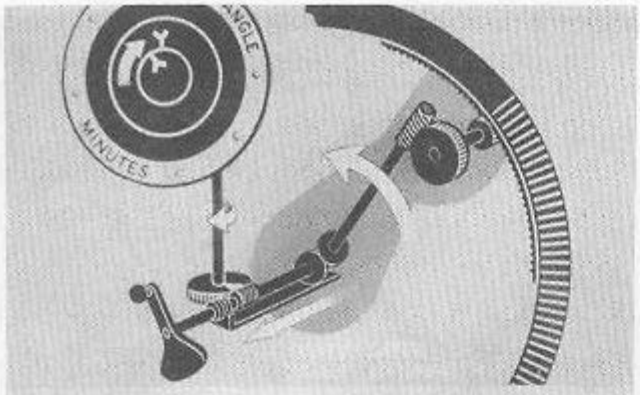


When the banjo moves in elevation, the compensator screw, because of its left-hand thread, is forced outboard. This causes the bar to slide outboard carrying the worm gear with it.

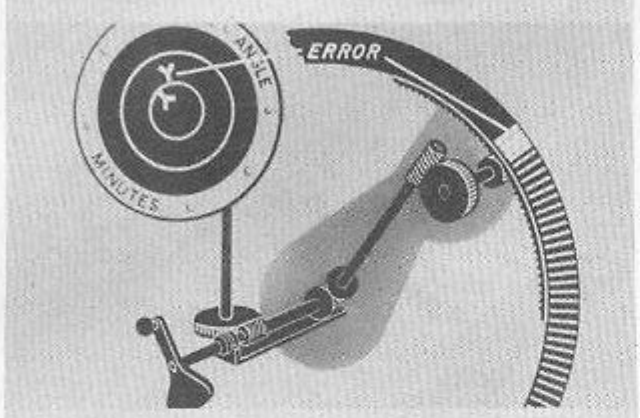


As the worm gear slides outboard it acts as a rack on the worm wheel and, so, rotates the vertical shaft of the sight angle dial. The rotation of this shaft. . .

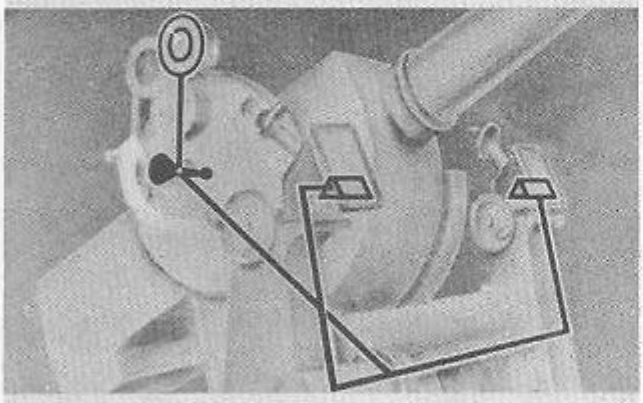




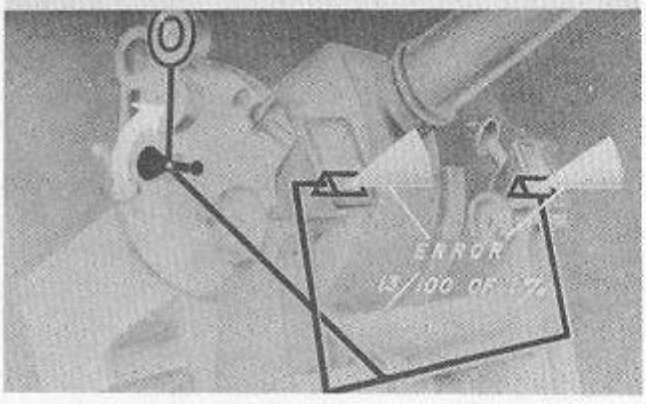
. . .causes the outer dial of the sight angle indicator to be moved. We can see now that as the banjo elevates with the gun, it causes the compensator screw mechanism to make a slight change in the position of the index pointer on the outer dial of the indicator.



The pitch of the threads on the compensator screw is calculated so that this change in the position of the index on the outer dial represents the error caused by the creep in the banjo gearing system.

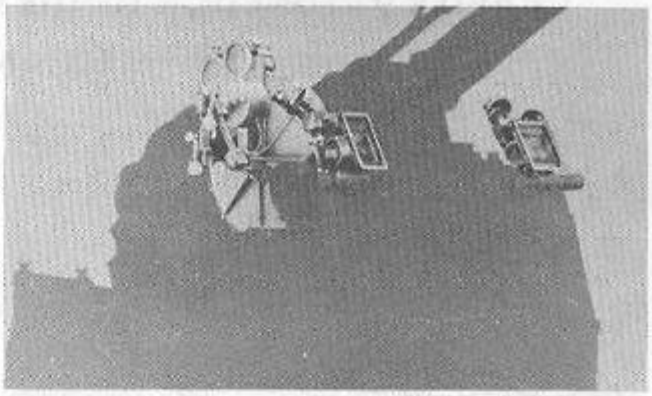


The index marks are then matched up by turning the sight angle handwheel. When this has been done, the prisms are again set correctly and the sight angle is <u>again</u> correctly established.

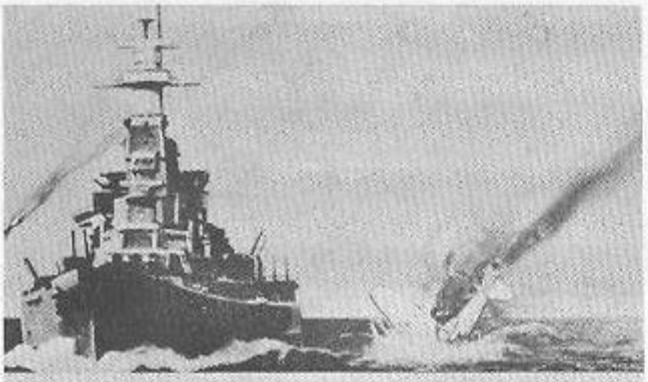


The error that is corrected by the compensator screw mechanism is thirteen one-hundredths of one percent. This figure may give you some idea of what a highly precise instrument the 5"/38 gun is.

We have seen in this chapter how the sight-setting mechanism operates to position the gun accurately with respect to the line of sight. Unless this mechanism is properly maintained, all of the gun's other features—its rapid fire, its ease of movement, its hard-hitting punch, its automatic operation—will be virtually useless. The sights are the eyes of the gun. Maintain them so that they will always be sharp and accurate.

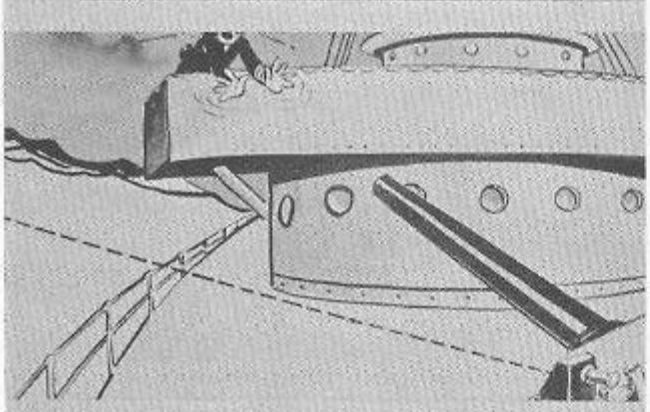


CHAPTER 9—FUNCTION OF THE FOOT FIRING AND FIRING STOP MECHANISMS

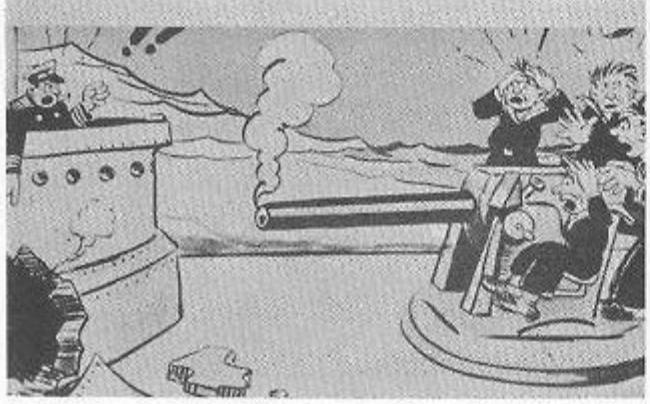


We have already seen that the 5''/38 gun is designed to develop a high rate of fire, and have studied some of the assemblies and mechanisms which make its rapid firing possible.

Firing is controlled by the pointer, who gives all his attention to the job of keeping the gun on the target. To do this he must keep his eyes glued to his telescope. As a result, his vision is limited to the field of the telescope.

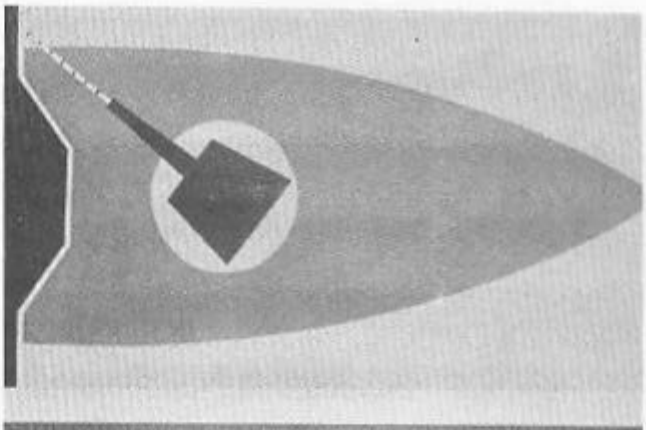


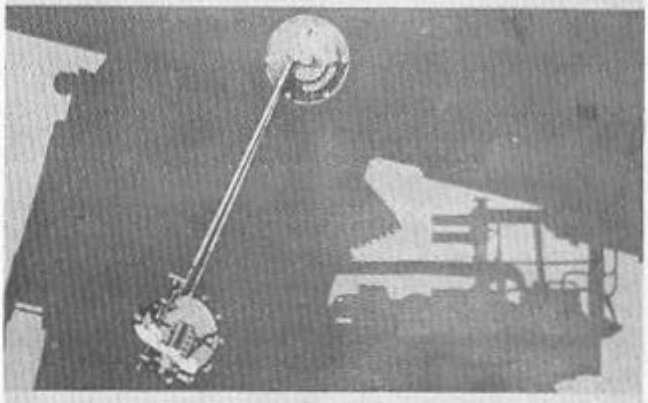
In tracking a fast-moving target with the line of sight offset from the axis of the gun bore, it is quite possible that, although the line of sight may be in the clear, the gun itself would be pointing at some part of the ship's structure.



Since the object of firing a gun is to hit the enemy, firing into your own ships is, to put it mildly, not good. To spare the pointer the embarrassment and consequences that would result from this happening. . .

. . .a mechanism is provided to prevent the gun from firing whenever it is bearing on any part of the ship's structure.



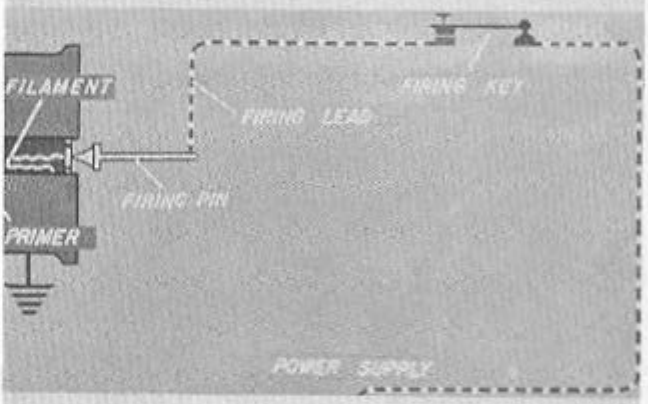


This mechanism, called the firing stop mechnism, is mounted on the left carriage cheek, on the pointer's side of the mount.

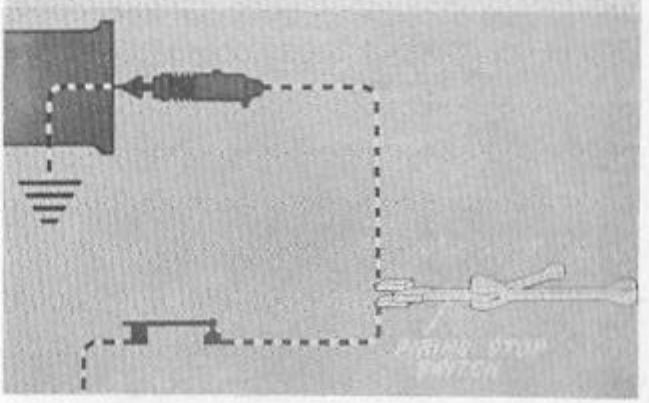
The firing system in the gun has two functions:

One, it must provide for rapid firing of the gun.

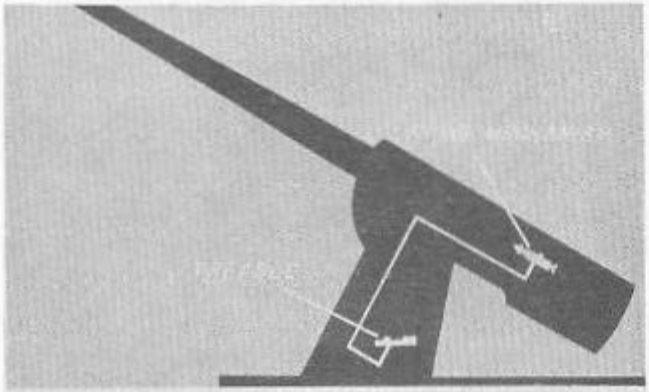
Two, it must be able to prevent firing into the ship's structure.



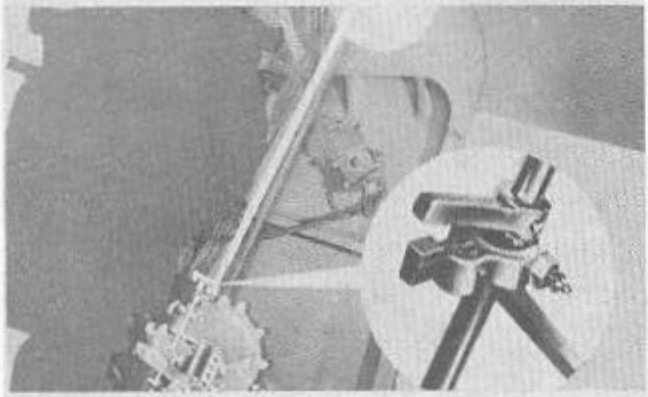
The preferred firing method is electrical because it is faster. In electrical firing, closing the pointer's firing key causes current to flow from a power supply, through the firing lead, the firing pin, and the filament in the primer. This current passing through it heats the filament and causes the primer to be detonated.



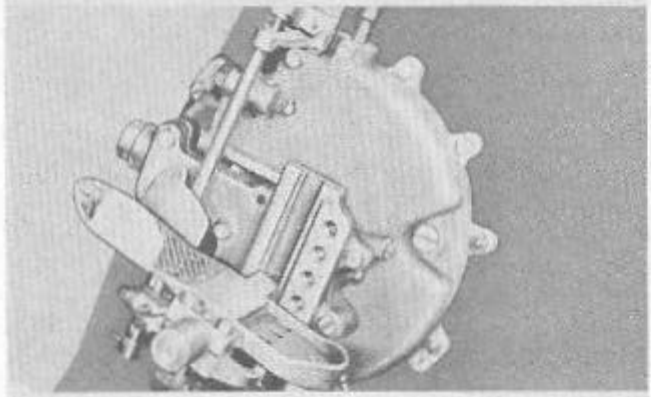
To provide a means for preventing electrical firing, the firing lead passes through the firing stop switch in the housing of the firing stop mechanism. This switch can be operated by the firing stop mechanism to break the electrical firing circuit. If for any reason the gun cannot be fired electrically, we must resort to our standby method. . .



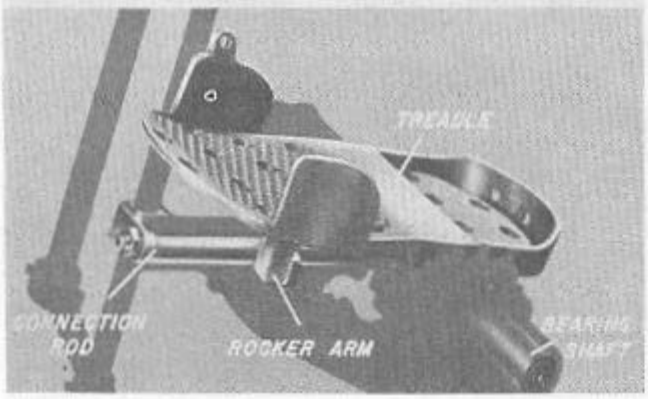
. . .percussion firing. In percussion firing the motion of the foot firing treadle is transmitted through linkage to release the plunger in the firing mechanism and so cause the primer to be detonated by percussion. (It must be pointed out that most of the 5''/38 powder cartridges being supplied to the fleet today are fitted with electrical primers only. Therefore, percussion firing is impossible with these cartridges.)



To prevent percussion firing, the firing stop mechanism breaks the foot firing linkage by means of a clutch arrangement. To see exactly how this linkage is broken and firing stopped. . .

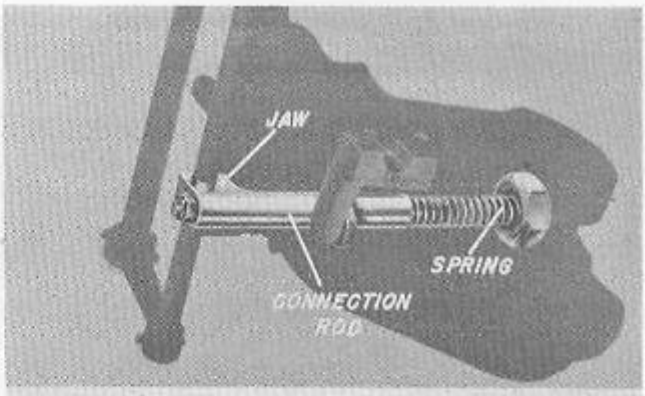


. . .we must first see how the parts of the foot firing mechanism are connected. We shall start with the parts that are located in the lower section of this mechanism.

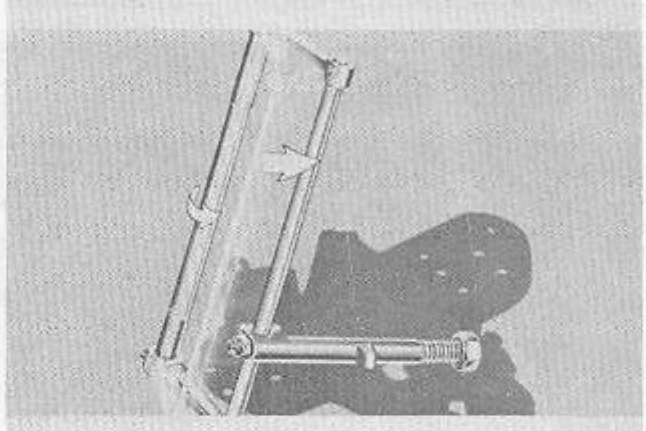


The treadle assembly consists of the treadle, a bearing shaft on which the treadle pivots, a rocker arm, and a connection rod. A lug on the rocker arm contacts the connection rod.

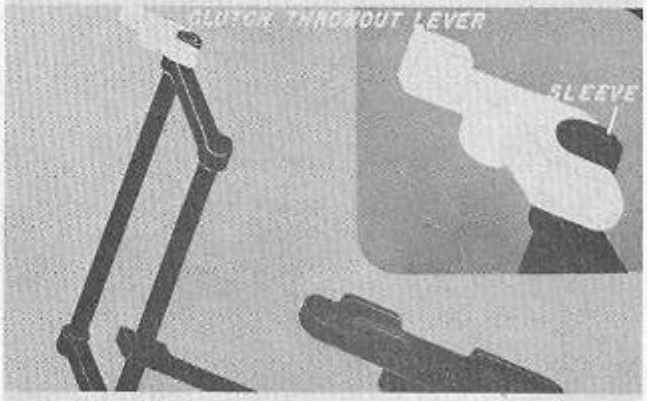
When the treadle is not depressed the connection rod is held forward by a spring. This connection rod has a jaw on its forward end. This jaw. . .



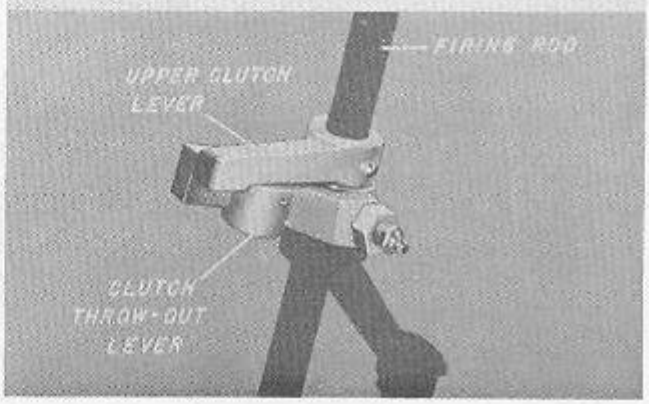
. . .enages the outboard rod of a connection lever assembly. The inboard rod of this assembly pivots around its center line.

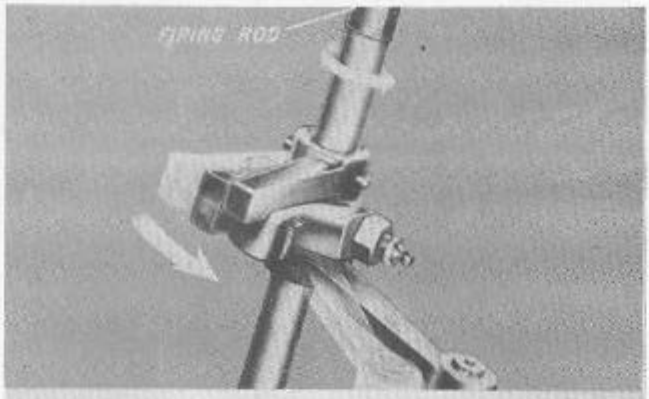


Secured to this inboard rod is a clutch throwout lever, shown in detail in the insert. Notice that there is a sleeve in the upper end of the rod. Seated in this sleeve. . .

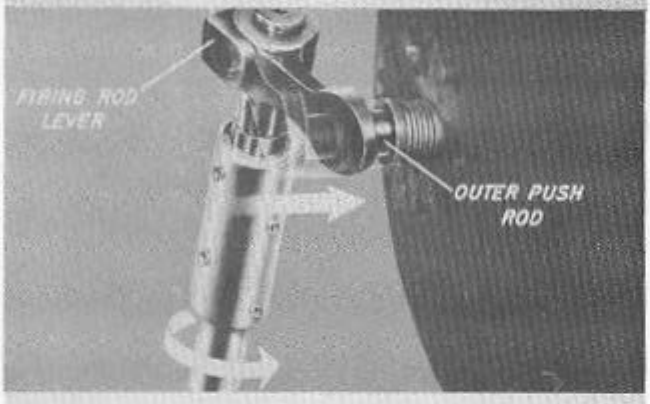


. . .is a firing rod. Secured to the lower end of the firing rod is an upper clutch lever, which bears against the clutch throwout lever.

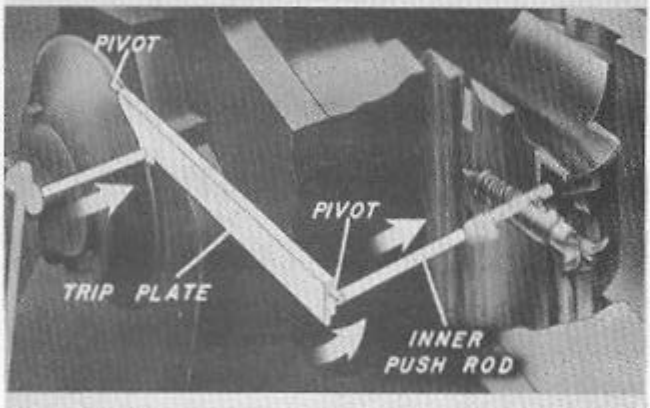




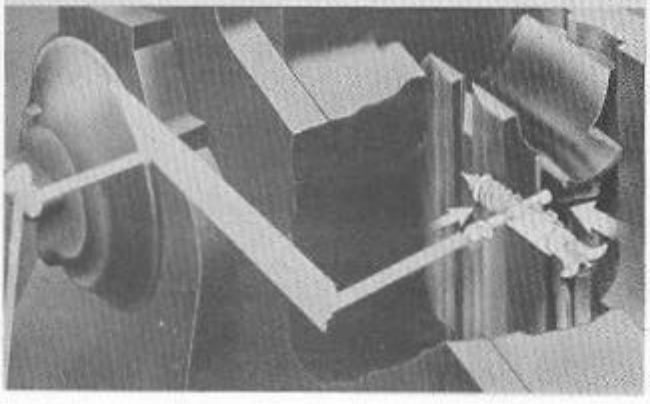
When the connection lever is rotated by the foot treadle, the clutch throwout lever rotates the upper clutch lever and the firing rod.



The firing rod in turn rotates the firing rod lever. This lever pushes the outer push rod. . .

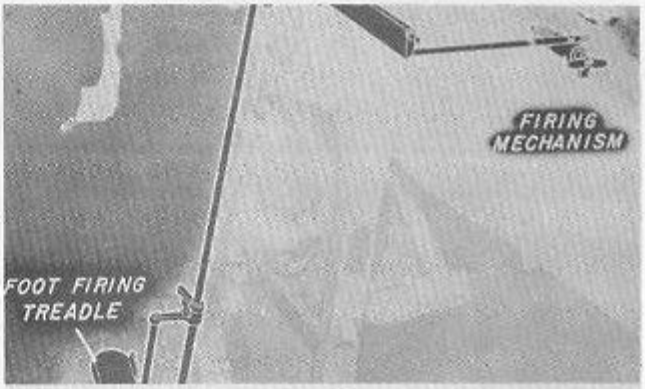


. . .against the trip plate. The trip plate, which is pivoted, transmits this motion to the inner push rod. . .

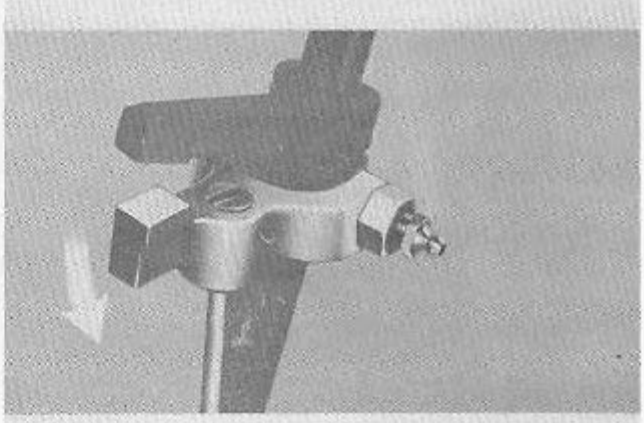


. . .causing the sear to be pushed in. The sear, in turn, releases the firing plunger and causes the gun to be fired by percussion.

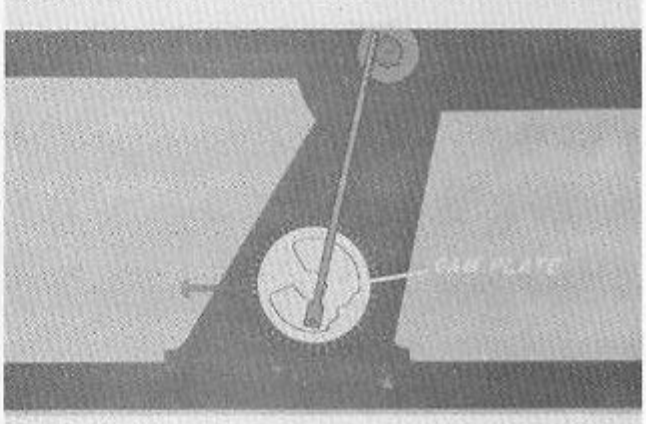
We have seen how the linkage from the foot firing treadle operates to fire the gun. To prevent firing, this linkage must be broken. . .



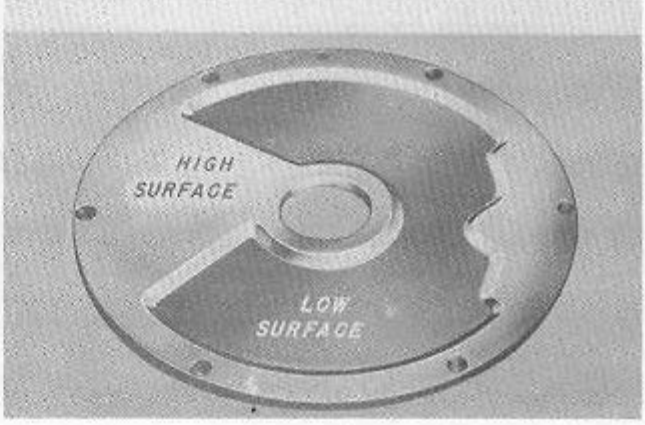
. . .by disengaging the clutch throwout lever so that it cannot engage the upper clutch lever and thus cannot rotate the firing rod. Breaking this clutch connection to prevent firing is done by the firing stop mechanism.

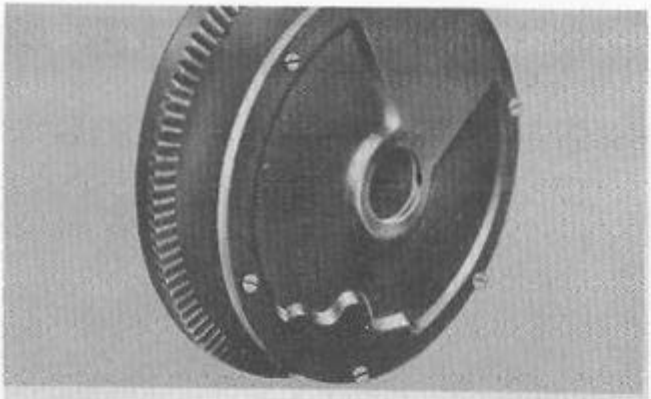


The firing stop mechanism is located in the same two housings as the foot firing mechanism. The heart of the firing stop mechanism is a cam plate mounted in the lower housing.

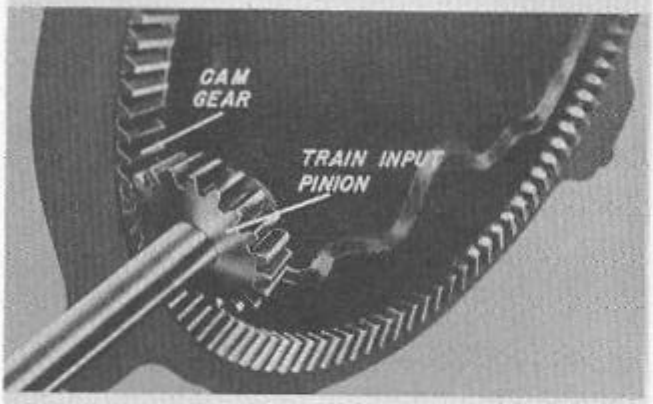


The face of the cam plate has a high surface and a low surface. The cam profile is plotted and the cam plate cut after the gun has been installed on the ship. The high surface on the plate corresponds with all of the points in train and elevation at which parts of the ship's structure would be in the line of fire. The low surface of the cam plate represents all of the points at which firing will be safe.

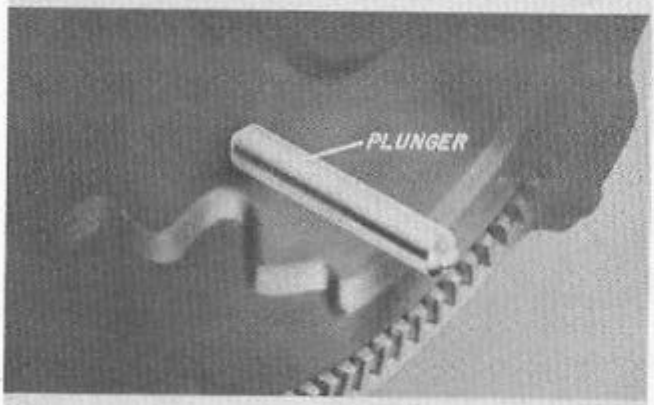




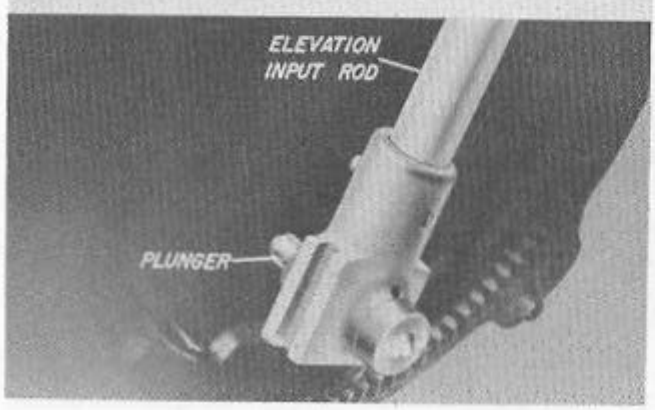
The cam plate is mounted on and secured to a cam gear.



This cam gear meshes with a train input pinion that is rotated when the mount is trained.



A plunger rides on the face of the cam plate. In this view all of the parts which operate the plunger have been removed. The plunger is always in contact with either a high spot or a low spot on the cam plate.



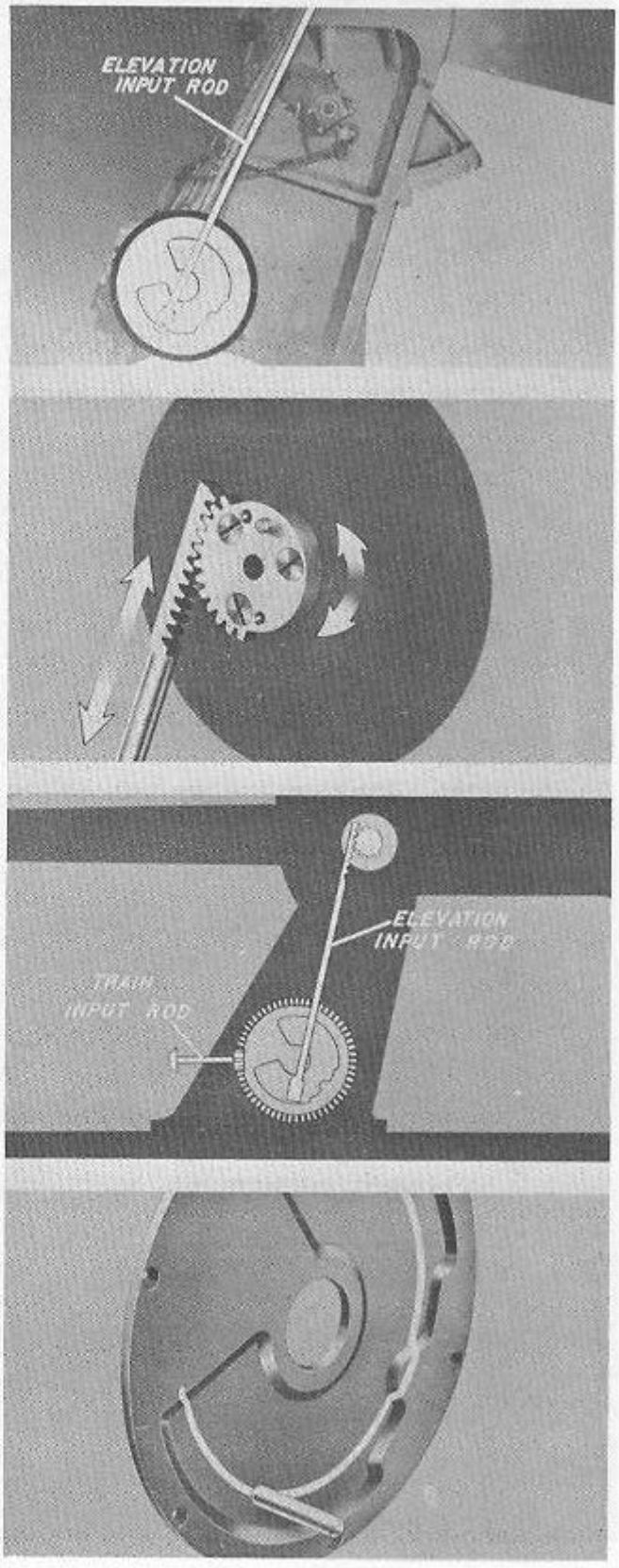
The plunger is held in a rod known as the elevation input rod. It is free to slide in and out in its mounting.

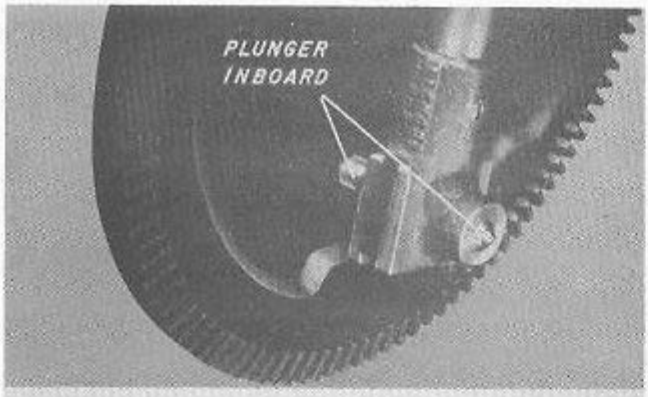
The elevation input rod extends from the cam plate in the lower housing. . .

. . .to the upper housing where a section of gear rack on the rod meshes with a pinion secured to the trunnion at its center. As the trunnion rotates with elevation or depression of the gun, this pinion raises or lowers the elevation input rod.

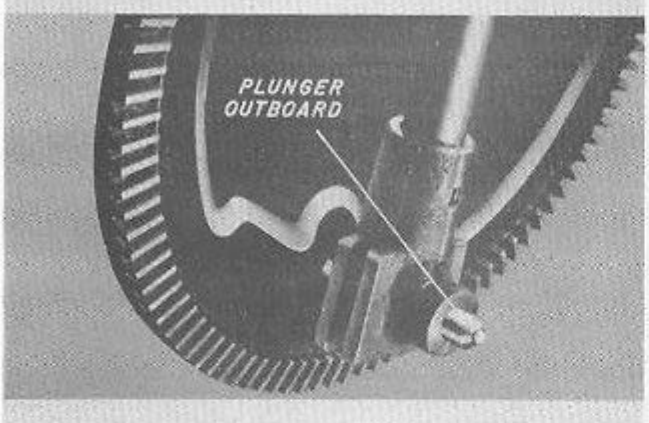
Thus we see how the position of the plunger on the cam plate is made to correspond with the train and elevation of the gun. As the mount trains, the train input rod rotates the cam plate, and as the gun is elevated or depressed the plunger is carried up or down over the surface of the cam plate.

The heavy white line shows the path of the contact between the cam plate the plunger as the cam plate rotates with the train of the mount. We assume here that the gun is not being elevated and the elevation input rod does not move.

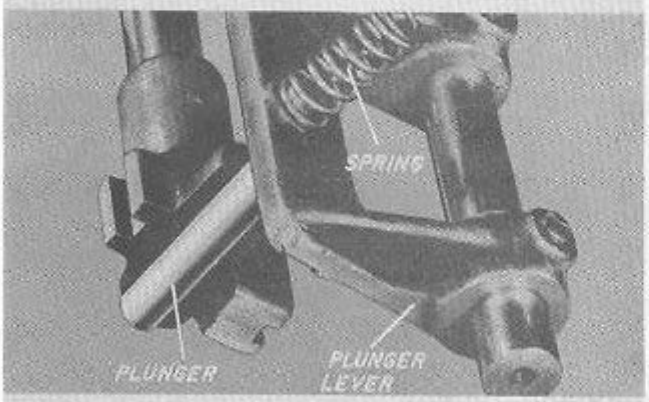




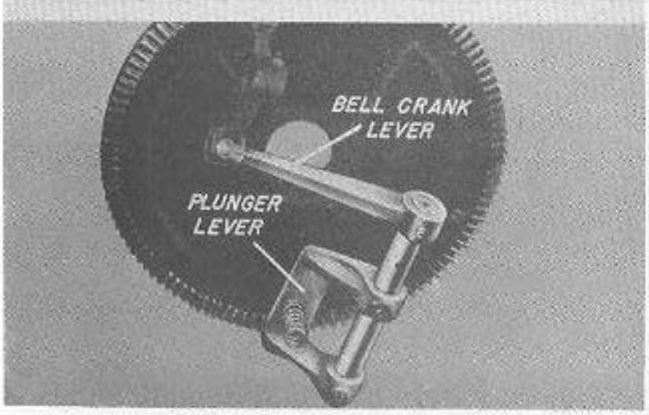
When the plunger is contacting a low spot, it is in the inboard position.



When the plunger rides over a high spot it is forced outboard. It is this plunger that controls the operation of the remaining parts of the firing stop mechanism. Let's see how this is done.

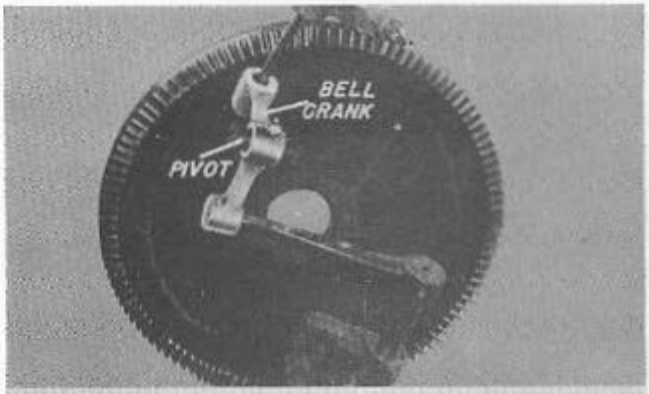


The outer end of the plunger contacts a plunger lever. The lever is held inboard by a spring and so keeps the plunger in contact with the face of the cam. The end of the plunger moves along the face of the plunger lever as the elevation input rod is raised and lowered.

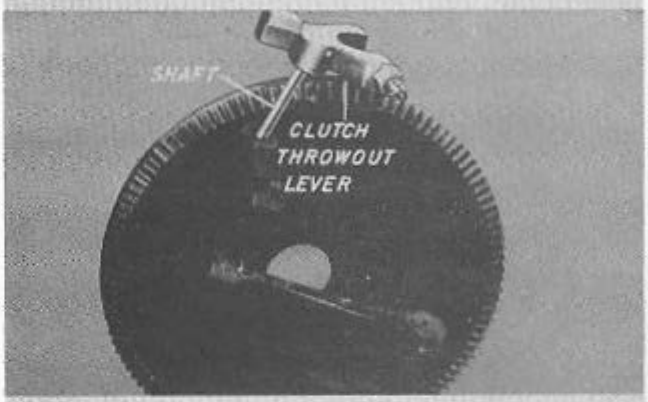


The plunger lever is connected to a bell-crank lever and pivots on the same shaft with it.

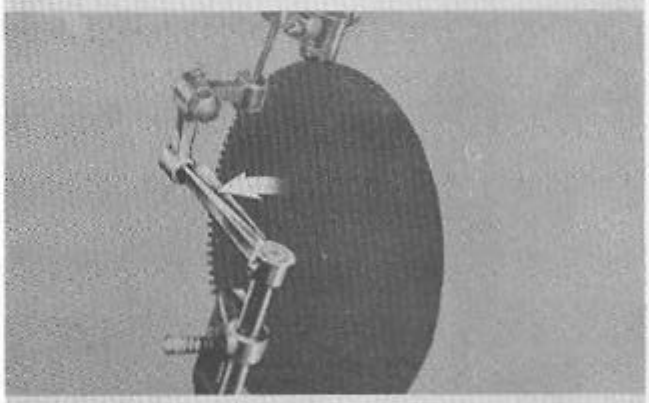
The bell-crank lever, in turn, is attached by a ball-and-socket joint to a pivoted bell crank.



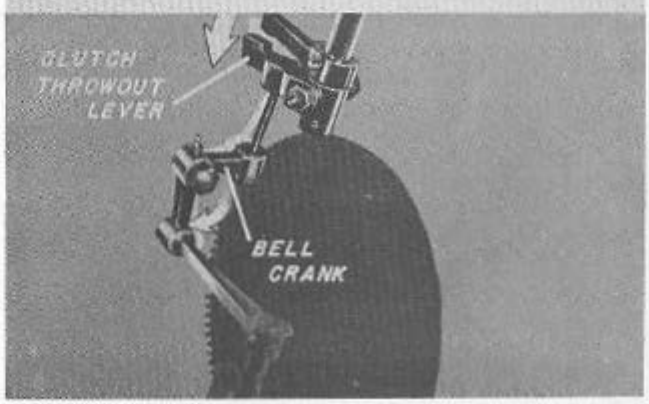
From the upper arm of the bell crank a shaft extends to the clutch throwout lever. When the plunger bearing against the cam plate is over a low spot the linkage we have just traced is not activated.

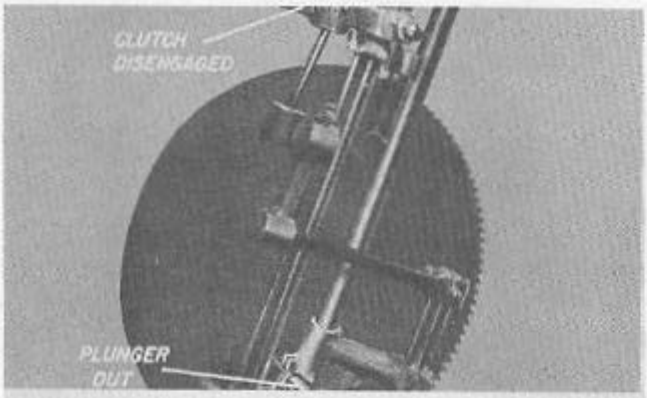


But when the plunger is on a high spot the linkage is activated to break the clutch connection and so prevent firing. The plunger in this position causes the plunger lever to move the bell-crank lever outboard.

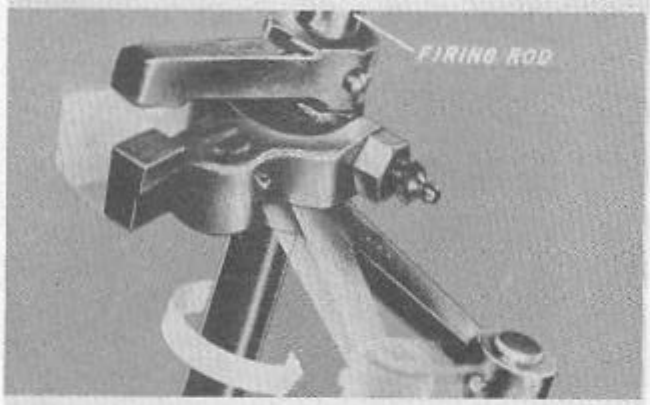


The outboard movement of the bell-crank lever rotates the bell crank and pulls the clutch throwout lever down.



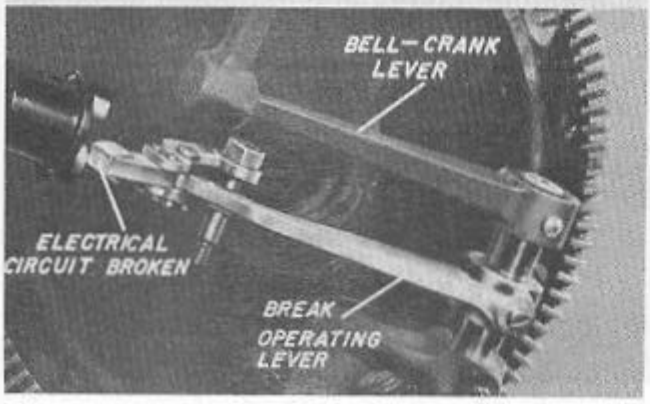


And so we see how, when the plunger rides on a high spot on the cam plate, and is pushed out, it operates through linkage to disengage the clutch connection to prevent the gun from being fired by percussion.



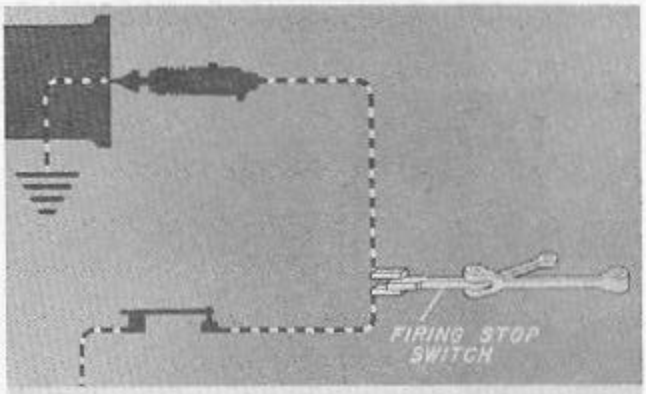
Breaking the clutch connection prevents firing because the firing rod, which is secured to the upper clutch lever, is not rotated. The firing stop mechanism, as we have described it so far, prevents only percussion firing.

Since it is equally necessary to prevent electrical firing when the gun bears on a part of the ship's structure, the firing stop mechanism is constructed so that it will also operate a firing stop switch.

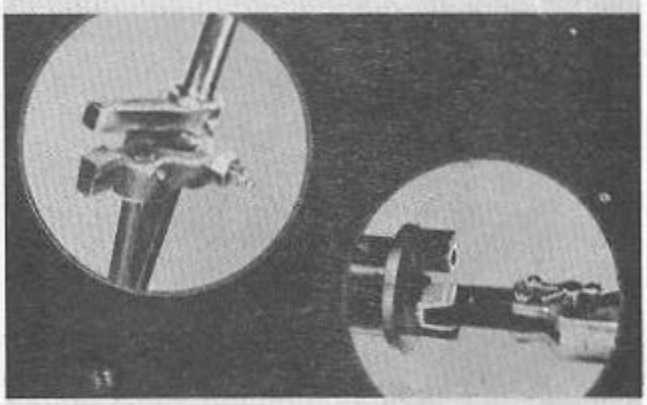


The electrical firing circuit is broken at the firing stop switch by a break operating lever located just below the bell-crank lever and on the same shaft. When the gun is bearing on part of the ship's structure and the high spot on the cam causes the plunger to be pushed outboard, this lever rotates the break operating lever to open the switch.

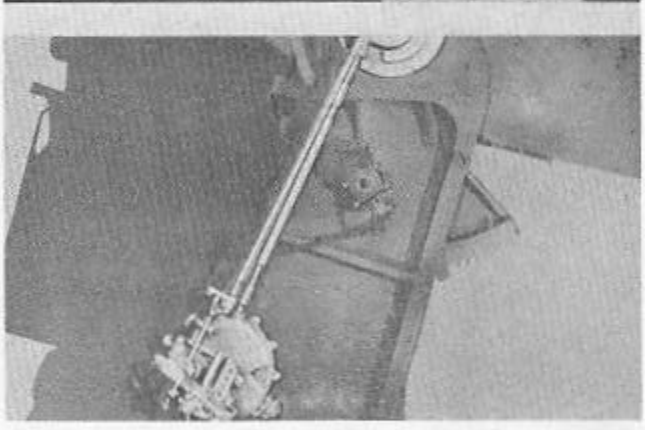
This schematic drawing shows the position of the firing stop switch in the electrical firing circuit.

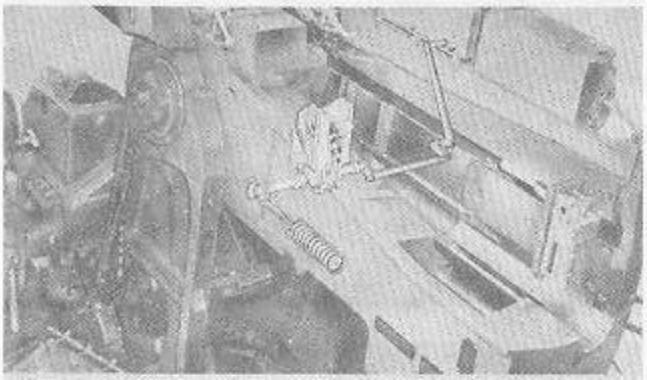


And so we see that the firing stop mechanism operates as a safety device to prevent percussion firing by disengaging a clutch to break the mechanical firing linkage, and operates further to prevent electrical firing, by opening a switch to break the electrical firing circuit.

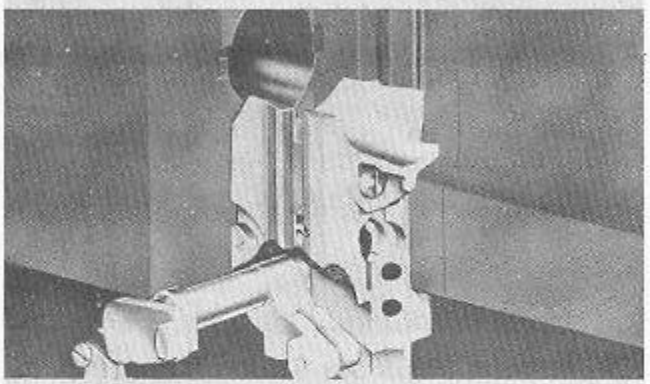


It is sometimes as important to prevent the gun from firing as it is to fire it. The foot firing and firing stop mechanism in the 5"/38 does both jobs. It operates to fire the gun by the standby method of percussion and to prevent firing either by percussion or electrically. The proper maintenance of this mechanism will thus make certain that you will have not only a dependable means of firing the gun should the electrical circuit fail, but will also be able to protect your own ship from accidential fire as well.

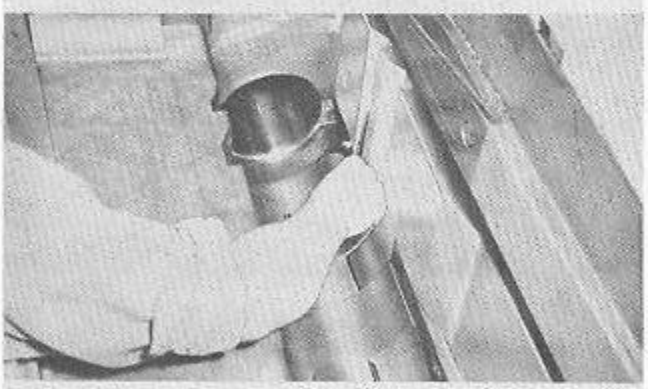




We have already seen that the 5''/38 has a sliding wedge-type breech plug, operated by an automatic breech mechanism which is largely responsible for the gun's very rapid rate of fire.



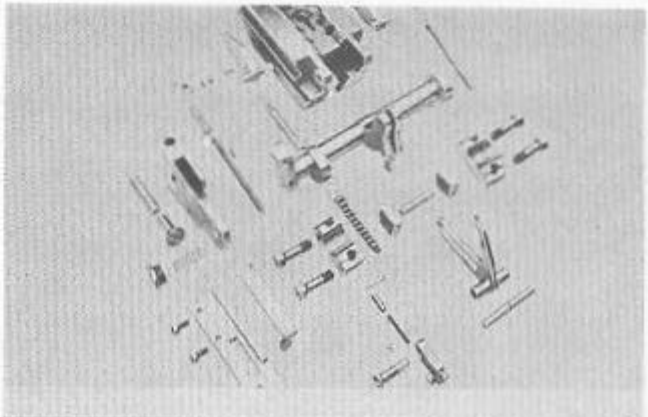
This breech mechanism is precision made. Tolerances between moving parts are extremely close. Dirt, burrs, or corrosion will seriously affect its efficient operation. For this reason, . . .



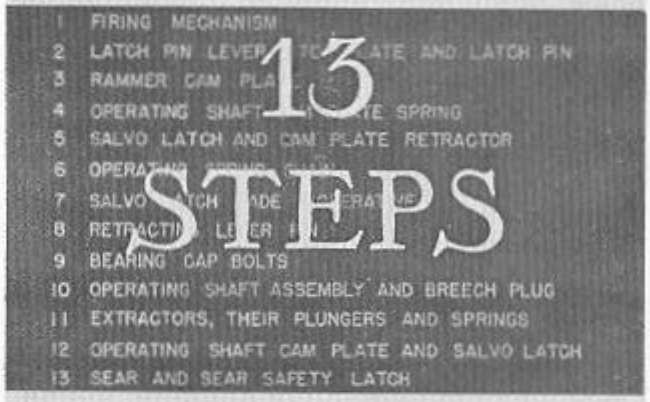
. . .the mechanism must be very carefully maintained, cleaned, checked, and overhauled regularly.

Whenever the ship is in port for an upkeep period, the breech mechanism must be completely disassembled for cleaning, lubrication, inspection, and repair.

Making possible the precise automatic operation of the breech mechanism are a great many individual parts. Each of these is important to the overall functioning of the mechanism. Care must be taken during overhauling to avoid straining or damaging any of these parts. Despite its complexity, the breech mechanism can be disassembled quickly and without damage to any of its parts if the proper routine is followed.



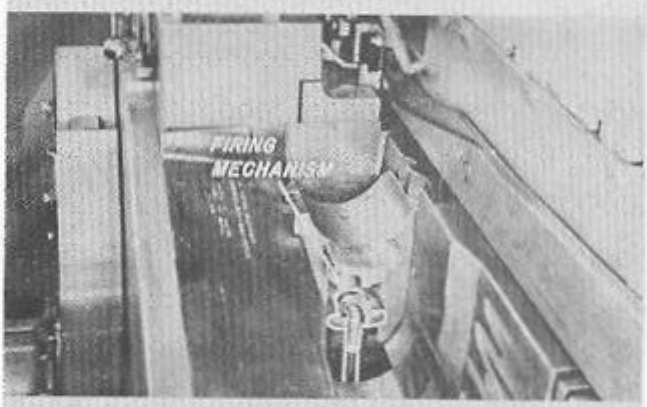
The mechanism can be disassembled in a logical and orderly fashion in thirteen simple steps. We shall discuss these in order.



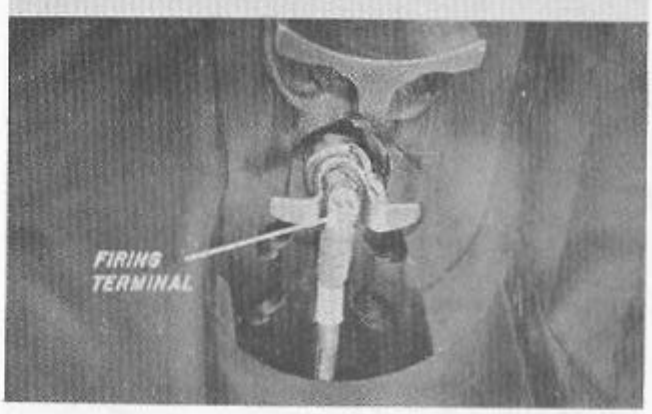
STEP 1: FIRING MECHANISM

Step one is to remove the firing mechanism.

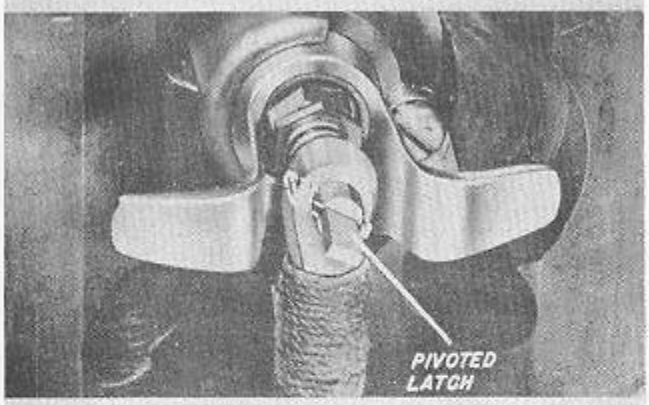
To prevent damage to the firing mechanism and to prevent interference with the retracting lever, the mechanism must be removed before the breechplug can be taken out of the housing.



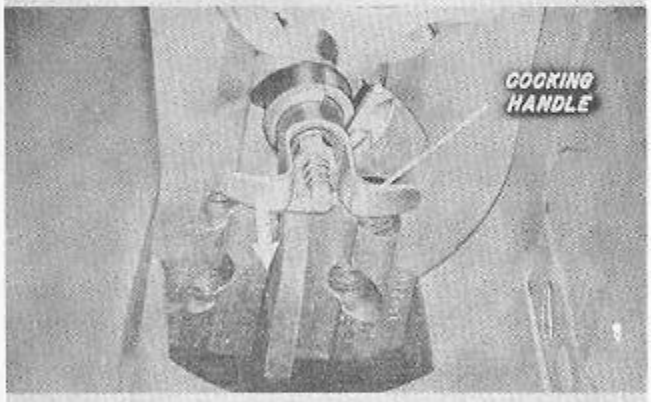
The electrical firing terminal must be disconnected and removed before we can get at the mechanism itself.



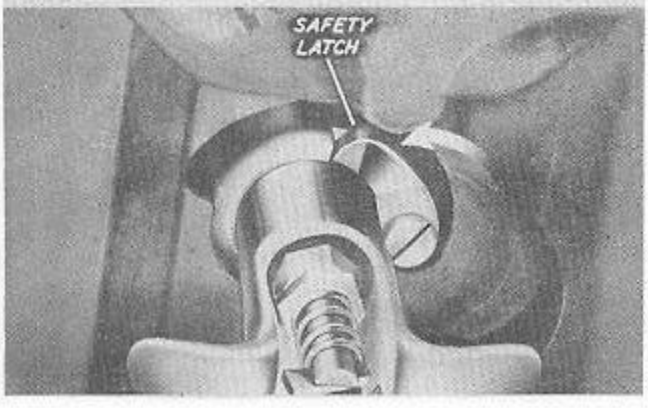
To disconnect the firing terminal, press it forward with a screwdriver, . . .



. . .then turn the pivoted latch on the end of the terminal head so as to line it up with the terminal head. The firing terminal then can be removed.

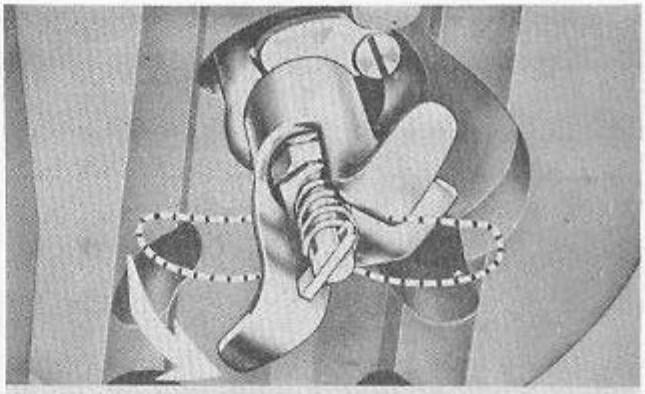


To remove the firing mechanism, pull the cocking handle toward you, . . .

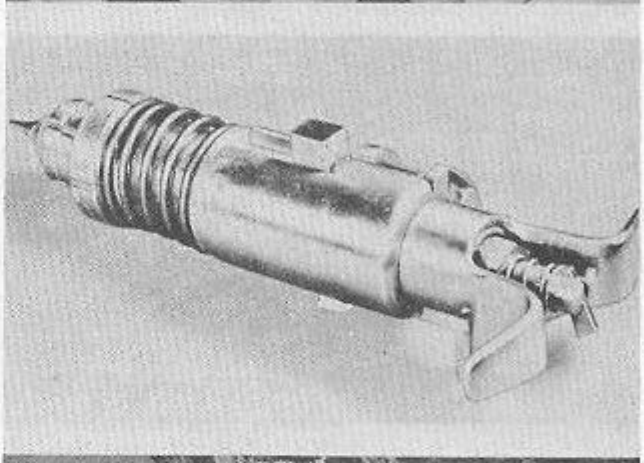


. . .and flip the safety latch into place, thus holding the firing mechanism cocked so that it can be unlocked and removed from the breechplug.

To unlock the firing mechanism, press forward on the cocking handle and twist it. The unlocked firing mechanism is then pulled out of the breechplug.



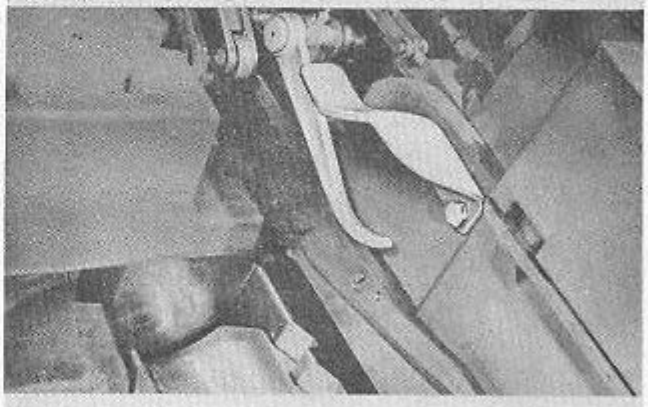
Here is the firing mechanism we have just removed. Disassembly and assembly of the firing mechanism will be described later.



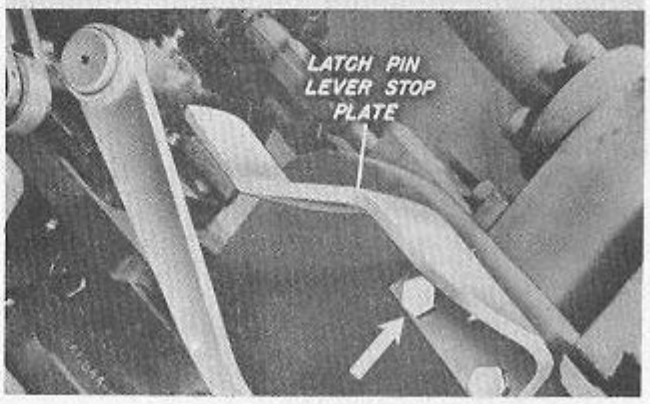
STEP 2: LATCH PIN LEVER STOP PLATE AND LATCH PIN LEVER

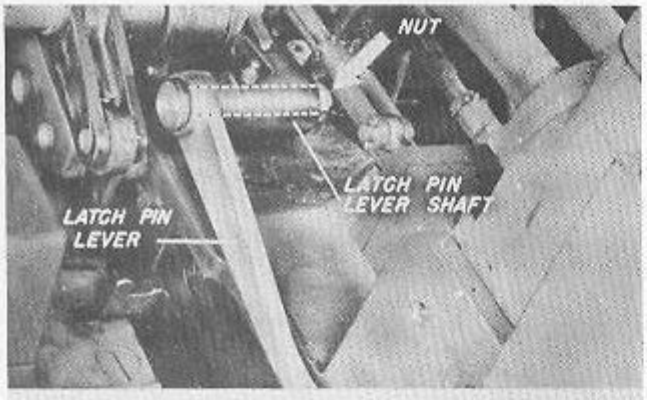
Step two is to remove the latch pin lever stop plate, and to raise the latch pin lever.

These parts would prevent lifting the breechplug out of the breech housing.

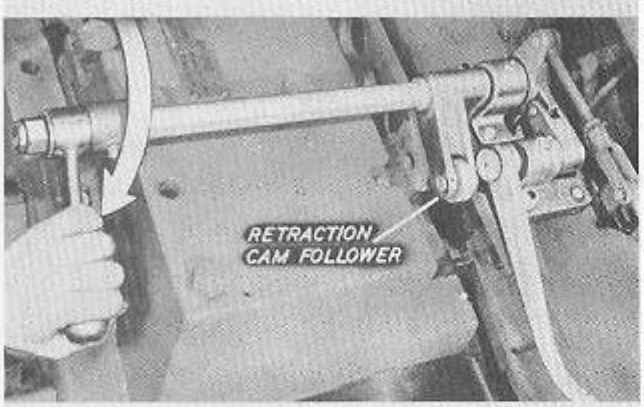


The latch pin lever stop plate is removed by unscrewing these two bolts and lifting out the plate.

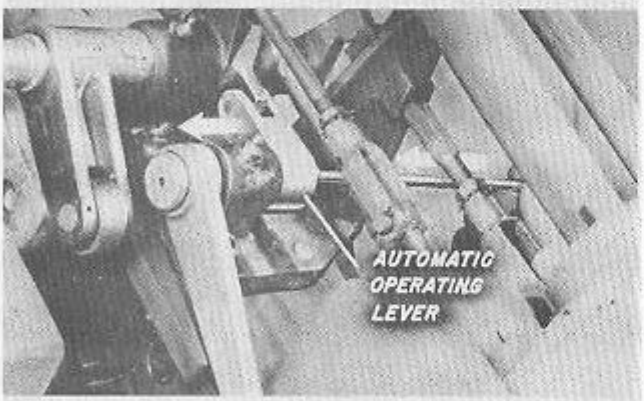




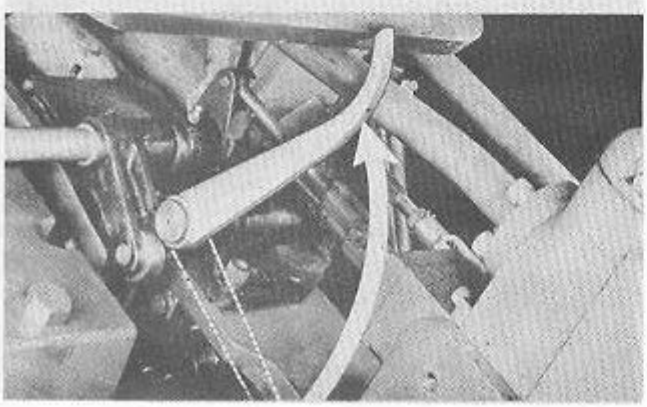
The latch pin lever is then raised up out of the way by first removing the nut on the far end of the latch pin lever shaft, . . .



. . .and by holding the rammer starting lever down in the "ram" position, so that the retraction cam follower will be lowered out of the way of the latch pin lever shaft.



We may now drive the latch pin lever shaft part way out with a brass drift pin to unkey it from the automatic operating lever.

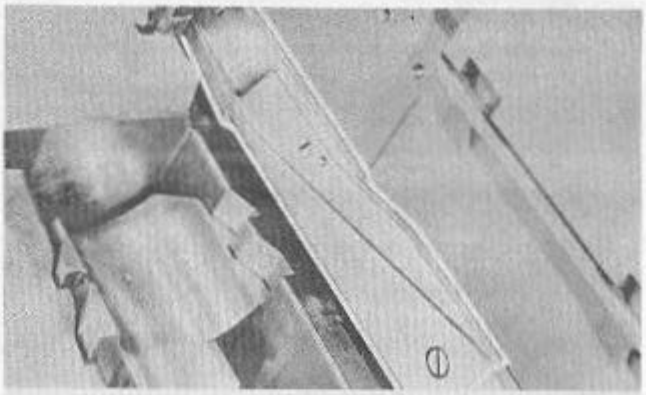


The latch pin lever now may be lifted up out of the path of the breechplug. It will stay in this position.

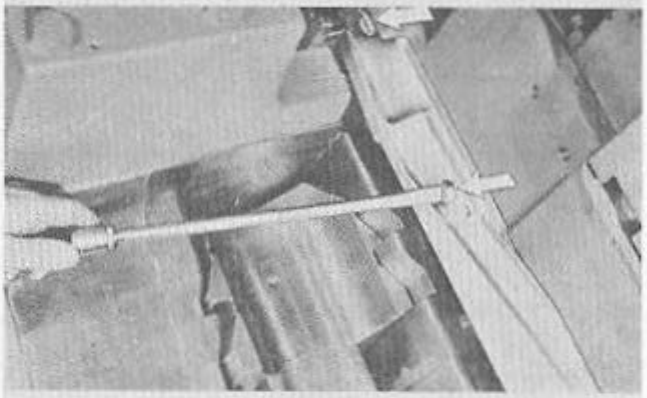
STEP 3: RAMMER CAM PLATE

Step three is to remove the forward section of the rammer cam plate.

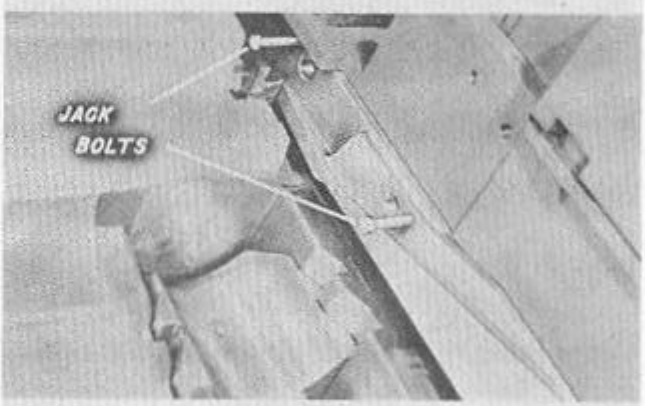
The rammer cam plate closes off the top of the breechplug guide grooves – so it also would prevent lifting the breechplug out of the housing.



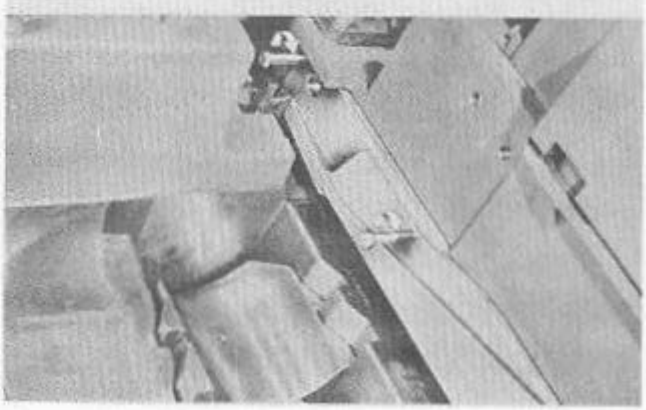
After removing the three screws holding the cam plate in place, -

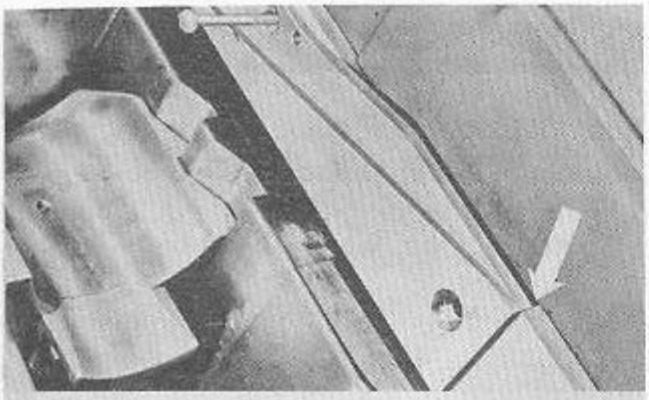


- screw two jackbolts into the small holes in the cam plate section until they bear against the gun slide. The jackbolts must be used because the cam plate section fits snugly in its recess in the slide.

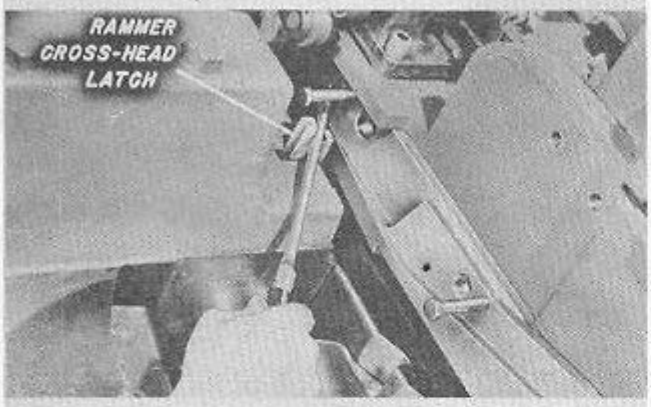


Take up on the two jackbolts alternately so as to back the cam plate section off evenly.

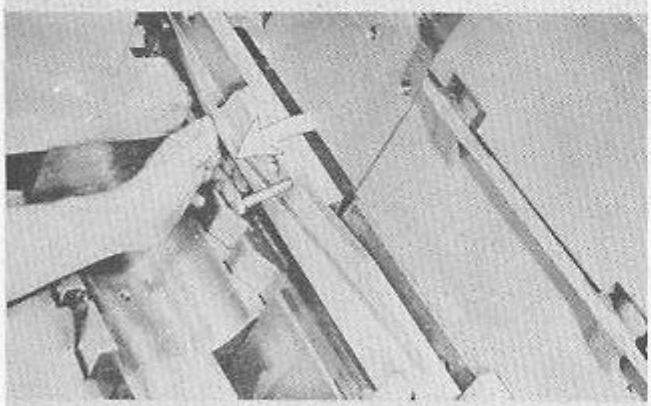




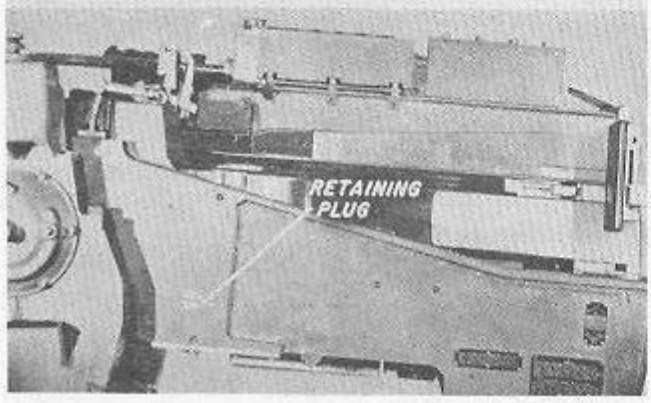
This is necessary to prevent one end of the cam plate section becoming wedged against the end of the recess.



Wedge the rammer crosshead latch back away from the cam plate section with a long screwdriver or bar.



The cam plate section then can be removed.

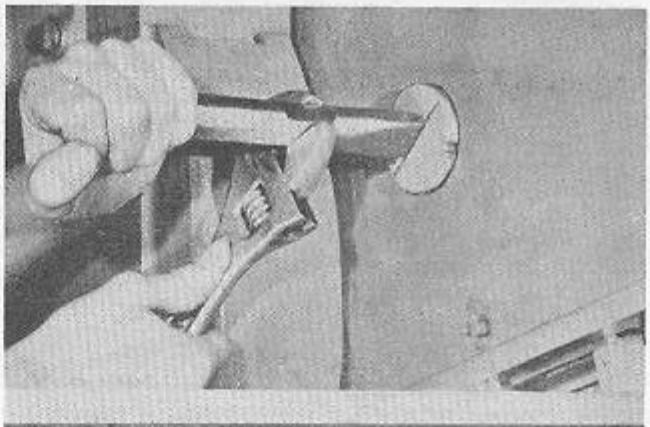


STEP 4: OPERATING SHAFT CAM PLATE SPRING

Step four is the removal of the operating shaft cam plate spring.

The operating shaft cam plate spring is mounted in the side of the gun behind this retaining plug. To free the cam plate so that it can be pushed out of the way during disassembly operations the spring must be removed.

After the keeper screw which holds the retaining plug in place is removed, unscrew the plug. . .

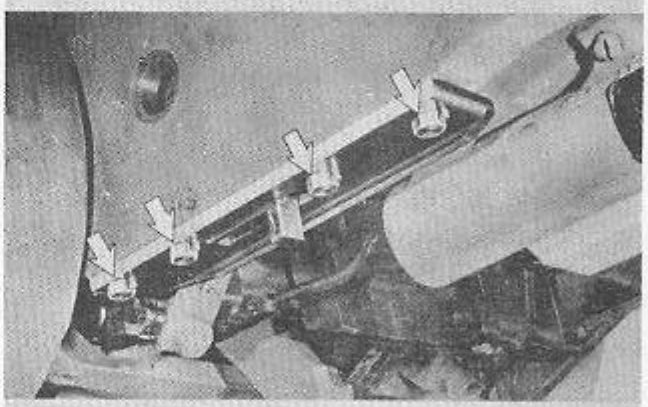


. . .and take out the operating shaft cam plate spring.

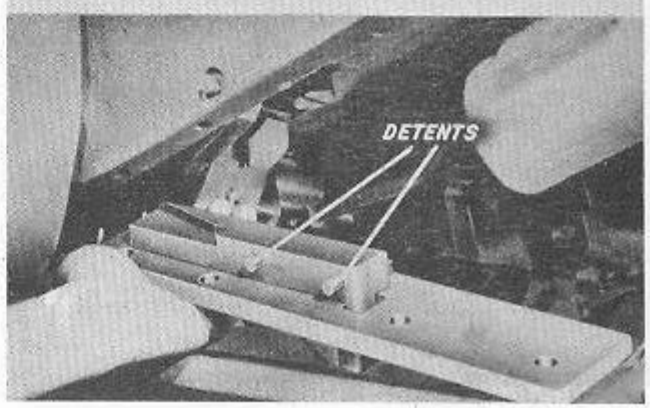
STEP 5: SALVO LATCH CAM PLATE AND CAM PLATE RETRACTOR

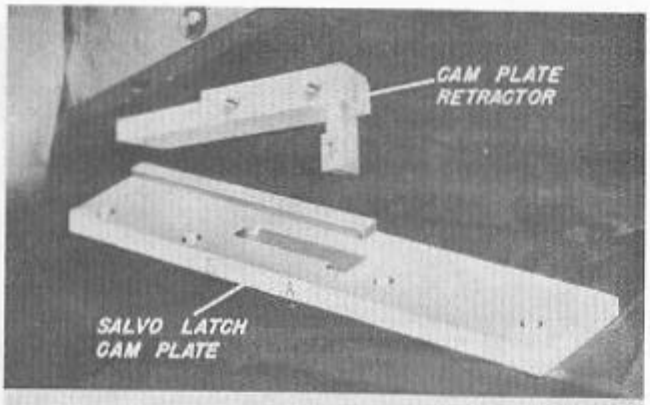
Step five is to remove the salvo latch cam plate and cam plate retractor.

The salvo latch cam plate is secured to the slide by four bolts each locked by a keeper screw. To provide easier access to the operating shaft these parts are removed at this stage. Each bolt, and the hole it belongs in, are correspondingly numbered to ensure proper assembly.

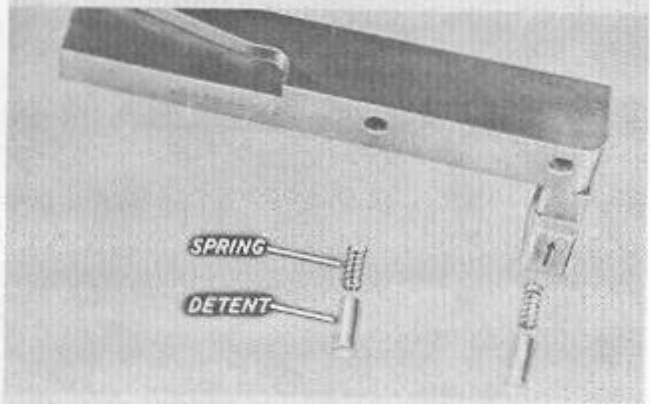


The salvo latch cam plate and the cam plate retractor will come off together. Be very careful not to lose the two detents.

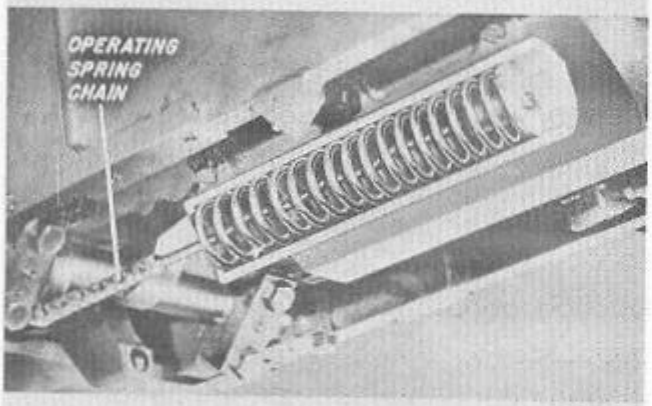




The cam plate retractor is slid aft on the salvo latch cam plate and simply lifted up off the cam plate.



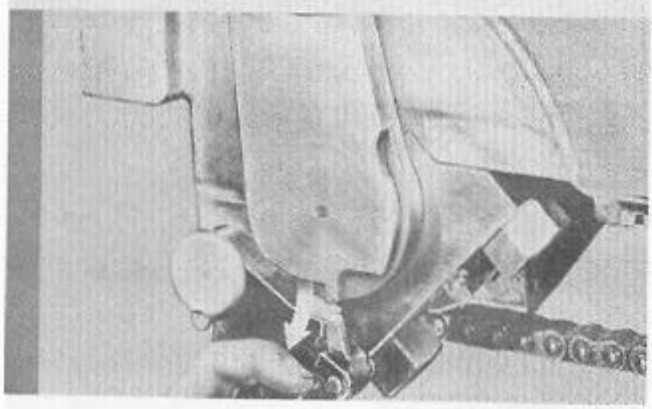
Remove the detents and the springs by tipping the cam plate retractor over on its side.



STEP 6: OPERATING SPRING CHAIN

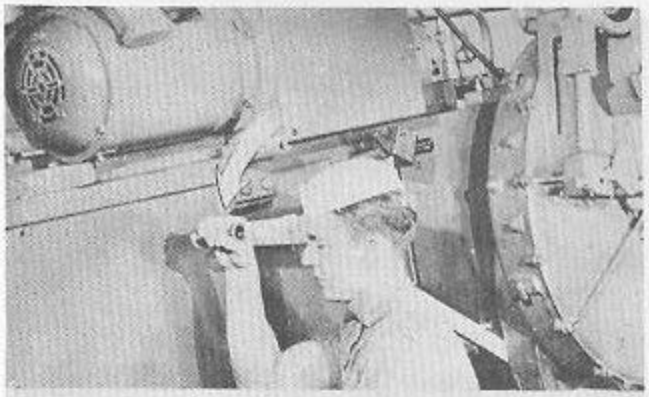
Step six is to disconnect the operating spring chain.

This job if not done properly, will be a dangerous one, since the chain is held taut by the constant tension of the powerful operating spring. This tension must be relieved.

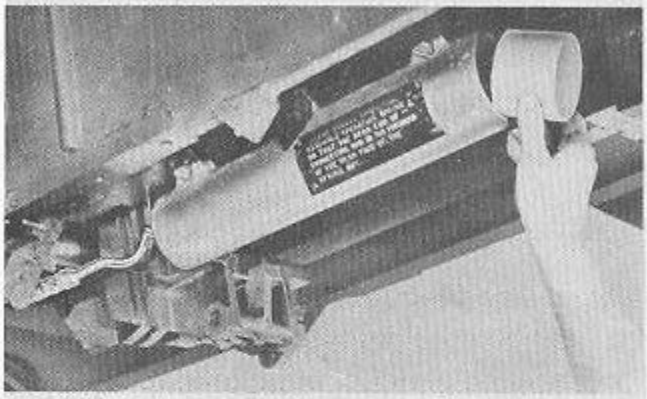


First, trip the salvo latch so that the operating shaft can be rotated, . . .

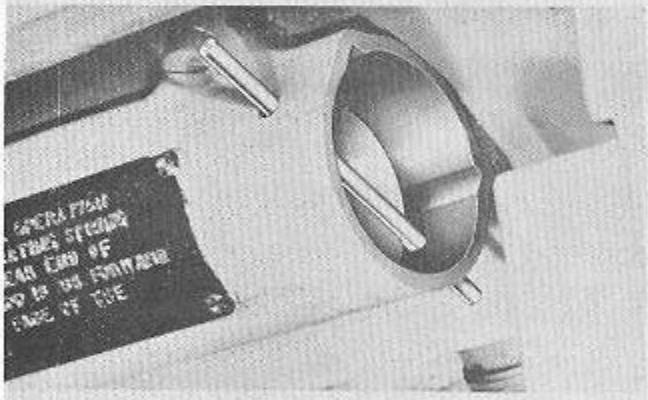
. . .then pull down the hand-operating lever to lower the breechplug part way and to compress the operating spring.



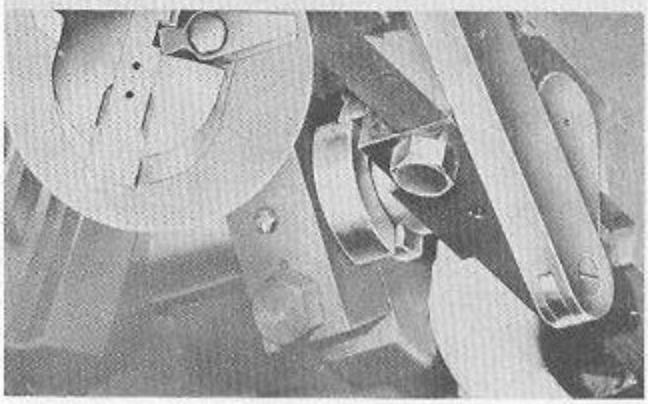
With the breechplug only part way down, hold the operating lever down to keep the operating spring compressed and insert a block in the after end of the operating spring housing.

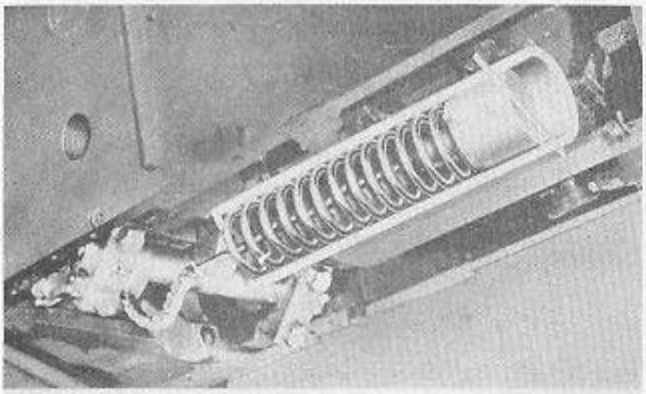


Hold the block in place by inserting a rod through the holes in the after end of the operating spring housing.

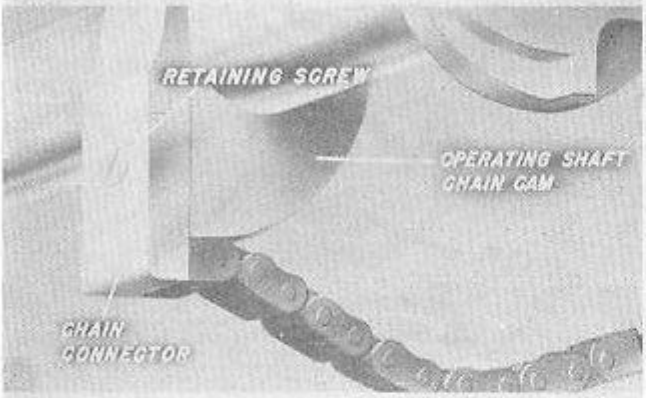


Returning to the other side of the gun, snap the hand-closing latch key forward. Then raise the breechplug all the way up with the hand-operating lever to release the tension on the operating spring chain.

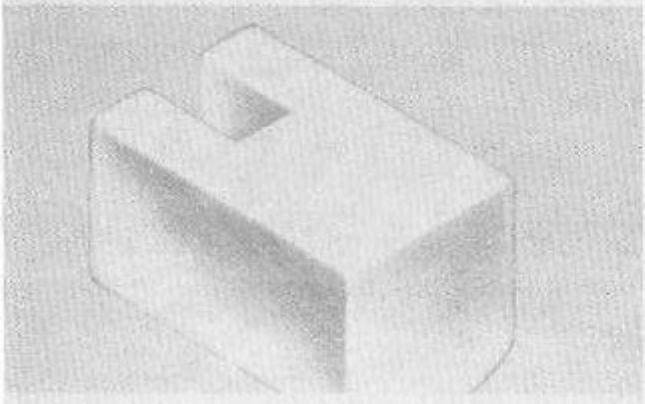




The block wedged in the after end of the spring housing holds the spring compressed as the operating shaft is rotated and relieves the tension on the chain.



Then remove the retaining screw holding the chain connector to the operating shaft chain cam.



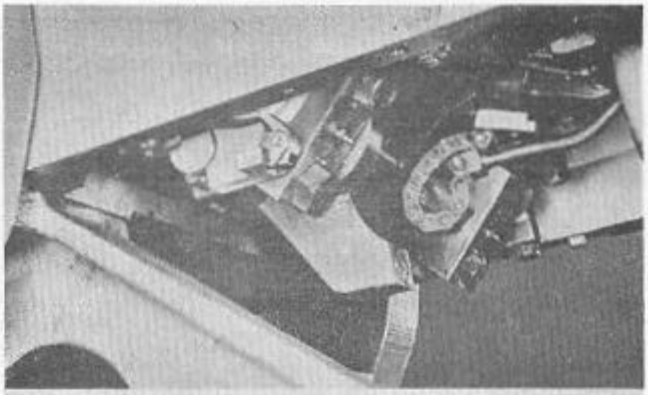
The breechplug now can be lowered but must be supported by this special block, made of wood or aluminum and slotted to fit under the breechplug shelf extension.

Place the block directly below the breechplug shelf extension, then trip the salvo latch again, and lower the breechplug gently with the hand-operating lever until the shelf extension rests on the block.

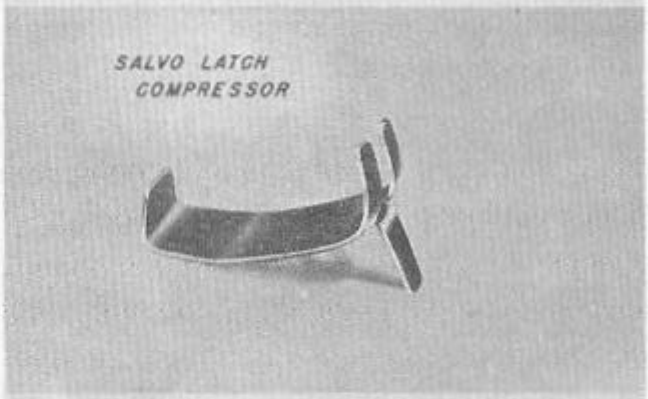
STEP 7: SALVO LATCH MADE INOPERATIVE

Step seven is to make the salvo latch inoperative.

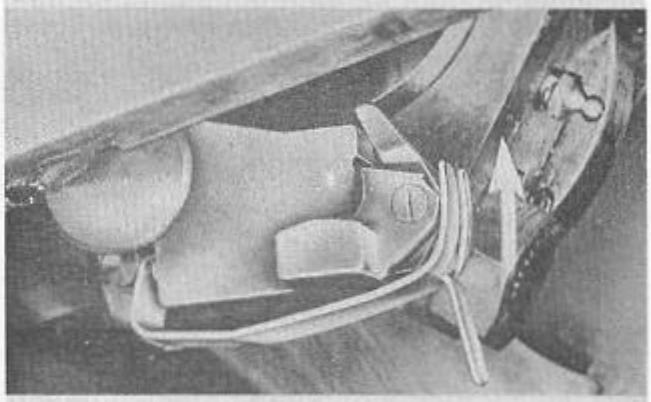
Here, under the side of the gun, we see the salvo latch. It must be made inoperative so that it will hang down out of the way.



This special tool, known as a "salvo latch compressor," is used for this operation.

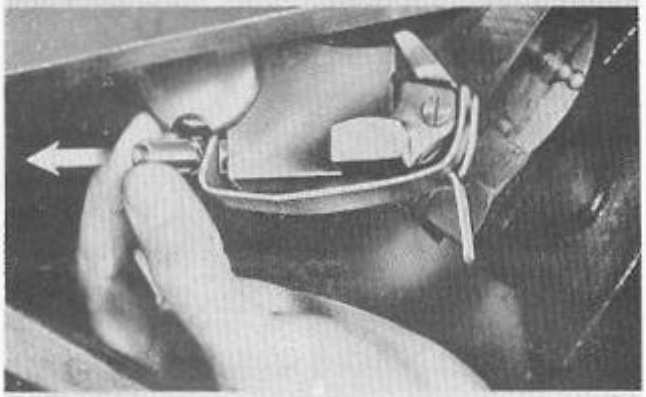


Hook the single-prong end of the compressor over the end of the salvo latch plunger, and snap the other end of the compressor up over the after end of the salvo latch. This will hold the salvo latch plunger compressed.

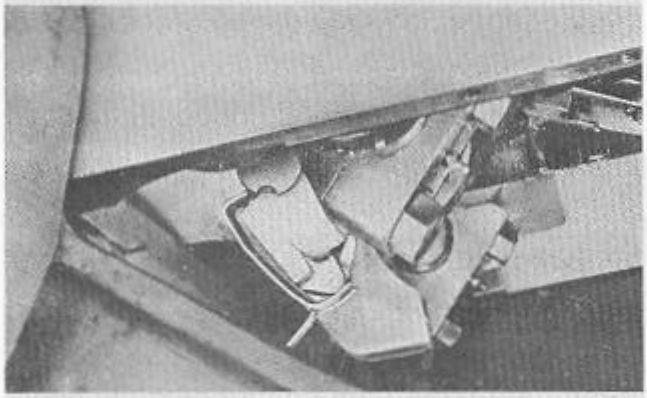


Loosen this keeper bolt so that the salvo latch pivot pin may be rotated.

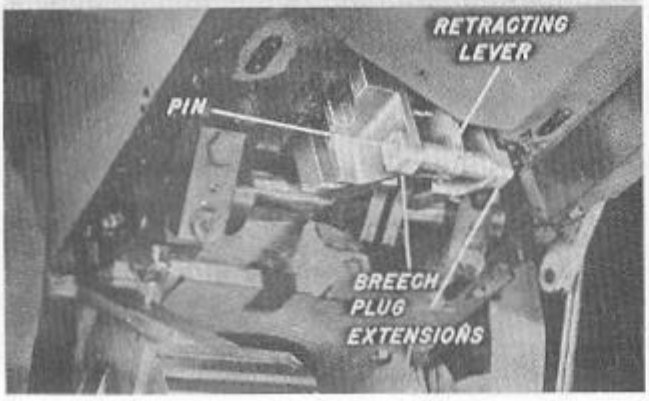
Rotate the head of the salvo latch pivot pin until its notch is over the end of the salvo latch plunger retaining pin.



Finally, pull out the retaining pin.



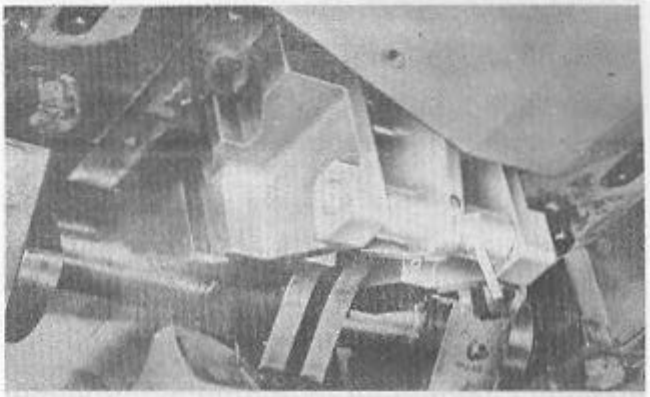
The salvo latch is now inoperative and will hang down out of the way.



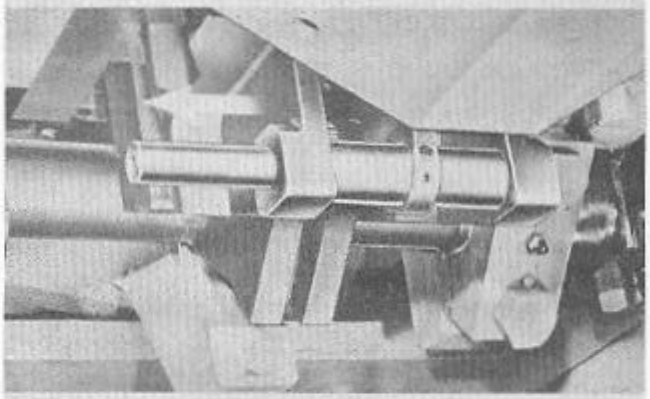
STEP 8: RETRACTING LEVER PIN

Step eight is to remove the retracting lever pin. Here we see the retracting lever pin connecting the retracting lever to the breech-plug extensions.

First, remove the cotter key locking the retracting lever pin in place,. . .

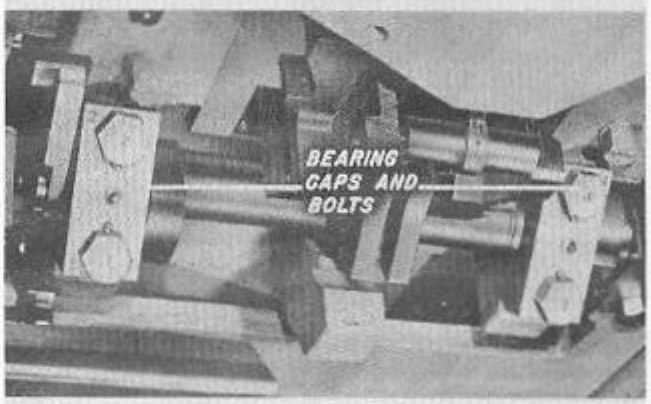


. . .and slide out the retracting lever pin.

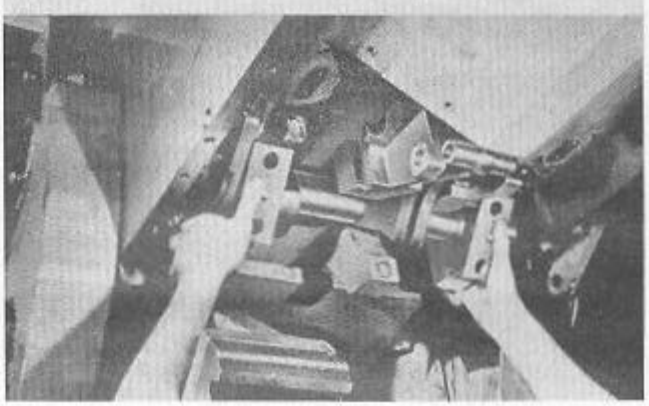


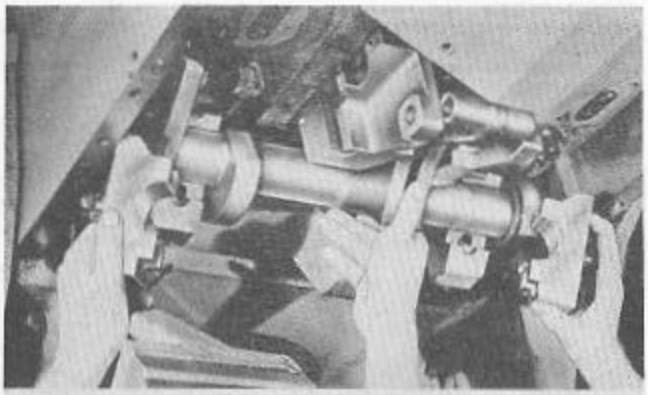
STEP 9: BEARING CAP BOLTS

Step nine is to remove the bearing cap bolts. Here we see the bearing caps and bolts supporting the operating shaft. Note that each bolt is numbered, and that the corresponding number appears on the bearing cap beside the bolt to ensure proper assembly. The bearing cap bolts are locked in position by keeper screws. Remove the keeper screws and the bolts.



Hold the bearing caps in place, because these caps are all that hold up the operating shaft at this point.

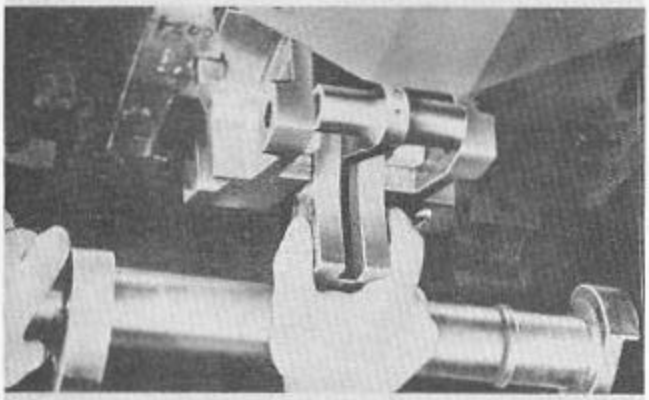




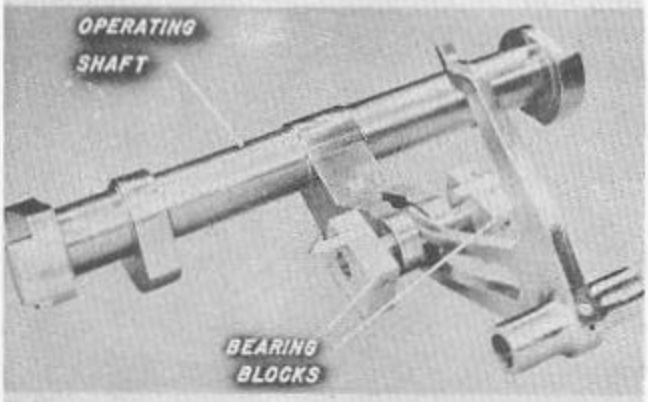
STEP 10: OPERATING SHAFT ASSEMBLY AND BREECHPLUG

Step ten is removal of the operating shaft assembly and breechplug.

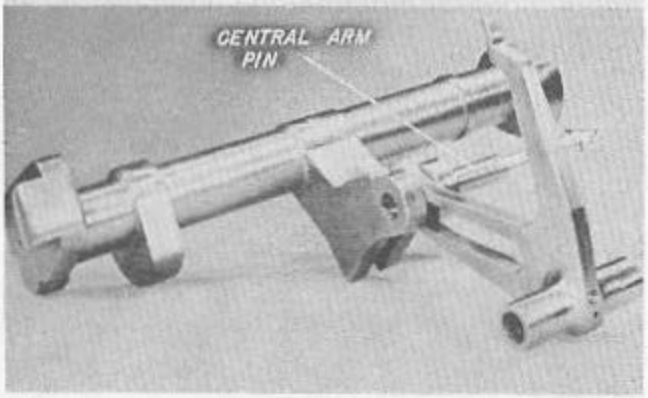
First, remove the bearing caps while holding up the operating shaft. The bearing caps will lift off--do not pry them off as they may burr the bearings.



Then lower the operating shaft down and aft. The bearing blocks will slide out of the breechplug as you do this.

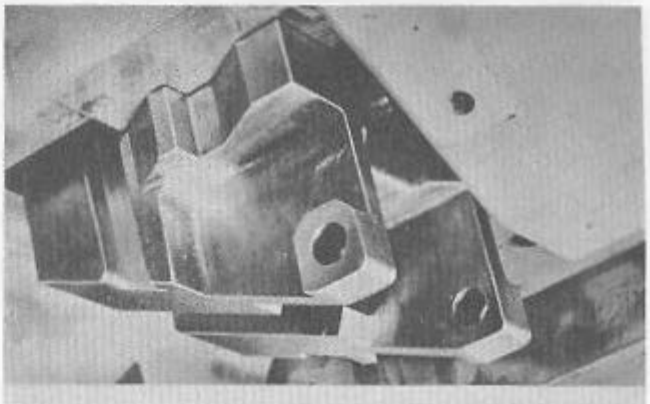


Here we see the operating shaft assembly. The bearing blocks will slide freely off the operating shaft central arm pin. Remove them as soon as they are exposed, preferably before you completely withdraw the operating shaft from under the gun.

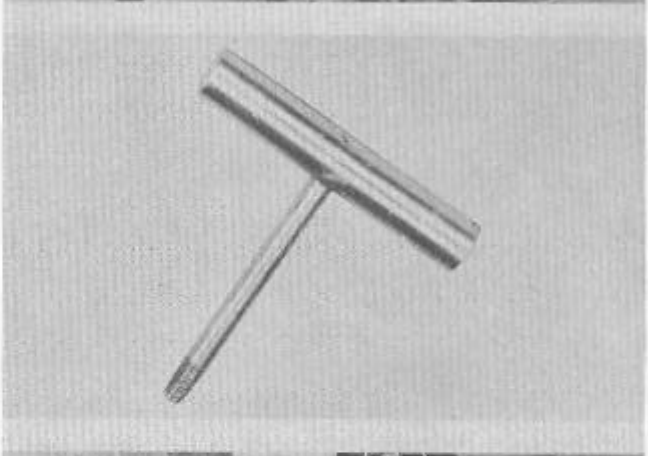


The retracting lever is separated from the operating shaft central arm by removing the central arm pin connecting them.

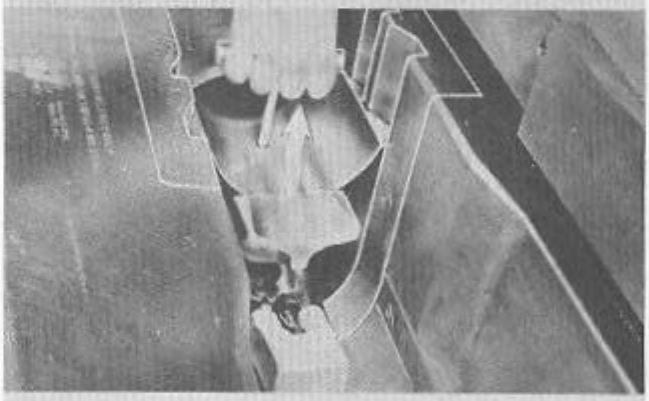
The breechplug is now free to be lifted up out of the housing.



This tool is used to lift the breechplug out of the breechplug guide plates.



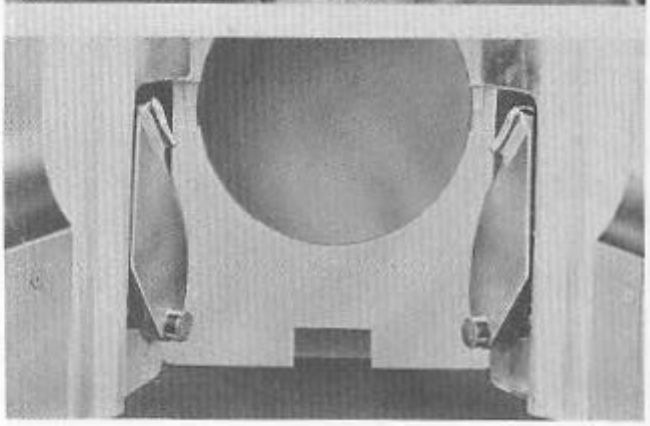
Screw the tool into the hole in the top of the breechplug, and lift the plug up and out of the breechplug guide plates. But be careful while doing this not to damage or burr the breechplug and the guide plates.

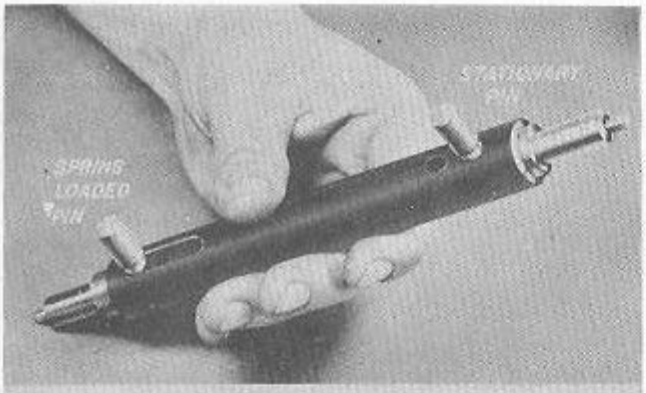


STEP 11: EXTRACTORS, EXTRACTOR PLUNGERS, AND EXTRACTOR PLUNGER SPRINGS

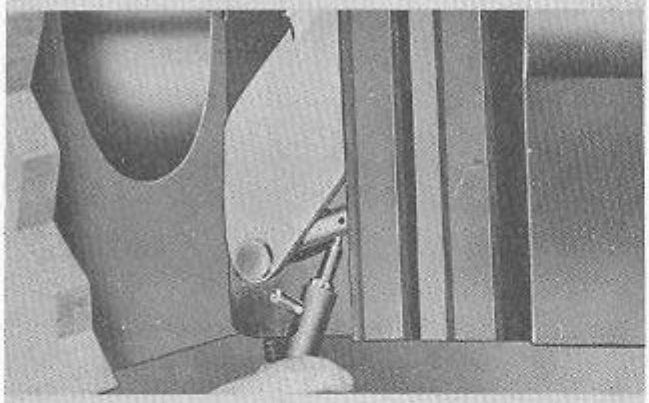
Step eleven is to remove the extractors, the extractor plungers, and the extractor plunger springs.

As we look forward now into the housing after the breechplug has been removed, we see these extractors in the sides of the breech housing.

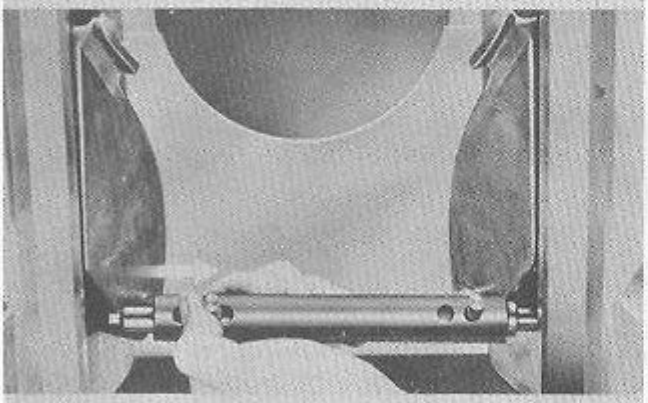




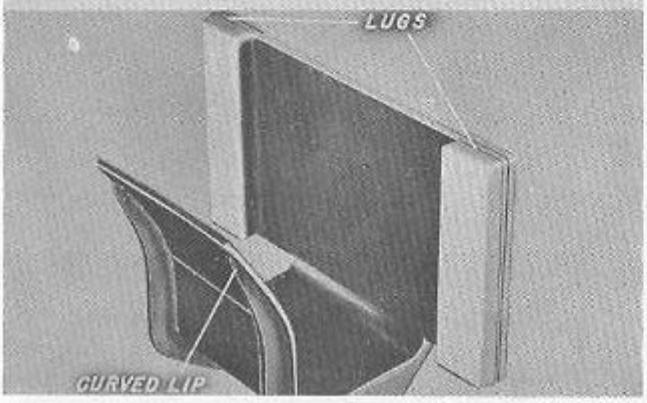
A tool—known as an "extractor plunger bar"—is used in removing the extractors. It has a stationary pin at one end and a spring loaded pin at the other.



In this view, we are looking from the side at one of the extractors. Insert the stationary pin of the plunger bar tool into this hole in one of the extractor plungers.

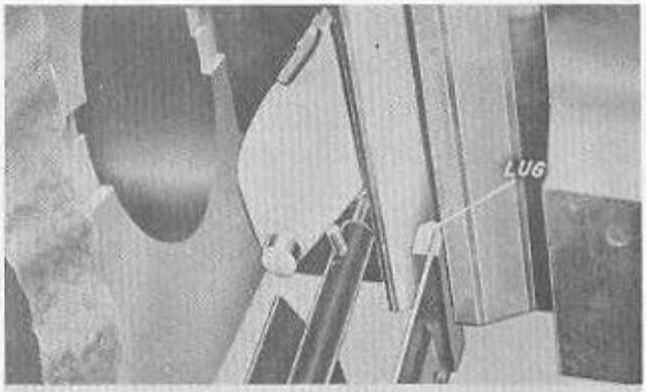


Then pull back the knob to compress the spring loaded pin and insert it into the corresponding hole in the other extractor plunger.

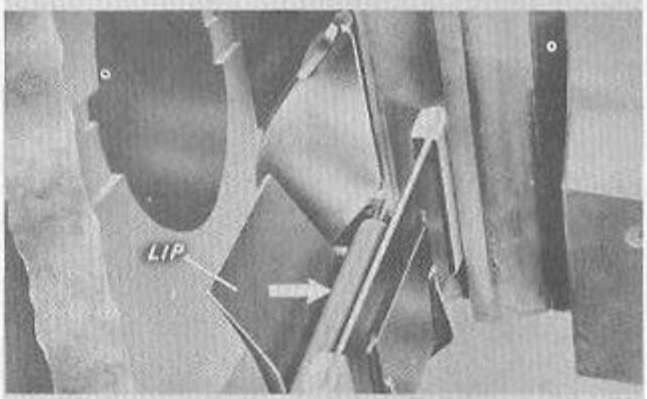


This tool—known as an "extractor plunger bar compressor"—is used to compress the extractor plungers. You will note that it is provided with two lugs and a curved lip.

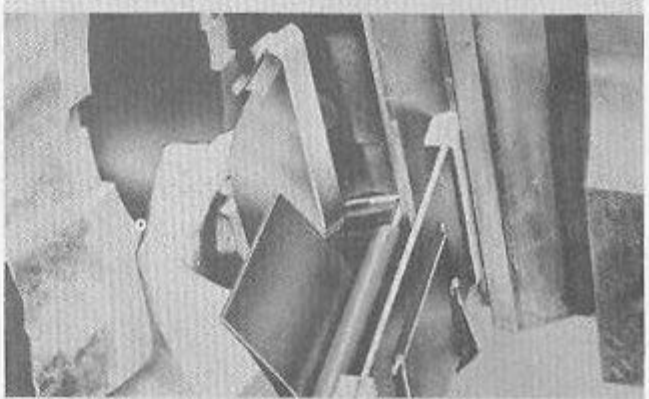
Insert the lugs of the plunger bar compressor tool up from below in the forward groove of each breechplug guide plate with the compressor lip forward of the compressor bar tool.



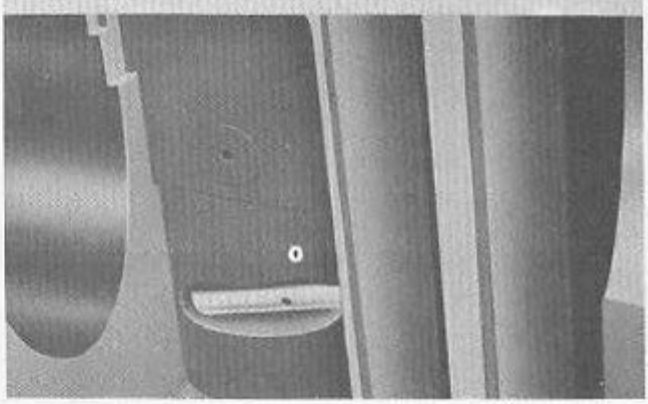
Push up on the compressor tool and the lip will force the plunger bar aft. This will hold the extractor plungers aft so that the extractors may be removed.

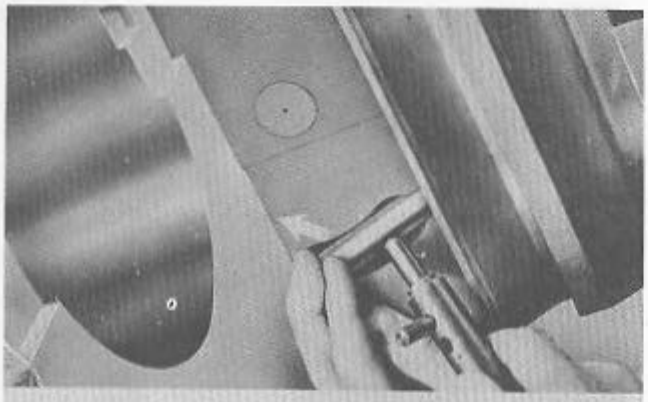


Lift out each extractor, being careful not to drop it.

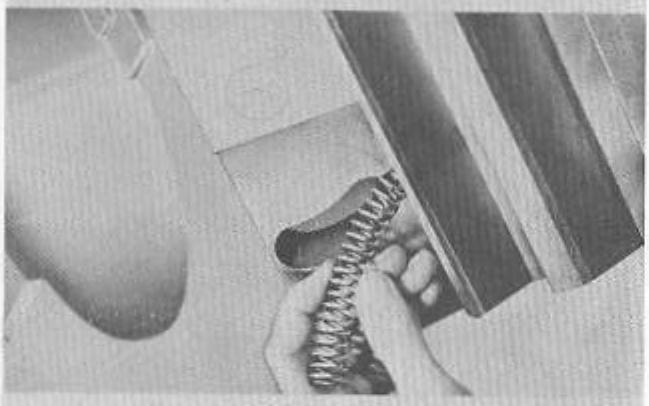


When you remove the compressor tool and the plunger bar tool, the extractor plungers will be all the way forward in the kidney-shaped slots. The extractor plungers then can be removed.

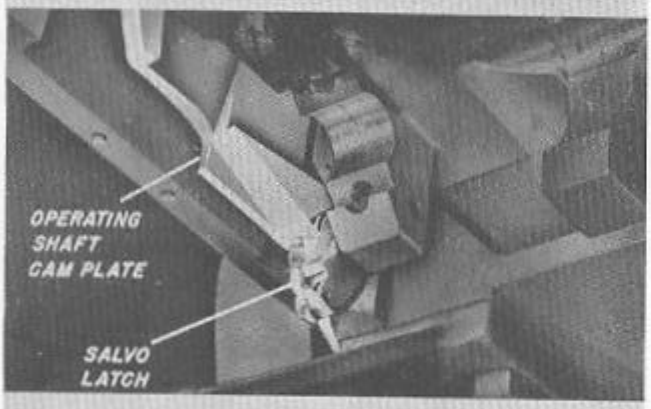




Again, insert the stationary pin of the plunger bar tool into the hole in the extractor plunger. Then, while holding your hand over the extractor plunger, pry it out with the tool.



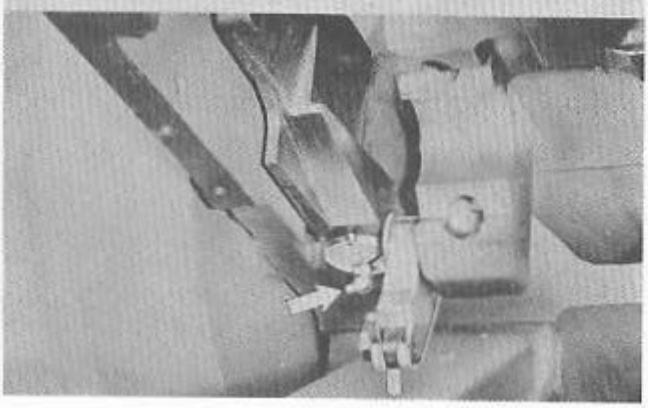
Finally, remove the plunger spring. The other extractor plunger and extractor plunger spring are removed in the same manner. (Note: The plunger bar tool is used in reassembly of the extractor plungers, but the compressor tool is no longer used. Neither tool is necessary for disassembly of the extractors. The extractors can be gently pried loose with a screwdriver. Be sure that the extractor plunger is not forced out violently by its spring. The extractor plunger can then be removed, as described, with the plunger bar.)



STEP 12: OPERATING SHAFT CAMPLATE AND SALVO LATCH

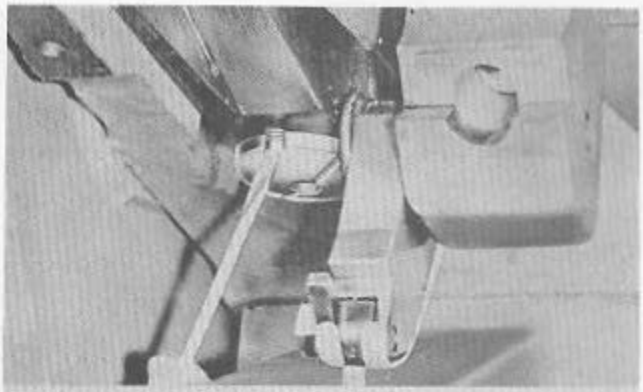
Step twelve is to remove the operating shaft cam plate and salvo latch.

As we look up under the gun, we see the operating shaft cam plate and the salvo latch.

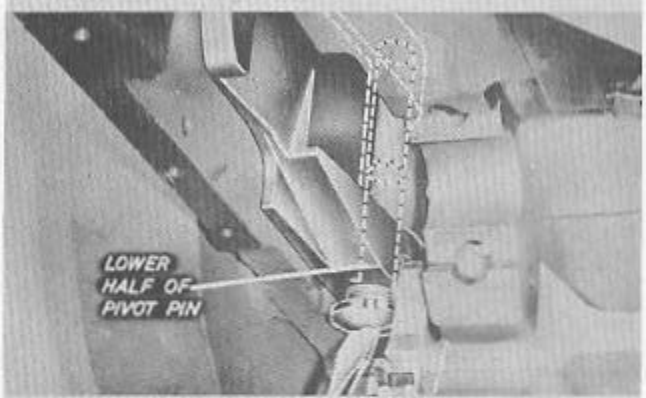


Unscrew the zerk fitting from the lower end of the cam plate pivot shaft, . . .

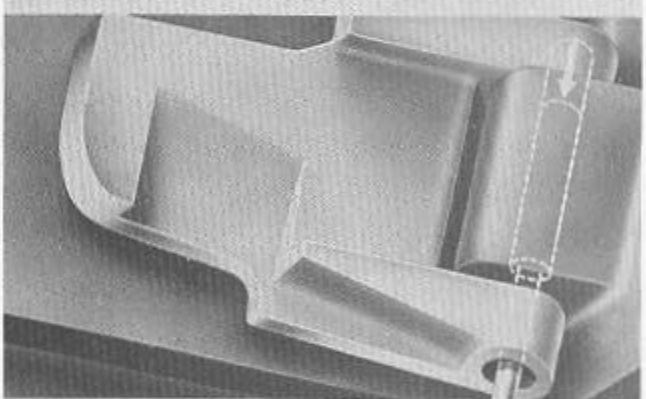
. . .remove the keeper screw,



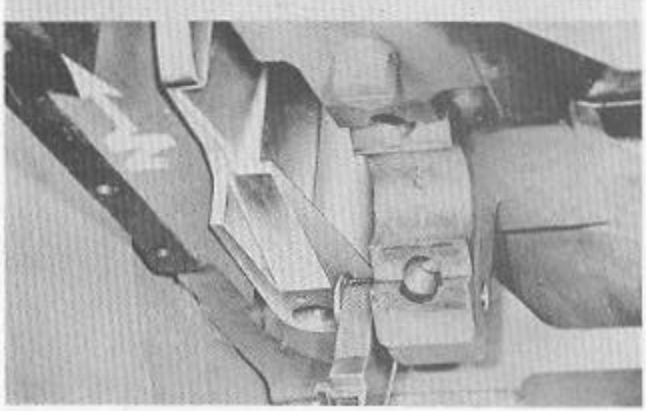
and unscrew and remove the lower half of the two-piece cam plate pivot pin.

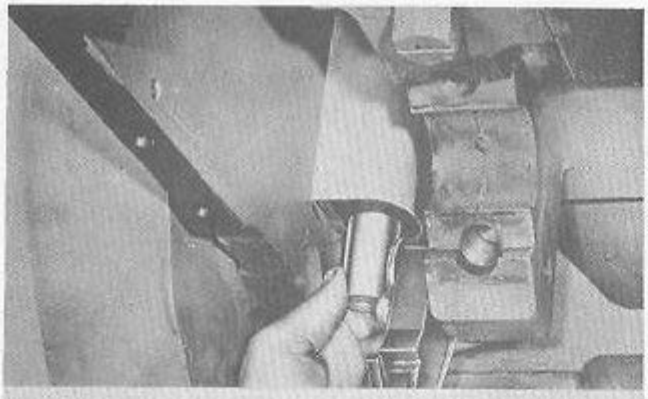


To remove the upper half of the cam plate pivot pin, screw a 3/8-inch bolt into its lower end and pull the shaft down into the hinge arm supporting the cam plate. Unscrew the bolt and remove it after you have done this.

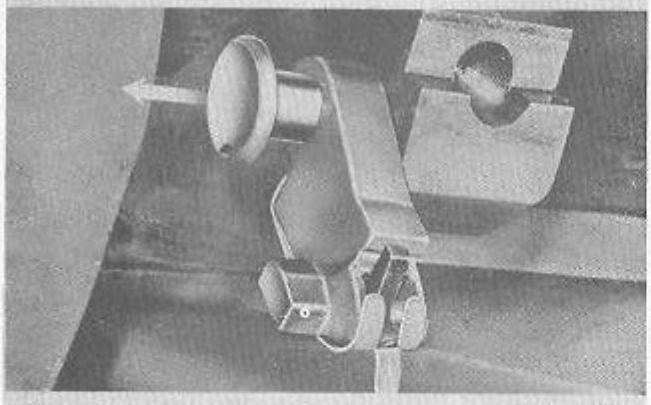


Then rock the cam plate to free it from the hinge and withdraw it.

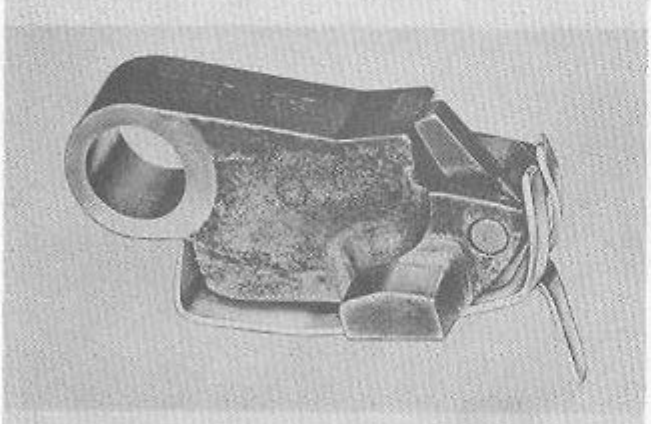




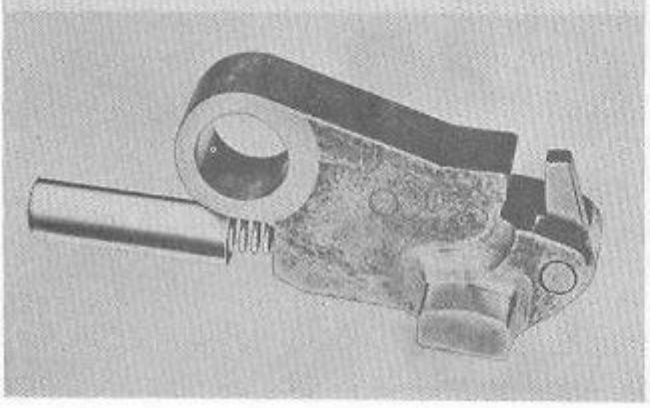
Pull the upper half of the cam plate pivot pin out of the hinge arm.



Finally, pull out the salvo watch pivot pin and remove the salvo latch.



Remove the salvo latch compressor tool. Hold the salvo latch cupped in your hand as you do this so that the plunger does not fly out when you take off the compression tool.

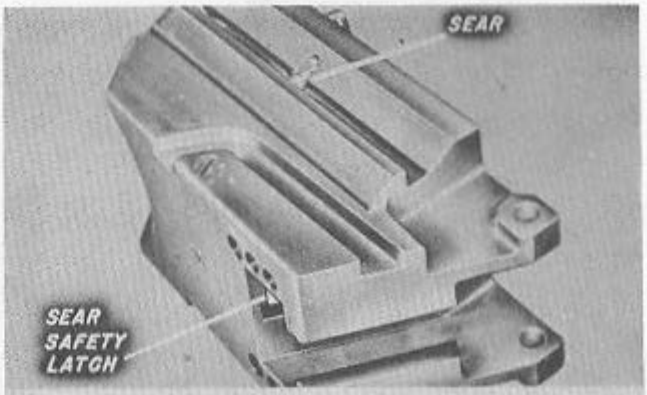


The plunger and spring are then withdrawn from their recess in the salvo latch.

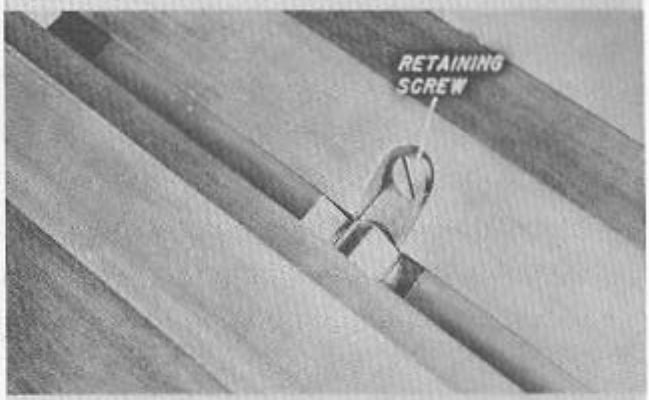
STEP 13: SEAR AND SEA SAFETY LATCH

The thirteenth step is to remove the sear and the sear safety latch.

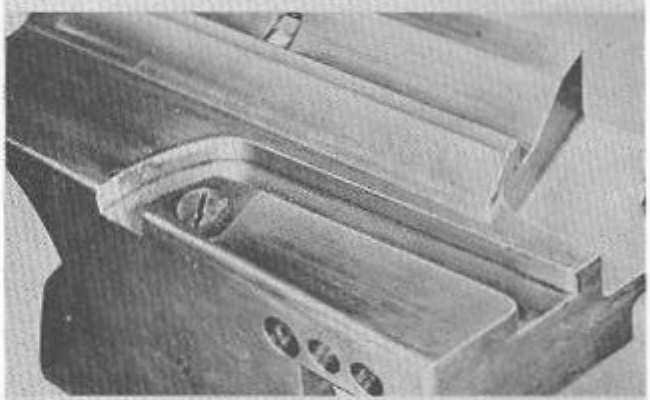
The sear and sear safety latch are mounted in the breechplug.



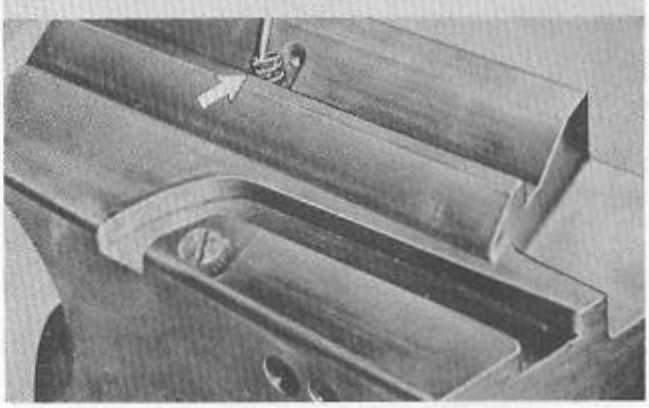
First, take out the sear retaining screw.

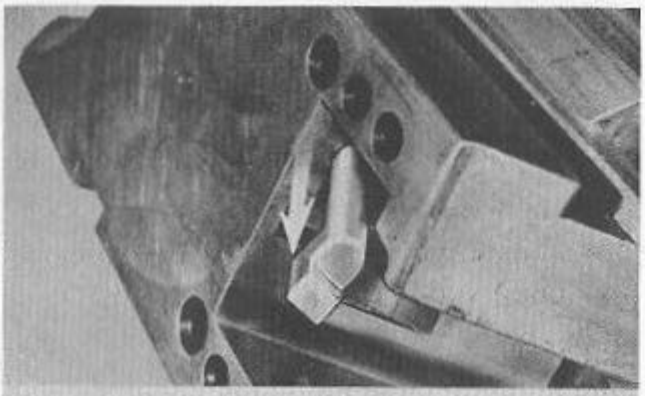


Then press in on the sear safety latch. Compression of the sear spring will cause the sear to pop out a short distance so that you can pull it out with your fingers.



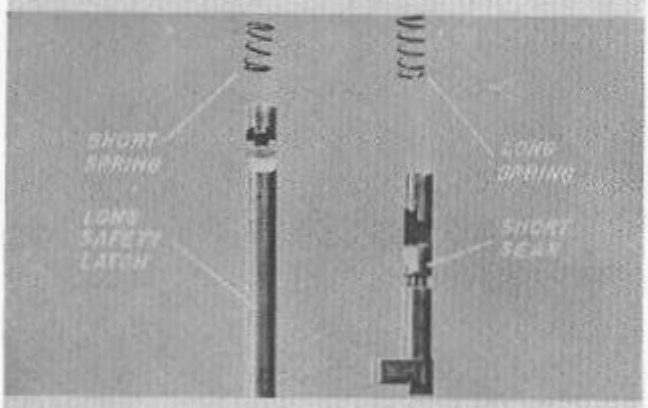
Using a scribe, pull out the sear spring while still pressing in on the safety latch.



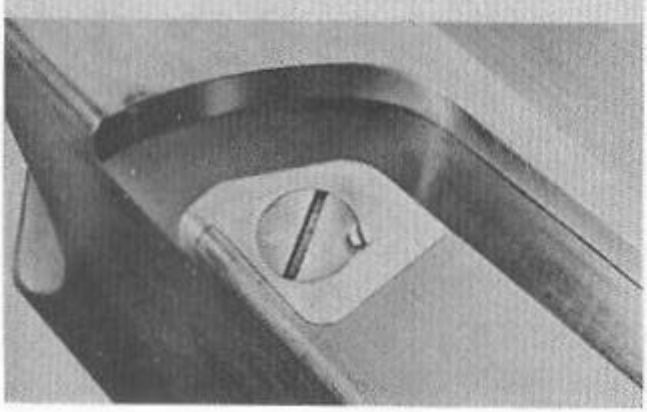


Pull the sear safety latch out with your fingers. You can do this easily by first pressing in on the safety latch and then letting up on it suddenly. The safety latch spring will make the safety latch pop out far enough to give you a grip on it.

Finally, insert a scribe in the safety latch recess and pull out the safety latch spring.

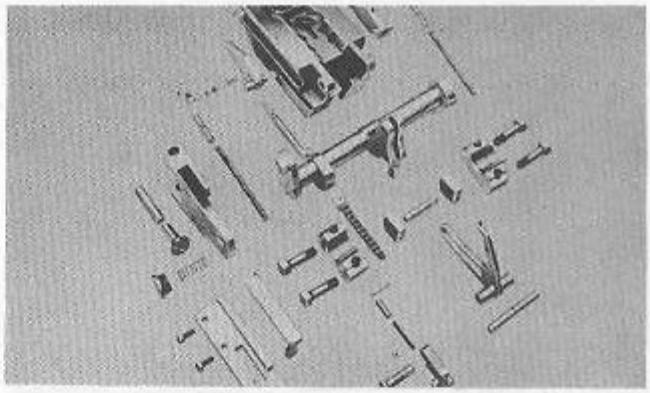


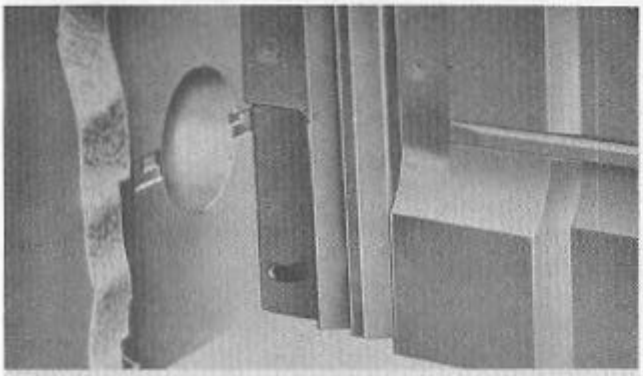
Look carefully at these parts we have just removed. Note that there is a difference in the length of the two springs and in the length of the sear and sear safety latch. Remember that the shorter spring goes with the longer operating member.



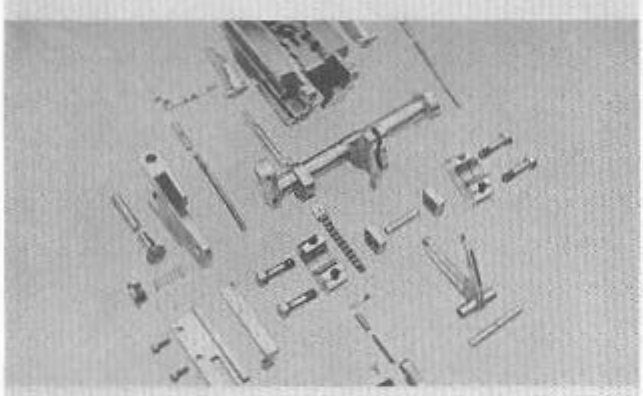
Inspect the pallets on the breechplug. If they show signs of wear, remove them.

Here we see the parts of the breech mechanism we have now disassembled. Each part should be cleaned thoroughly and inspected. All burrs should be carefully removed with a fine stone. Replace any part having a crack in it. The breech mechanism will function properly and smoothly only if the parts are kept free from rust, dirt, scratches, and burrs. So be very careful in handling the parts of this mechanism.

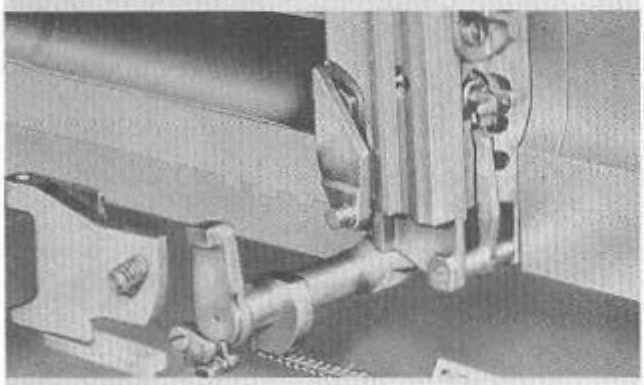




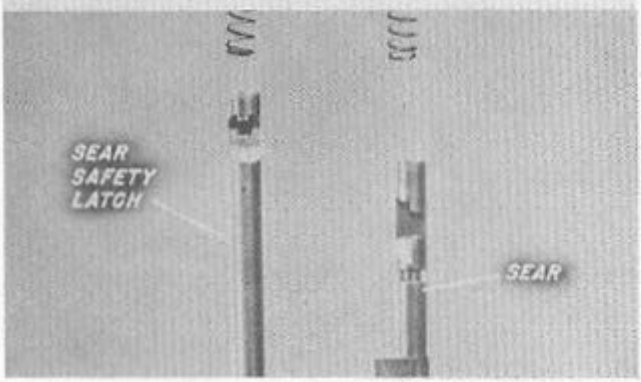
When all foreign matter has been removed, the breechplug guide plates thoroughly cleaned and lubricated, . . .



. . .and all parts of the breech mechanism have been thoroughly overhauled, cleaned, and checked, the mechanism must be carefully reassembled. Assembly can be accomplished quickly and accurately by reversing the order of the thirteen steps followed in its disassembly.



Assembly of the breech mechanism is a matter of putting the breechplug back in its guide grooves and connecting up its operating parts. For this reason. . .



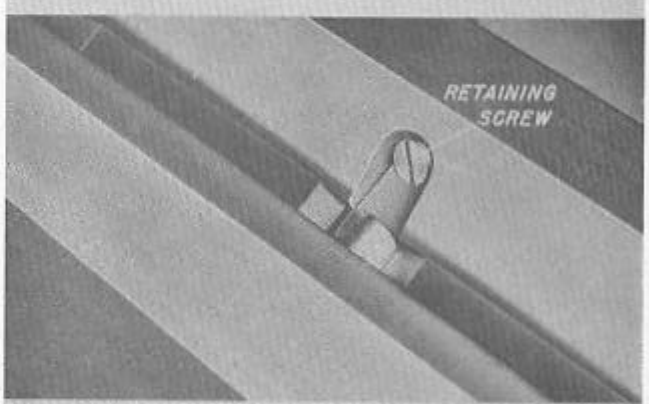
STEP 1: SEAR SAFETY LATCH AND SEAR.

. . .the first step is to reassemble the plug itself by replacing the sear safety latch and the sear in their recesses. When the plug was disassembled, we found that the sear safety latch was fitted with a short spring and the sear with a long spring. It is important that these parts should be matched up with the proper springs.

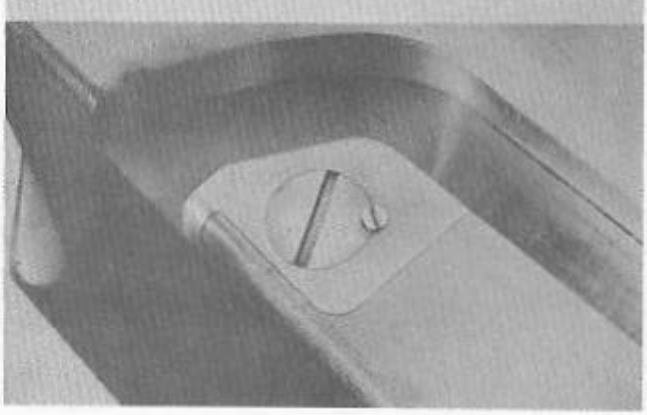
First, insert the sear safety latch, and the short spring in place in its recess in the bottom of the breechplug. If the short spring were not placed here, the safety latch would be held down in the bearing block camway and would jam the bearing block when the plug is raised to close the breech.

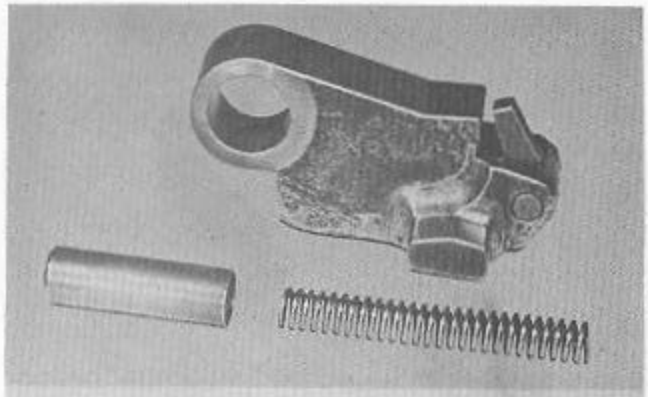
To assemble the sear, push up on the safety latch and seat the sear and the long spring in its recess in the side of the breechplug. The long spring assures a positive cocking action.

Press in the sear until it is locked in position by the sear safety latch. Then secure it with its retaining screw.



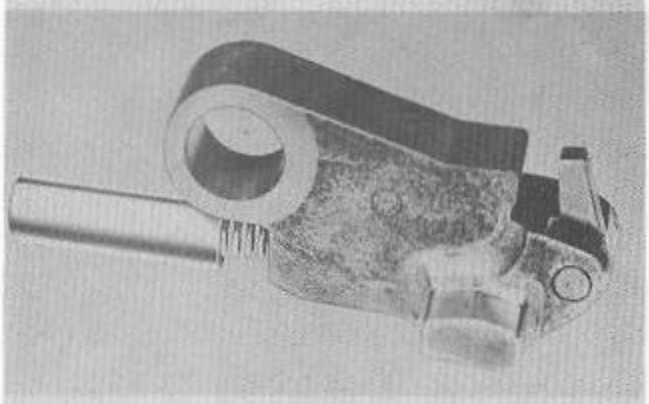
If the pallets have been removed for cleaning or replacement, secure them in place on the breechplug with their retaining screws and lock each retaining screw with its keeper screw. The breechplug is now completely assembled and ready to be placed in its guide plates. But, before putting in the plug, it is advisable. . .



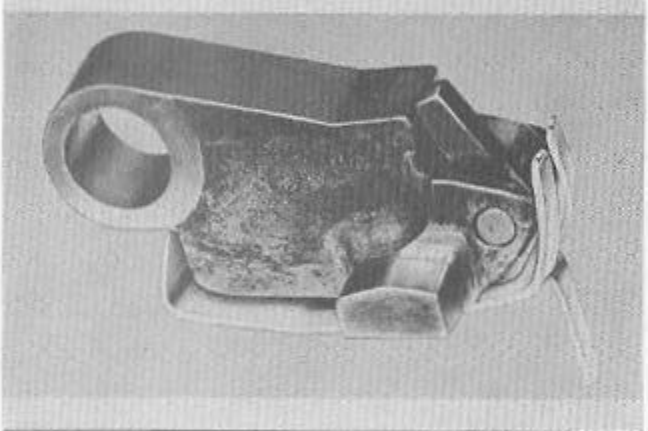


STEP 2: SALVO LATCH AND OPERATING SHAFT CAM PLATE

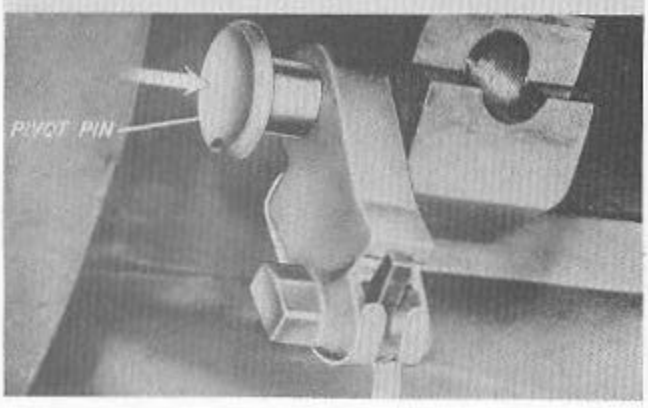
. . .as step two, to assemble the salvo latch and the operating shaft cam plate in the gun. This can best be done now, while there is plenty of room. Proper functioning of the salvo latch is vital to safe and efficient operation of the breech mechanism, so check it carefully before putting it back. The spring is the operating part of the latch. Check it carefully. See that the pawl and the spring plunger are cleaned and well lubricated and that they work freely.



Insert the spring and plunger in their recess in the salvo latch. Compress the spring. . .

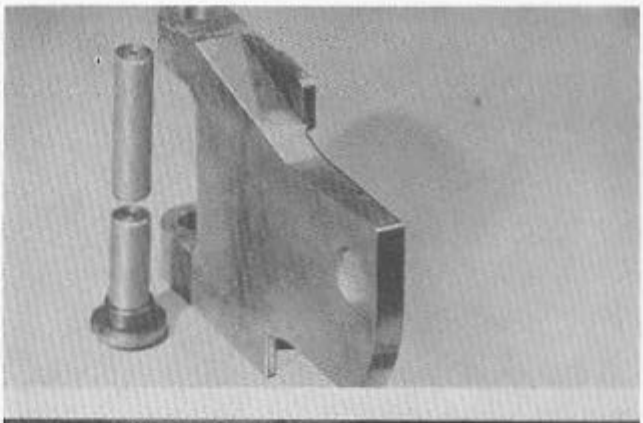


. . .and hold it with the compressor tool. The purpose of this tool. . .

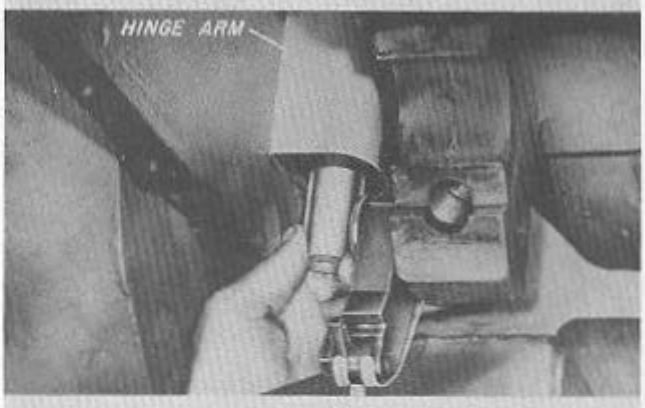


. . .is to hold the salvo latch inoperative until the breech mechanism parts have been assembled. Mount the latch on the operating shaft bearing lug by means of its pivot pin.

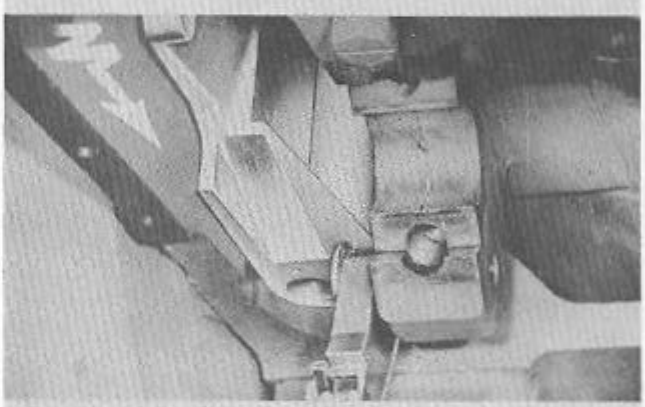
The operating shaft cam plate also can be mounted on the gun more easily before the operating shaft is in place. The cam plate is mounted with the two-piece pivot pin that holds it in place.



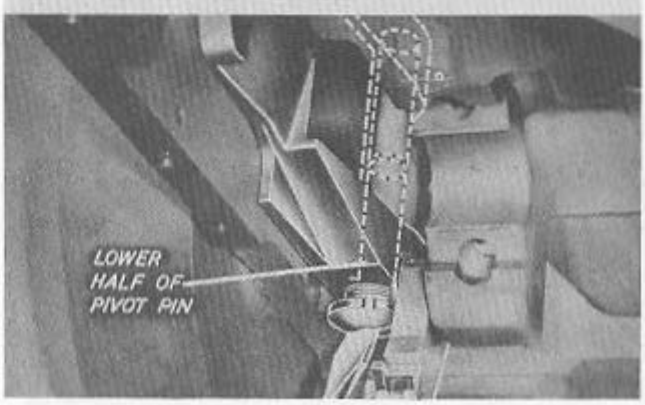
First, insert the upper half of the cam plate pivot pin into the cam plate hinge arm.

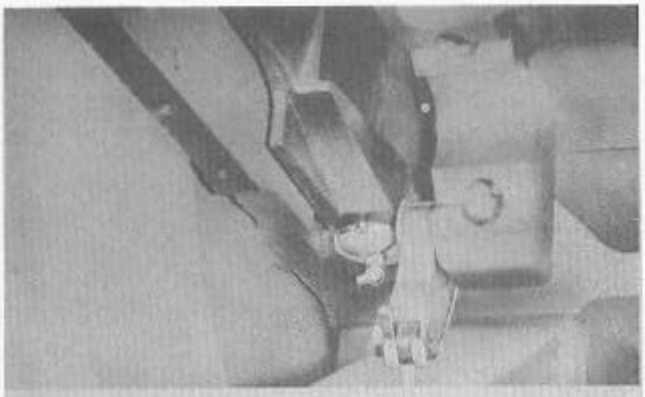


Then mount the operating shaft cam plate on the hinge arm. Rock it back and forth, if necessary, to slide it into place. Then to secure it in place. . .

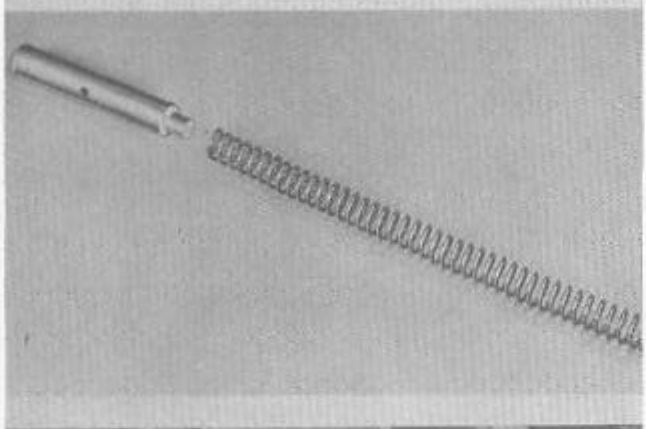


. . .screw the lower half of the cam plate pivot pin into the lower bracket of the cam plate. This also will force the upper half of the pivot pin into position.





Then lock the pivot pin with its keeper screw and replace the zerk fitting. Lubricate the pivot through this zerk fitting.



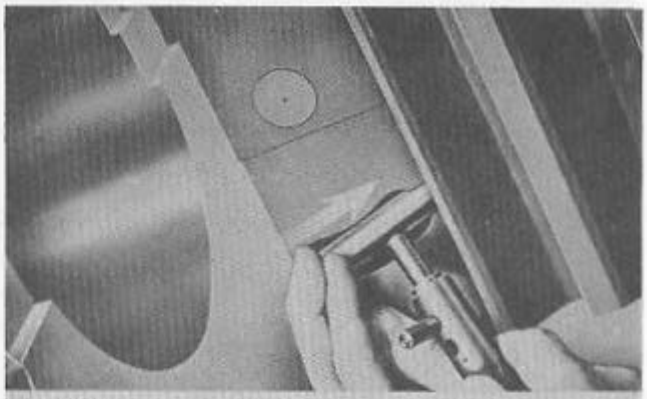
STEP 3: EXTRACTOR PLUNGER SPRINGS, EXTRACTOR PLUNGERS, EXTRACTORS

We're now ready for step three—replacing the extractor plunger springs, the extractor plungers and the extractors. First, insert the reduced end of the extractor plunger into the end of the extractor plunger spring. The spring will fit only over this end of the plunger.

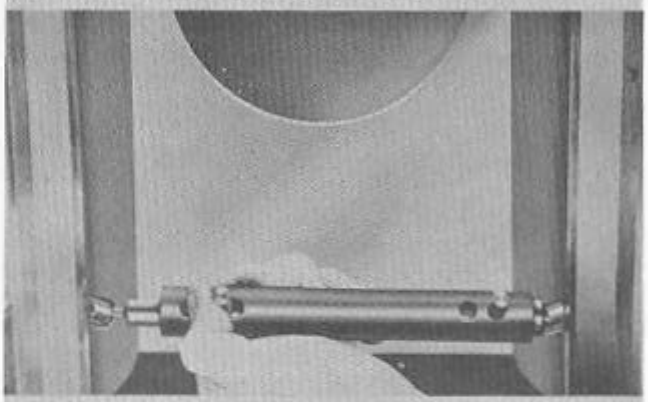
Then insert the other end of the spring in the hole in the after end of the kidney-shaped slot in the breechplug guide plate.

To compress the spring to seat the plunger in the kidney-shaped slot, we use the plunger bar tool. The fixed pin at the end of this tool is inserted in the hole in the side of the extractor plunger. Having done this, hold your fingers over the end of the extractor plunger. . .

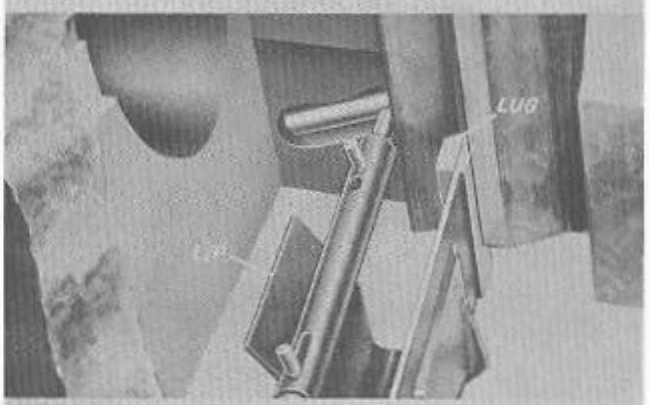
. . .and force it aft to compress the spring. When the spring is compressed sufficiently, you can force the plunger into the end of the kidney-shaped slot. Be careful to hold the pin of the tool firmly in the hole in the plunger and hold your fingers over the end of the plunger to prevent its popping out if the tool should slip. Repeat the operation for the other extractor plunger and its spring.



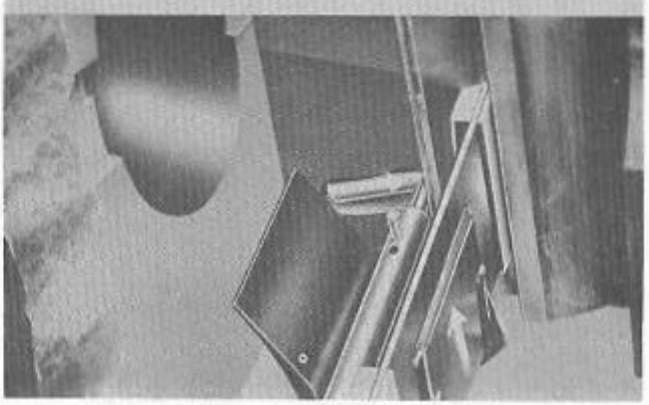
To retract the plungers so that the extractors can be seated, without danger of the plungers popping out of their slots, insert the pins at the ends of the plunger bar tool into the hole in each extractor plunger.

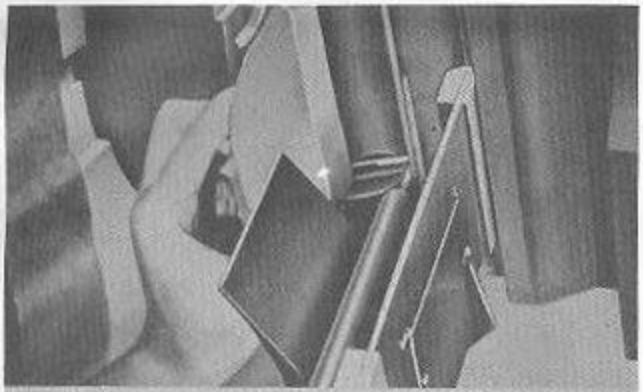


Then, insert the lugs of the plunger bar compressor tool into the forward groove of each breechplug guide plate with the lip of the compressor tool forward of the plunger bar tool.

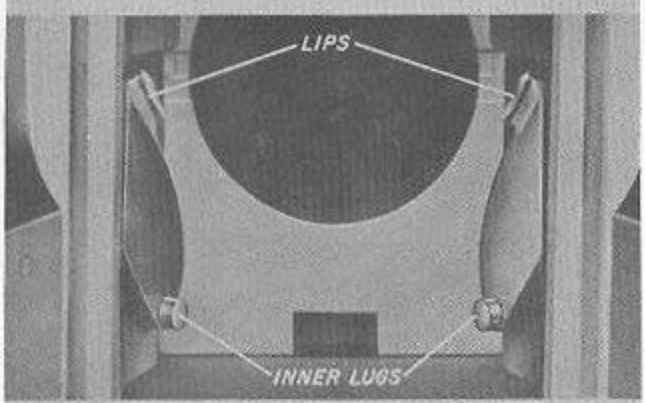


When the compressor tool is forced up, the sloping lip of the tool will spring the plunger bar tool aft, thus forcing the extractor plungers aft to provide space for the outer lugs.



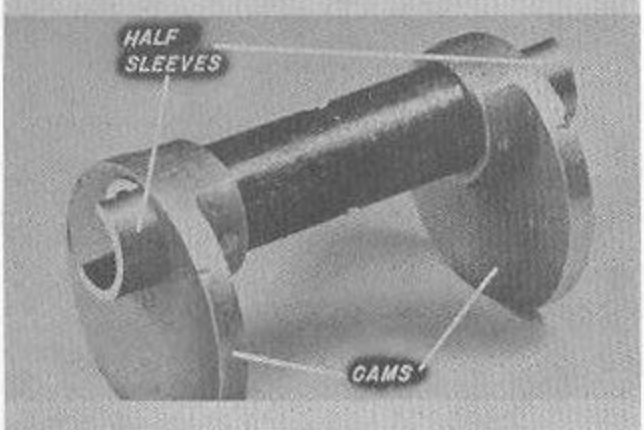


Now, insert the extractors with their outer lugs in the kidney-shaped slot in front of the extractor plungers. After this is done, remove the special tools. When all these parts have been assembled. . .

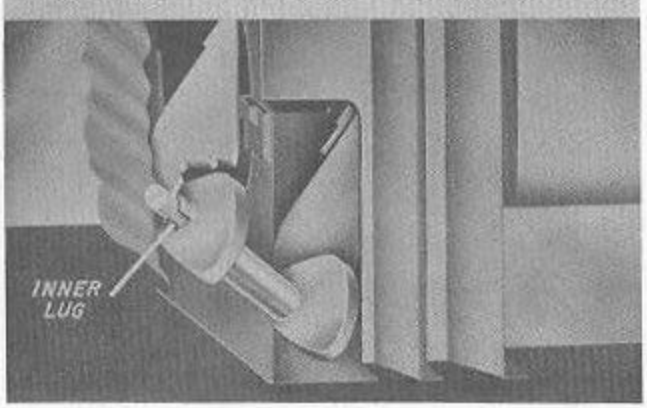


STEP 4: REPLACING BREECHPLUG

. . .you are ready for step four: replacing the breechplug in the breech housing. The breechplug is lowered into the guide plates from above. To permit this, the extractor lips must be forward and the inner lugs aft to fit into their camways on the breechplug. But, the function of the extractor plunger and springs is to hold the extractors with their inner lugs forward and their lips aft. To rock the extractors to the required position. . .

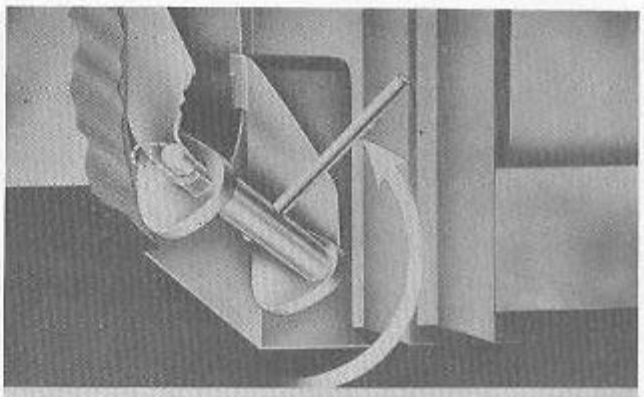


. . .this "extractor rotator" tool is provided. This tool rocks the extractors and at the same time prevents their slipping out of their seats. The tool consists of two cams mounted on a shaft and of half sleeves on each cam to engage the inner plug of each extractor.

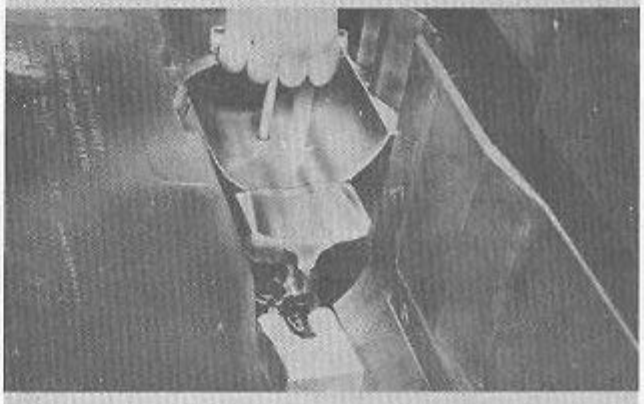


Place the half-sleeve ends of the tool on the top of the inner plug of each extractor.

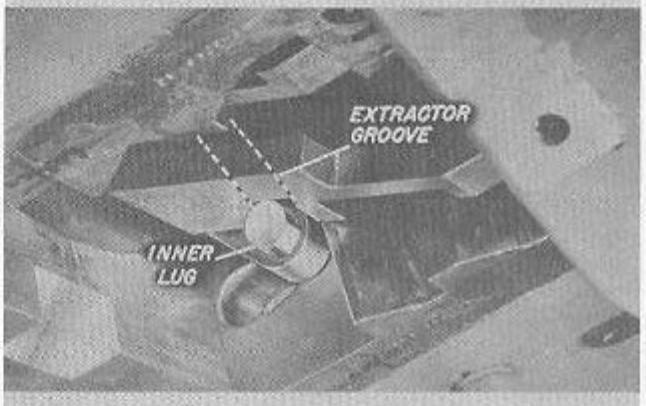
Then insert a rod in the rotator tool and rock the inner lugs aft. With the extractor lugs held aft. . .



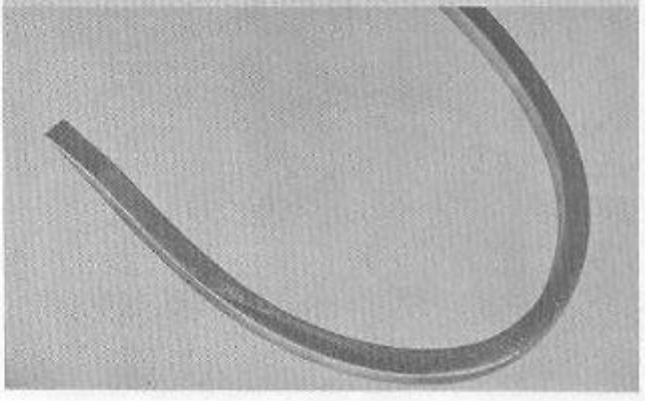
. . .place the wood or aluminum block in the loading tray and lower the breechplug gently into the breech housing. As you lower the breechplug, the extractor inner lugs should slip into the extractor grooves on the sides of the breechplug. The extractor rotator tool will be forced off the lugs and out underneath as the breechplug is lowered into place.

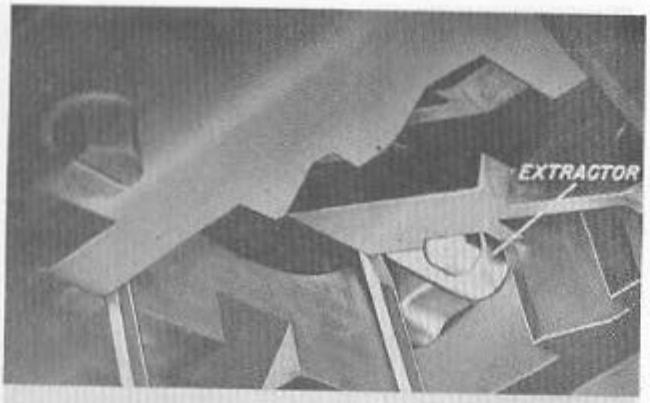


Here, looking up underneath the breechplug, we see that it may be necessary to force the inner lugs of the extractor further aft before they will fit into the extractor grooves, To do this. . .



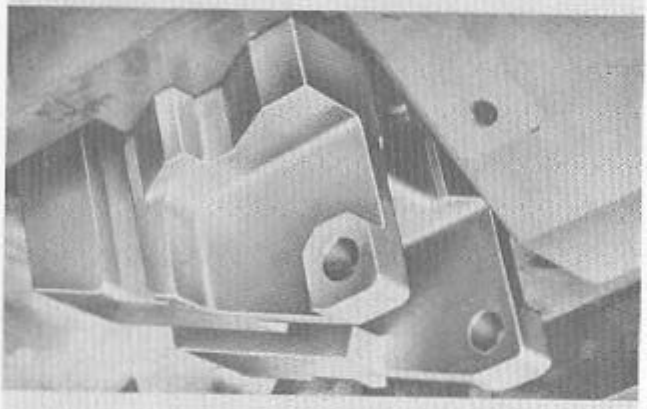
. . .a U-shaped tool is used.



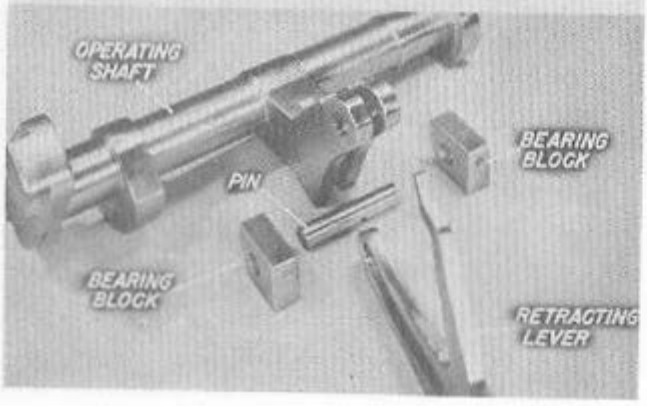


Push the ends of the tool up in front of each extractor and pull aft on the tool to force the bottom of each extractor further aft until their inner lugs are lined up with the camways on the breechplug. Never attempt to short cut by using this tool in place of the extractor rotator tool. . .

. . .because the extractors would probably pop out of their recesses and you'd have to start all over again.



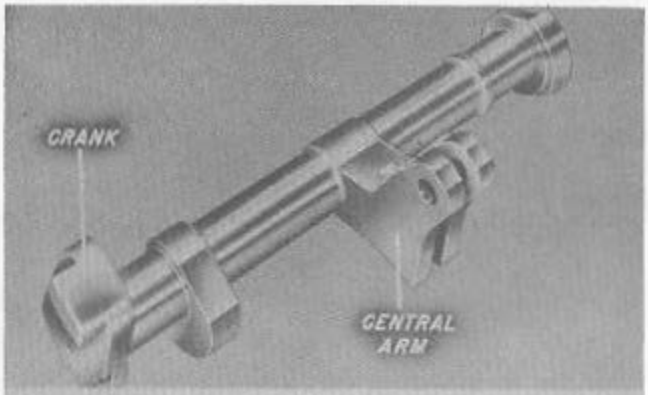
With the extractors properly positioned, lower the breechplug until its shelf extension rests on the block in the loading tray. The block holds the plug up in this position just high enough so that the operating shaft can be seated in the bearing cap lugs and just low enough so that the central arm bearing blocks can be seated in their camways. With the plug in this position. . .



STEP 5: OPERATING SHAFT AND BEARING CAPS

. . .step five is to assemble and mount the operating shaft and secure it in place with its bearing caps. The operating shaft assembly consists of the operating shaft, the bearing blocks, the central arm pin, and the retracting lever.

Place the operating shaft on a flat surface with the operating shaft crank on your left and the operating shaft central arm toward you.

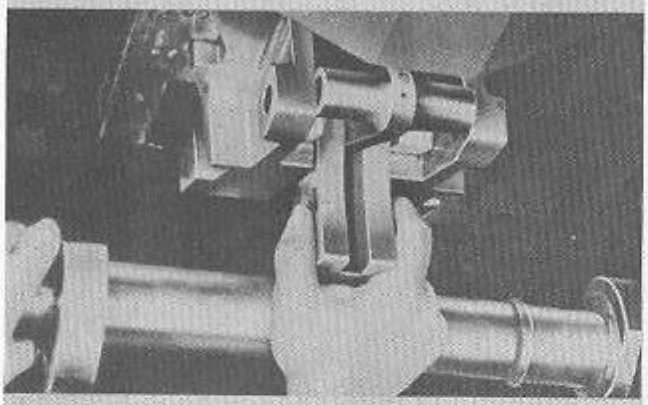


Insert the slotted arm of the retracting lever into the central arm with the other arm of the retracting lever projecting upward.

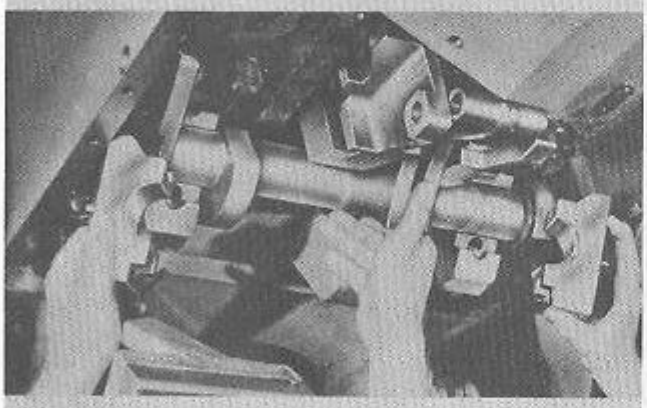
The central arm pin and the retracting lever pin are both of the same diameter and either one could be fitted in the central arm. But the central arm pin is the shorter of the two. . .

. . .and should be inserted through both the central arm and the slotted arm of the retracting lever. The pin extends on each side of the central arm just enough to receive the bearing blocks. The central arm pin must be inserted here because the retracting lever pin would be too long, and would jam against the bearing block camways.

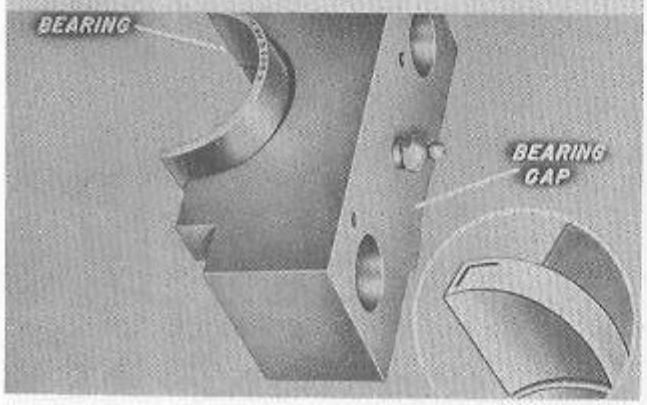
Slide a bearing block onto each end of the pin with the oil hole in each bearing block aft and on top. If you mount the bearing blocks otherwise, the breechplug will jam when you raise it to close the breech.



Now, lift the complete operating shaft assembly up under the breechplug, inserting the retracting lever behind the breechplug, holding the bearing blocks in place so that they won't fall off. Insert the bearing blocks in their camways in the lower end of the breechplug. Remember that the oil holes in the bearing blocks must be on top and pointing aft.

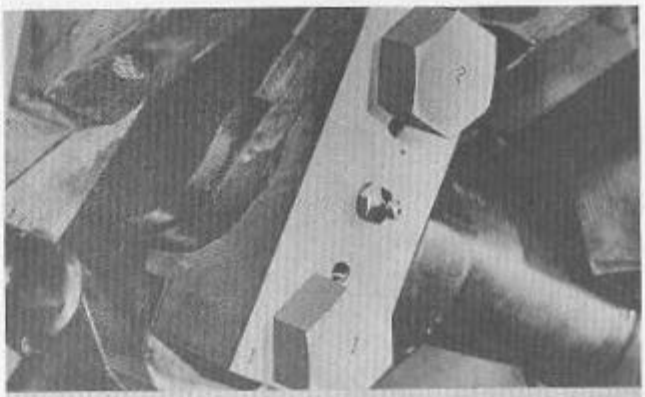


Seat the operating shaft against its bearing lugs, then mount the bearings and bearing caps in place.

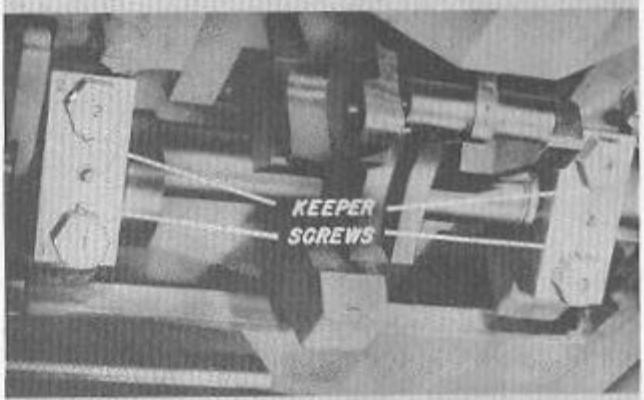


Each bearing has a letter "L" on one edge and a letter "R" on the other edge. One edge of each bearing also has a serial number stamped on it. With the serial number on the outboard side of the bearing, each bearing must be mounted with the "L" on the left and the "R" on the right. This ensures placing the proper bearing on the proper side of the operation shaft.

Finally, insert the bearing cap bolts. Be sure that the number on each bolt corresponds to the number beside each bolt hole. Otherwise, when the bolts are tightened, the keeper screw holes will not line up properly with the bolt heads.

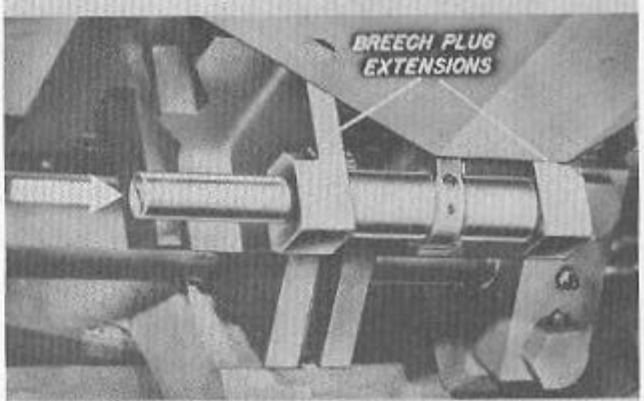


When the bolts are tight, replace their keeper screws. Lubricate the bearings through the zerk fittings on the caps.

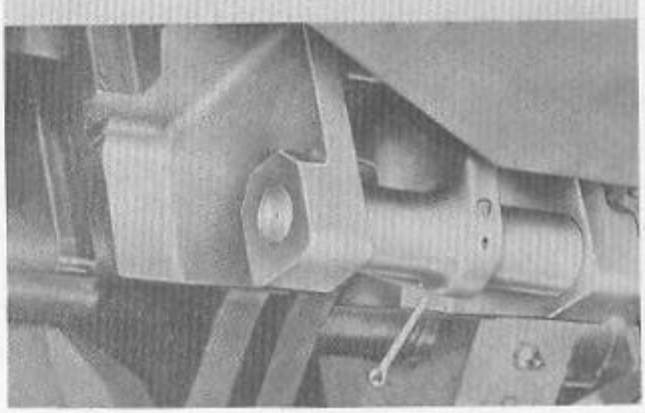


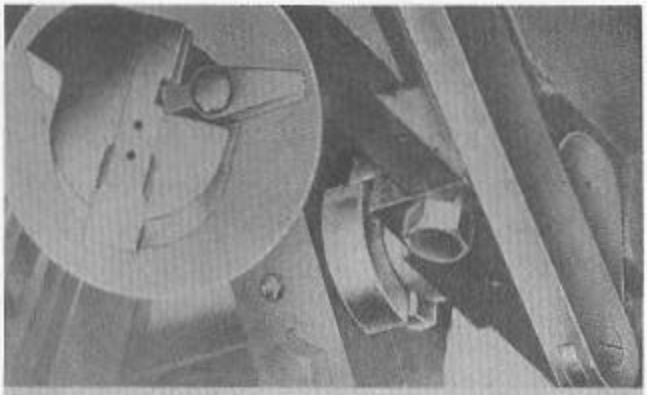
STEP 6: RETRACTING LEVER PIN

As step six, the retracting lever must be secured in the plug with the retracting lever pin. To do this, insert the retracting lever pin through the lower breechplug extensions and through the retracting lever.



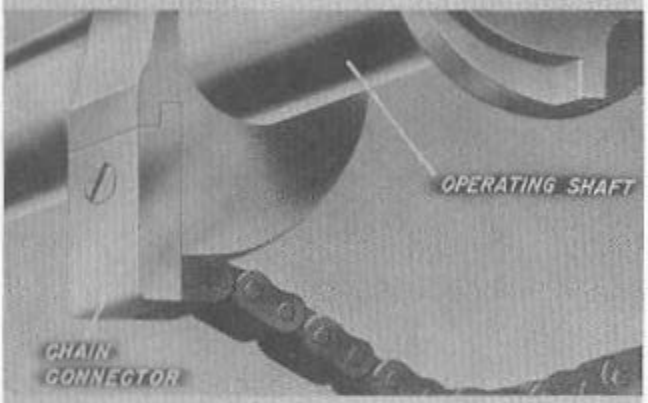
Then insert a new cotter key through the elbow of the retracting lever in order to lock the pin in place. With the operating shaft connected to the breechplug. . .



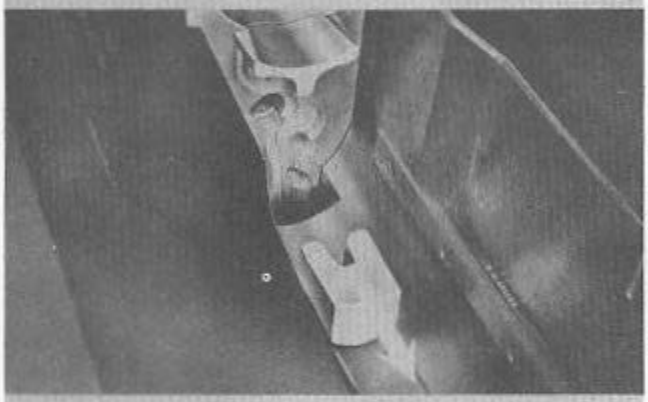


STEP 7: OPERATING SPRING CHAIN

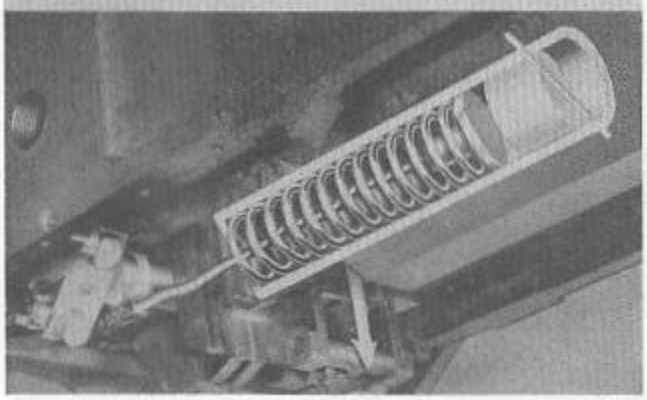
. . .step seven is to connect the operating spring chain to the cam. First, snap the hand-closing latch key forward and lift the hand-operating lever to raise the breech-plug.



As this is done, the operating shaft will be rotated to bring the chain cam around so that the chain connector can be mounted on it. The connector is then secured in place with its retaining screw.

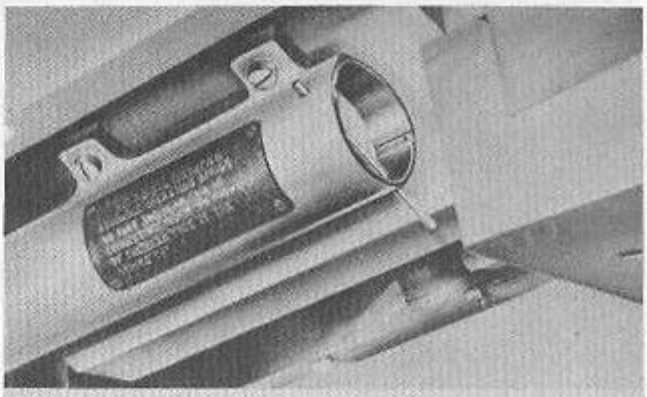


Now, remove the block. . .

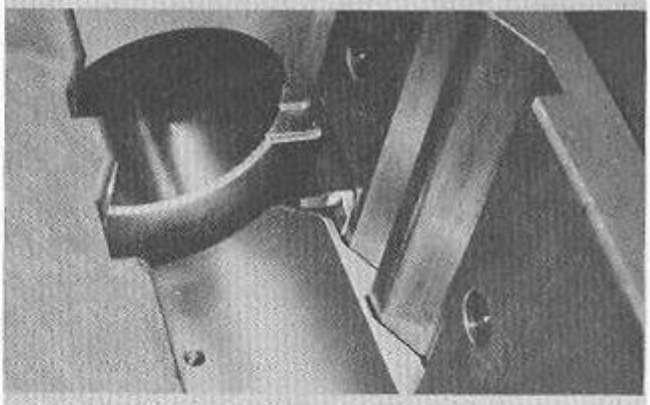


. . .and lower the breechplug gently as far as it will go. Bear down all the way on the operating lever until you hear the extractors snap locked. In this position the operating spring is held in compression. . .

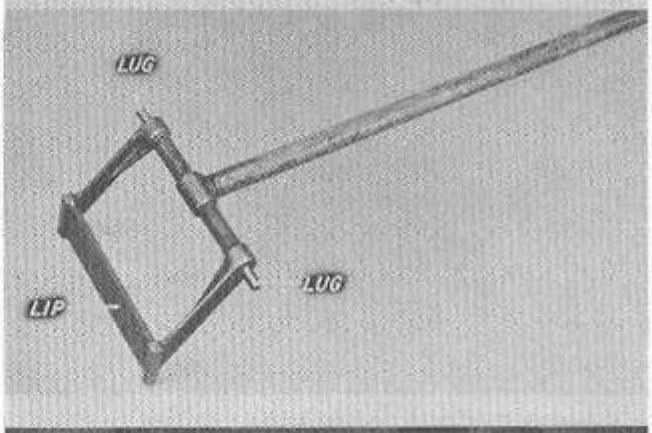
. . .so that the rod and block can be removed from the after end of the spring housing. To permit the operating spring to function freely to raise the breechplug when the extractors are unlocked, see that the hard closing latch key is released.



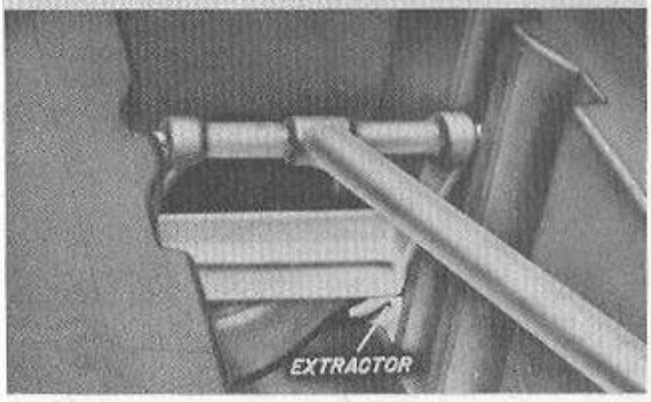
Looking now into the breech end of the loading tray, you will see that the extractor lips have snapped all the way aft. The breechplug is now locked in its down position. The extractors must be tripped forward to unlock the breechplug. This is done. . .

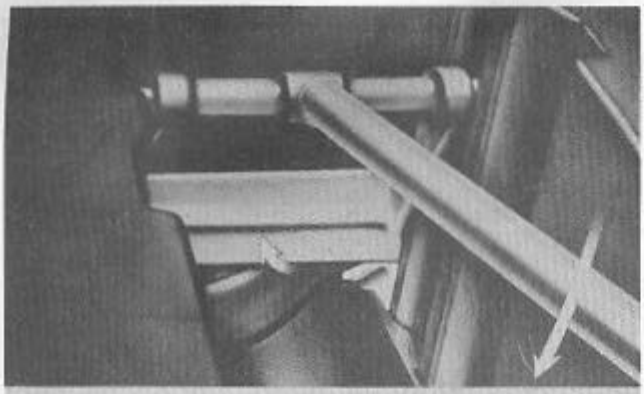


. . .by using this tool which has two projecting lugs and a forward lip.

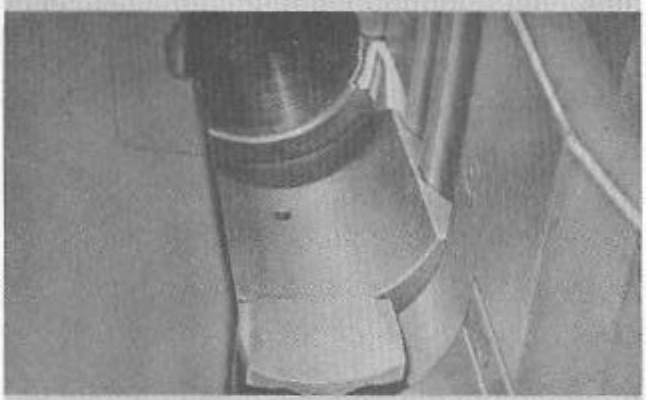


Insert the tool with the lugs in the forward breechplug guide groove and with the lip of the tool against the top of each extractor.

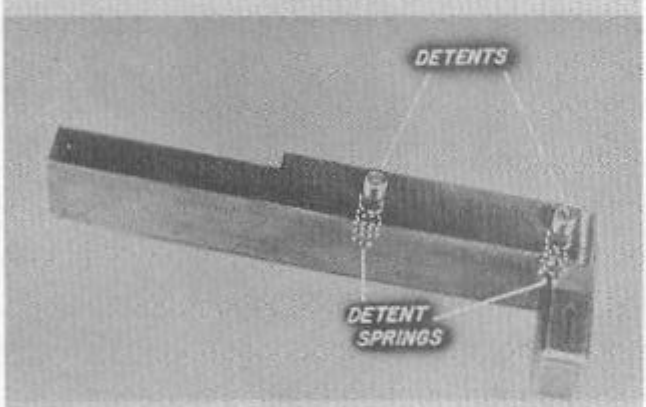




Now by pressing down on the handle of the tool force the lips of the extractors forward.

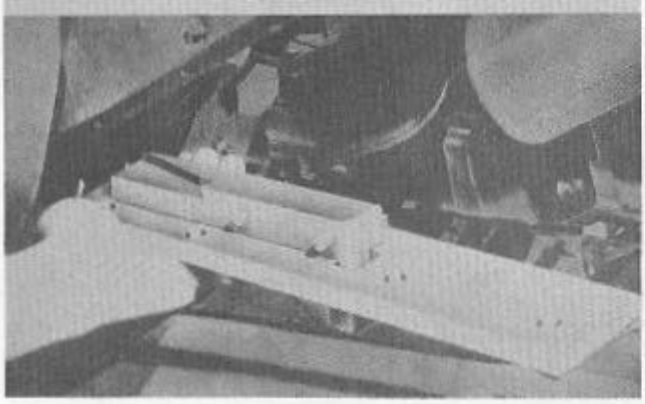


When the extractors are pushed all the way in, the plug will be raised by the action of the operating spring.



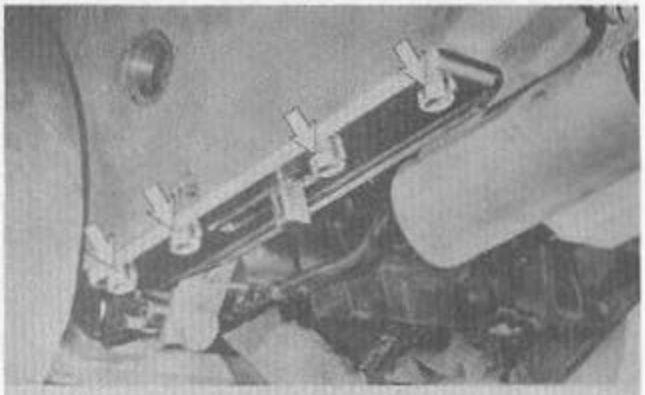
STEP 8: CAM PLATE RETRACTOR AND SALVO LATCH CAM PLATE

Step eight is to assemble and mount the cam plate retractor and the salvo latch cam plate. First, insert the springs and detents in the cam plate retractor.



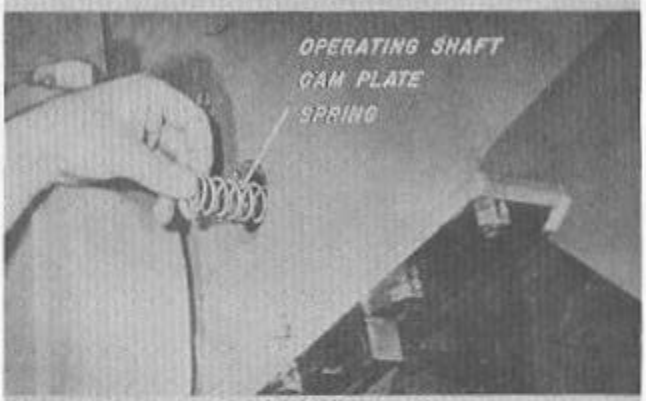
Then install the cam retractor by passing its lever through the slot in the salvo latch cam plate. The cam retractor and salvo latch cam plate assembly now is ready to be mounted on the gun.

Put the retractor and cam plate assembly in place and secure it. Be careful to insert each numbered bolt in the correspondingly numbered hole. When the bolts are tight, replace the four keeper screws.

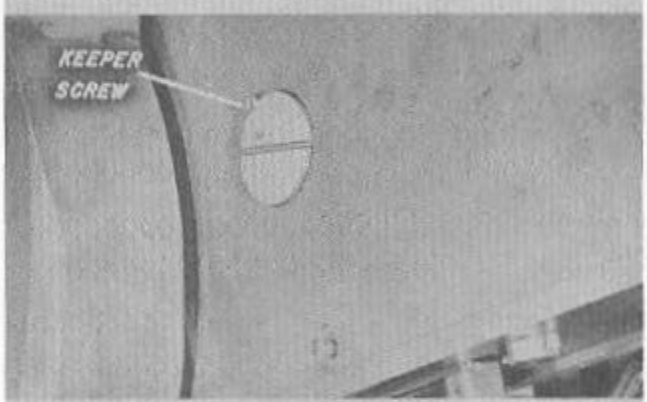


STEP 9: OPERATING SHAFT CAM PLATE SPRING

Step nine is to replace the operating shaft cam plate spring. First, insert the operating shaft cam plate spring. . .

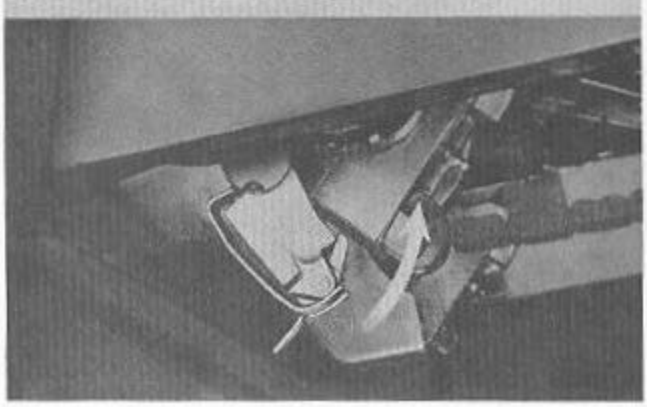


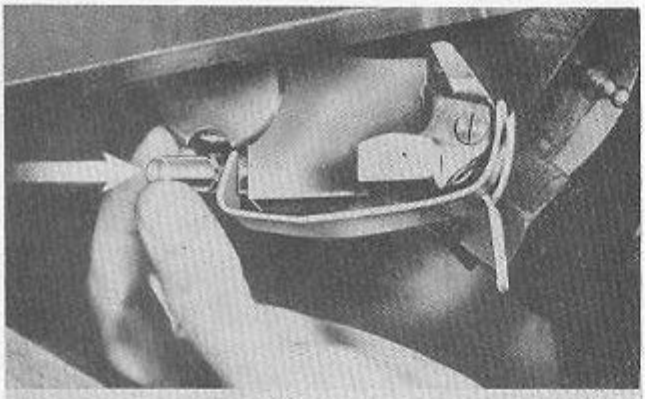
. . .then screw in the plug, and secure it with the keeper screw.



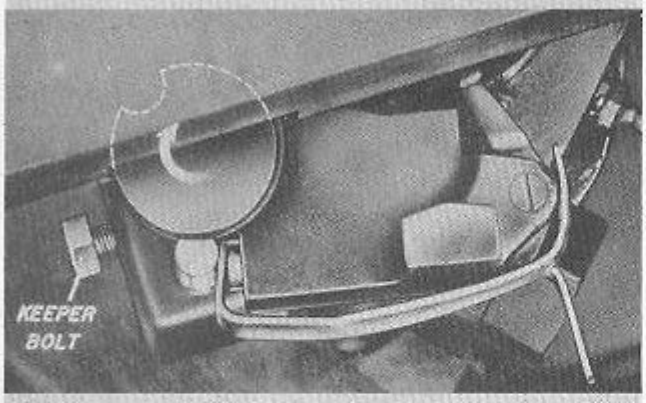
STEP 10: SALVO LATCH MADE OPERATIVE

As step ten the salvo latch is made operative. When this has been done, the breech mechanism will be completely assembled. The salvo latch cam plate and cam plate retractor have been removed here so we can see the salvo latch more clearly. Lift up the after end of the salvo latch. . .

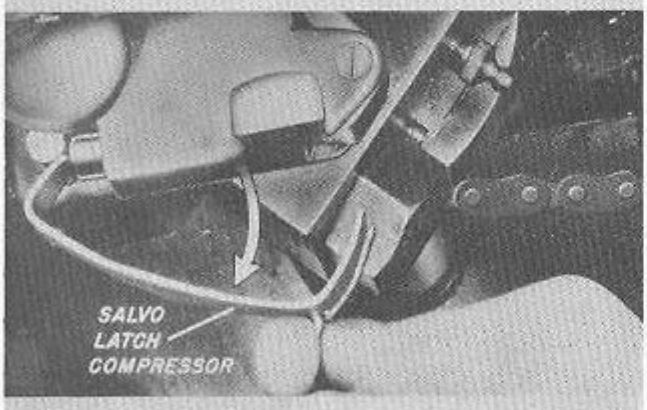




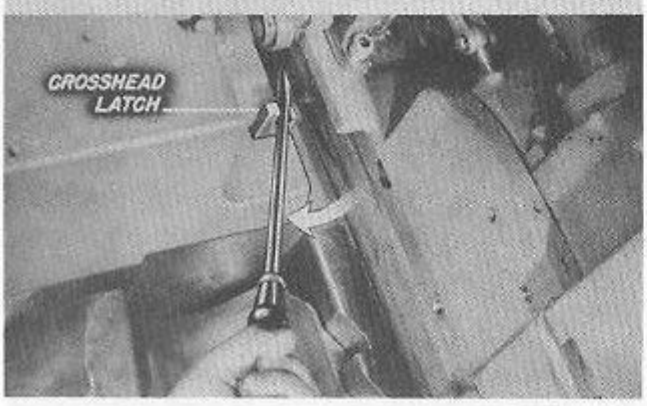
. . .and insert the salvo latch plunger retaining pin in its recess in the breech housing.



Turn the head of the salvo latch pivot pin so that it locks the plunger retaining pin in place, and lock the pivot pin in this position with its keeper bolt.



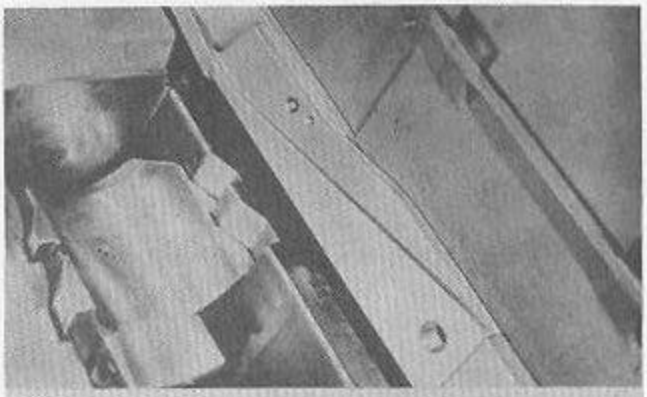
Then pull off the salvo latch compressor tool to free the salvo latch plunger and spring, and to put the salvo latch in operating condition.



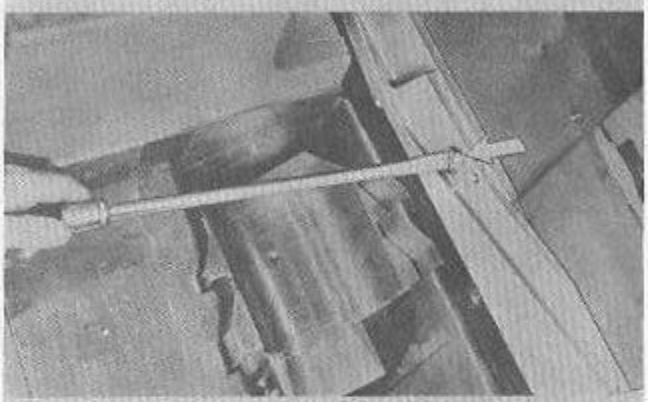
STEP 11: RAMMER CAM PLATE

The remaining steps involve the replacement of the parts removed preparatory to disassembly of the breech mechanism. Thus, step eleven is to replace the rammer cam plate. This is done first by wedging the rammer crosshead latch to the left. . .

. . .and then replacing the forward section of the rammer cam plate. When the cam plate is in position, the rammer crosshead latch can be released.

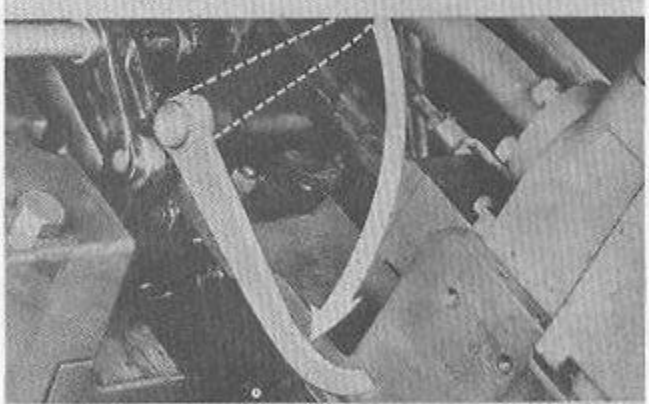


Take up on the screws alternately so as to draw the cam plate section uniformly into place.

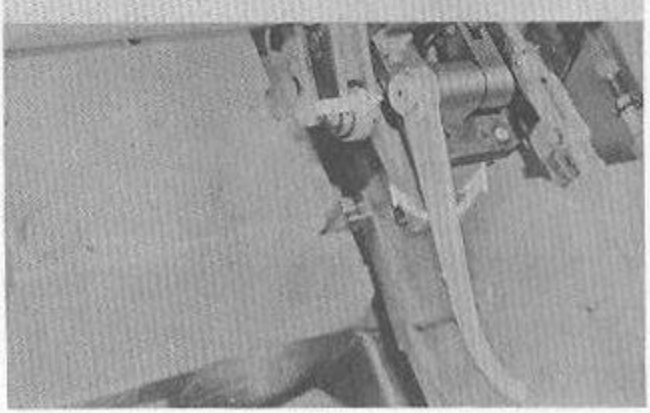


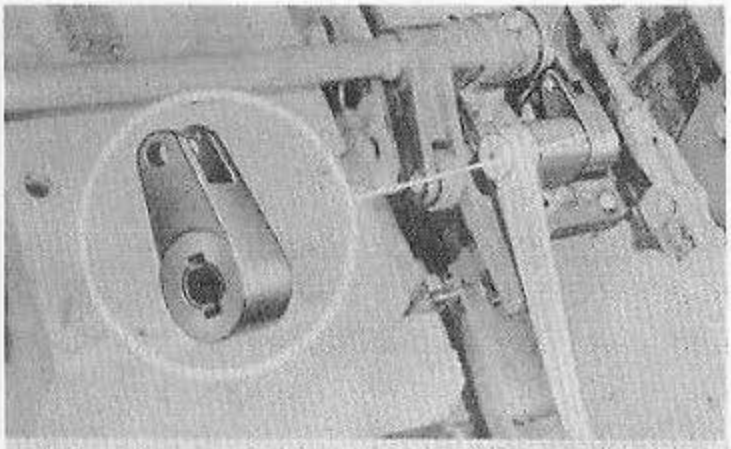
STEP 12: RAMMER TRIP LEVER AND RAMMER TRIP LEVER STOP PLATE

Step twelve is to lower the rammer trip lever into position and to replace the rammer trip lever stop plate. To do this lower the rammer trip lever to its normal position. . .

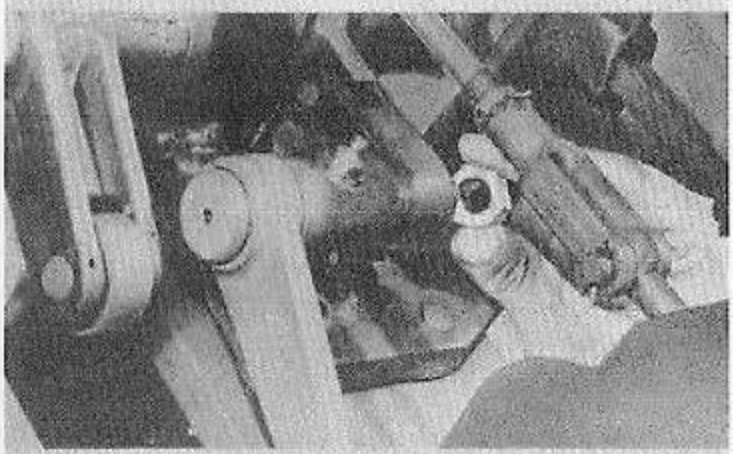


. . .and push the rammer trip lever shaft through its bearing into the automatic operating lever. Rock the rammer trip lever shaft, if necessary. . .

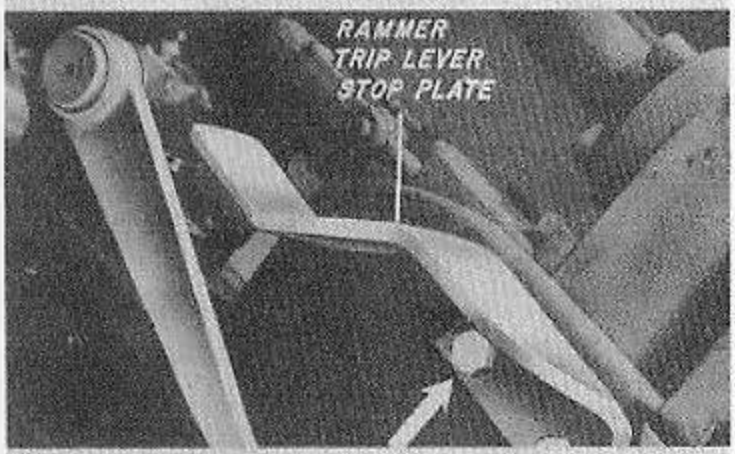




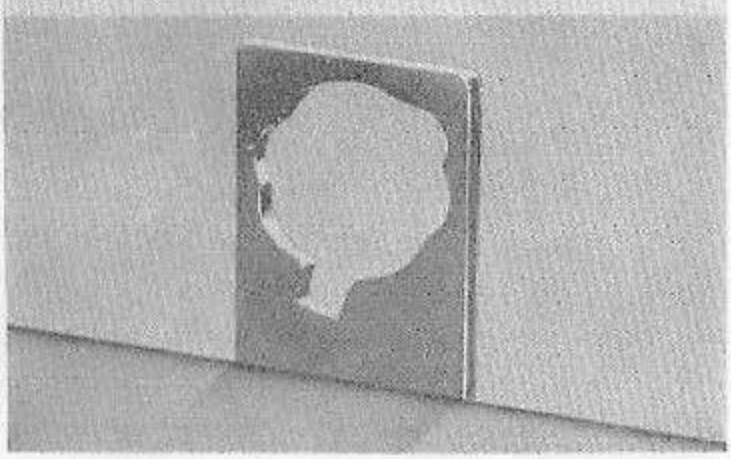
. . .so that the key on the end of the shaft will engage the keyway in the automatic operating lever.



Then secure the rammer trip lever shaft by replacing the nut on the far end of the shaft.



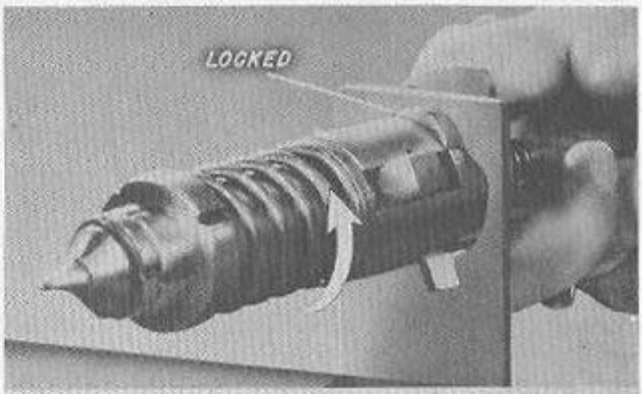
Replace the rammer trip lever stop plate.



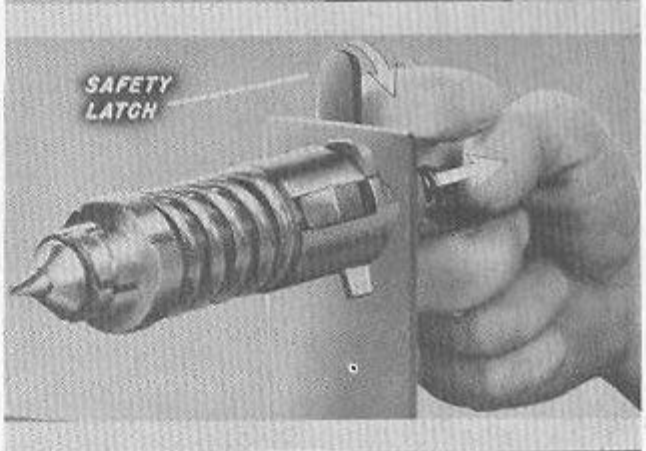
STEP 13: FIRING MECHANISM

To prepare the breech mechanism for firing, the thirteenth and last step is to place a cleaned and overhauled firing mechanism in the breechplug. To cock the firing mechanism so that it will go into its seat in the plug, a tool, made up from a strip of metal and welded to the edge of the gun platform may be used. It has a hole for the firing mechanism and a slot to pass the cocking sleeve lug.

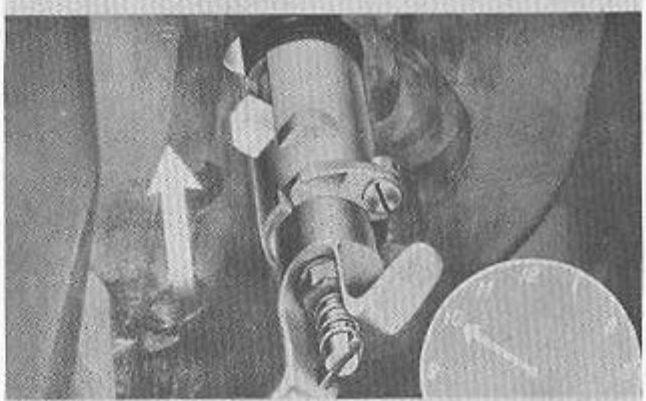
Insert the firing mechanism through the tool and then twist the firing mechanism until the bayonet lugs are locked in back of the tool.



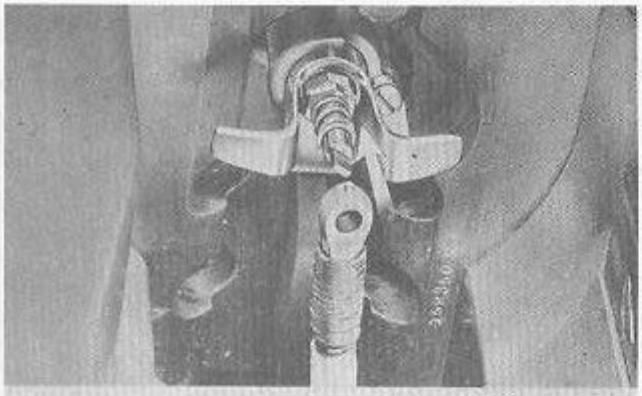
Now pull aft on the cocking handle and rotate the safety latch into position so that the firing mechanism will stay cocked. It now can be mounted in the breechplug.



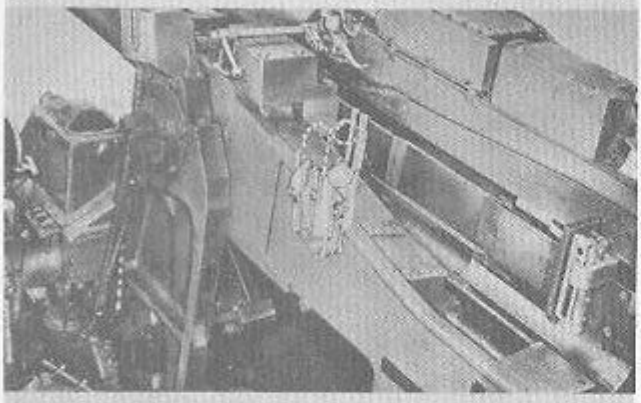
To do this, insert the firing mechanism in the breechplug with the cocking sleeve lug at the ten o'clock position so that it will fit into its keyway in the breechplug.



Then twist the cocking handle clockwise to lock the bayonet lugs in place. Trip the safety latch to release the cocking handle. . .

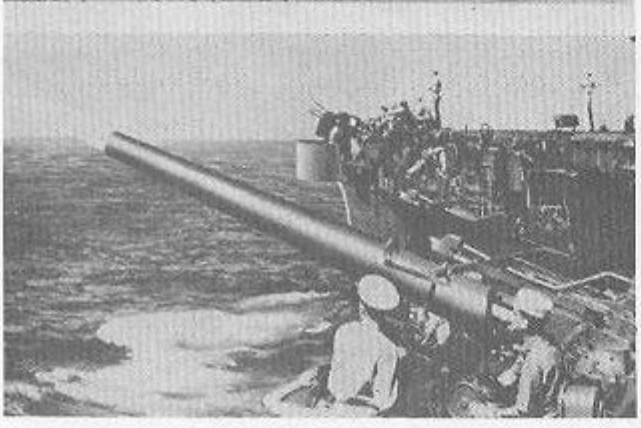


. . .and connect up the firing lead.



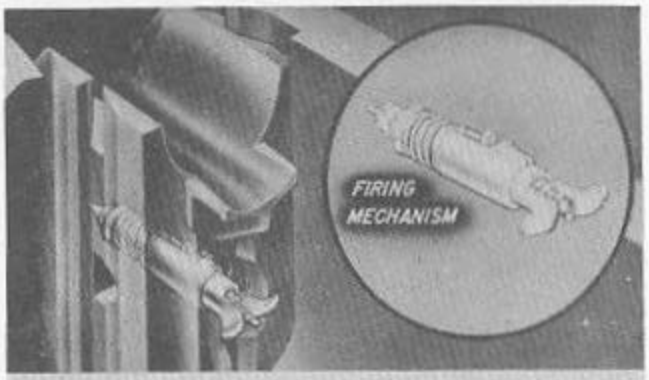
We have seen that smooth functioning of the breech mechanism is vitally important to the uninterrupted rapid fire action of the 5''/38 gun.

For this reason, thorough overhauling of the breech mechanism is an important part of maintenance routine. Moreover, you must be able to overhaul this mechanism rapidly, for there is not time to waste during the upkeep period if the ship and her guns are to be returned to active service as soon as possible.



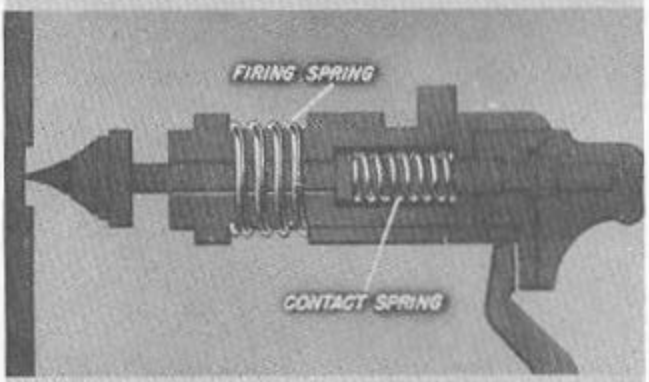
And, even more important, speed is essential especially in combat areas when correcting casualties. So, learn the disassembly and assembly routine of the mechanisms so thoroughly that you can do it in a matter of minutes!

To fire a gun rapidly and without failure, the firing mechanism must be maintained in perfect working order.

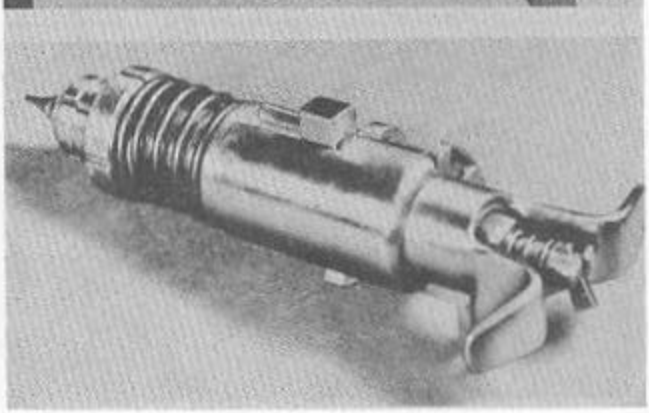


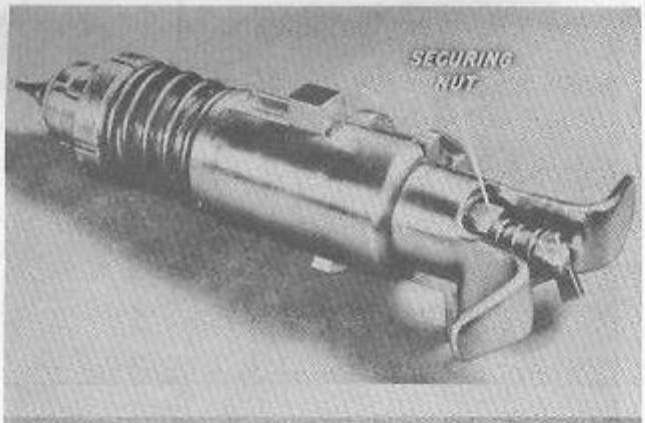
Failure to fire is one of the most common casualties in the 5''/38. Yet it is one of the easiest to prevent by careful daily checking of the firing mechanism. The daily checkoff list requires that the firing mechanism should be removed from the breechplug and a spare substituted. The purpose of this procedure is to permit cleaning and inspection of the firing mechanism without putting the gun out of commission.

We have seen that the firing mechanism is dependent on the action of two springs—the firing spring for precussion firing, and the contact spring to provide a positive contact to permit electrical firing. Springs are always subject to fatigue and have to be checked constantly.

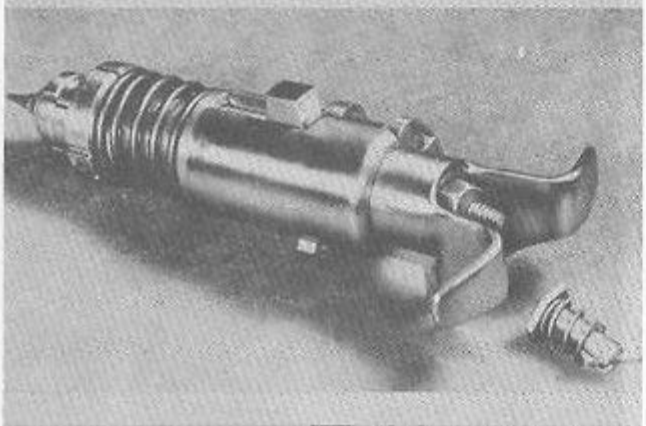


Checking the springs involves disassembly of the firing mechanism so that the free length of the springs can be checked. In addition, disassembly of the firing mechanism provides opportunity for complete cleaning of the mechanism and for inspection of the firing pin insulation which is important to proper functioning of electrical firing.





Because a single securing nut holds most of the parts, disassembly of the firing mechanism is relatively simple. To disassemble the mechanism,. . .



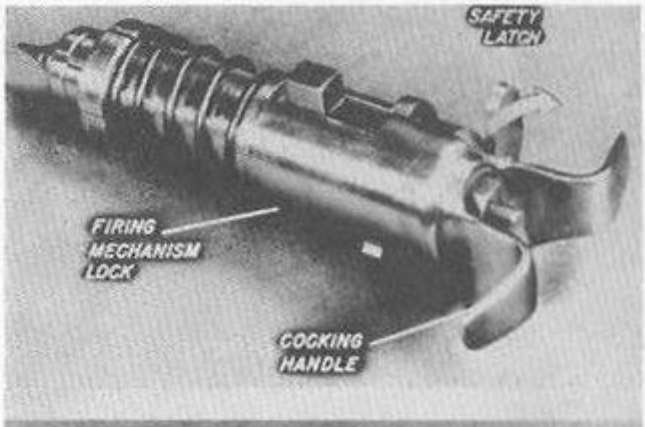
DISASSEMBLY

. . .first unscrew the firing terminal head so that the securing nut is accessible for removal. With the firing terminal removed, the mechanism is held together only by the securing nut. To get it out of the breech-plug, we cock the firing plunger compressing the powerful firing spring.

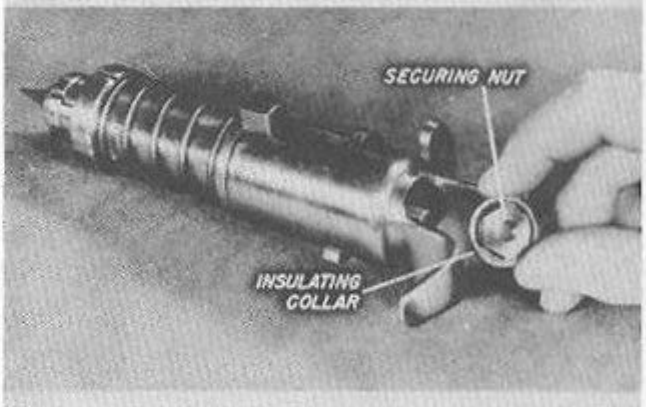
The fellow who starts removing that securing nut without taking the proper precaution. . .

. . .is in for a big surprise. To prevent the parts from bouncing off your chin, it's necessary, first, . . .

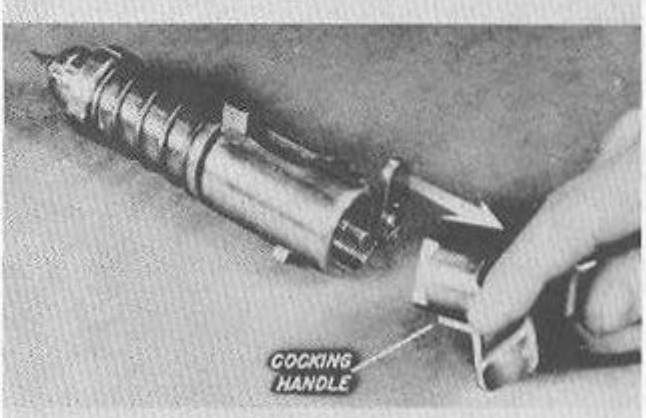
. . .to release the safety latch, to uncock the firing plunger, and relieve the compression of the powerful spring. When you rotate the safety latch out of the way, the firing spring will snap the cocking handle forward sharply against the firing mechanism lock. So, keep your fingers clear.



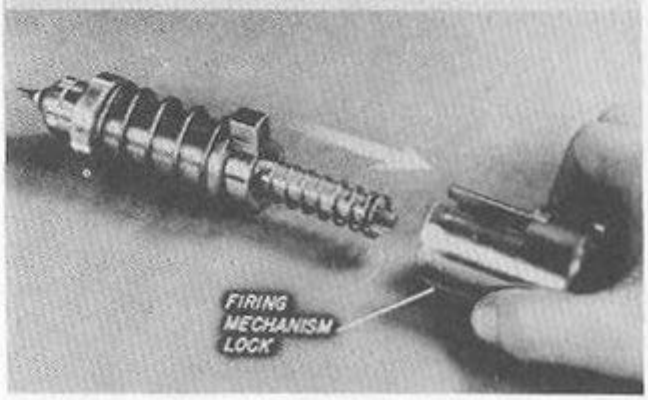
Now, with the mechanism uncocked, it is quite safe to unscrew the securing nut on the after end of the firing pin. An insulating collar will come off with the nut.

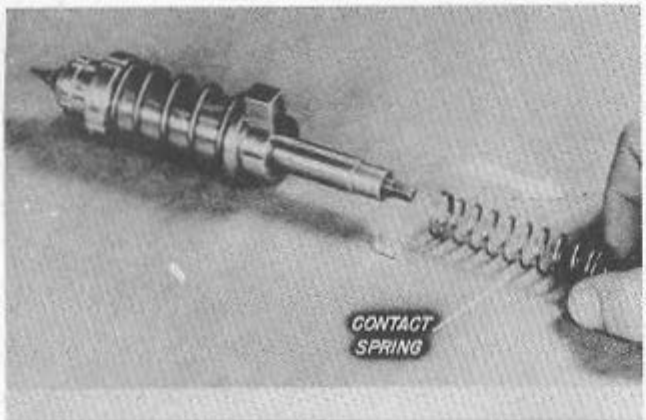


Then pull the cocking handle off the end of the firing pin.

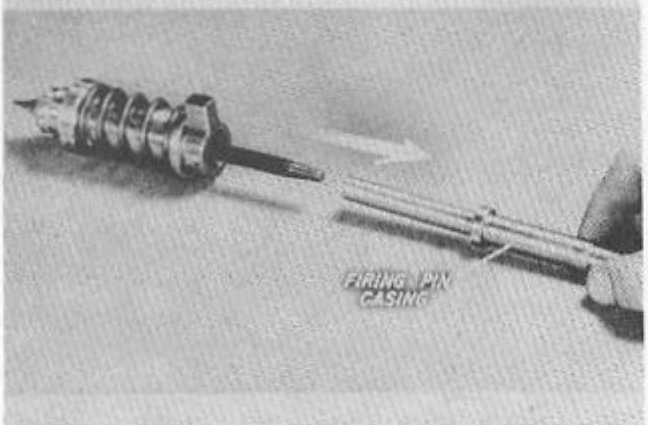


Remove the firing mechanism lock. . .

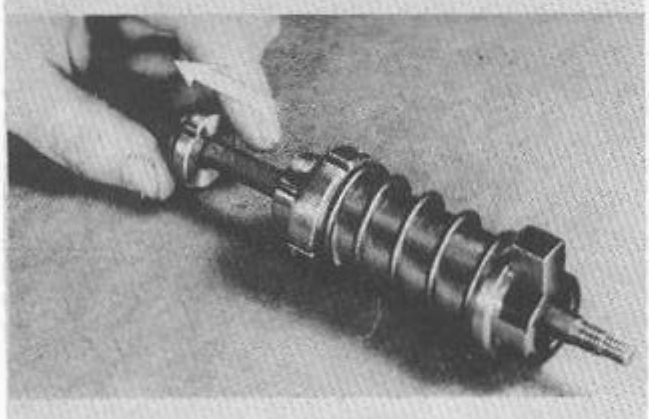




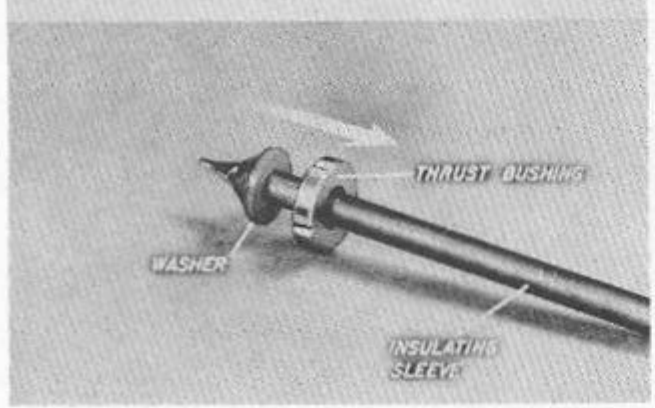
. . .and withdraw the contact spring.



Next, pull the firing pin casing out of the cocking sleeve assembly, . . .

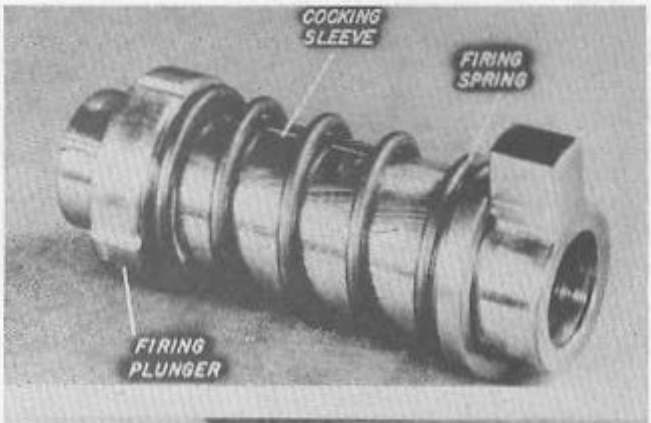


. . .and withdraw the firing pin from the other end of the cocking sleeve.assembly.



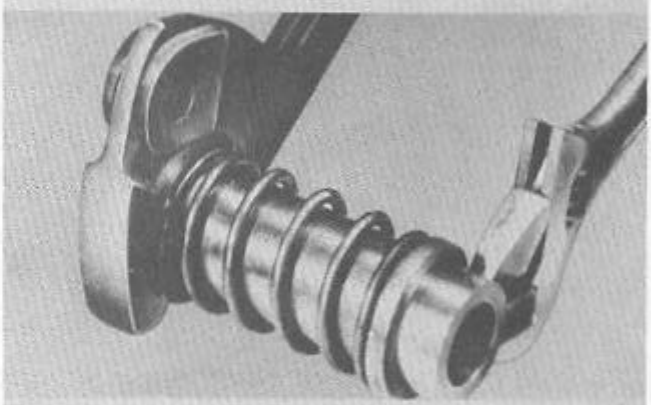
When the firing pin has been removed, slide this thrust bushing and the insulating washer in front of it off the end of the firing pin rod. The insulating sleeve is cemented on the firing pin and does not come off.

The remaining portion of the firing mechanism is this firing plunger assembly consisting of the firing plunger, the cocking sleeve, and the firing spring. To take this apart, . . .

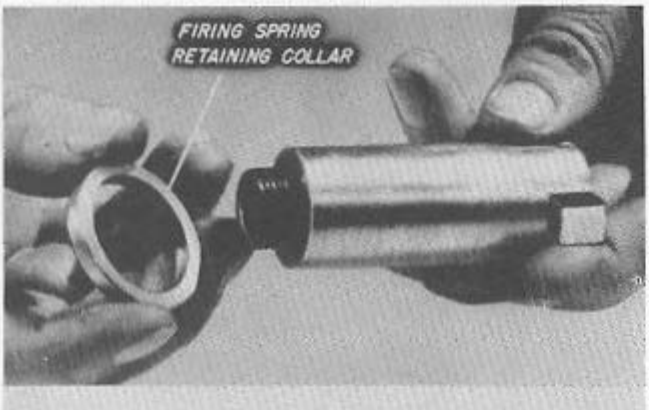


. . .first, loosen the setscrew which locks the firing plunger to the forward end of the cocking sleeve, . . .

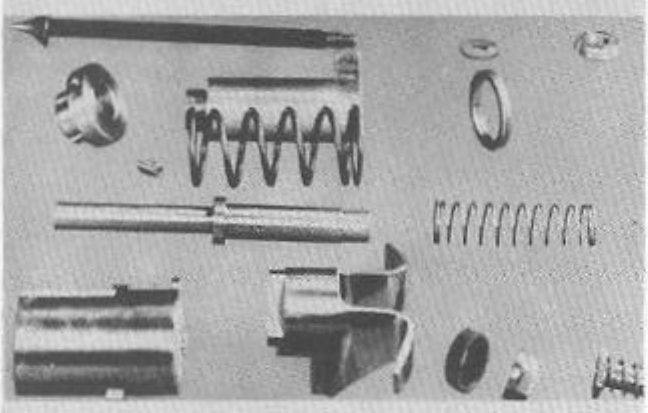
. . .and unscrew the firing plunger with a spanner wrench.



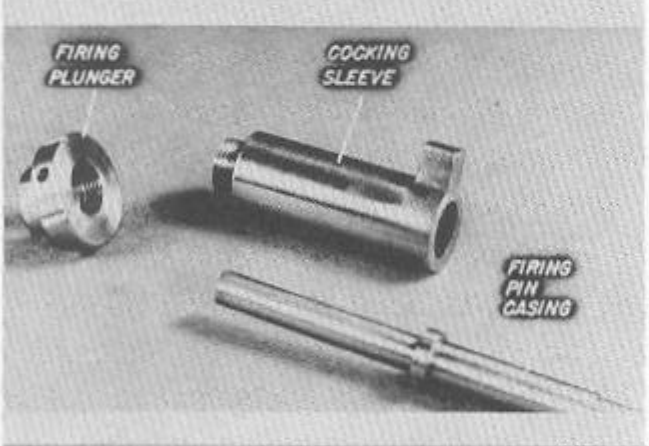
Then, slide the firing spring off the forward end of the cocking sleeve, . . .



. . .and remove the firing spring retaining collar.

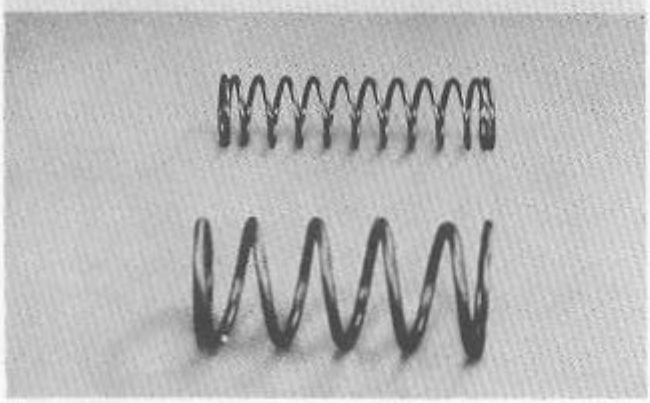


The firing mechanism has now been completely disassembled into its component parts. Clean these parts thoroughly. Then, before reassembling the mechanism, . . .



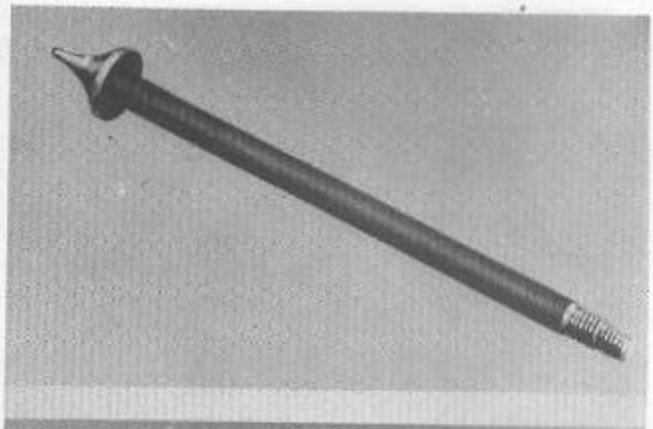
INSPECTION

. . .inspect the firing plunger, the cocking sleeve, and the firing pin casing for burrs, cracks, or corrosion. Remove burrs with an oil stone. Replace any cracked parts, and lubricate with light oil. Do not get oil on the inside of the firing pin casing which comes in contact with the firing pin insulation.

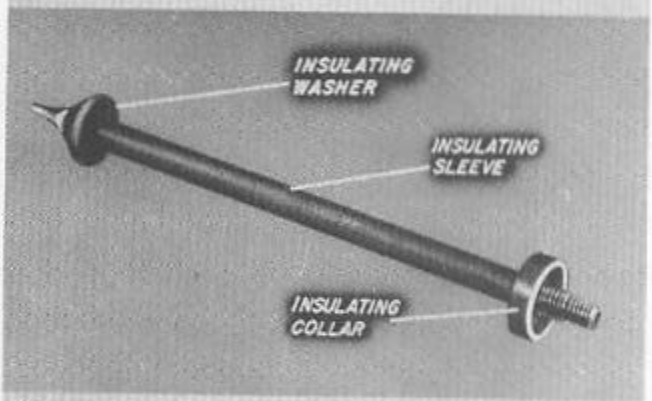


Carefully inspect the firing spring and the contact spring for cracks or evidence of corrosion. Check the measured free length of the springs against dimensions given in the blueprints or against the length of new springs. If the springs are cracked or too short, replace them with new ones. Remember, firing depends upon the strength of these springs.

Inspect the firing pin carefully. See that the point is not bent or blunted. Strike the pin against a metal surface and, by the quality of its ring, make sure that it is not cracked or broken. If the pin is damaged, replace it with a new one.

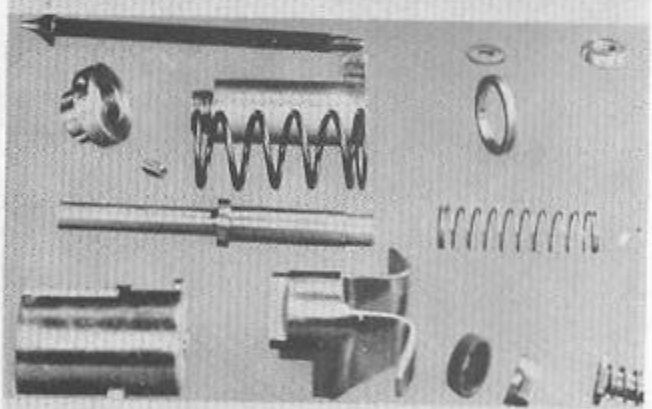


In addition, inspect all the insulating parts of the firing pin carefully. See that they are free of grease or dirt which would injure their insulating properties. It is important that each of these parts, the insulating washer, the insulating sleeve, and the insulating collar, be in perfect condition to assure a faultless electrical firing.

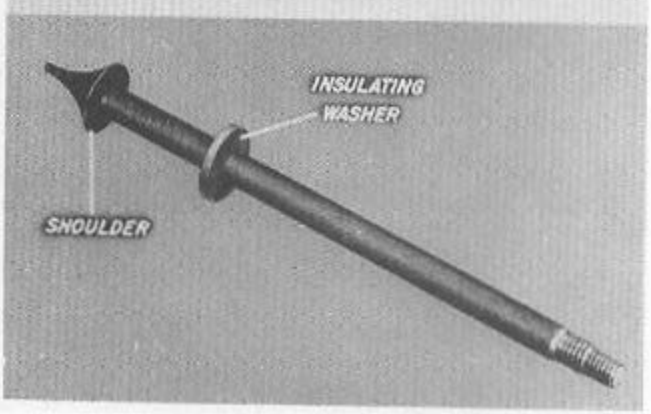


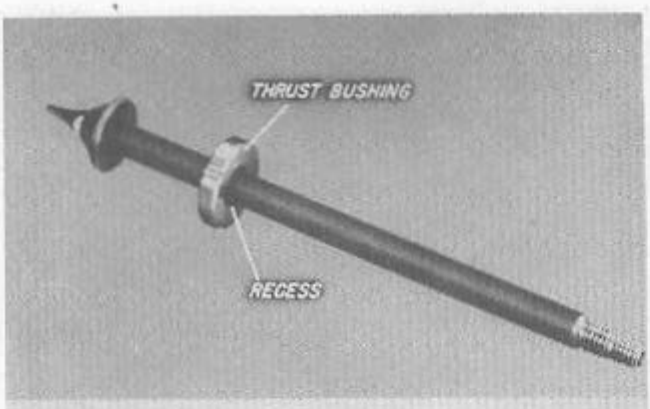
ASSEMBLY

When all the firing mechanism parts have been thoroughly cleaned, checked, and lubricated, and worn parts replaced by new ones, the mechanism should be reassembled so that a spare will always be on hand in the event of failure or casualty. To do this, first, reassemble the firing pin and firing plunger subassemblies. To assemble the firing pin, . . .

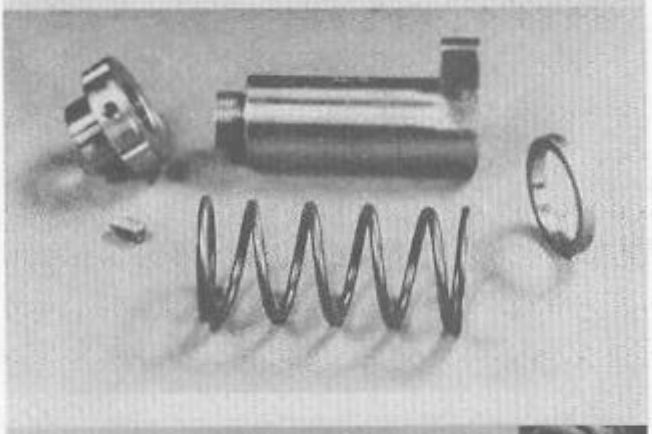


. . .slide the insulating washer (that's the flat one) over the firing pin sleeve until it seats against the firing pin shoulder.

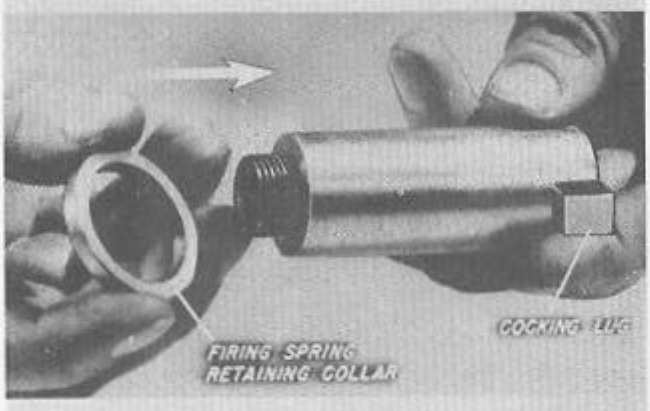




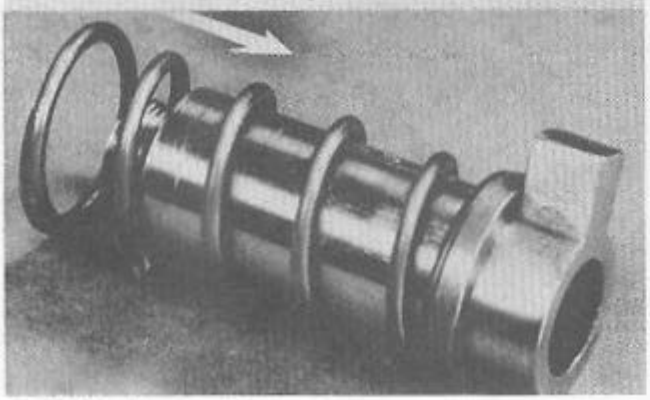
Then, mount the thrust bushing on the firing pin sleeve with its smooth face forward against the insulating washer. The other side of the thrust bushing has a recess to receive the firing pin casing, and this recess must face the after end of the firing pin.



To reassemble the firing plunger assembly, . . .

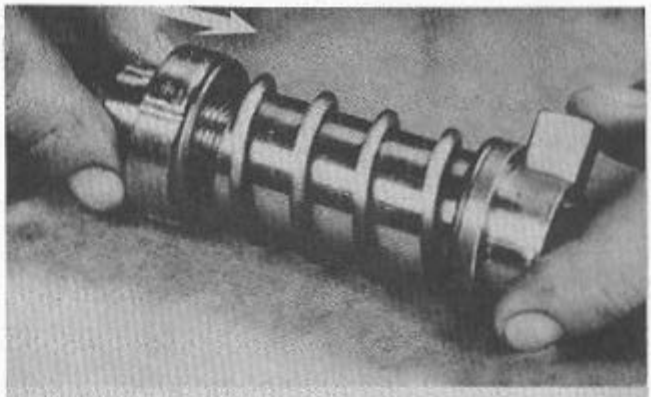


. . .place the firing spring retaining collar over the cocking sleeve, seating it against the cocking lug.

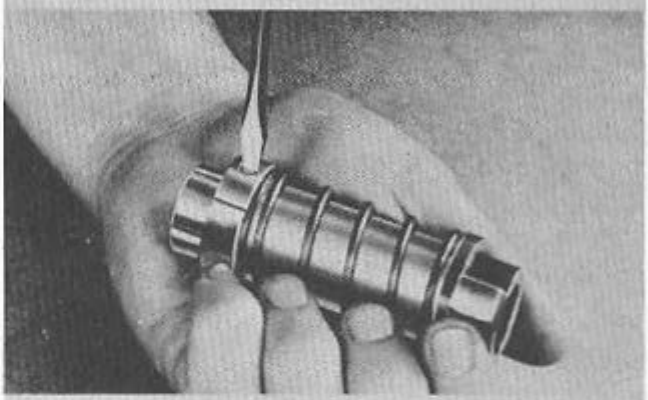


Then slide the firing spring over the cocking sleeve and seat it against the collar.

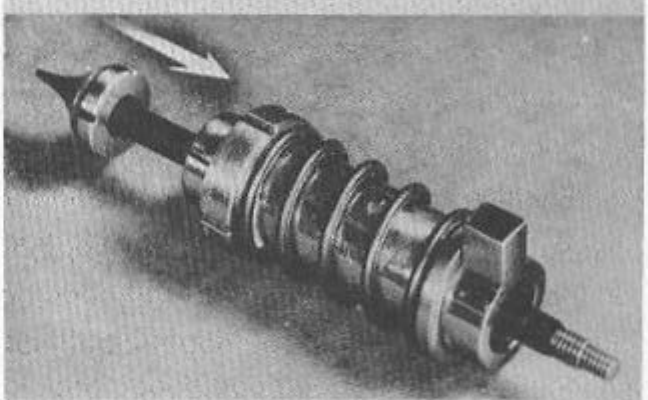
Screw the firing plunger onto the forward end of the cocking sleeve as far as it will go, compressing the firing spring.



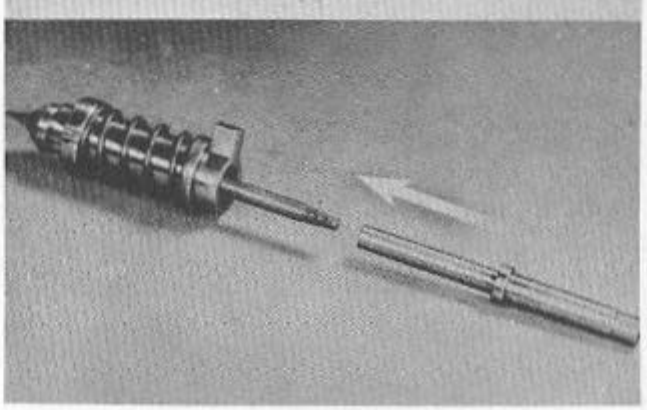
And secure it by tightening the setscrew on the firing plunger.

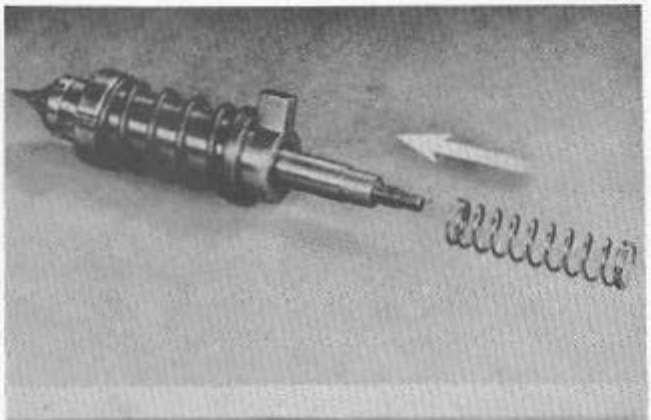


Now, to assemble the firing mechanism, insert the assembled firing pin through the firing plunger end of the assembly so that the thrust bushing bears against the firing plunger.

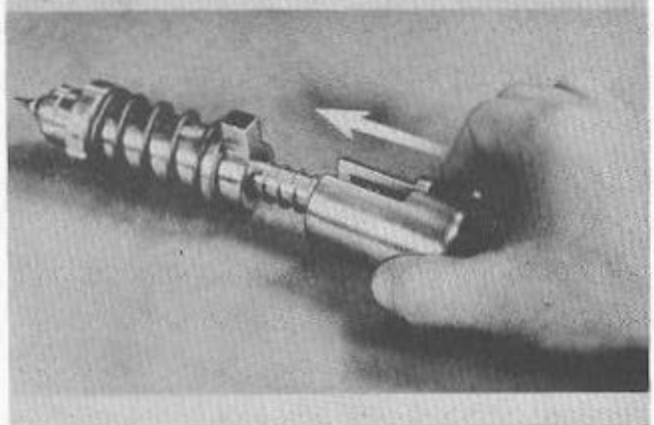


With the firing pin in place, slide the firing pin casing over the after end of the firing pin rod and into the cocking sleeve. Note that the small diameter end of the firing pin casing is forward.

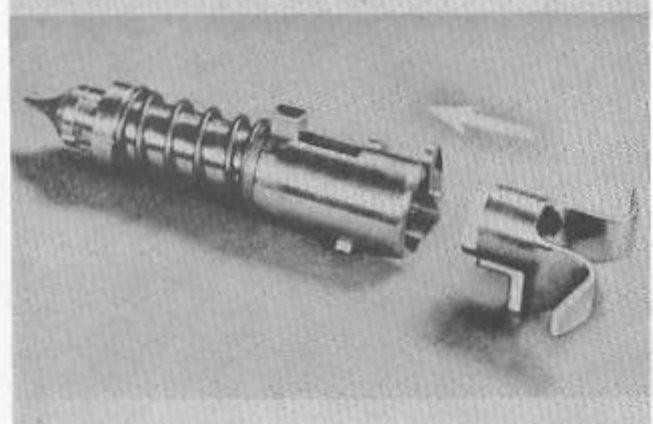




Then mount the contact spring over the firing pin casing.



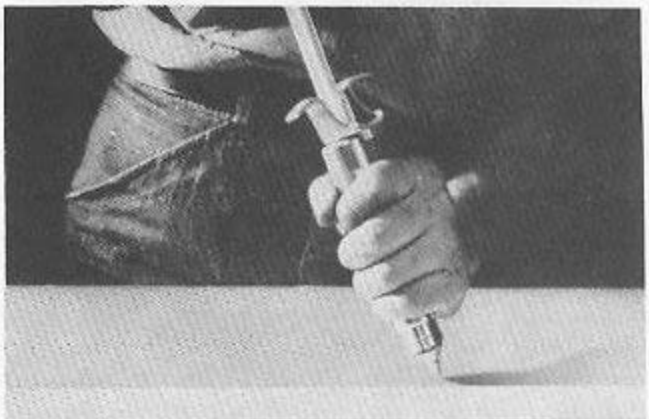
Slip the firing mechanism lock over the after end of the firing mechanism with its slotted end forward. The cocking sleeve lug fits into this slot.



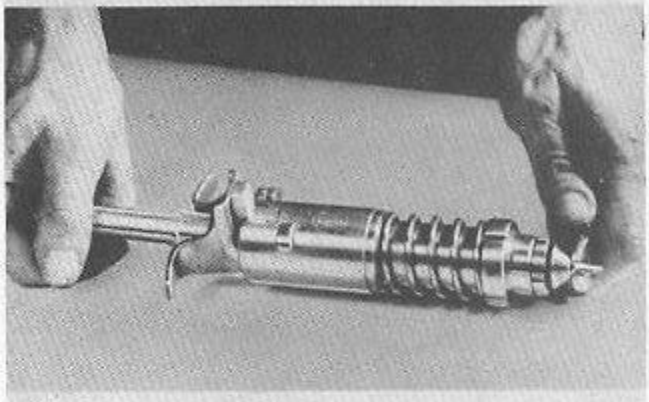
Then place the cocking handle over the after end of the firing pin rod and fit it into place in the firing mechanism lock.

To lock the parts together, the securing nut must be screwed on the end of the firing pin. Place the smooth face of the insulating collar against the cocking handle. The recess for the nut must face aft.

Screw on the securing nut with a socket wrench pressing down on the cocking handle, or firing mechanism lock, to compress the contact spring so that the securing nut can catch the threads on the after end of the firing pin rod.

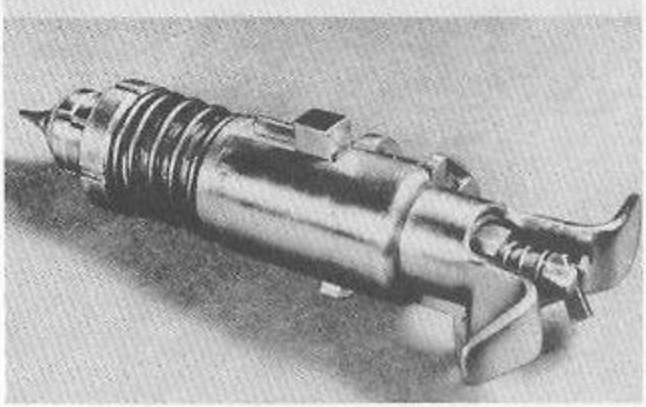


To keep the parts properly aligned, hold the firing pin with a wrench as you tighten the securing nut. The nut must be drawn up tight so that the firing mechanism will fit properly into its recess in the breech-plug.

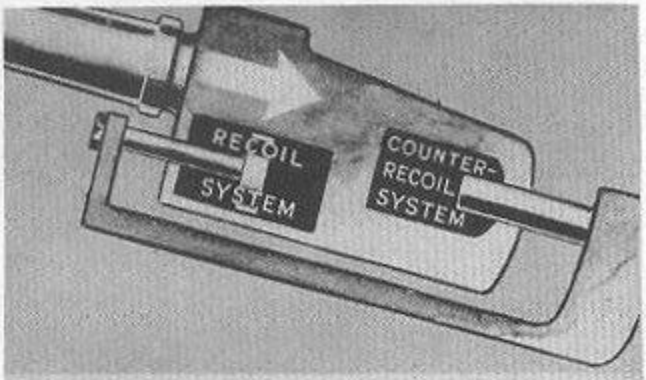


To complete the assembly, screw the firing terminal head onto the after end of the firing pin rod. The firing mechanism is now completely overhauled.

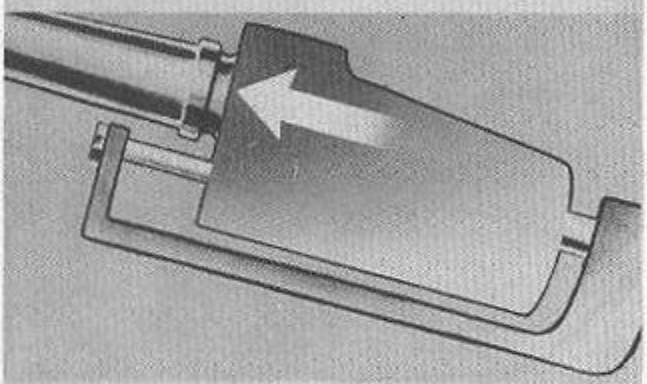
This little assembly does a mighty big and important job. Keeping it in top condition calls for almost daily disassembly and assembly. Get to know this procedure well so that you will be able to follow it rapidly at a time when the safety of your ship and its crew may depend on it.



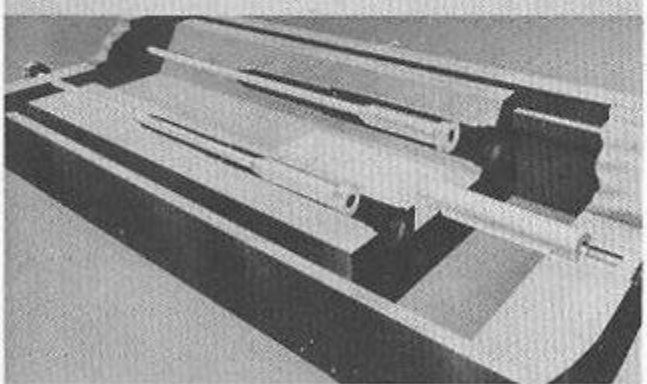
CHAPTER 13—DISASSEMBLY AND ASSEMBLY OF THE RECOIL AND COUNTERRECOIL SYSTEMS—PART ONE



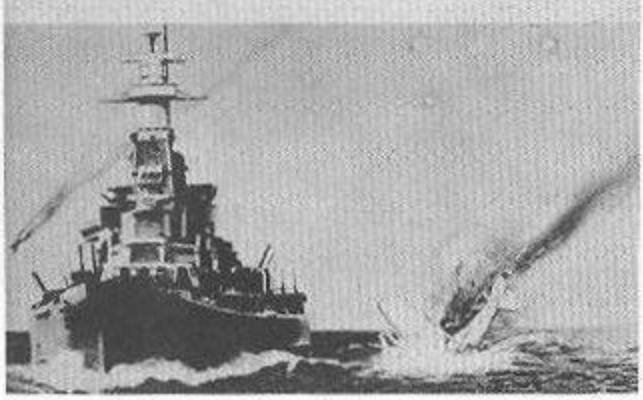
We have seen that the recoil and counterrecoil systems together absorb the tremendous force of the gun's recoil. . .



. . .and return the gun to battery quickly and smoothly so as to facilitate rapid loading and extracting and help the gun to maintain its high rate of fire.

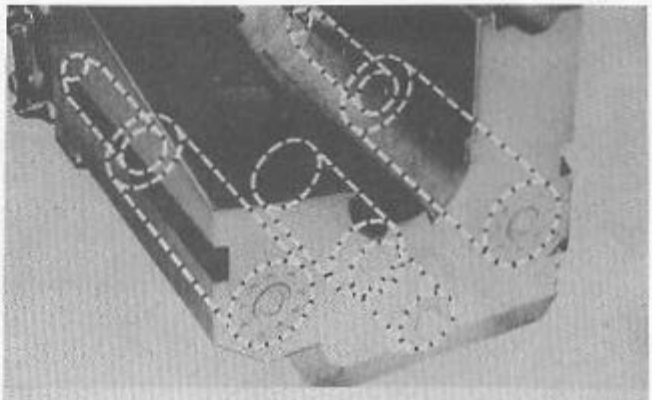


Both systems are filled with fluids which in operation are subject to extremely high pressures. The recoil system is filled with recoil liquid and the counterrecoil system with both air and oil. To prevent leakage of these fluids both systems are made to precision tolerances and are fitted with efficient packings.

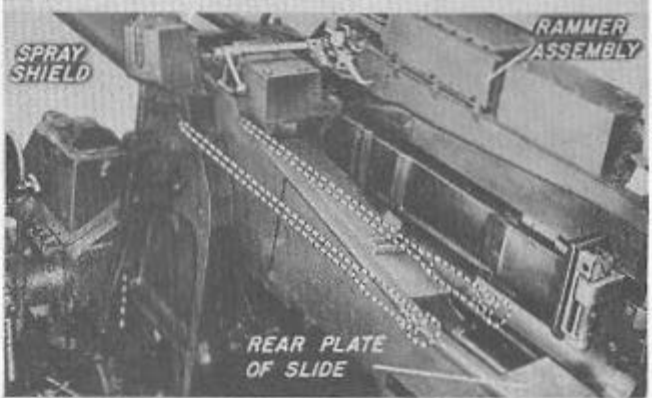


To enable the gun to take full advantage of its high rate of fire, both the recoil and the counterrecoil systems must be properly and painstakingly maintained.

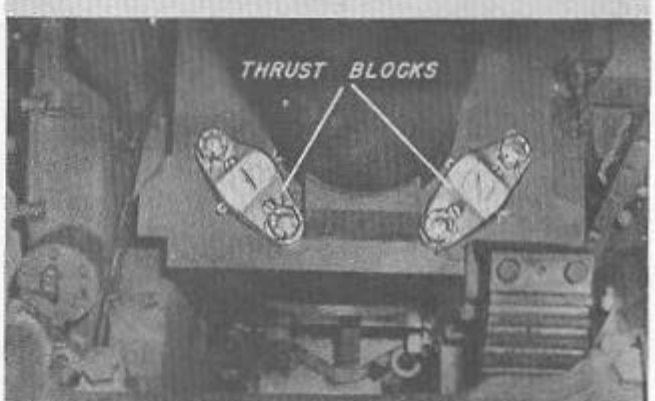
To renew worn packings or to clean out any foreign matter, burrs, or corrosion, it may be necessary to disassemble one or both of these systems.



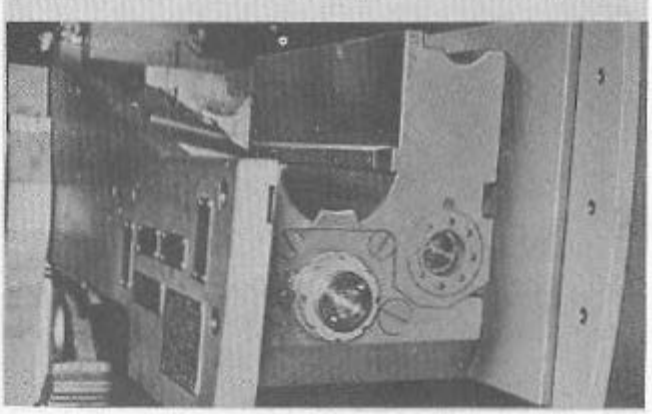
To make the recoil system accessible for dissassembly, it is first necessary to remove three parts of the gun; first, the front gun shield or spray shield if the gun is equipped with one; second, the rammer assembly; and third, the rear plate of the gun slide.

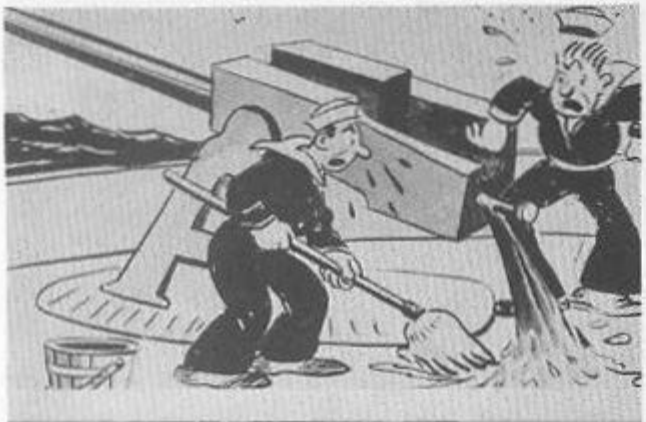


The spray shield must be removed to make accessible the thrust blocks securing the recoil piston to the front plate of the slide.

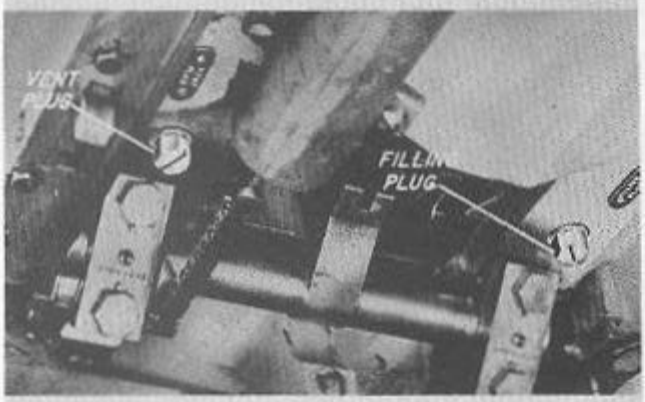


The rammer assembly is removed so that the rear plate of the slide can be lifted out to permit removal of the recoil pistons from the breech housing.

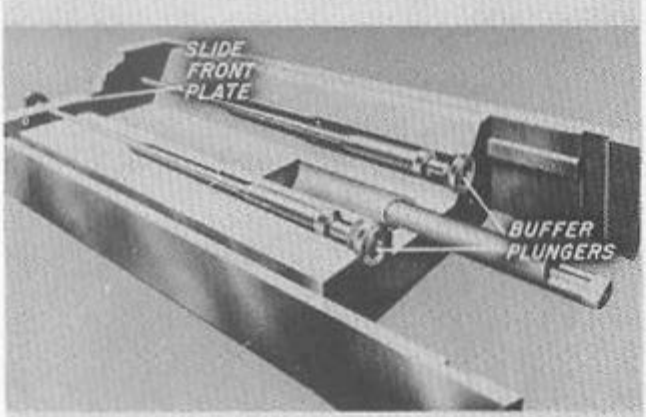




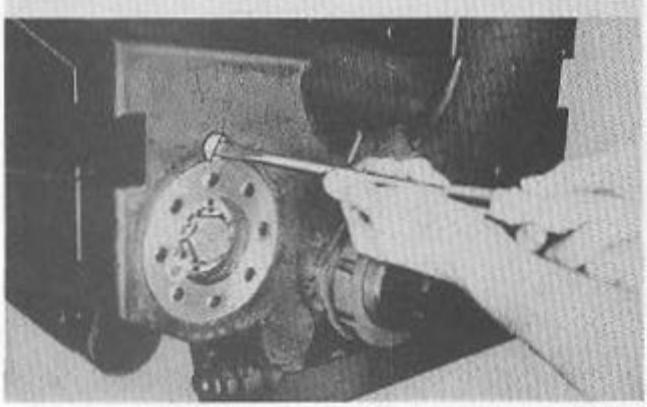
Since the recoil system is filled with liquid, it is a very good idea to drain the liquid before taking the system apart. Of course, if you prefer to save yourself this exercise. . .



. . .the first step in the disassembly of the recoil system is to remove the recoil liquid. To do this, set the gun at zero elevation or horizontal position and remove the recoil vent and filling plugs located on the underside of the housing and just aft of the operating shaft bearing caps. The recoil liquid will drain out freely.

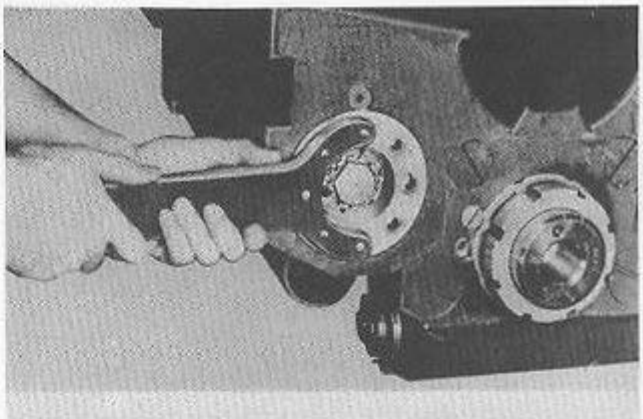


The system can be disassembled in two simple operations. First, the buffer plungers must be removed so that the pistons can be backed out of the cylinders; second, the piston rods must be detached from the slide front plate so that the pistons can be removed through the after part of the housing. To remove each buffer plunger. . .

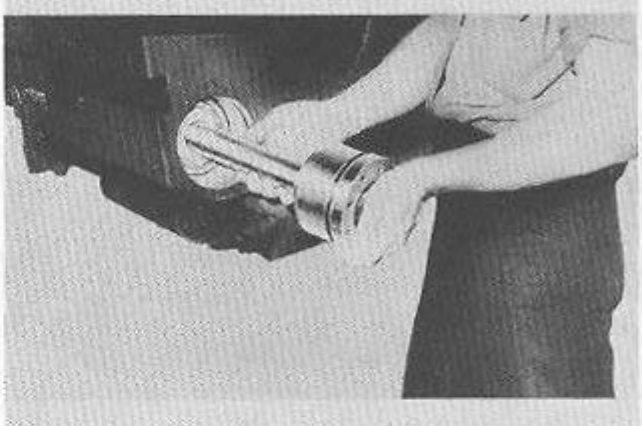


. . .first remove its keeper screw. . .

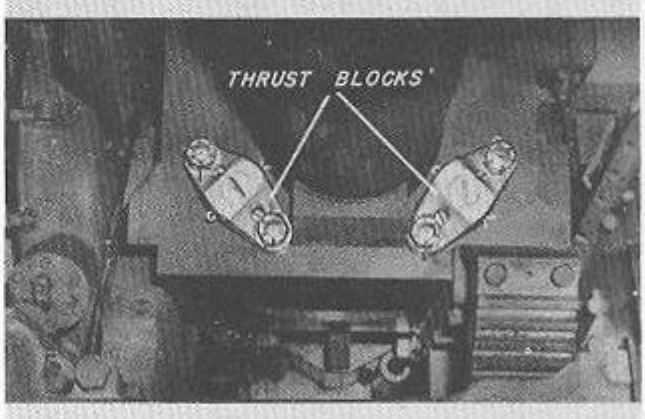
. . .and then unscrew the buffer plunger with a spanner wrench. . .



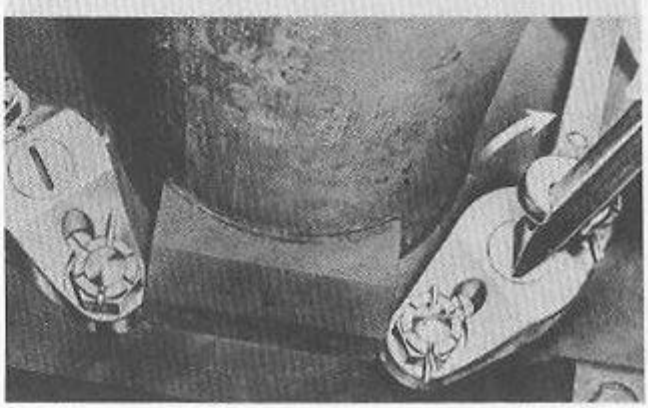
. . .and remove it from the gun. Do not tamper with the needle valve adjustment. It is set at the proving ground and should not be changed. Having removed the buffer plungers we are now ready to take out the pistons.

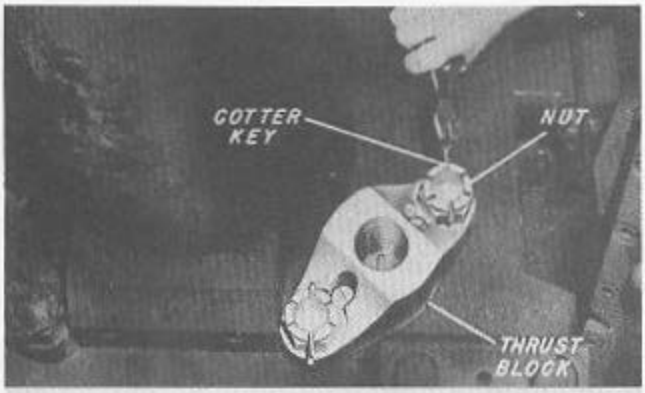


The forward ends of the recoil piston rods are mounted in thrust blocks on the slide front plate. To free each piston rod pull out the cotter key.

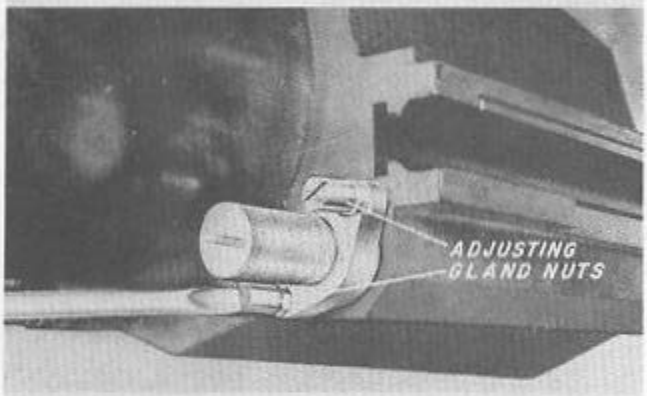


Rotate the piston rod clockwise until it has been backed in free of the threads in the thrust block.

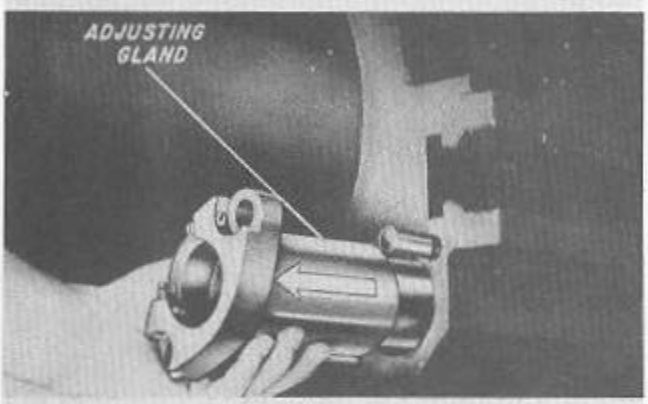




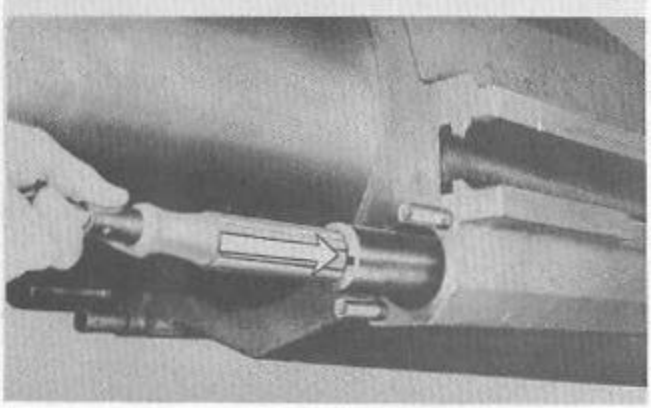
Remove the cotter keys and nuts securing the thrust block to the slide and remove the thrust block.



This enables us to reach the adjusting gland nuts and to take off the gland.



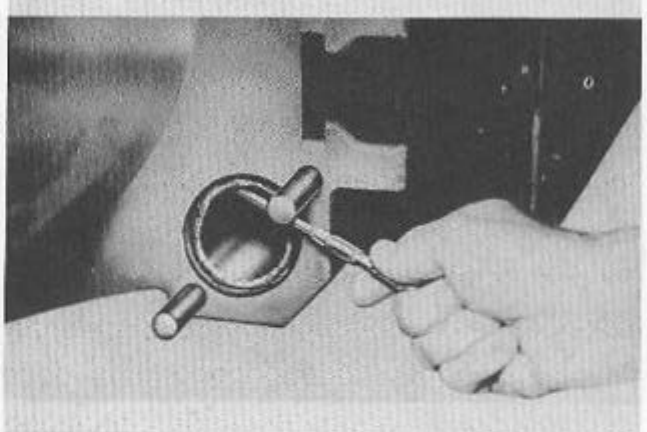
It's withdrawn over the end of the recoil piston rod.



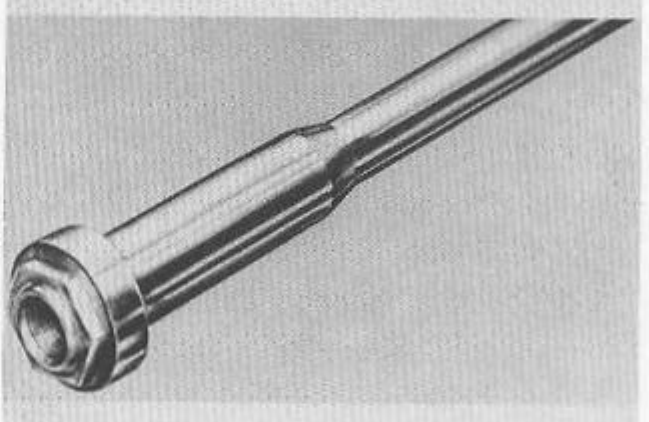
With the handle of a screwdriver, push the recoil piston rod aft. . .

. . .until the piston can be grasped and pulled out through the after end of the housing.

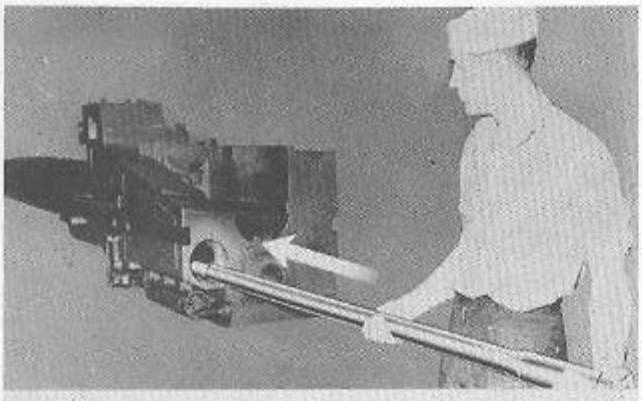
Then remove the graphited-flax packing rings from the forward end of the recoil cylinder.



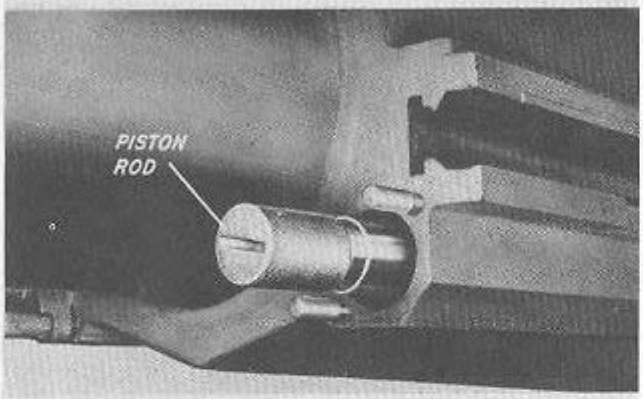
Clean the recoil piston and inspect it carefully for burrs, dirt, or corrosion.



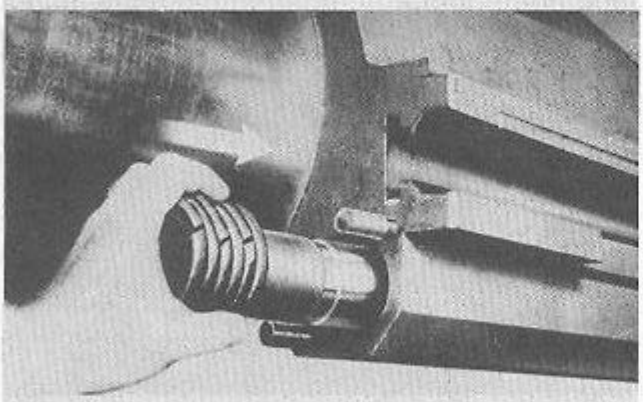
Clean and inspect the recoil cylinder, looking for sediment in the throttling grooves.



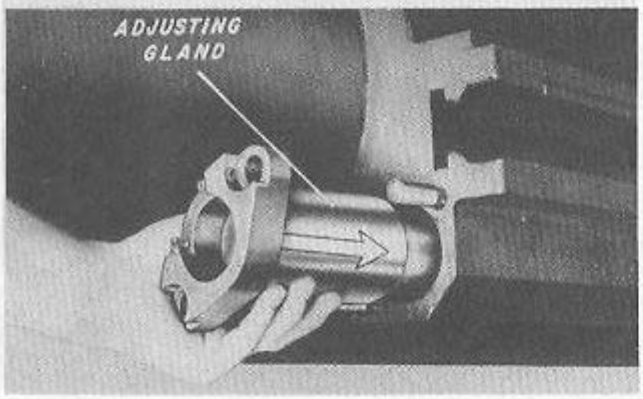
After the parts have been thoroughly checked and cleaned, the recoil mechanism is assembled. First, insert the recoil piston rod into the recoil cylinder and push it forward. . .



. . .until the threaded end of the piston rod projects beyond the forward end of the breech housing.

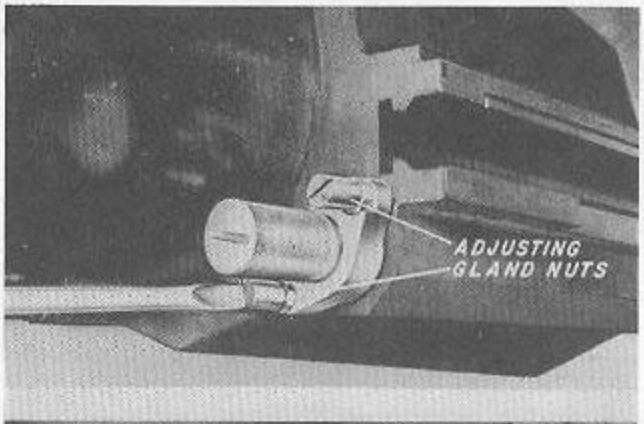


Now, to make sure leakage will be prevented, carefully insert six new graphited-flax packing rings. Their split ends should be alternated.

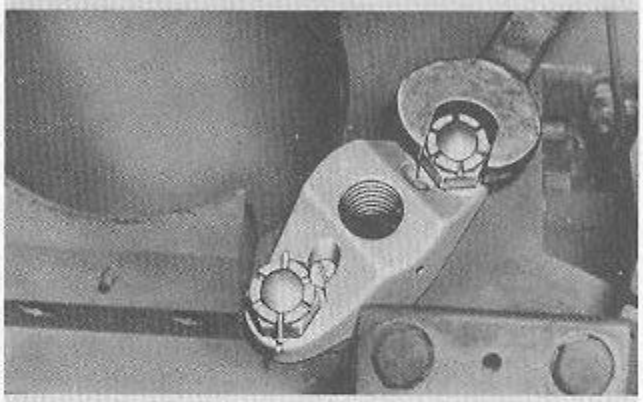


The packings are secured by the adjusting gland. Slide this gland over the forward end of the recoil piston rod. . .

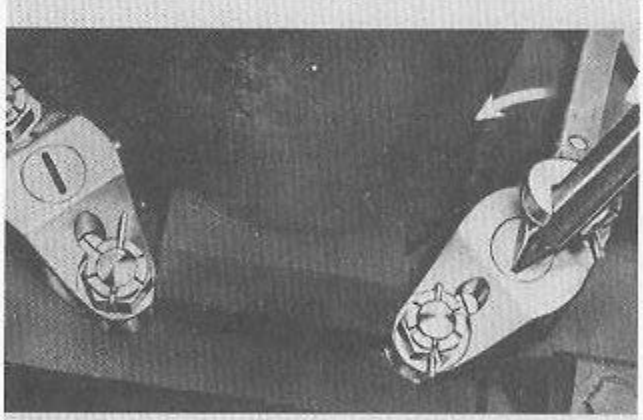
. . .and hold it in place with the adjusting gland nuts.



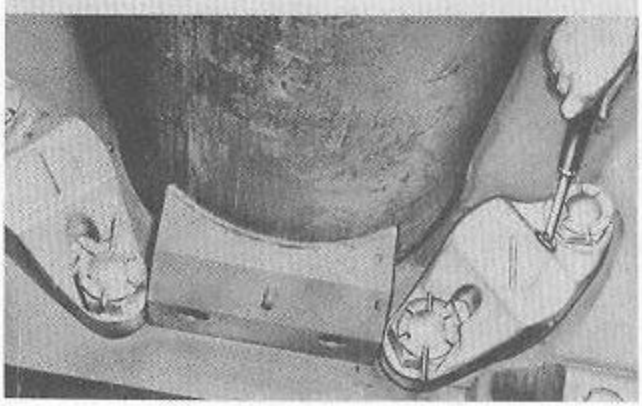
Then mount the thrust blocks on the forward end of the slide over the adjusting gland. Lock each nut with its cotter key.

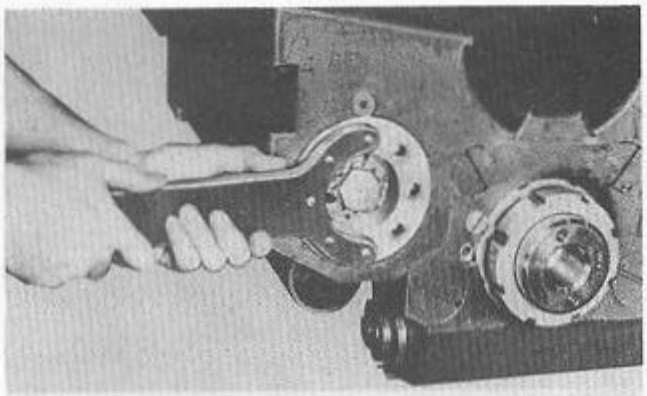


To secure the piston to the front plate of the slide, rotate the forward end of the piston counterclockwise until the piston rod threads catch in the thrust block. Screw the piston all the way forward in the thrust block securing it with its cotter key.

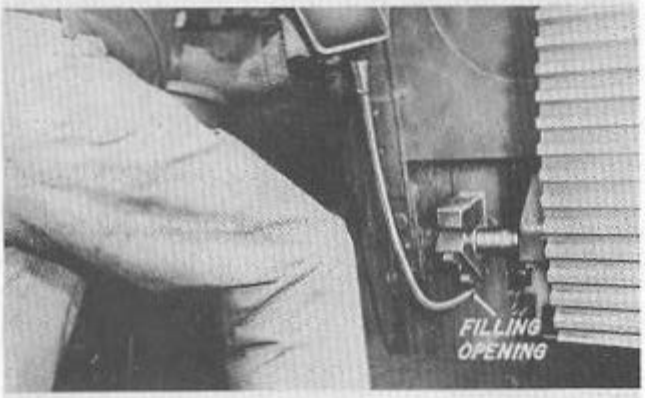


With the piston rod in place, tighten the two adjusting gland nuts uniformly to assure proper seating of the packings.

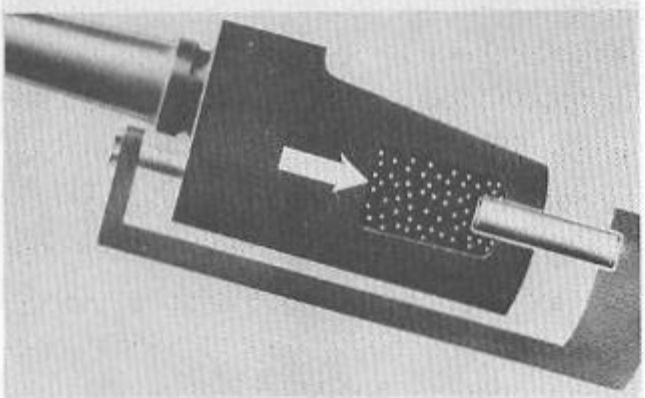




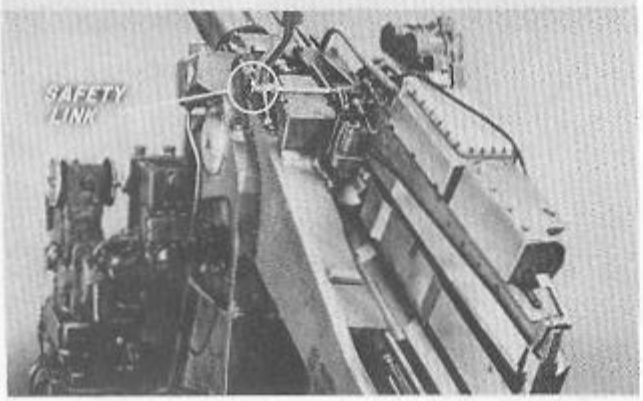
Next assemble the buffer cylinder in the after end of the recoil cylinder. When it is tight, replace the keeper screw. Note: The copper gasket for the buffer cylinder should be either annealed or renewed before reinstalling.



Finally, elevate the gun to 65° degrees and refill the recoil system. When it has been filled and vented, replace the vent plug and filling plug. This completes the assembly of the recoil system.

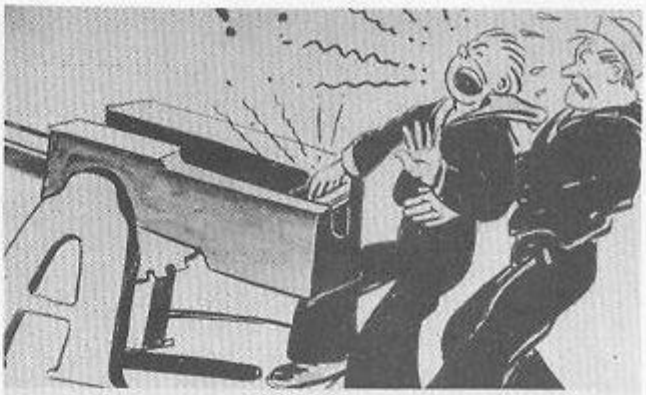


You will remember that the compressed air in the counterrecoil air chamber is subjected to constantly changing and extremely high pressures. If this air pressure drops consistently from day to day, leakage is indicated and the counterrecoil system will have to be disassembled.

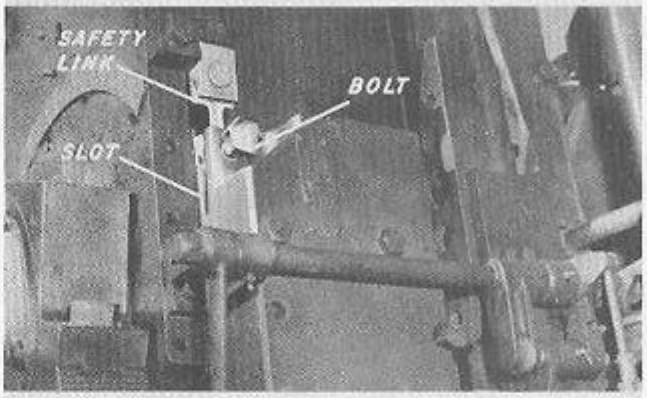


The first step in disassembly of any part of the counterrecoil system is to secure the safety link located on the top left-hand side of the slide. The purpose of this safety link. . .

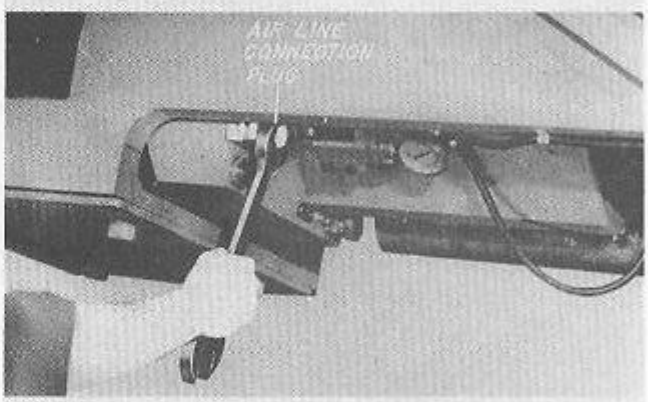
. . .is to prevent the housing from crashing against the slide rear plate when the air is bled out of the counterrecoil air chamber.



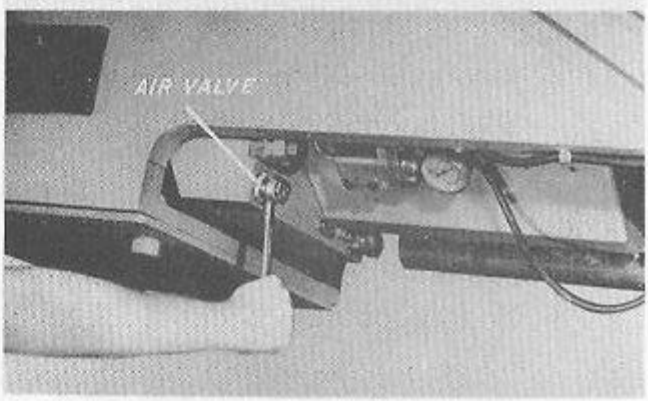
To secure the safety link, slide it into the slot in the housing and lock it in place with its bolt.

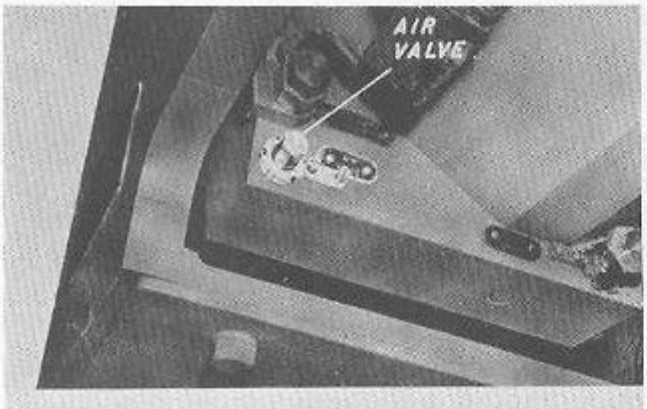


Then with the air valve closed, unscrew the air line connection plug which is located underneath the after end of the housing.



Then open the air valve sufficiently to bleed out the air. The plug is provided with a bleeder hole so that the air can be bled slowly out of the counterrecoil air chamber.

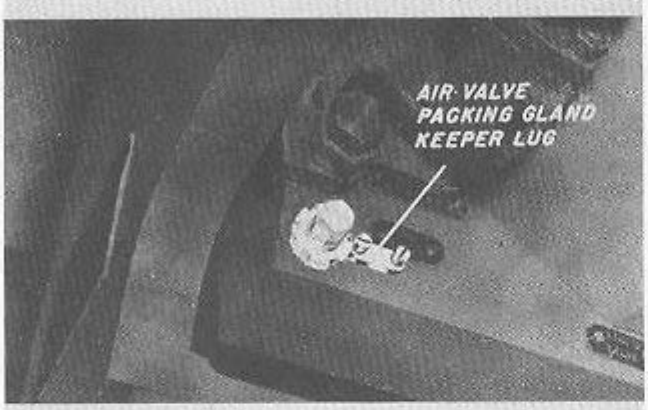




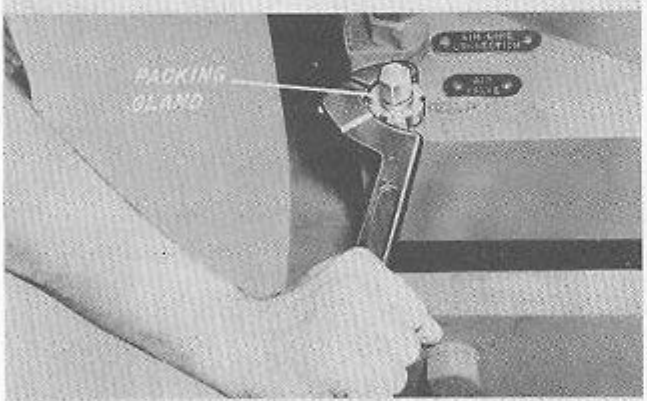
Air leakage can occur in three places in the counterrecoil system:

1. At the air valve.
2. At the air line connection.
3. In the counterrecoil plunger packing.

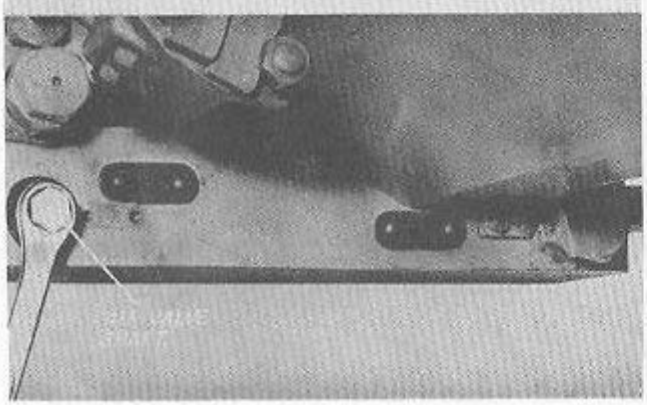
These are in addition to possible leakages in the differential system which we will consider later. The first place to look for an air leak is at the air valve. To disassemble the valve. . .



. . .remove the air valve packing gland keeper lug.

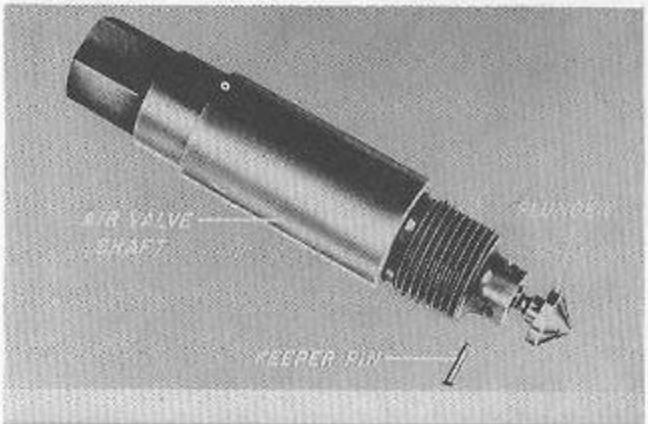


The packing gland around the air valve is removed with a spanner wrench.

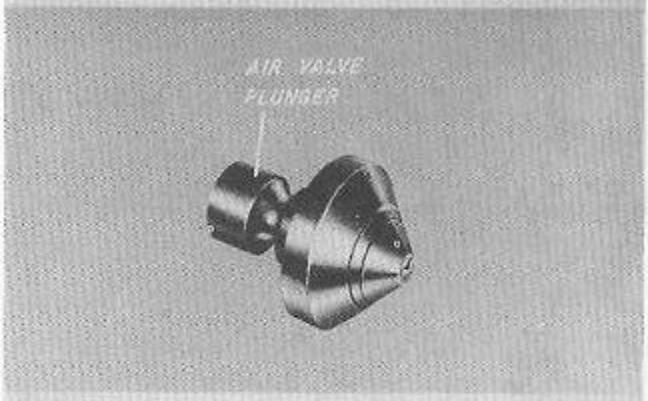


Then unscrew and remove the air valve shaft.

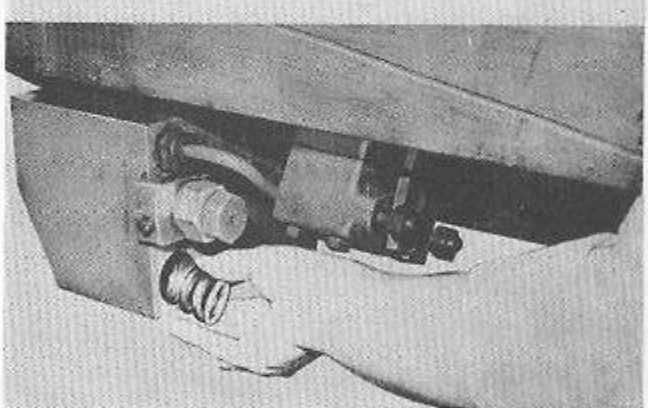
To remove the plunger on the end of the air valve shaft, drive out the keeper pin and pull the plunger out.



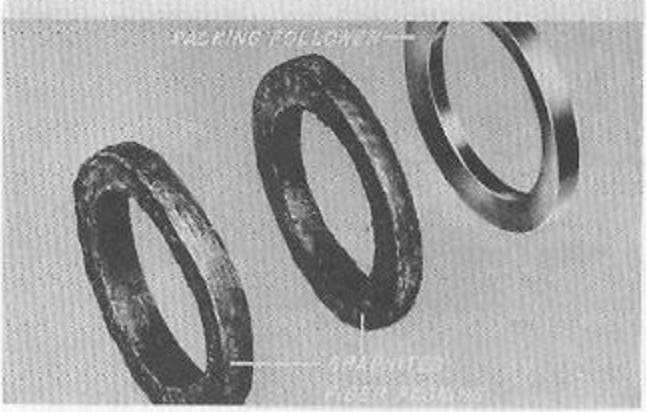
Inspect the air valve plunger for dirt and wear. If it is worn, replace it with a new or reground plunger.

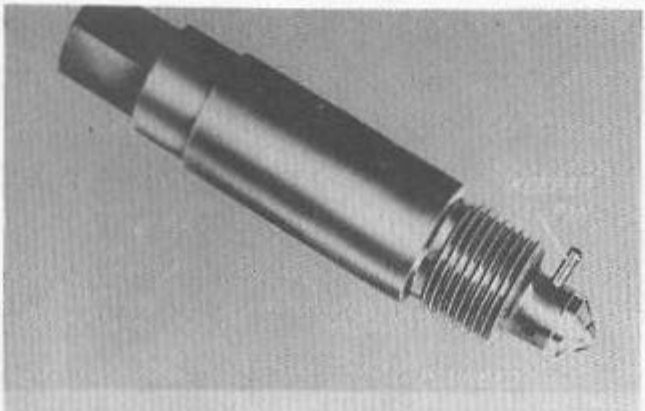


Remove the packing follower and graphited-flax packing located part way inside the air valve opening.

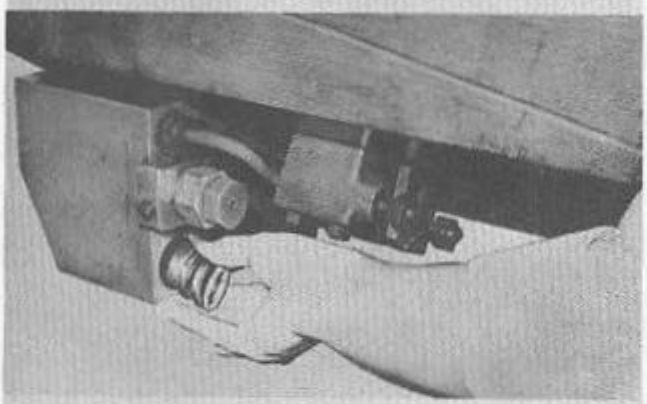


Inspect the packing follower and the graphited fiber packing. Replace with new packing if required.

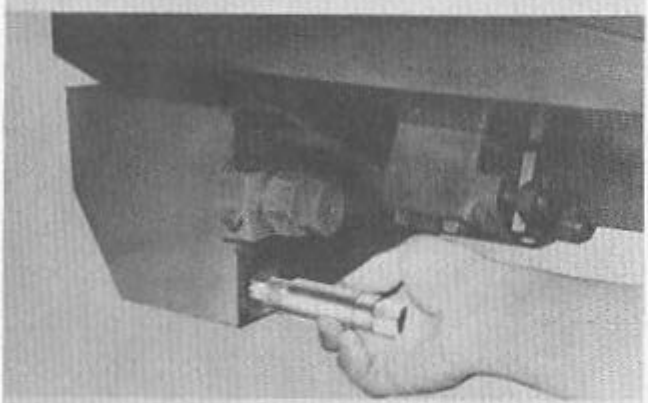




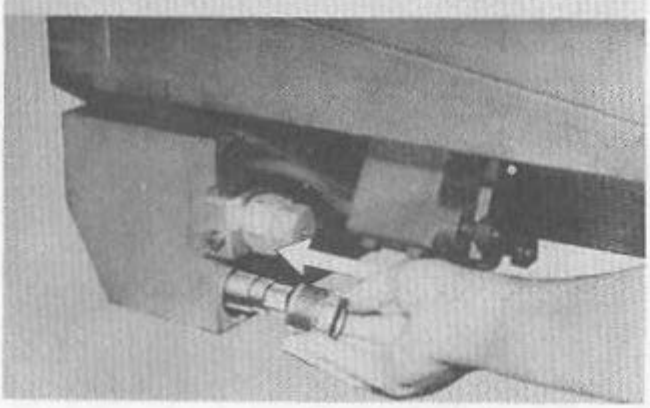
To assemble the air valve, insert the plunger in the end of the air valve shaft and lock it in place with a keeper pin.



Next replace the gland packing and packing follower inside the air valve recess. . .

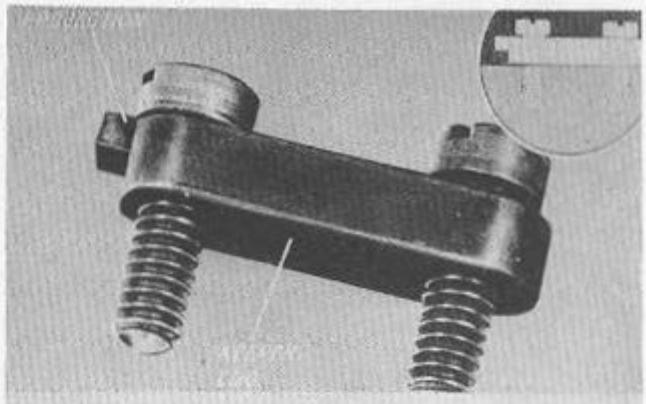


. . .and screw in the air valve.

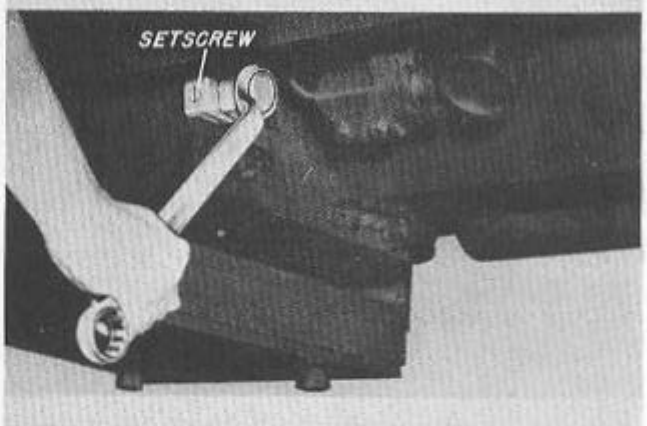


Slip the air valve packing gland over the end of the air valve and screw it in place with a spanner wrench. Do not set it up too tightly. One turn after the face of the packing gland touches the packing follower is sufficient.

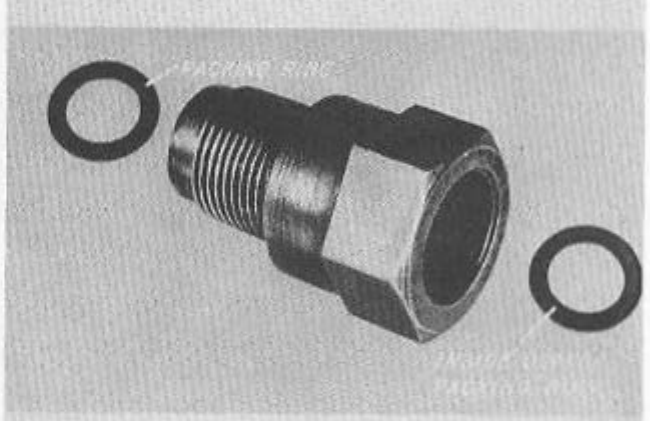
Note the projection on the end of the keeper lug for the air valve packing gland. It should be displaced outwardly from the gun surface when assembled as shown in the insert so that it will fit into one of the slots in the gland nut and thus lock it in place.



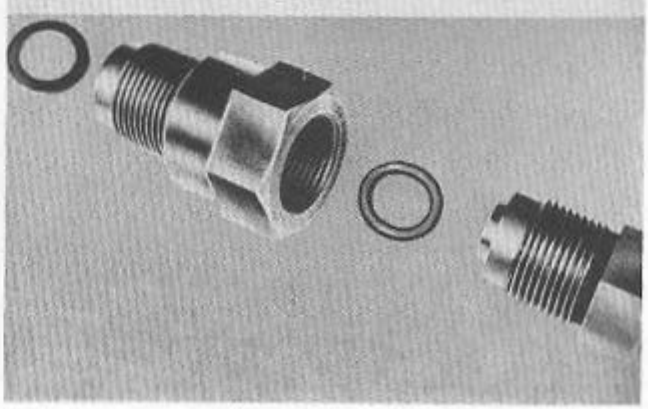
The second place to look for an air leak in the counterrecoil system is at the air line connection. To take this out, loosen the setscrew and remove the airline connection.

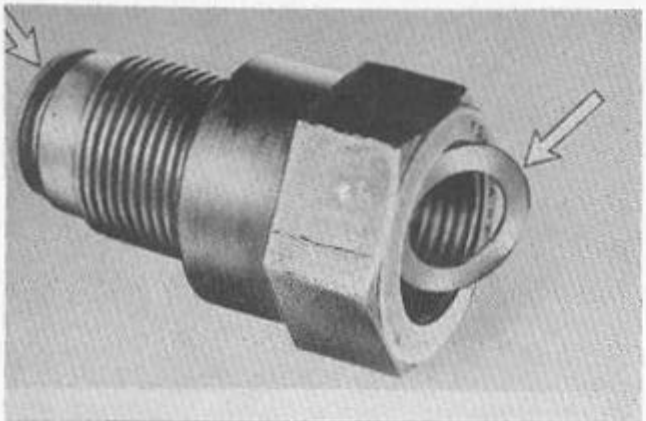


Remove the copper packing ring which remained inside the housing when you removed the air line connection and also the identical copper packing ring located inside the air line connection itself.



Clean and inspect all parts of the air line connection assembly, using a wire brush and metal polish on the two copper packing rings if necessary.

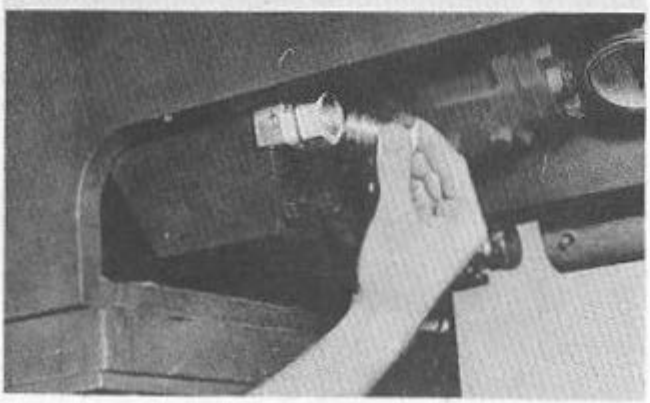




To reassemble this unit, anneal and replace the copper packing rings.

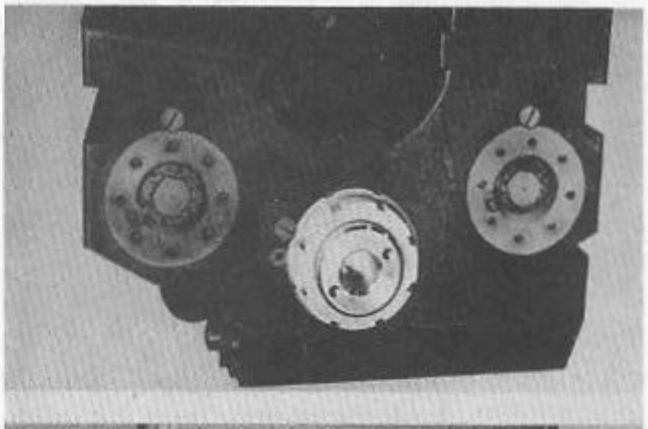
Remember that this air line connection lock came off when we removed the air line connection. Hold it in place. . .

. . .and screw in the air line connection. Take up on the set screw on the lock after the air line connection is tight.

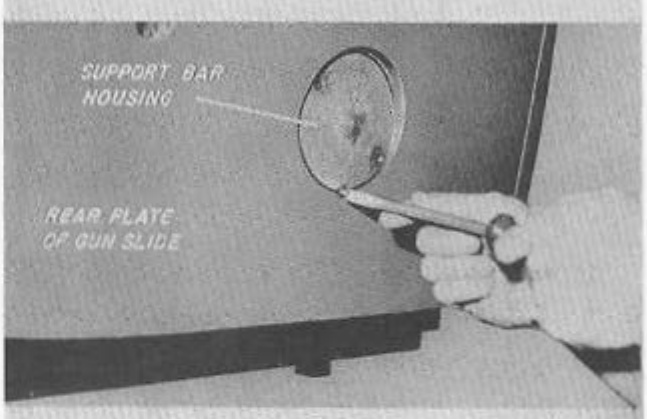


Finally, screw the plug into the air line connection.

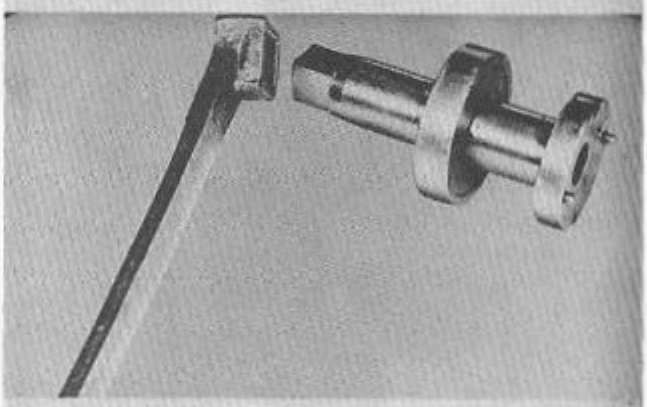
The third place to look for a leak is in the counterrecoil plunger packing rings. Leakage here is usually evidenced by loss of liquid and protrusion of the differential piston. To get at this packing the counterrecoil plunger must be removed.



First, take out the keeper screw for the support bar housing in the rear plate of the gun slide.

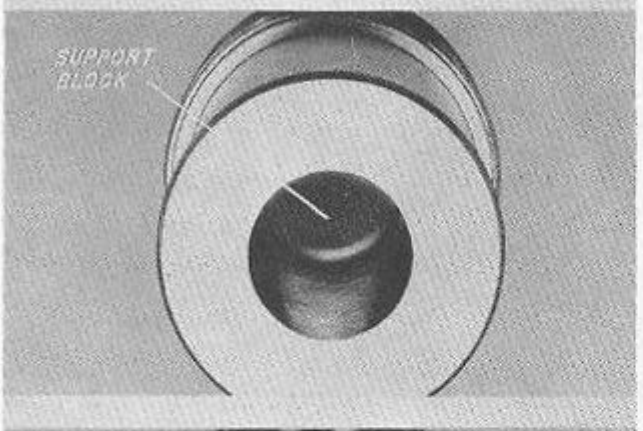


Then using this two-piece spanner wrench. . .

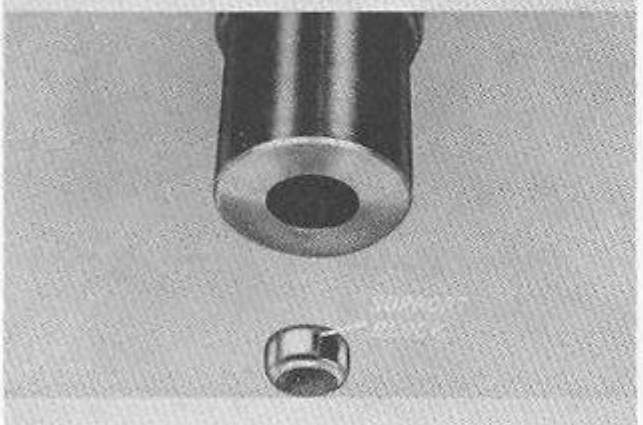


. . .unscrew the support bar housing.

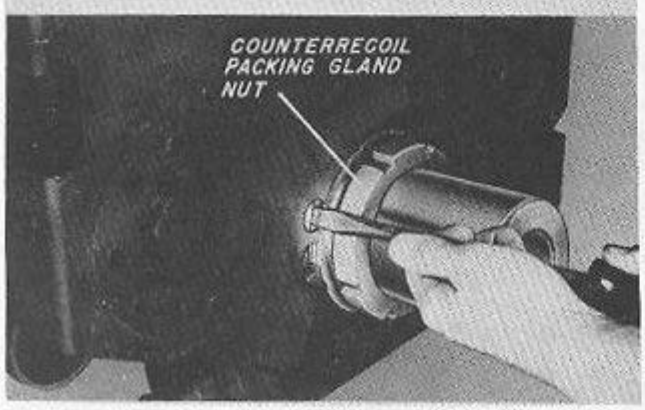
The support bar will come out with the housing.



The support block located in the recess in the support bar housing is sometimes difficult to remove because it is packed in grease. The grease may be dissolved by pouring diesel fuel oil or kerosene into the support bar housing and allowing it to stand for a while.

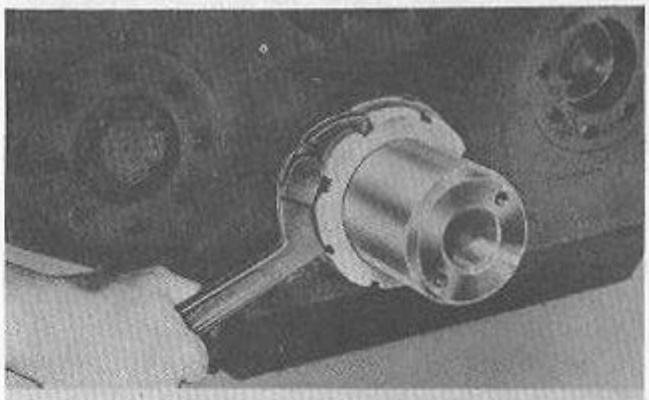


You then should be able to remove the support block by tipping the support bar housing up on end.

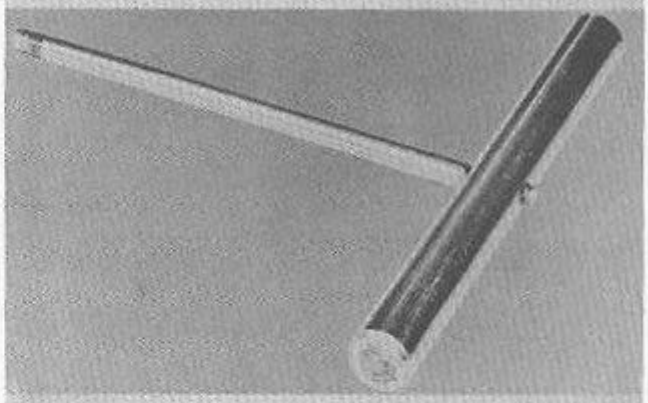


With the support bar housing removed from the slide, we now can start to take out the counterrecoil plunger. First remove the setscrew from the counterrecoil packing gland nut. . .

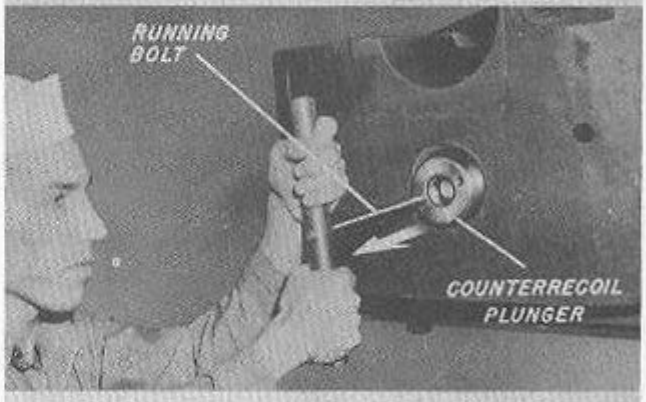
. . .and unscrew the adjusting nut.



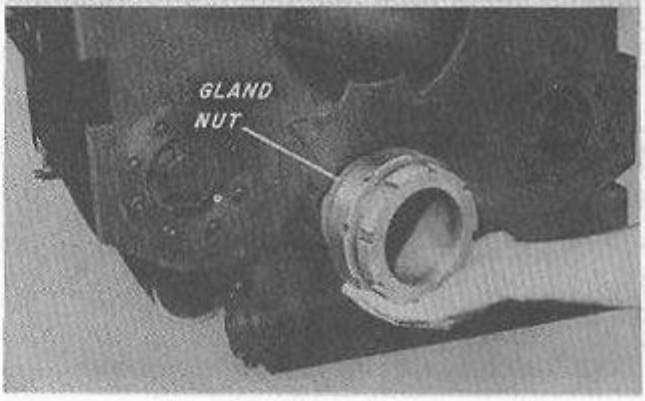
To pull out the plunger use this running bolt.

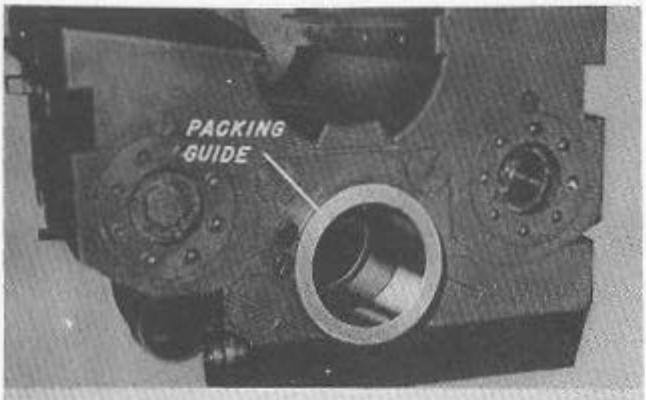


The running bolt is screwed into one of the small holes in the counterrecoil plunger. Pull out the plunger.

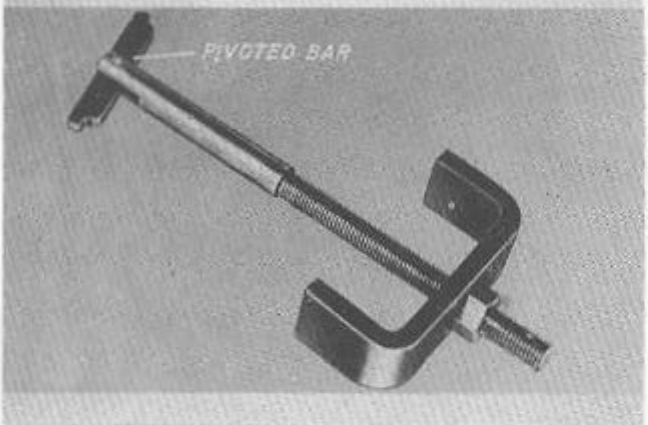


Unscrew and remove the packing gland nut. . .

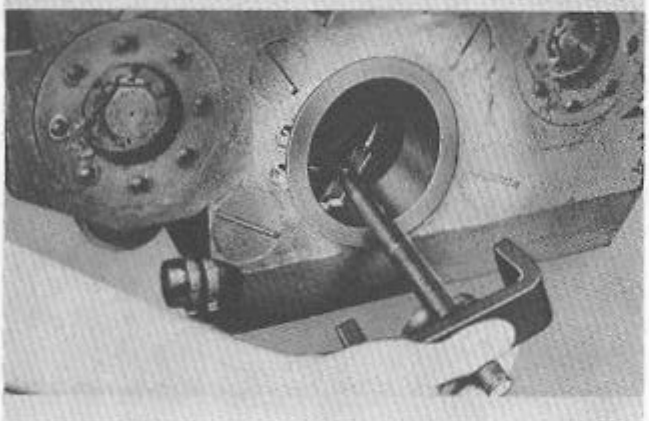




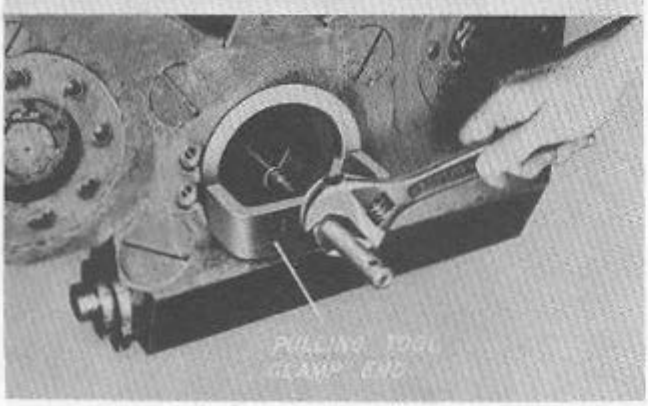
. . .and replace it with a packing guide. The purpose of this guide is to prevent scoring the packings as they are removed.



This tool is used to pull out the counterrecoil plunger packing assembly. You will note that a bar is pivoted at one end of this tool.

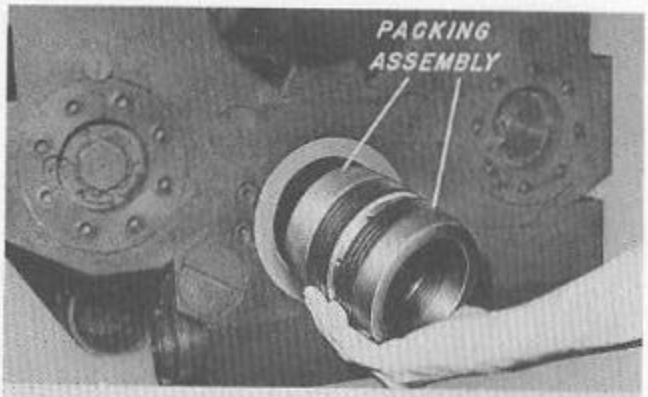


Insert the pivoted bar of the pulling tool inside the chamber. Then turn the bar crosswise to hook it behind the packing ring assembly.

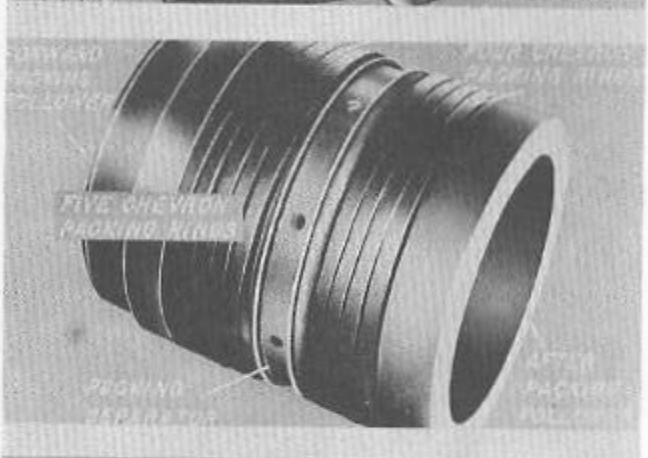


Now with the clamp end of the pulling tool braced against the end of the packing guide take up on its nut. . .

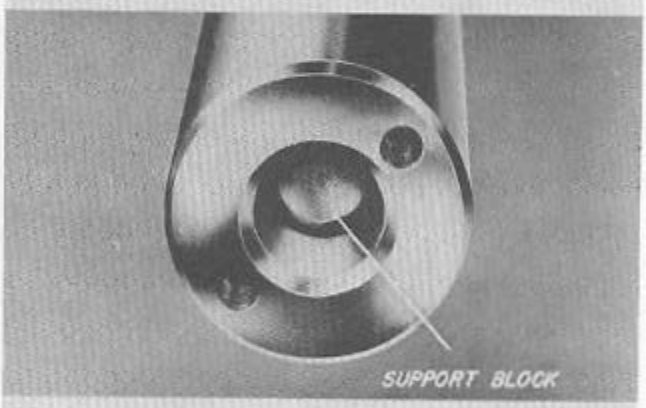
. . .to pull the packing assembly out. Remove the tool and lift the packing assembly out of the housing.



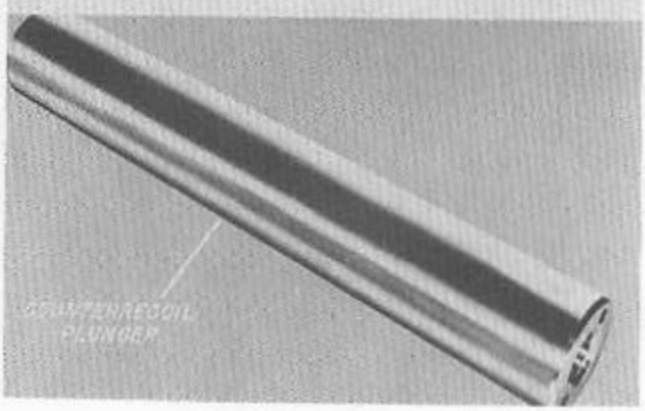
The packing assembly consists of a forward packing follower, five chevron packing rings, a packing separator, four more chevron packing rings, and finally, an after packing follower. Clean and inspect all the parts carefully. If the packing rings are worn or damaged, replace them with new rings which have been soaked in neat's foot oil at least over night and preferably for about 3 days.

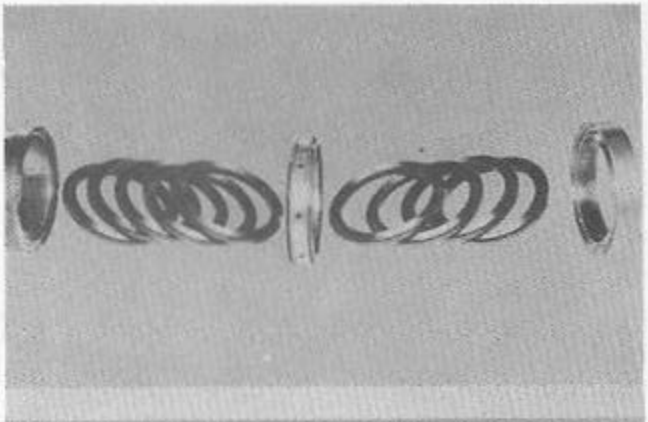


Remove the second support block from the end of the counterrecoil plunger the same way that the other support block was removed from the support bar housing.



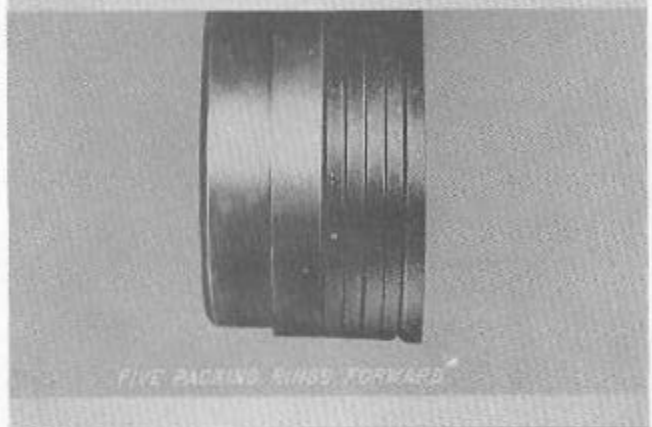
Also clean and inspect the counterrecoil plunger and the interior of the counterrecoil chamber. Check particularly for evidence of oil in the chamber which will indicate faulty packings.



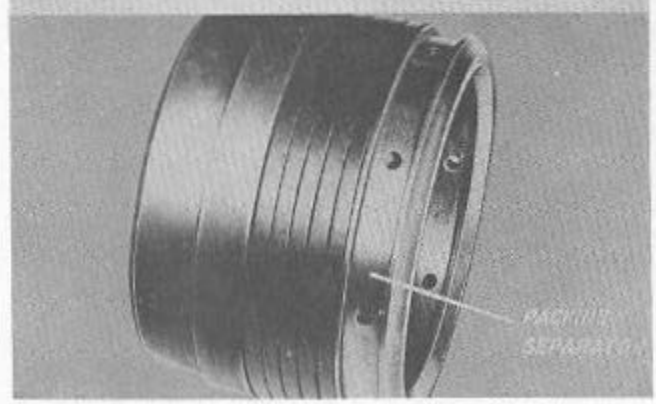


When faulty packings have been replaced, assemble the packing unit parts in proper order.

The larger packing follower with a shoulder is the forward packing follower. Note the rounded groove cut to receive the convex face of the first chevron packing.

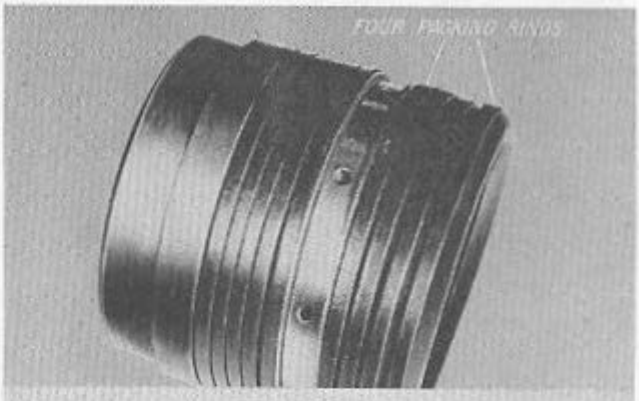


Assemble five packing rings against the forward packing follower.

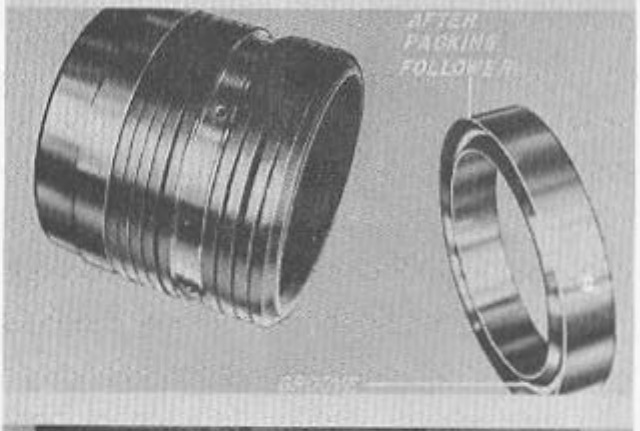


Then add the packing separator. It is reversible and either side will fit the concave face of the packing ring.

Then add the other four packing rings with their concave faces against the packing separator.

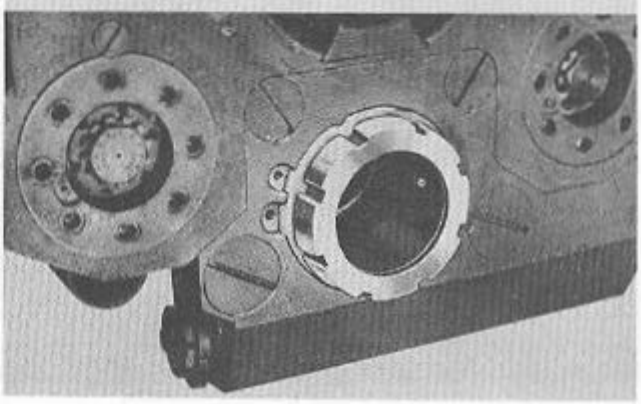


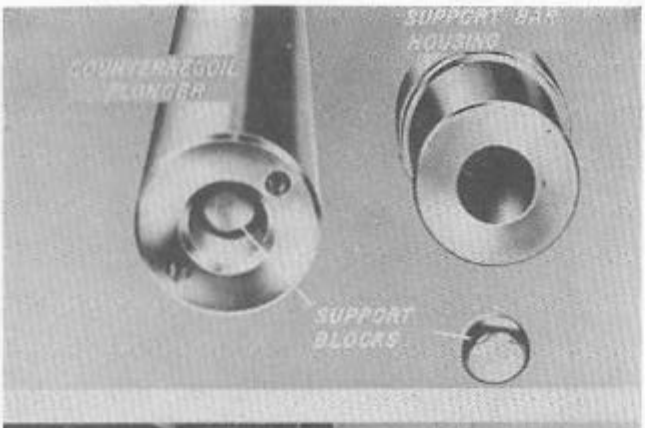
Finally add the after packing follower. Be sure that its grooved face fits up against the convex face of the last packing ring.



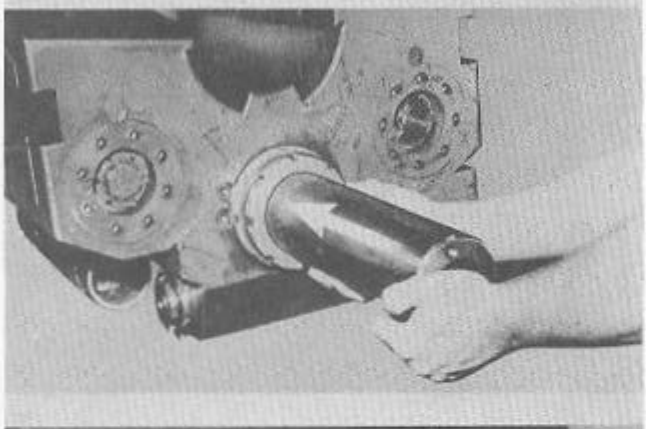
Now insert the packing assembly through the packing guide until it bears against the shoulder in the counterrecoil chamber. After the packing assembly is in place remove the packing guide.

Screw in the adjusting nut only handtight. If you tighten the adjustment nut too much the chevron packing rings will be expanded and will prevent the counterrecoil plunger from passing through.

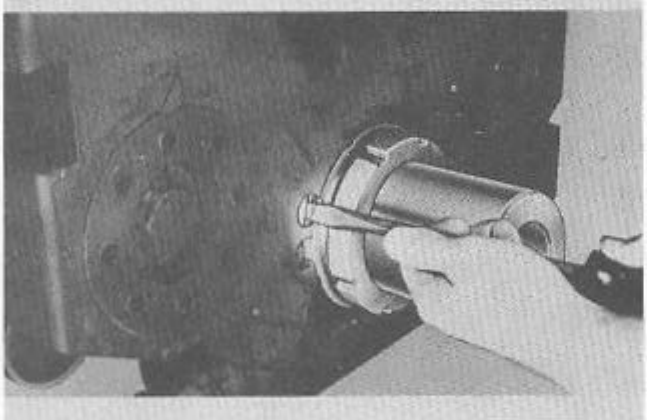




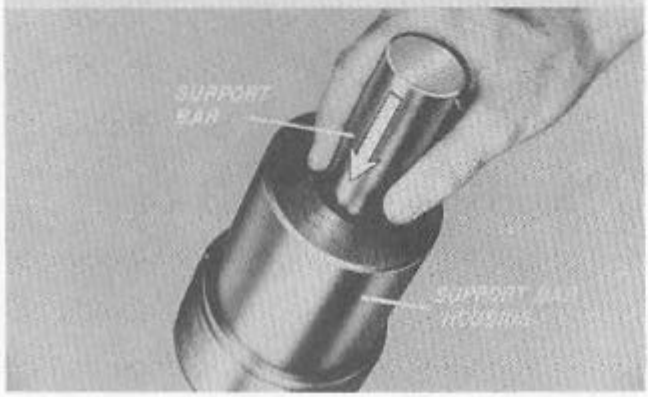
Replace one of the two identical support blocks inside the after end of the counterrecoil plunger and the other in the support bar housing.



Insert the counterrecoil plunger through the gland nut.

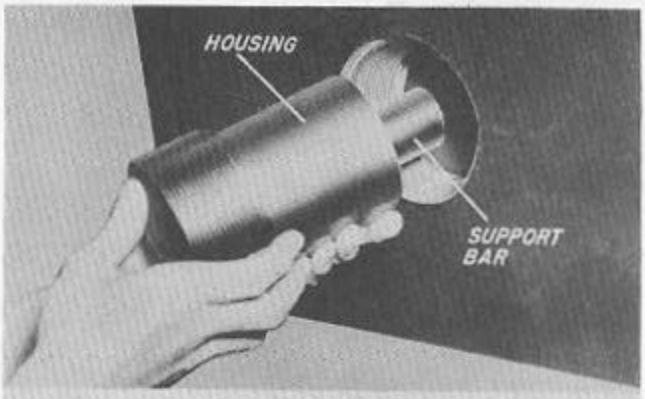


Replace the keeper screw to lock the gland nut.

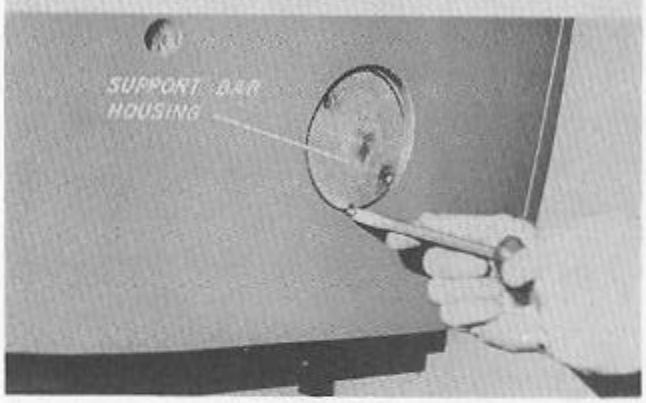


Insert the support bar in the support bar housing. . .

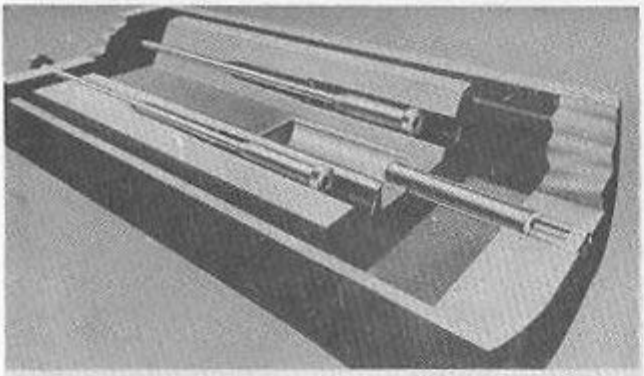
. . .and mount the support bar housing in the rear plate of the slide, seating the support bar in the end of the counterrecoil plunger.



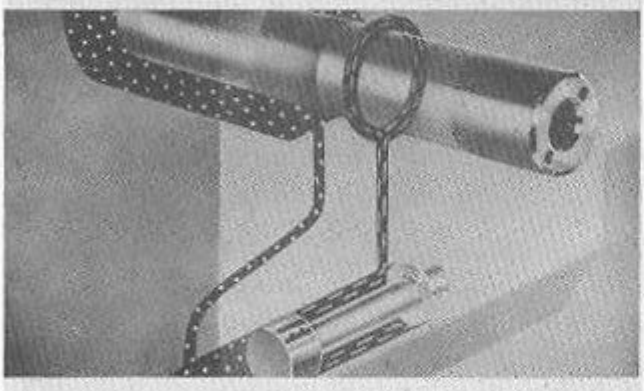
A mixture of white lead and tallow should be spread over the threads of the support bar housing before it is screwed in to protect the threads against rust.



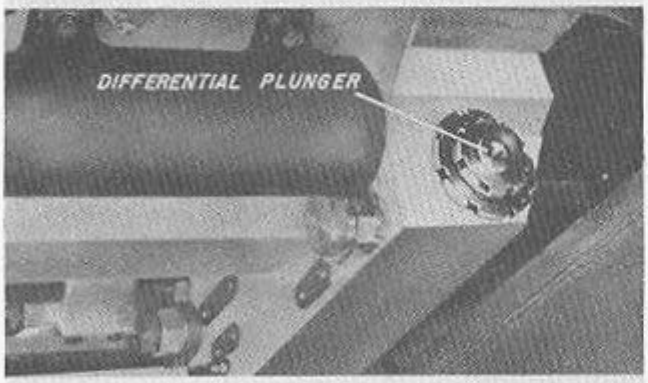
CHAPTER 14—DISASSEMBLY AND ASSEMBLY OF THE RECOIL AND COUNTERRECOIL SYSTEMS—PART TWO



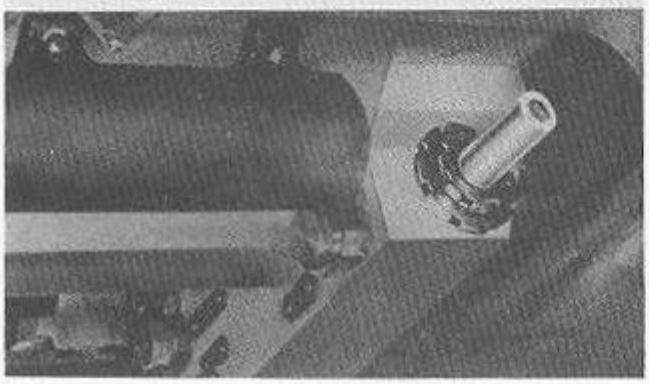
We have seen how most of the leakage in the recoil and counterrecoil systems can be corrected. However, there is one further place in the counterrecoil system where dangerous leakage may occur, . . .



. . .the differential system. The purpose of this system, as we already know, is to provide a means for preventing the high-pressure air in the counterrecoil chamber from leaking out around the counterrecoil plunger. This is done by the oil seal packing assembly which we studied in chapter 5. The differential system maintains the oil in the seal at a pressure that is always greater than that of the air in the chamber, so that, if there are leaks, it will be the oil that leaks into the air chamber, and the air will not leak out.

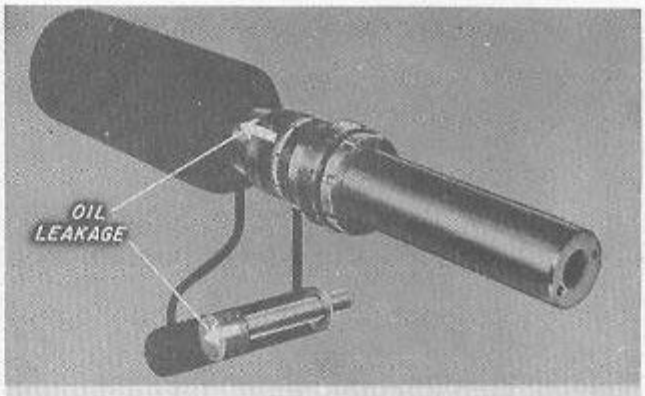


The position of the differential piston rod (or differential plunger as it is often called), indicates the extent of the oil supply within the cylinder. If the plunger is flush with the packing gland nut through which it passes, the system is full of oil. As this oil supply diminishes. . .

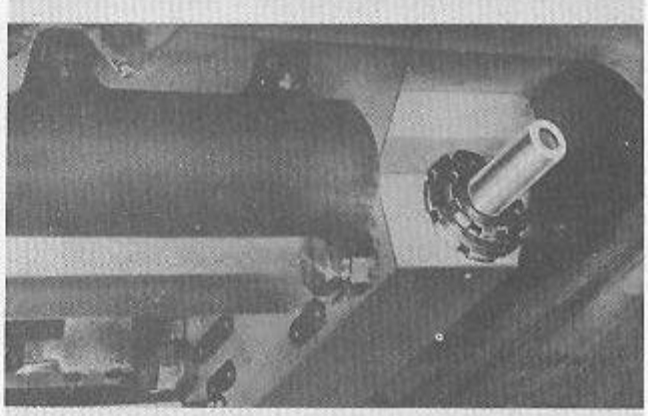


. . .the piston moves out. If the piston moves out consistently from day to day, leakage of oil is indicated.

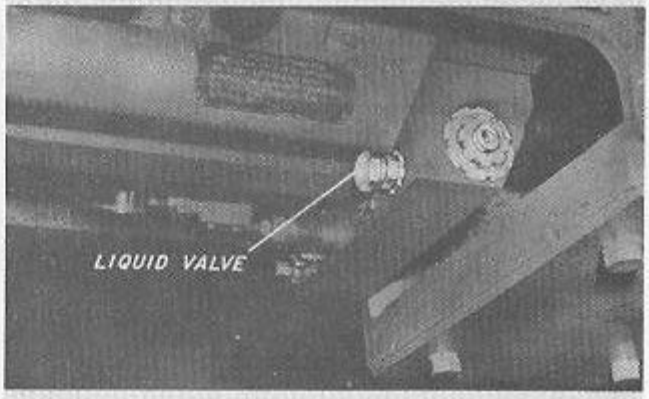
This oil may be leaking into the counterrecoil air chamber.



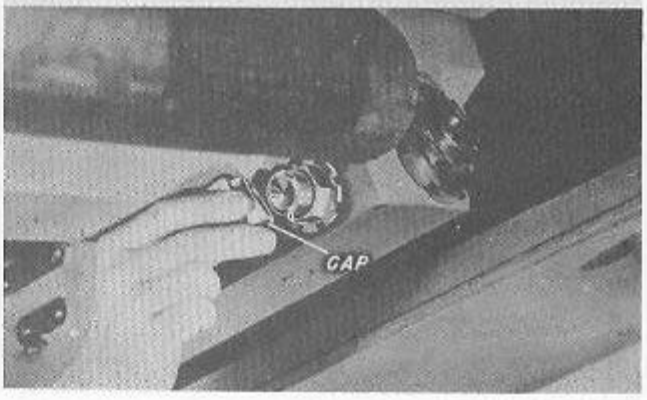
Or, the oil may be leaking out past the differential plunger. In either case, if the leakages goes uncorrected, the differential cylinder may become empty, destroying the pressure differential in the oil, so that air can leak rapidly from the counterrecoil air chamber. To correct such leakage, it is usually necessary to disassemble the differential system in order that we may inspect it and replace worn or faulty parts. In taking this system apart, . . .

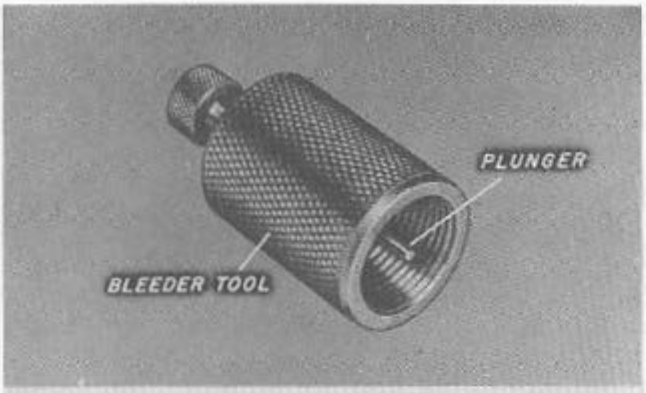


. . .let's first look at the differential cylinder liquid valve located on the underside of the after end of the gun housing. If this valve leaks, it should be cleaned, inspected, and repaired or replaced. In removing the valve, we must first be sure that the safety link is connected, and that the air is bled out of the counterrecoil cylinder. Having checked this, we proceed to bleed the oil out of the differential cylinder. To do this, . . .

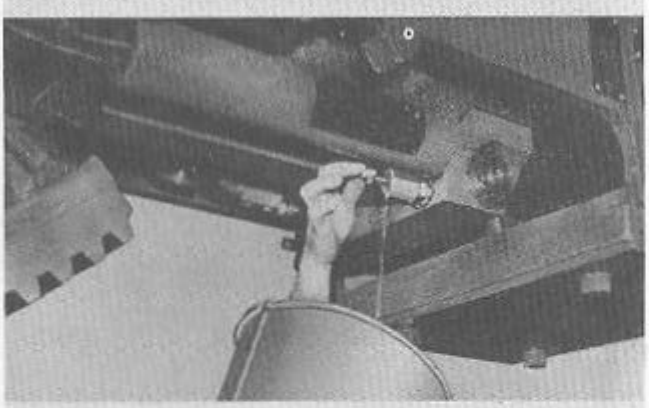


. . .we first unscrew the cap from the differential liquid valve.

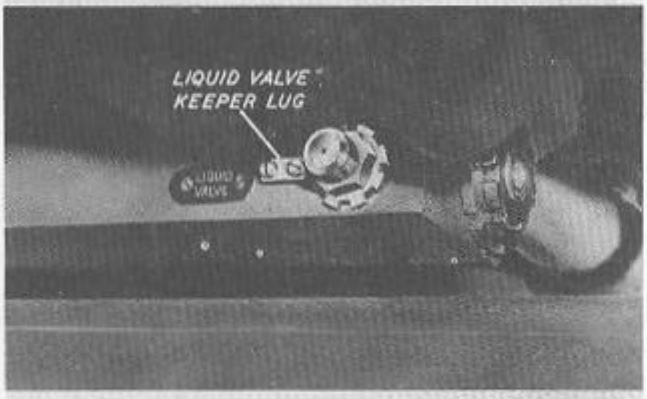




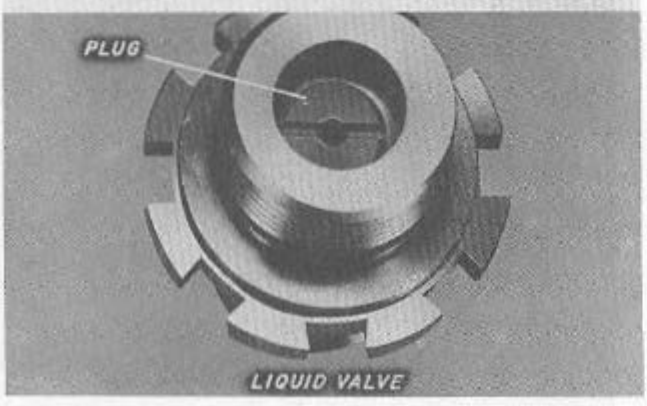
A bleeder tool having a screw-type plunger is then screwed on in place of the cap we have just removed. The liquid valve is like that on an automobile tire. It must be pushed in by the plunger of this tool in order to let the oil flow out.



Holding a bucket under the bleeder tool, screw in its plunger and drain the oil from the differential cylinder.

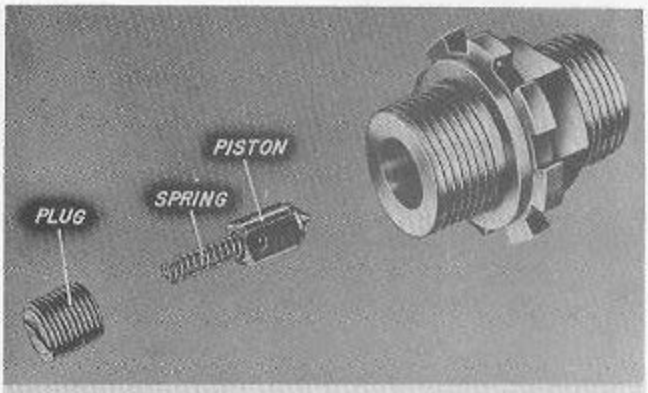


When all the oil is drained, remove the bleeder tool and then take out the two screws holding the liquid valve keeper lug in place. Unscrew and remove the liquid valve.

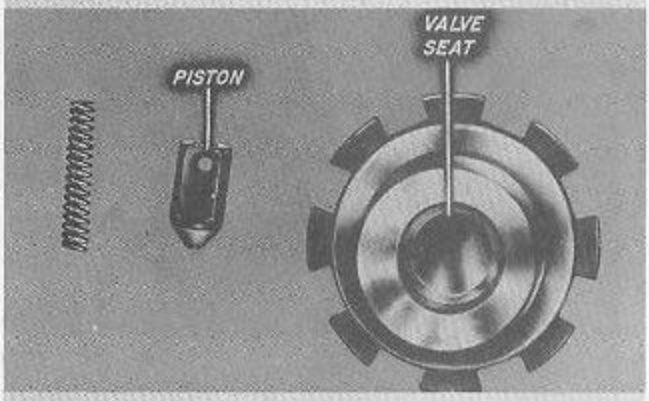


If leakage is indicated in this valve, we must take it apart. First, we unscrew the plug inside the inner end of this valve.

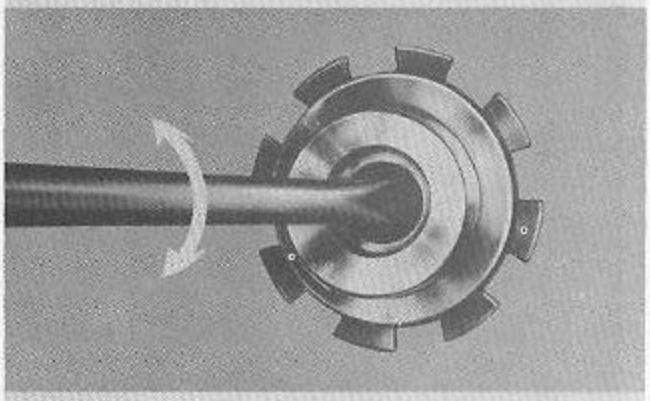
The plug, spring, and piston inside the liquid valve will fall out as you tip the valve up on end.



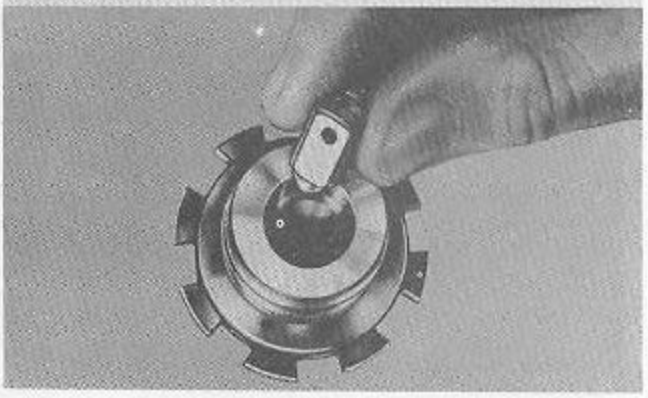
To prevent leakage, inspect the spring for signs of weakness and make sure that the surfaces of the piston and valve seat are free of dirt, burrs or corrosion. If the piston is scored, replace it with a spare and later grind the old one in its seat. The grinding is done. . .

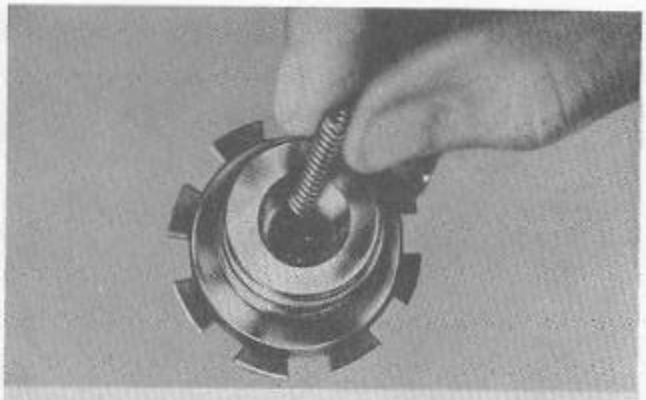


. . .by inserting a screwdriver into the recess in the piston and grinding in the piston by rotating it, using a fine valve-grinding compound as an abrasive.

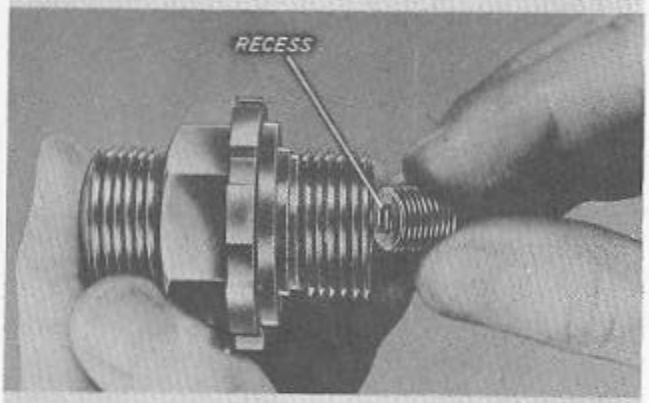


After a thorough cleaning to remove all the grinding compound, assemble the valve by first dropping the piston into the valve seat.

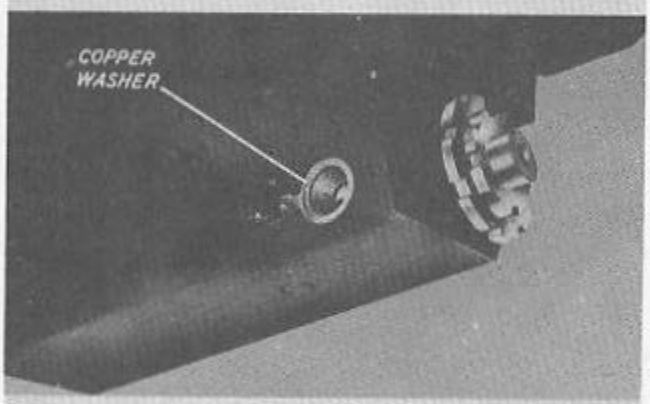




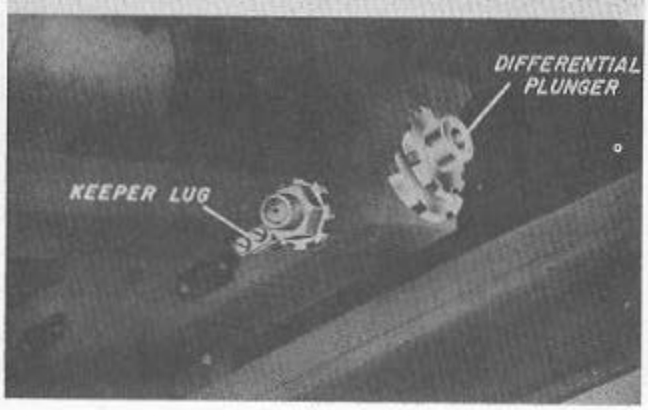
Then insert the valve spring. . .



. . .and complete the assembly by screwing in the plug. Be sure that the spring fits up inside the recess in the plug so that the piston will seat properly in the valve.

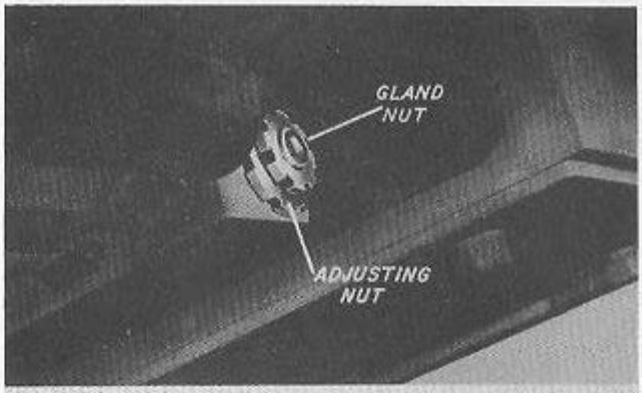


A copper washer was exposed when the liquid valve was unscrewed from the differential cylinder. The washer should be annealed and cleaned thoroughly before the valve is replaced.

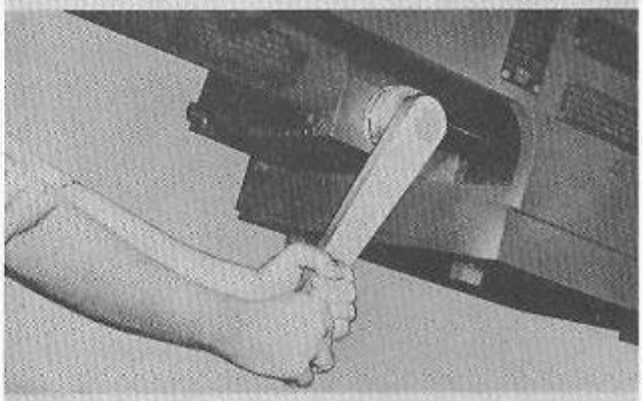


Replace the copper washer in its seat and screw in the liquid valve. Be sure that the liquid valve is screwed into the cylinder with its open end in. Then secure the valve in place with its keeper lug. If daily inspection of the differential cylinder plunger indicates that the plunger packing is leaking, the plunger should be removed. To remove the plunger. . .

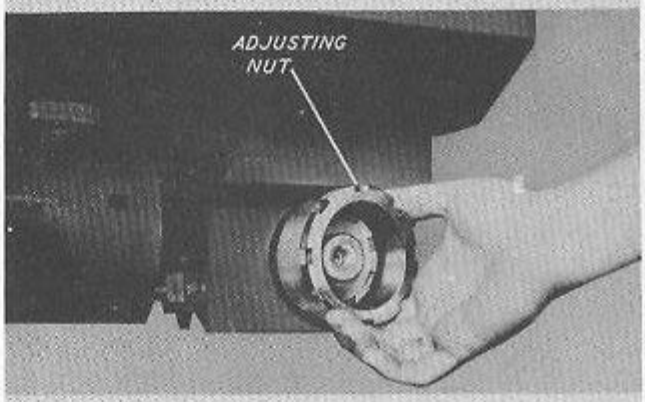
. . .loosen the differential packing gland nut a couple of turns. To get at the adjusting nut behind the gland nut. . .



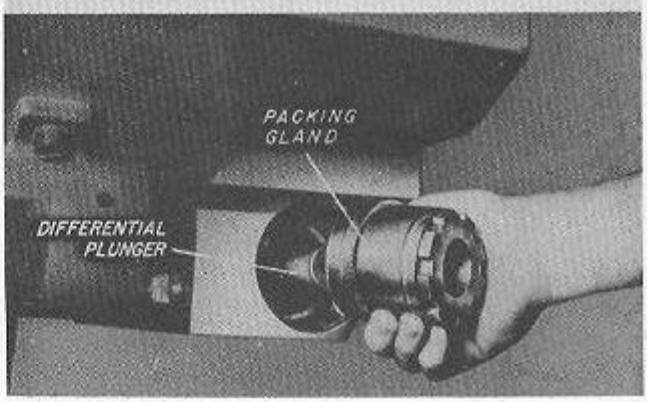
. . .use the two-piece adjusting nut tool to loosen the adjusting nut on the differential plunger packing gland. . .

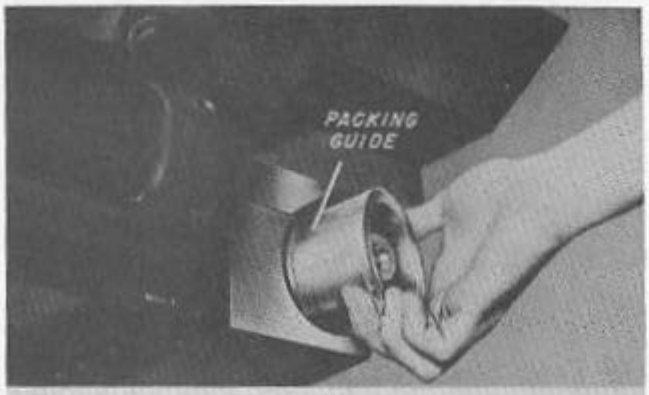


. . .and remove the adjusting nut.

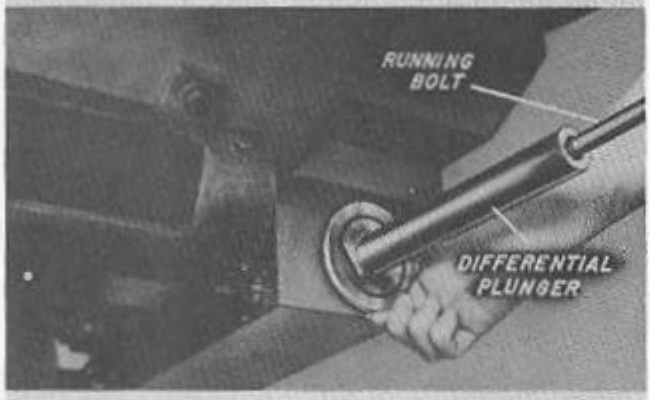


Pull the packing gland out over the end of the differential plunger.





A "packing-guide" is used to cover the threads.

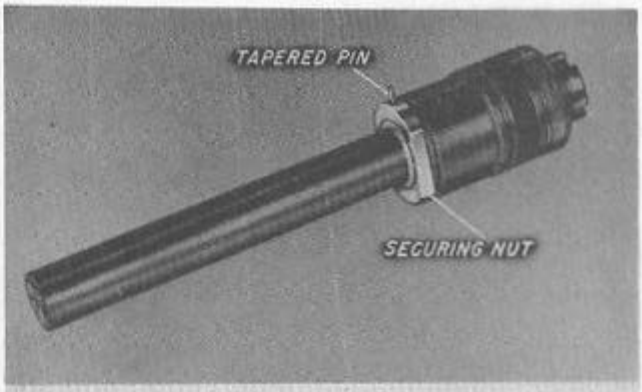


Pull out the differential plunger, using a running bolt. The packing guide covers the differential cylinder threads so that the soft packing rings on the end of the plunger will not be damaged. Remove the packing guide after the plunger is pulled out.

Clean and inspect the interior of the differential cylinder. Look for cracks, burrs, scratches or sediment which are likely to damage the packing rings and cause leakage.

Then inspect and clean the chevron packing rings on the piston. If the rings are roughened or worn, they should be replaced.

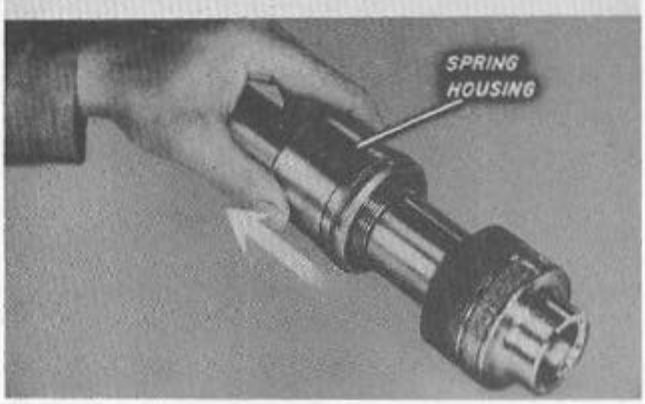
Remove the packings by driving the tapered pin out of the securing nut with a brass drift.



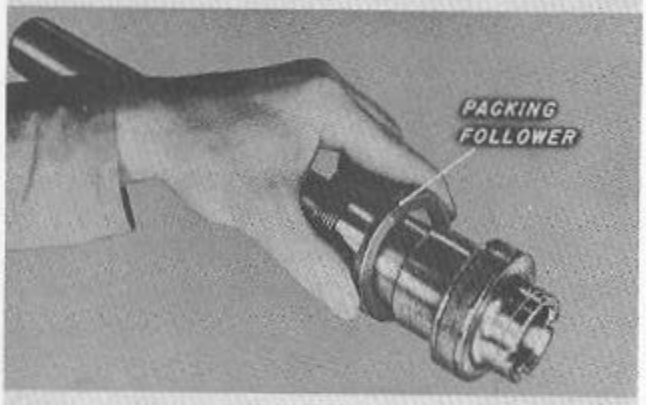
Then remove the securing nut.

Take off the packing spring. . .

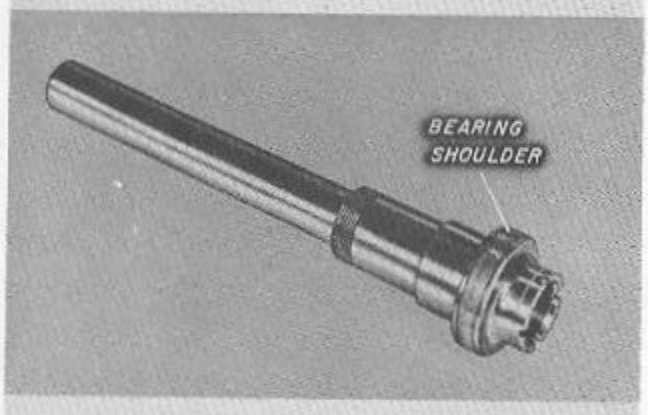
. . .and slide off the spring housing.



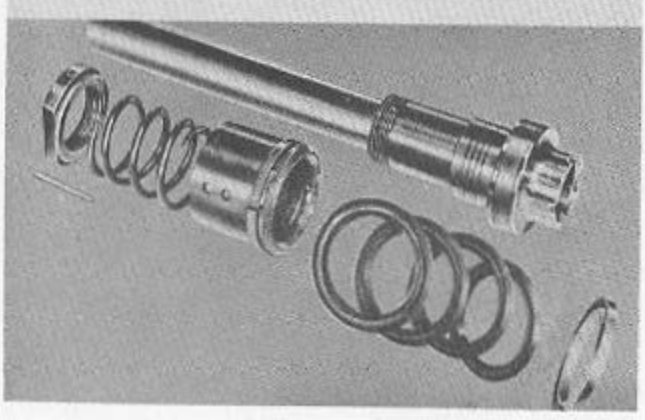
Then slide off the four chevron packing rings.



Finally, draw off the packing follower.

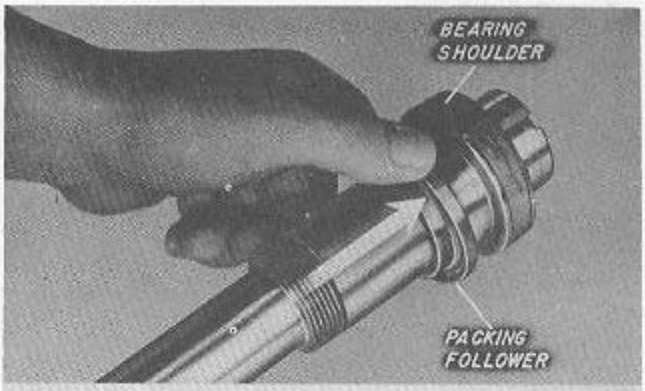


The front of the piston is provided with a soft metal bearing shoulder. Be careful not to score it while you are working on the piston.

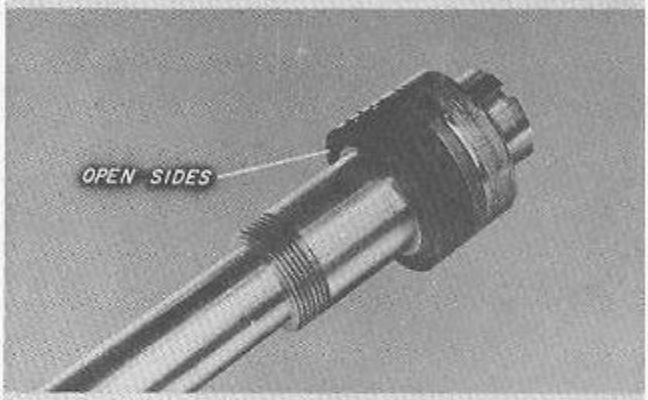


Clean thoroughly all parts of the differential piston assembly, removing any rust and burrs and inspecting all parts for cracks. Having done this, we are ready to reassemble the differential system. We start with these parts of the differential plunger.

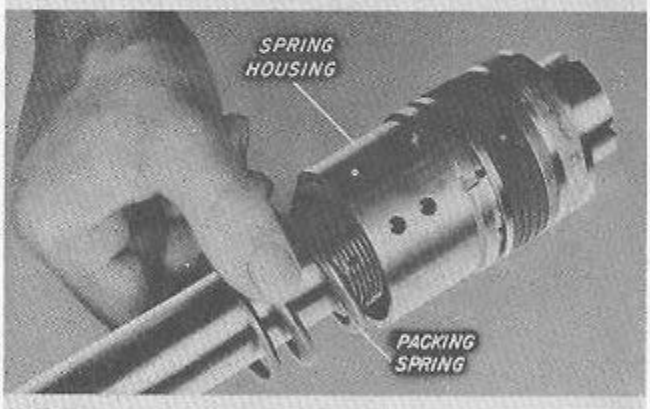
Slide the packing follower over the end of the plunger. Be sure that the grooved side of the follower is away from the bearing shoulder.



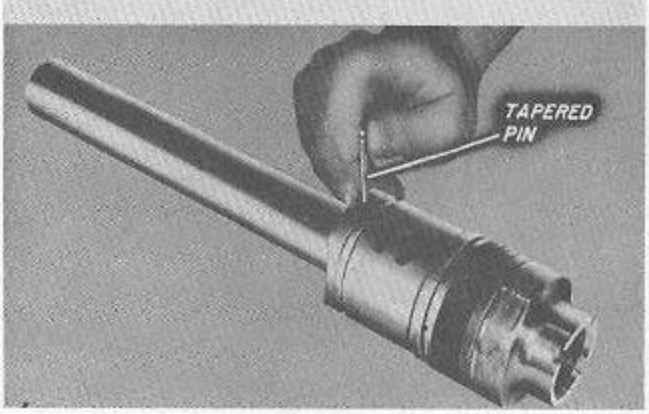
Then, mount the four packing rings on the plunger with their open sides away from the packing follower. New packing rings are very stiff. If new rings are to be installed, they should be soaked at least overnight, and preferably for 72 hours, in neets-foot oil, before they are used. Remember that chevron packings are always installed with the open side against the higher pressure, so that this pressure will expand the ring and make a tight seal.



After the packing rings, we install the spring housing with its open end away from the packing rings and slide the packing spring into the recess.



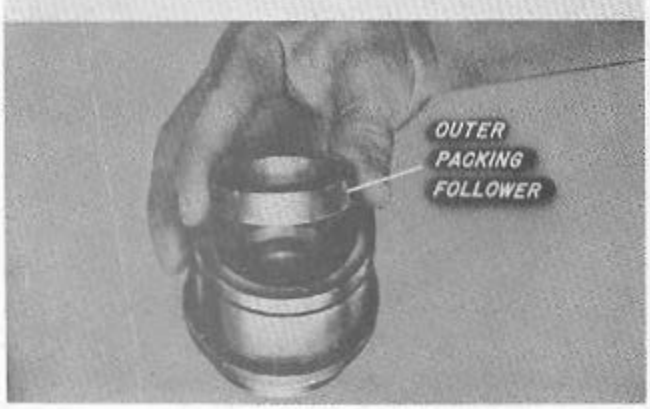
Now, screw on the securing nut, tighten it all the way, and then back it off until the tapered pin can be inserted. The plunger is now completely assembled and is ready to be installed in the differential cylinder.



Place the packing guide over the threads in the end of the differential cylinder and ease the differential plunger in. After the plunger is in place, remove the packing guide. The packings on the differential piston serve to prevent oil from leaking into the air chamber.

To prevent leakage around the other end of the plunger, there is another set of packings in the packing gland, that closes off the open end of the cylinder. In order to inspect these packing rings, the gland must be taken apart.

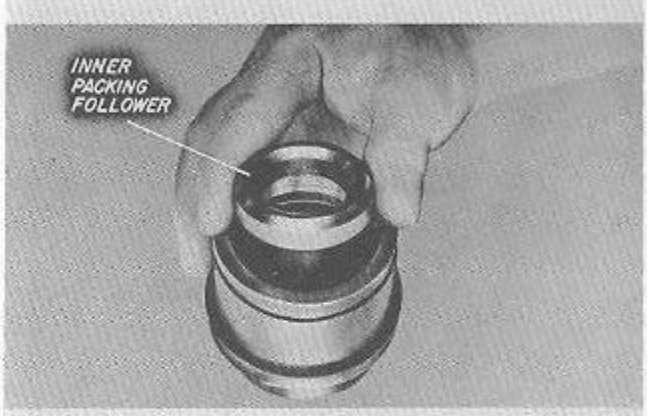
The gland nut is removed. . .



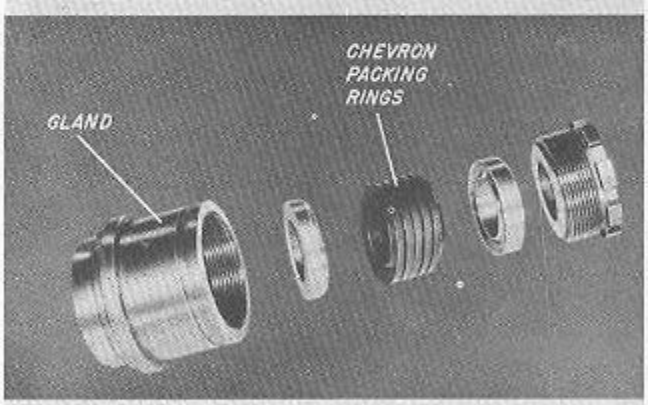
. . .and the outer packing follower lifted out. . .

. . .permitting the five chevron packing rings to be removed. Be careful not to damage them.

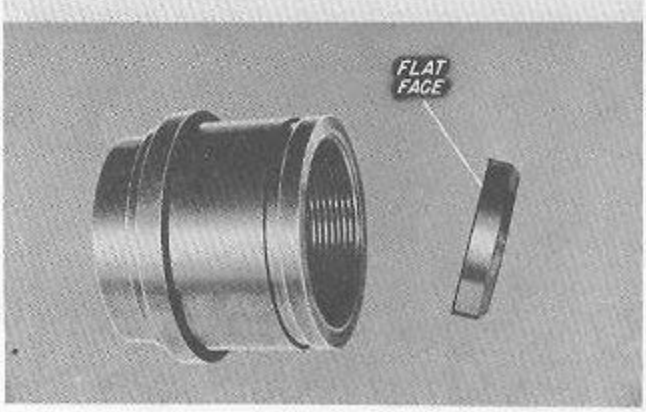
Finally, remove the inner packing follower.

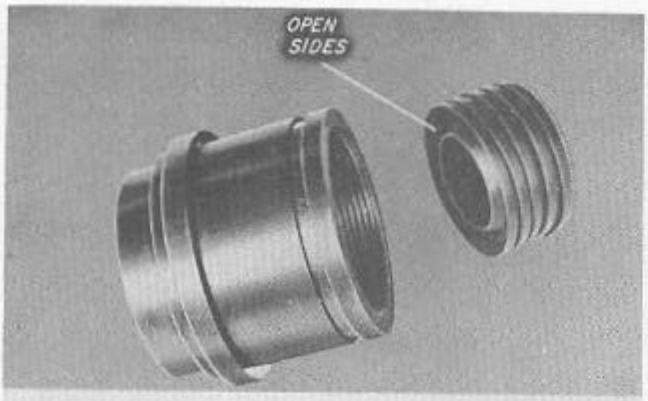


Inspect and clean thoroughly all the parts of the packing gland. If necessary, replace the chevron packing rings with new ones that have been presoaked in oil. In reassembling this gland, . . .

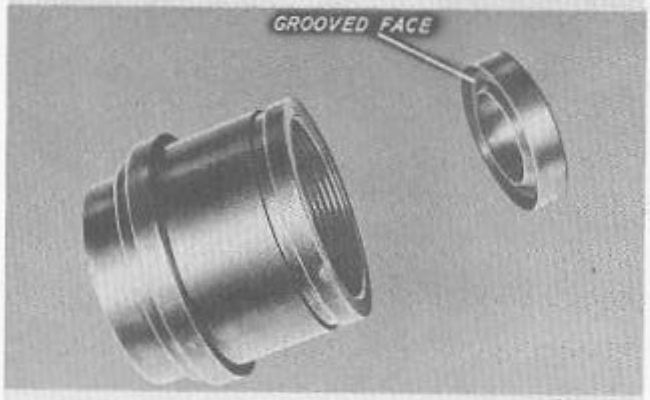


. . .first insert the inner packing follower with its flat face in. . .

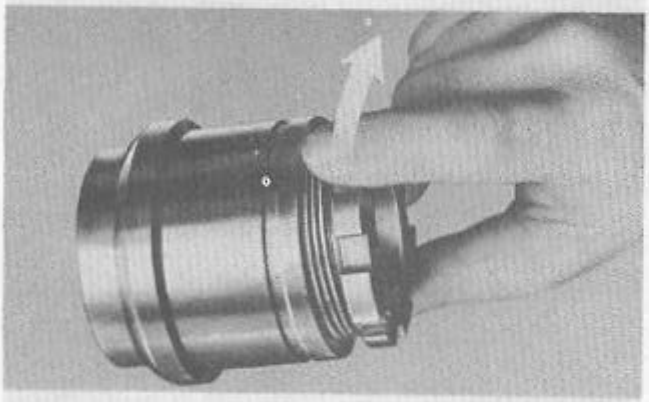




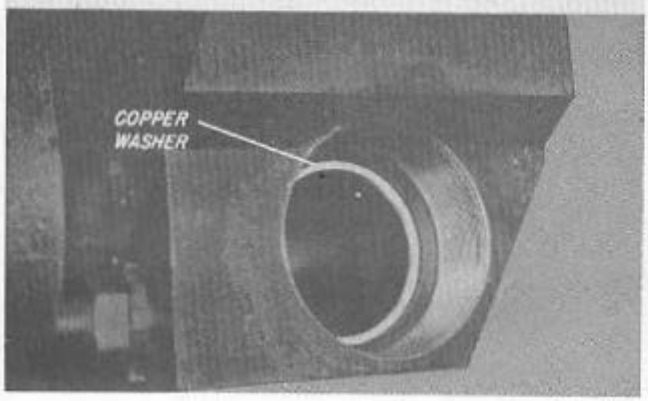
Then insert the five packing rings, with their open sides in, against the inner packing follower. Remember that the open sides of the rings must face the oil pressure.



Insert the outer packing follower with its grooved face toward the packing rings.

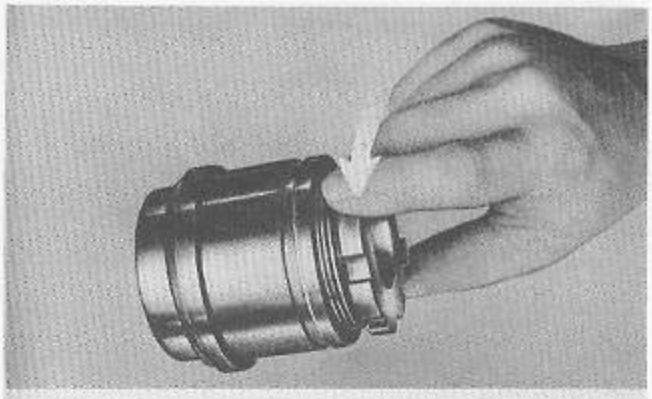


To secure the packing assembly, screw in the gland nut hand-tight. This gland nut now should prevent leakage around the plunger. To prevent leakage around the gland nut itself, . . .

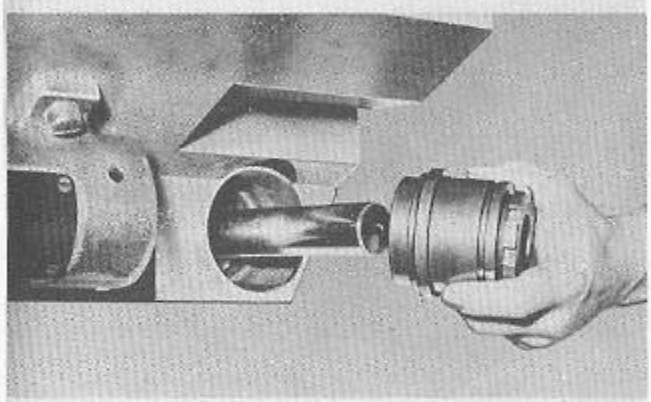


. . .a copper washer is placed inside the differential cylinder opening. Clean this washer with a wire brush and metal polish and anneal it by heating it to red heat with a blowtorch, and quenching it in water to clean off the scale. Then, put the washer back in.

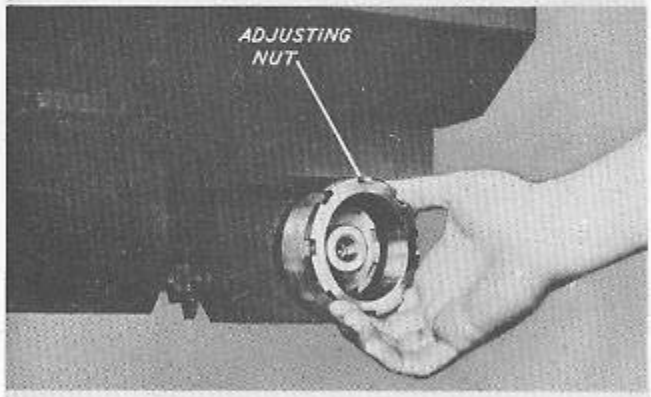
Before putting the packing gland back in the cylinder, back off its nut one complete turn so that the packing rings will not bind.



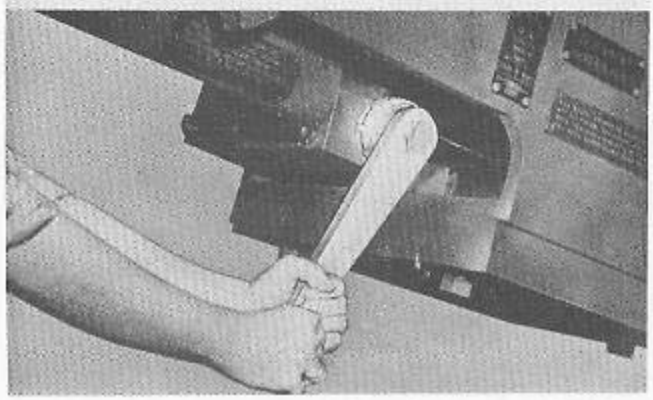
Then slide the assembled gland over the end of the differential plunger.

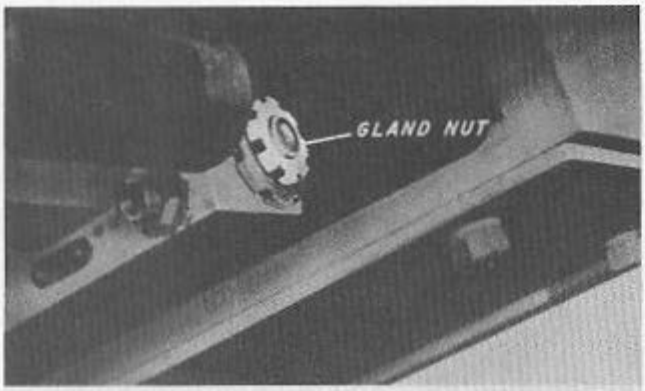


Slide the adjusting nut over the end of the plunger and screw it into the cylinder.

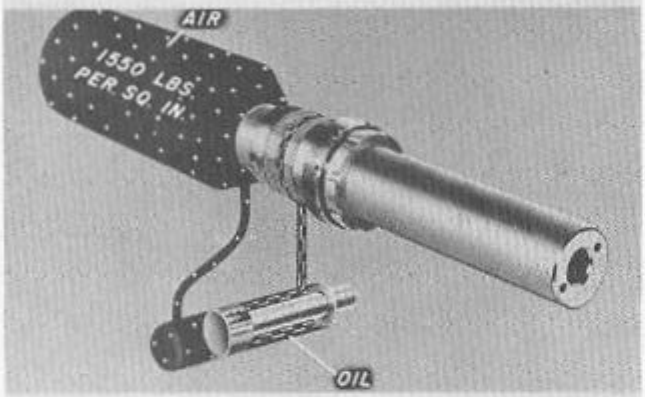


Tighten the adjusting nut. Put all your weight behind the wrench, compressing the copper washer to prevent leakage.

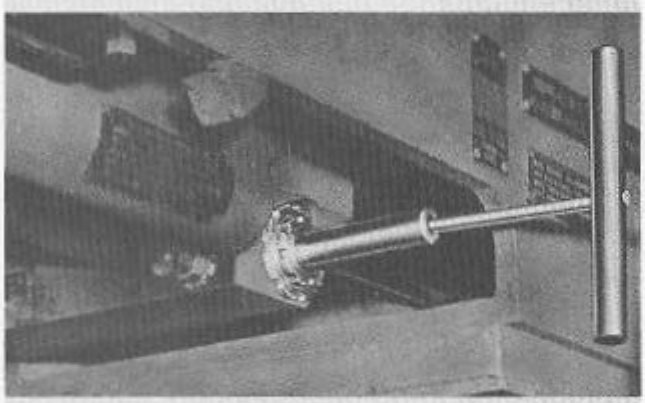




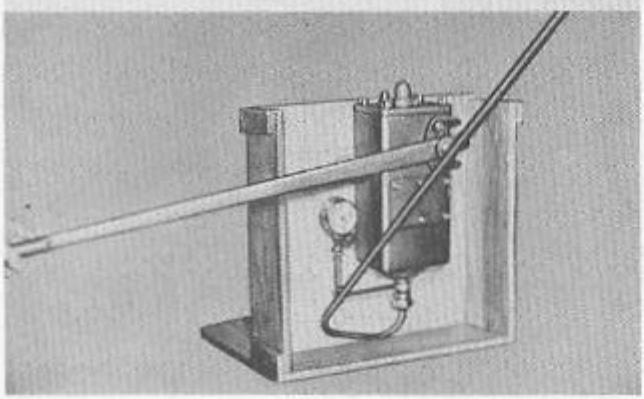
To seat the packings snugly around the plunger, screw up the gland nut until it is again handtight. The proper adjustment of this gland nut completes the overhaul of the differential system. In this overhaul, we have made all parts of the system oiltight.



To put the counterrecoil system in operating condition, we must fill the differential cylinder with oil and recharge the counterrecoil air chamber until a pressure of approximately 1,550 pounds per square inch is reached.

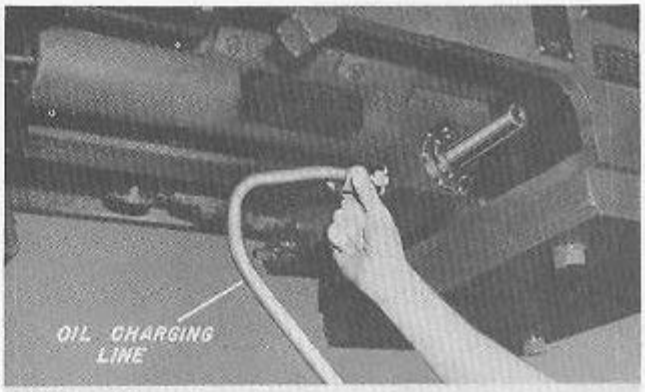


Before starting to put in the oil, screw a running bolt into the end of the differential plunger and pull it all the way out to force air out of the oil side of the differential cylinder.

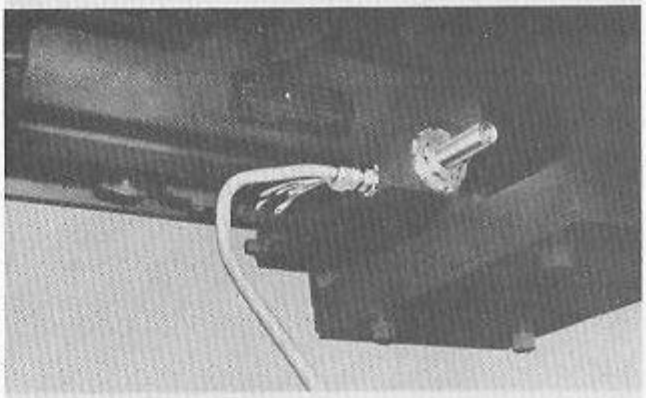


For pumping the oil, we use this standard charging pump. Notice that the pump is hand operated, and that the pump unit contains a pressure gauge. (Note: The pictured pump has been replaced with a newer, more efficient, type.)

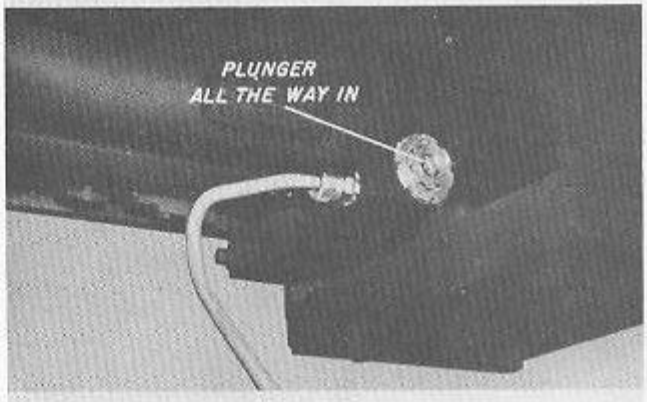
To fill the differential cylinder with ice machine oil, connect the threads of the oil charging line coupling loosely to the liquid valve.



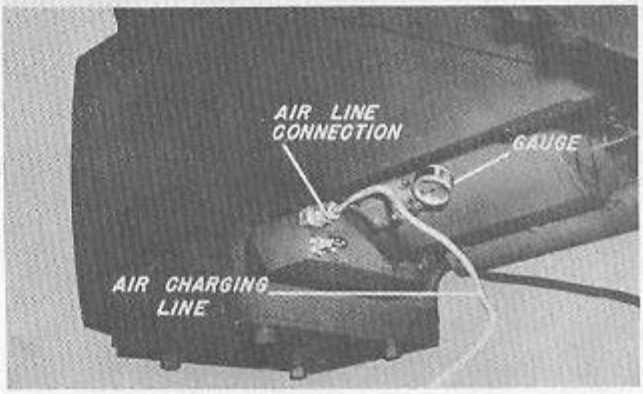
Pump oil through the line until it leaks out at the loose coupling. This drives all air out of the oil charging line so that it will not be forced into the differential cylinder.

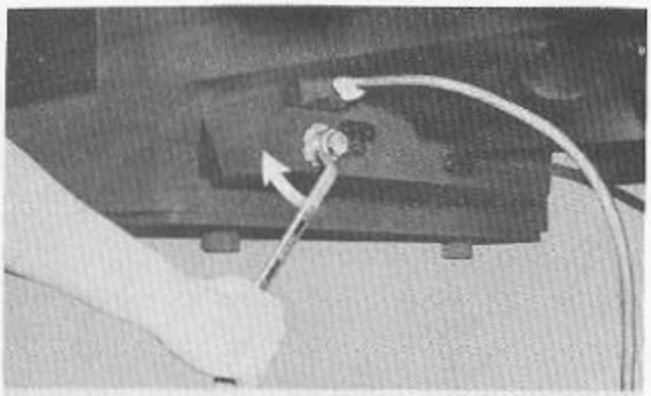


Now, tighten the oil line coupling and pump oil into the differential cylinder until the plunger is all the way in and the pressure gauge on the oil pump reads 3,000 pounds. The differential cylinder must be filled with oil, in this manner, in order to set the packing.

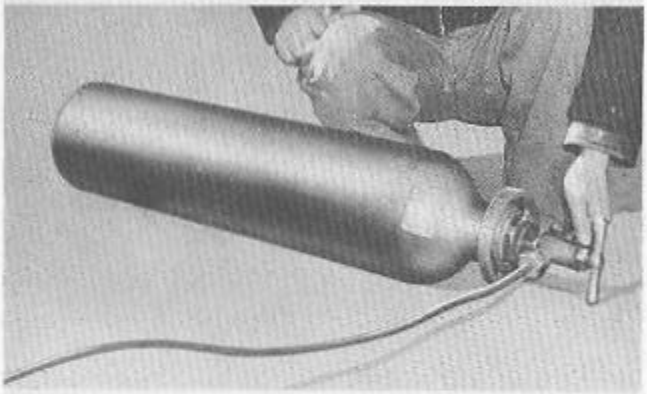


To charge the chamber, connect the air charging line to the air line connection on the other side of the gun. Open the air valve and charge air until the counterrecoil cylinder gauge reads 1,550 pounds. When this pressure has been reached, shut off the air supply valve.



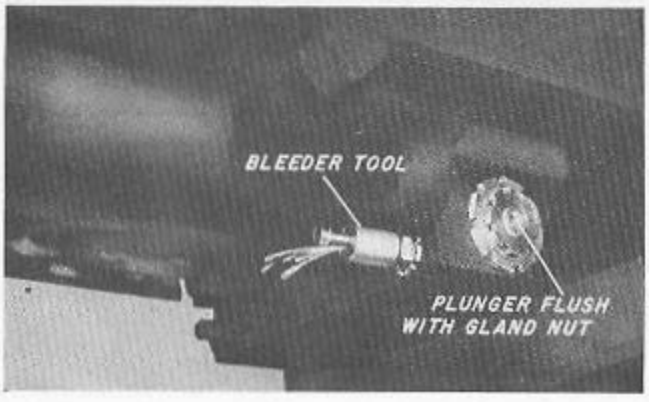


Before disconnecting the air charging line, close the counterrecoil air valve, . . .



. . .and bleed the air out of the air charging line, using the bleeder at the air supply valve.

When the air charging line has been removed, replace the air line connection plug.

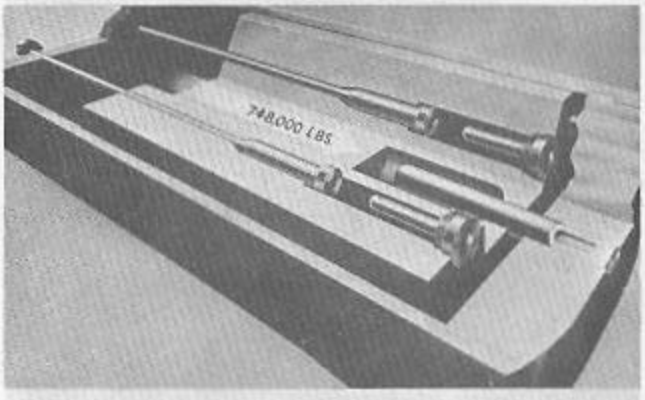


Then remove the oil charging line, replace the bleeder tool and bleed oil out of the differential cylinder as previously described. Continue bleeding until the end of the differential plunger is flush with the packing gland nut.

Finally, remove the bleeder tool and replace the liquid valve cap to protect the valve from dirt and corrosion. When the safety link has been disconnected we have completed the overhaul of the recoil and counterrecoil systems. Both systems have been filled and the gun has been placed back in commission.

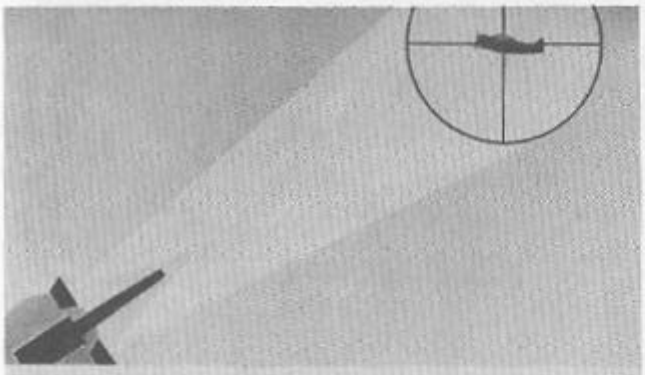
When the 5"/38 is firing, these two systems working together must stop the recoil movement of the gun and return it to battery in a fraction of a second, if a high rate of fire is to be maintained.

The firing of each round creates forces ranging up to 748,000 pounds which must be absorbed by these two relatively small systems. Although they are extremely tough and although their packings are built to withstand the high operating pressures involved—wear will occur.

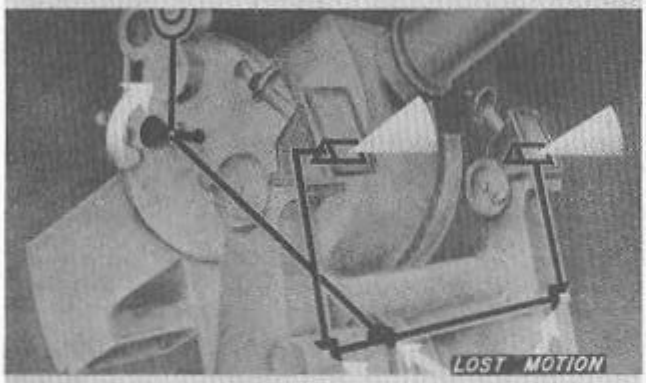


For this reason, it is vitally important that you understand these overhaul procedures thoroughly so that you can maintain the gun in efficient working order at all times.

CHAPTER 15—DISASSEMBLY AND ASSEMBLY OF THE SIGHT-SETTING MECHANISM

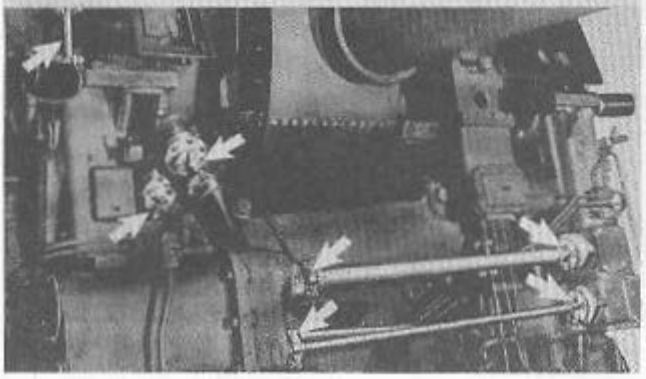


We have seen that the sights of the 5"/38 gun are chiefly responsible for the accuracy of its fire, and that the sight-setting mechanism must, for this reason, operate to a high degree of precision.



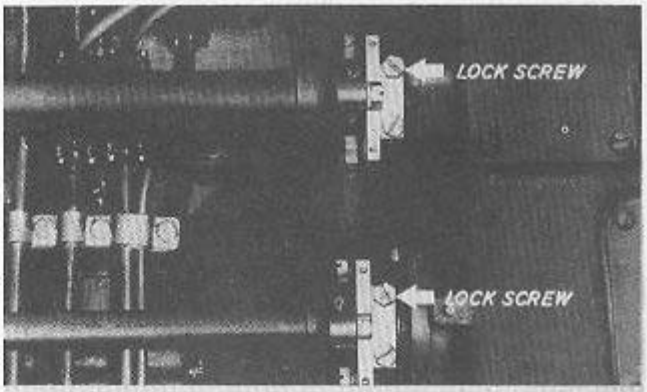
If there is lost motion in any part of this mechanism, the prisms in the telescopes will not move the correct amount, and so will cause inaccurate sight and deflection angles to be set. This, of course, will result in the gun being improperly aimed. Let's assume that there is lost motion in both elevation and deflection systems.

The lost motion may be within the sight-setting mechanism housing, in which case disassembly of the mechanism will be necessary.

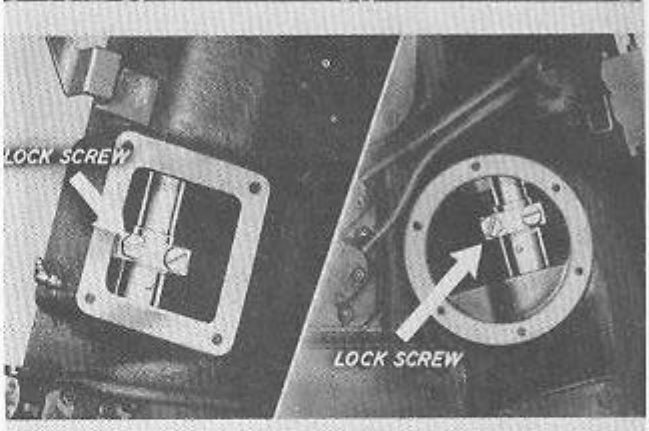


Or, lost motion may be in the linkages from the housing to the prisms in the telescopes. If it is here, disassembly of the sight-setting mechanism will not be necessary. So, to save yourself work, first eliminate the possibility of lost motion in these linkages by checking each of the exposed flexible couplings to see that they are tight. If the lost motion is not in the flexible couplings, . . .

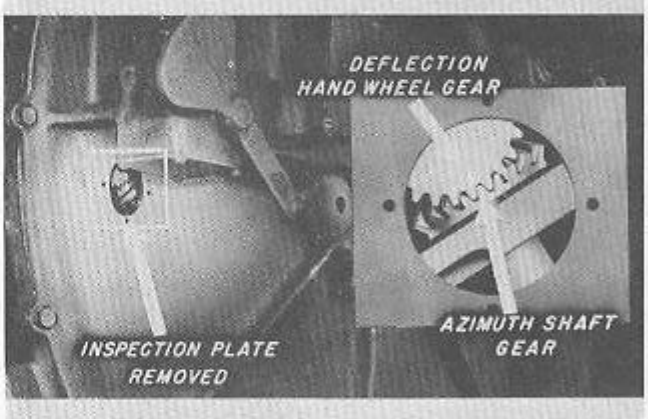
. . .check the vernier couplings to each telescope. The vernier couplings to the prisms in the pointer's telescope are located at the pointer's end of the elevation and deflection cross shafts. Make sure that the lock screw on each of these vernier couplings is tight.



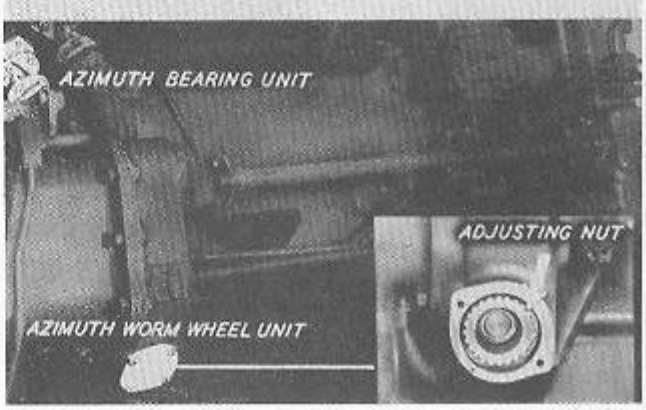
The vernier couplings to the prisms of the trainer's telescope are in the vertical shafts within the trainer's handwheel bracket. To check these, remove the inspection plates. At the left is the coupling on the vertical shaft to the deflection prism. At the right is the coupling to the elevation prism. See that the lock screw is tight on each of these vernier couplings.

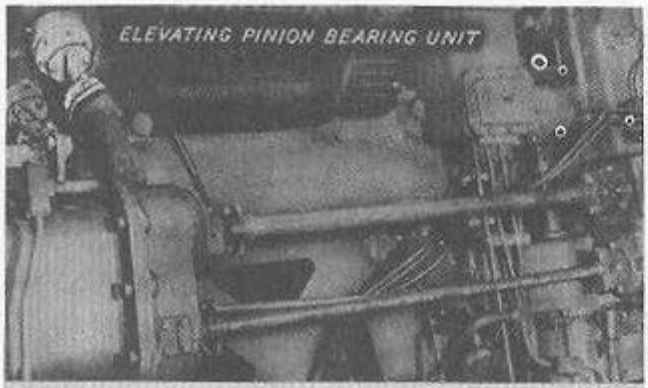


Finally, check for lost motion in the azimuth and elevation shafts. To determine whether there is lost motion in the azimuth shaft, remove the inspection plate located just under the deflection handwheel. This will expose the bevel gears that connect the deflection handwheel to the azimuth shaft. With these bevel gears exposed, you can test for lost motion in this shaft. To correct the lost motion, . . .

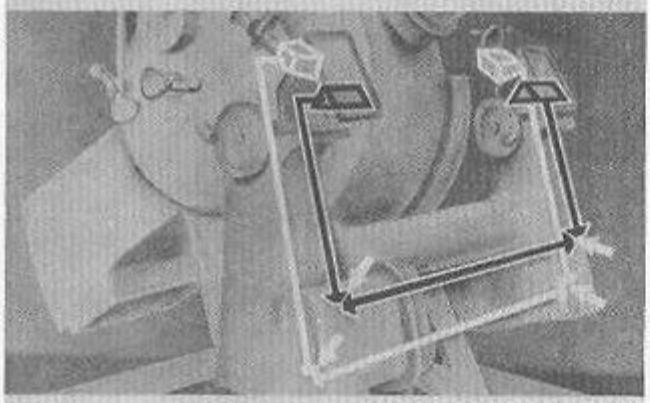


. . .first, try tightening the adjusting nut in the azimuth worm wheel unit. This nut is located behind an inspection plate on the elevating gear bracket at the point where the worm on the lower end of the azimuth shaft meshes with the worm wheel on the deflection cross shaft. If this does not do the job, we must check another adjusting nut located in the azimuth bearing unit at the point where the azimuth shaft leaves the housing of the sight-setting mechanism. Since adjustment of this nut involves disassembly, we shall discuss it later.

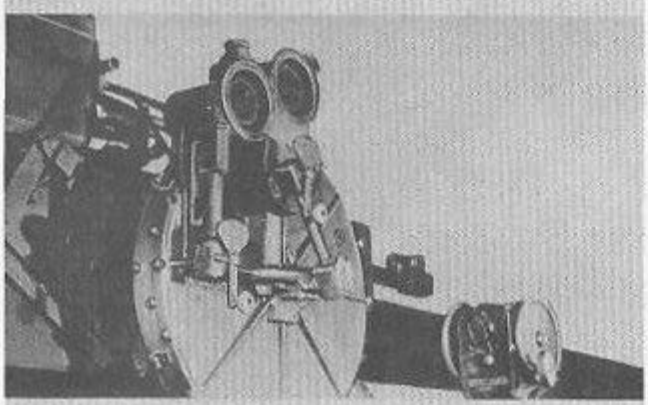




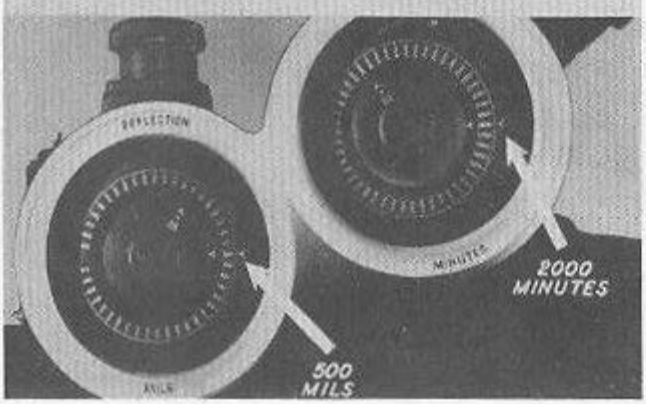
A similar adjusting nut at the lower end of the elevating pinion bearing unit is reset to remove lost motion at the point where the elevating pinion meshes with the main sight driving gear. The adjustment of this nut also involves disassembly and will be described later.



If lost motion in the sights is caused at the bevel gears that connect the elevation and deflection cross shafts to the vertical shafts, a precision machine job, beyond the capacity of the ship's force, is necessary. Fortunately, trouble seldom occurs here.



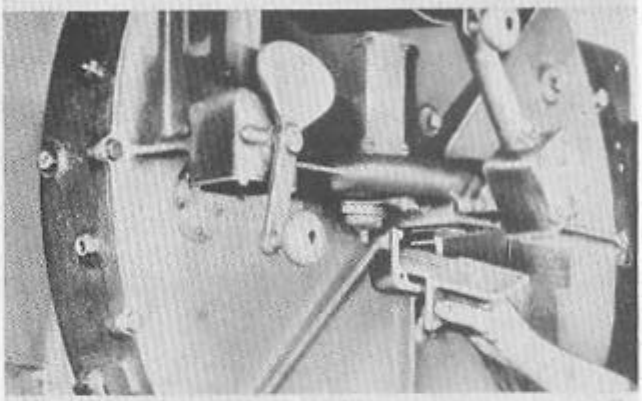
If the lost motion is not found in any of these linkages, the mechanism within the housing must be disassembled. Before beginning the actual work of disassembly, remove the telescopes.



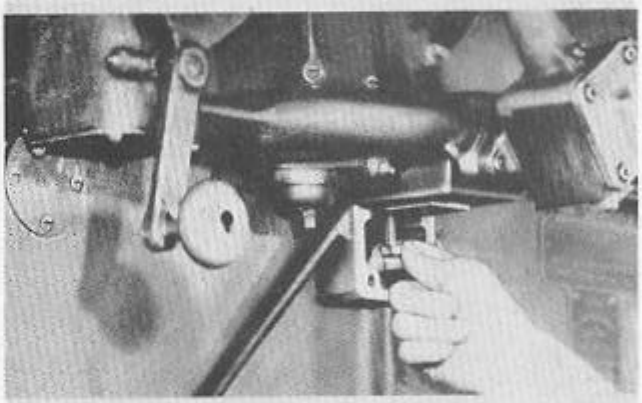
Before any parts are removed, set the gun at zero elevation. Set the deflection indicator to read 500 mils and the sight angle indicator to read 2,000 minutes. This must be done to line up the scribed marks on the mechanism parts so that they can be reassembled in proper alignment.

The first step in disassembly is the removal of the securing bolts from the compensator sliding bar bracket.

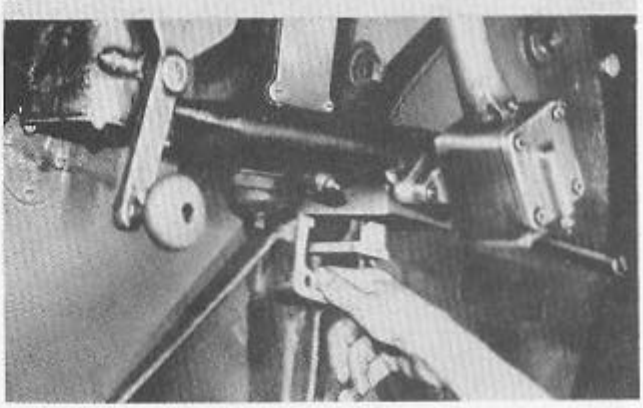
With the bolts removed, take the brackets off the dial housing. Removal of this bracket provides access to the compensator sliding bar.

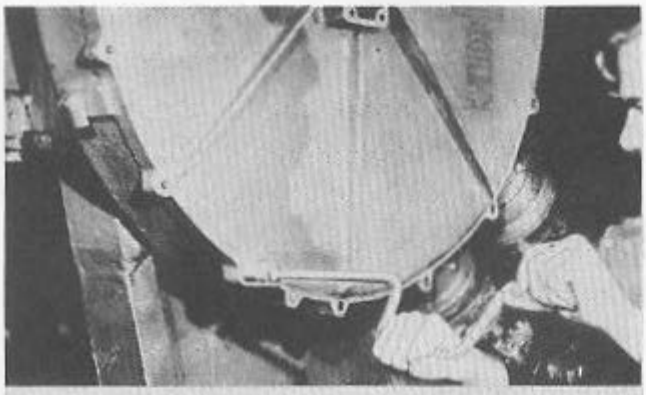


To provide a handhold on the sliding bar, screw one of the bracket mounting bolts into a tapped hole on the underside of the bar.

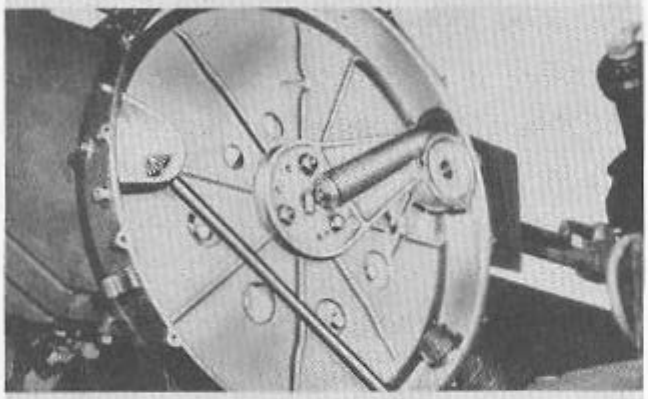


Then pull the compensator sliding bar downward to remove it from the dial housing.



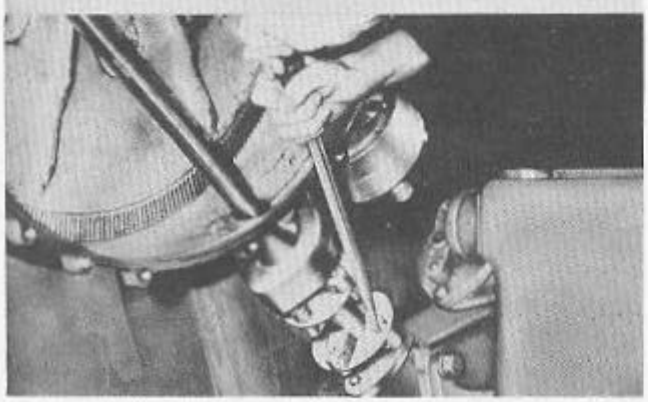


Next, remove the securing bolt from the dial housing itself. . .



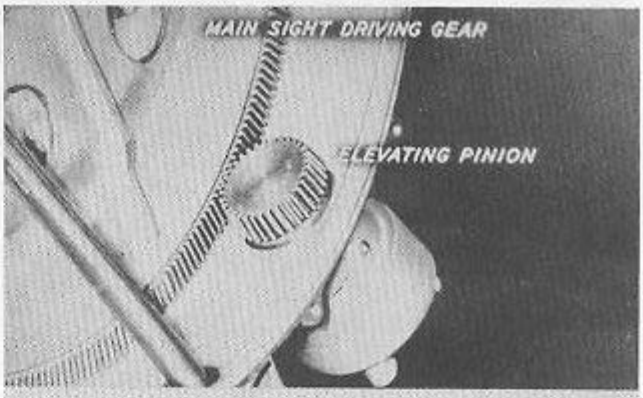
. . .so that the dial housing can be lifted away from the main housing.

A flexible coupling in the elevating pinion shaft is detached by removing four cotter keys and screws—two at the lower end of the coupling, and two at the upper end.

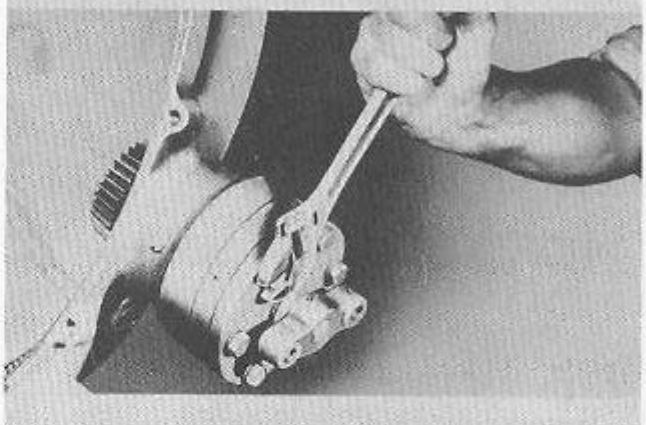


The flexible coupling in the azimuth shaft is removed in the same way.

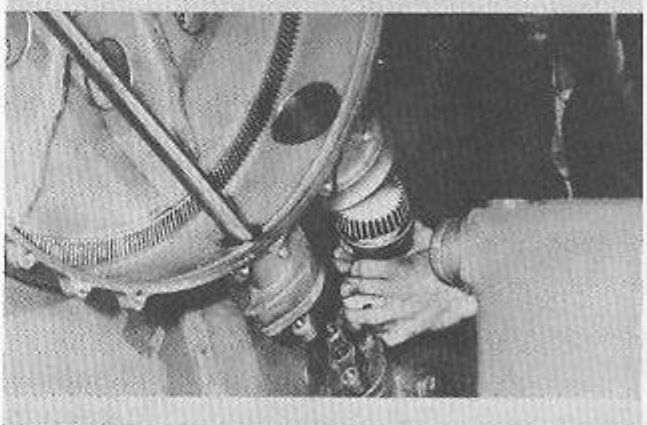
A check is made at this point to detect lost motion between the main sight driving gear and the elevating pinion. If lost motion is found here, we must remove the elevating pinion bearing unit for disassembly.



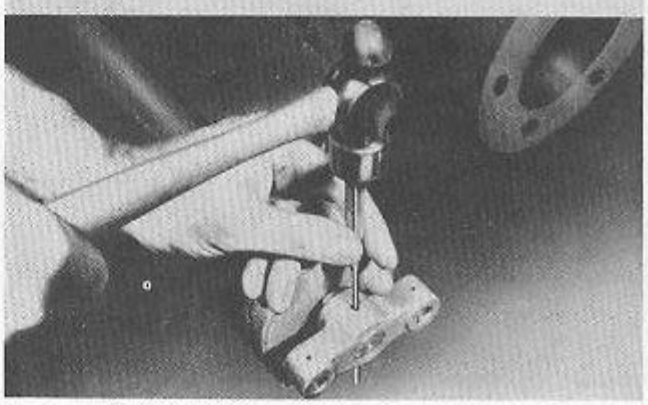
To do this we must take off the housing plate by unscrewing the cap bolts.



The elevating pinion bearing unit will then slip easily out of its seat. Set this unit aside for later disassembly.

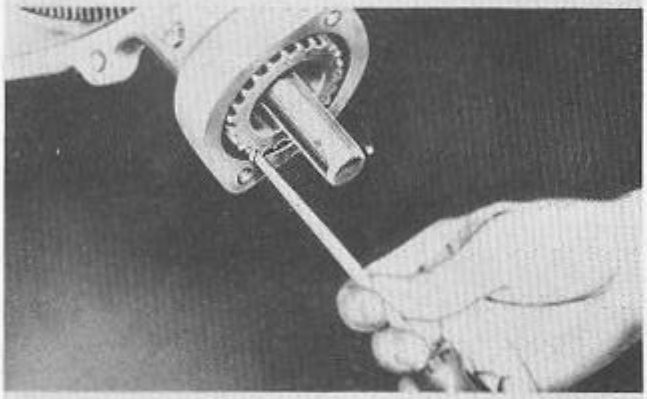


We come back now to the azimuth shaft. The upper shoulder of the flexible coupling still remaining on the shaft is freed by drifting out the taper pin.

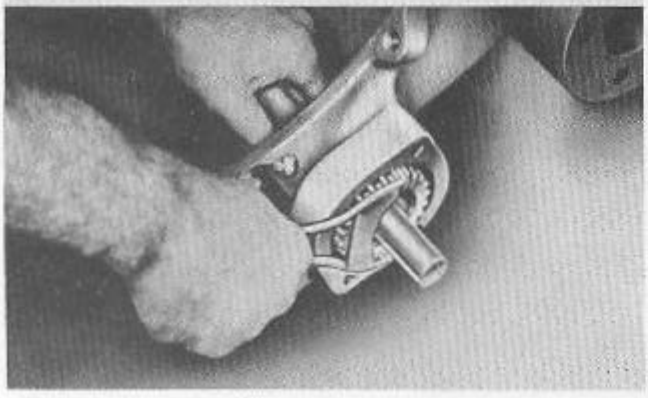


With the taper pin out, the upper shoulder of the flexible coupling can be slipped off the end of the shaft.

By removing two cap bolts, take off the housing plate. This provides access to the azimuth shaft bearing unit. Removing the housing plate. . .

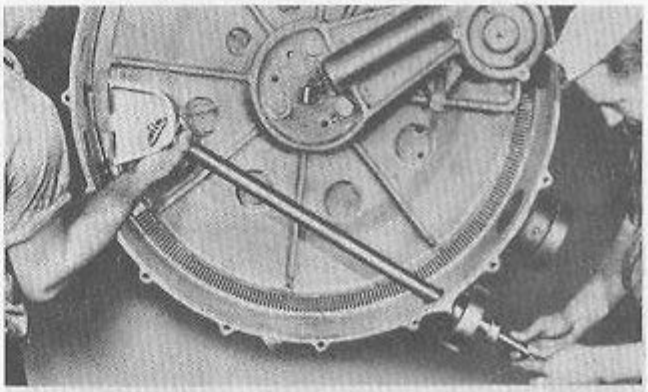


. . .exposes the adjusting nut in the azimuth shaft bearing unit. This nut, as we will see later, is adjusted to eliminate lost motion in the azimuth shaft. To disassemble the azimuth shaft bearing unit, we must unlock the adjusting nut by removing its keeper screw.

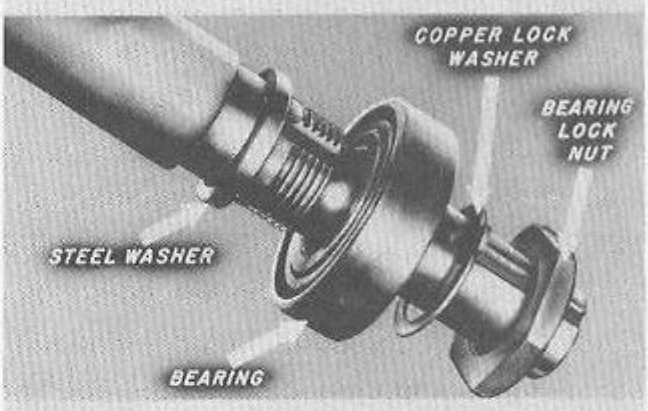


The adjusting nut is removed.

Free the azimuth gear bracket from the main housing. Then lower the azimuth shaft until its bearing is clear of its seat in the main housing.

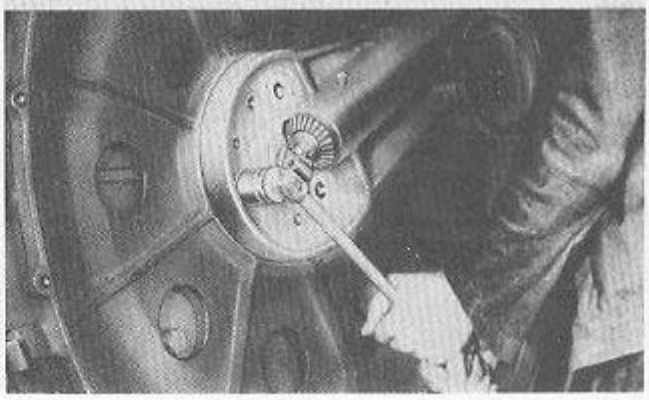


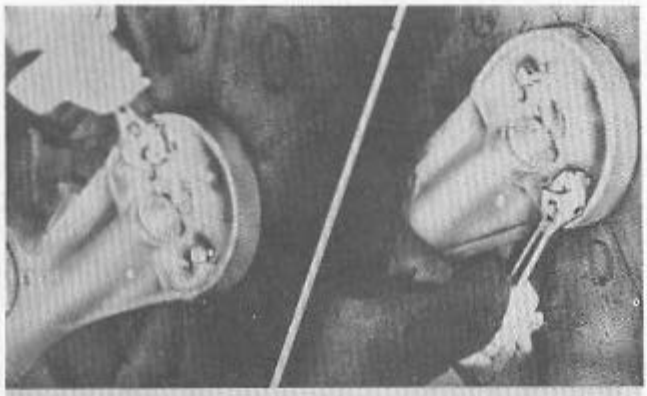
To disassemble this unit, unscrew the bearing locknut and remove the copper lockwasher, the bearing itself, and a steel washer.



With the bearing removed, the azimuth shaft can be pulled out of the housing.

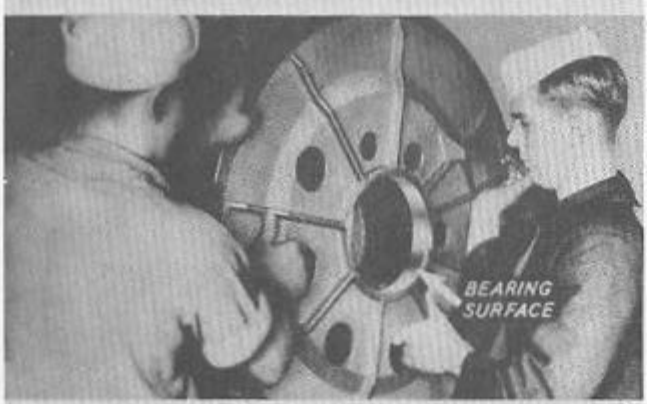
Remove the bolts that secure the banjo to the trunnion clip.



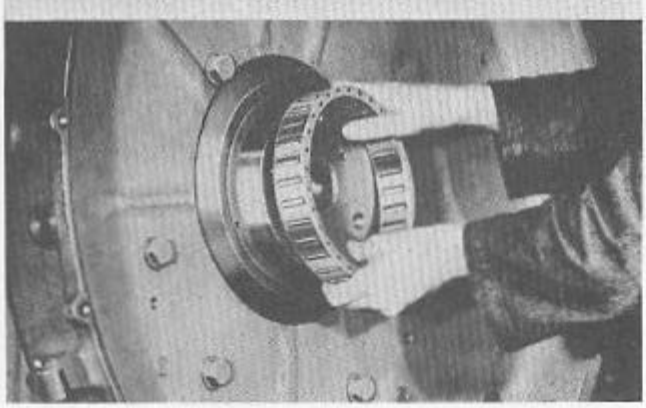


The banjo fits tightly on the trunnion clip and must be jacked off. To do this, seat two of the dial housing securing bolts in the jackscrew holes in the banjo. Tighten these bolts alternately a little at a time to free the banjo from the trunnion clip. Then lift the banjo off the clip.

The banjo is disassembled to inspect for lost motion between the keyways on the sight driving pinion, and the keys on the worm wheel. If lost motion is discovered, a new worm wheel or pinion must be installed.

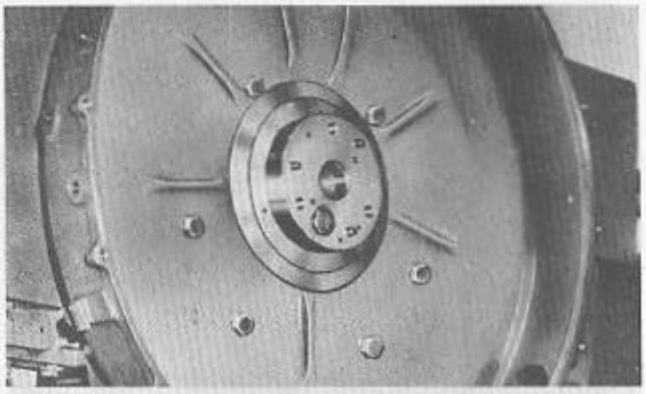


Slide out and remove the main sight driving gear. The inner bearing surface that rides the roller bearing must be inspected for signs of corrosion or pitting.

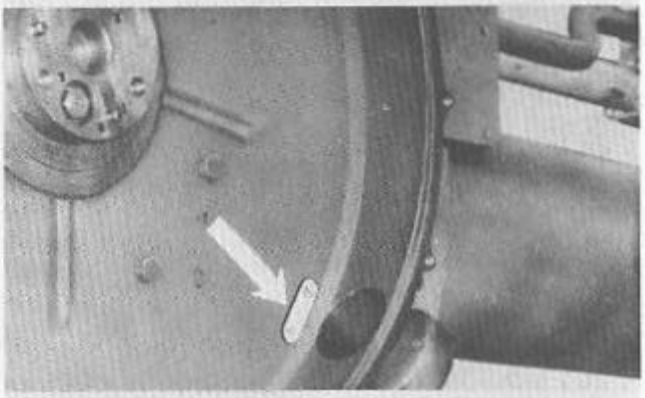


Remove the roller bearing from the trunnion clip. Inspect the rollers for signs of corrosion and pitting. These rollers should be cleaned and lubricated.

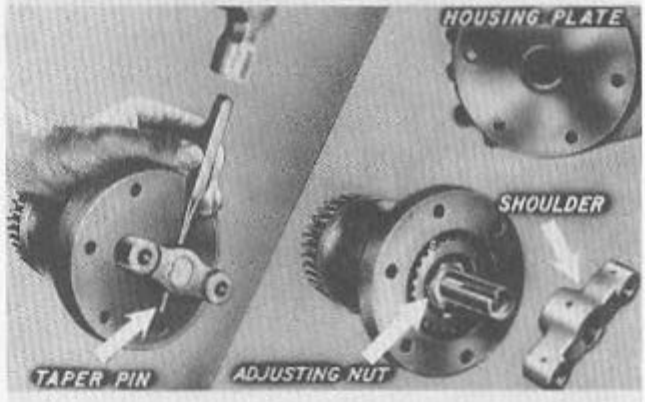
It is seldom necessary to remove the main housing. However, if it must be taken off, it can be freed from the cheek by unscrewing the securing bolts.



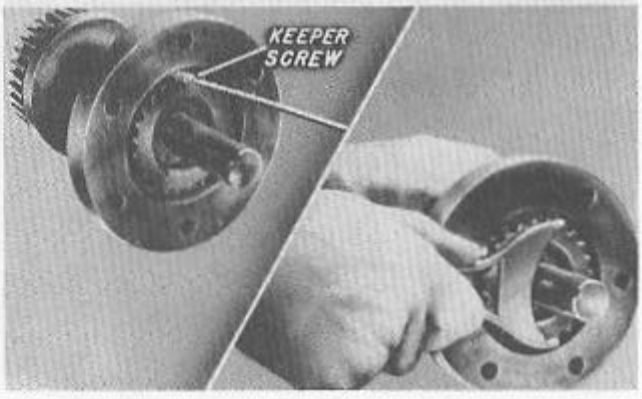
Inspect the brass rubbing pad on the main housing for excessive wear. This rubbing pad is secured to the main housing and bears against the underneath surface of the main sight driving gear. Its purpose is to cause the main sight driving gear to be held in mesh with the elevating pinion. Wear on the rubbing pad is caused by over-tightening of the adjusting nut in the elevating pinion bearing unit which causes the pinion to force the driving gear too tightly against the rubbing pad, and so to wear the pad down as the driving gear moves. A worn pad must be replaced. We have now completely removed the sight-setting mechanism parts from the housing. Before reassembling the cleaned and adjusted parts. . .

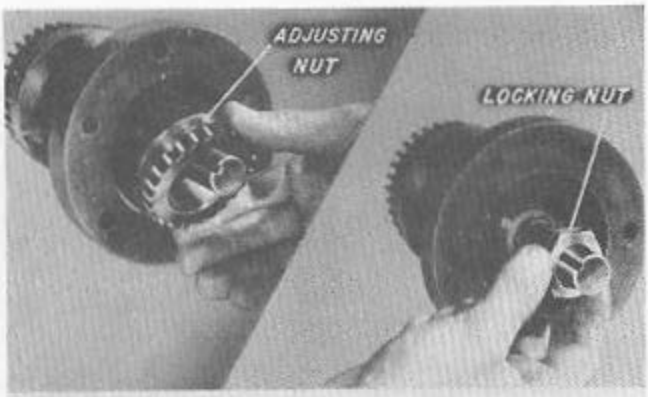


. . .we must overhaul the elevating pinion bearing unit that we set aside earlier. If the bearings bind or the presence of water in the housing is suspected, the unit must be disassembled. The first step in disassembly is to drift out the taper pin securing the coupling shoulder to the shaft. This permits removal of the coupling shoulder and the housing plate to expose the adjusting nut.



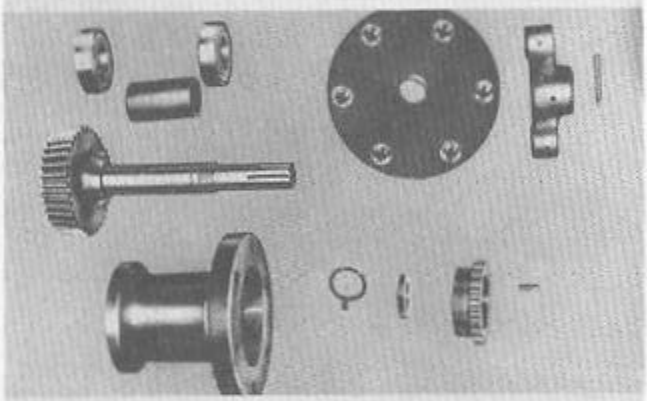
Remove the keeper screw and loosen the adjusting nut with a spanner wrench.



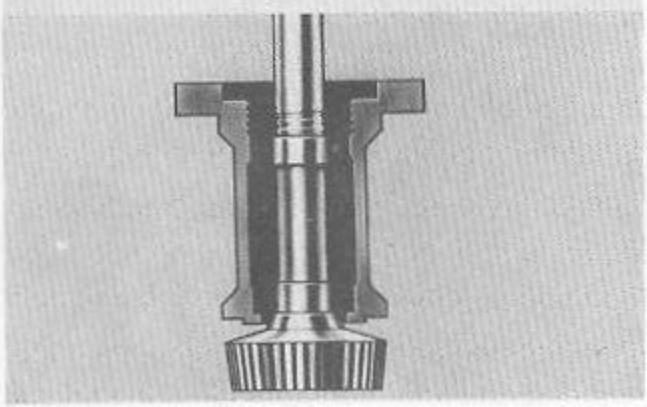


When the adjusting nut is removed, a locking nut and copper lockwasher can be slipped out.

The elevating pinion shaft is then driven out of its housing with a brass drift. After the shaft has been removed, insert a large drift in the pinion end of the housing and, with a couple of light taps, force out the two ball bearings and their spacing sleeve.

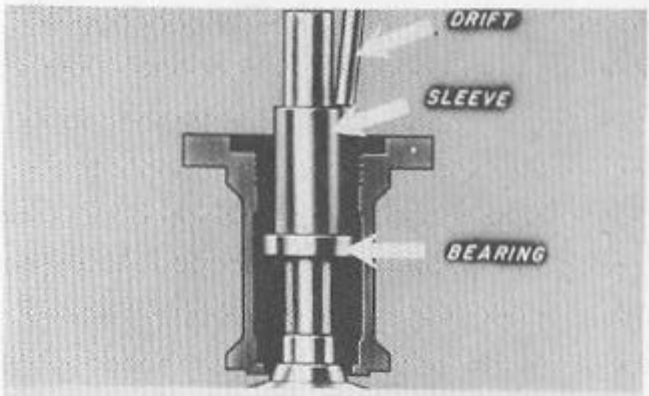


Removing the parts of the elevating pinion bearing unit completes the disassembly of the sight-setting mechanism. After these parts and all other parts removed from the sight setting mechanism have been thoroughly cleaned and lubricated, we are ready to begin the assembly operation.

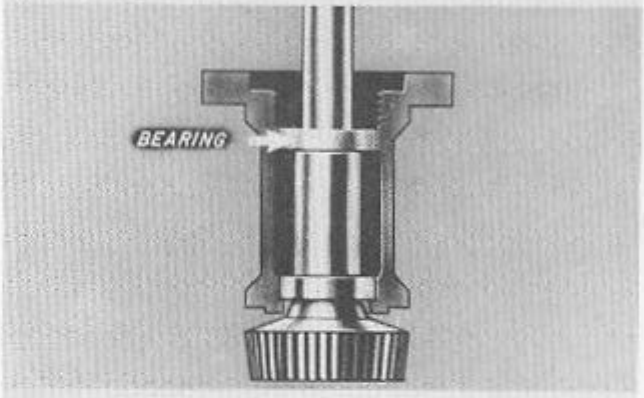


We start assembling with the elevating pinion bearing unit. The initial step is to set the housing around the shaft of the elevating pinion (as shown).

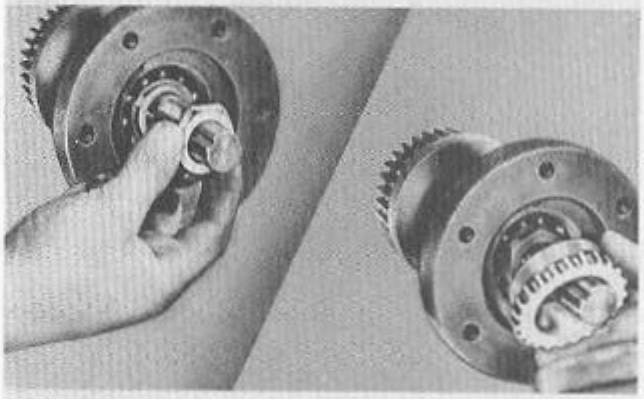
Slip one of the ball bearings and the spacing sleeve over the shaft. Drive the bearing to its seat in the housing with a brass drift.



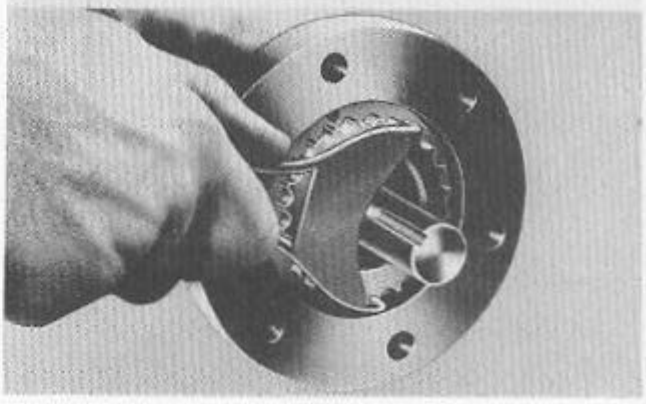
Then slip the other ball bearing over the shaft and push it to its seat in the housing. To secure these in place. . .

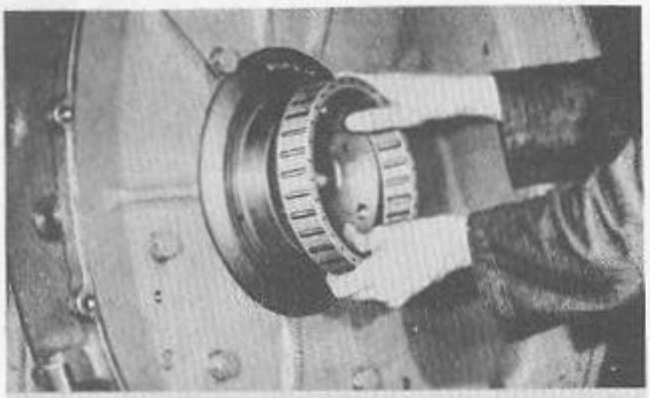


. . .screw the locking nut onto the shaft over the lockwasher and then slip the adjusting nut over the shaft. . .

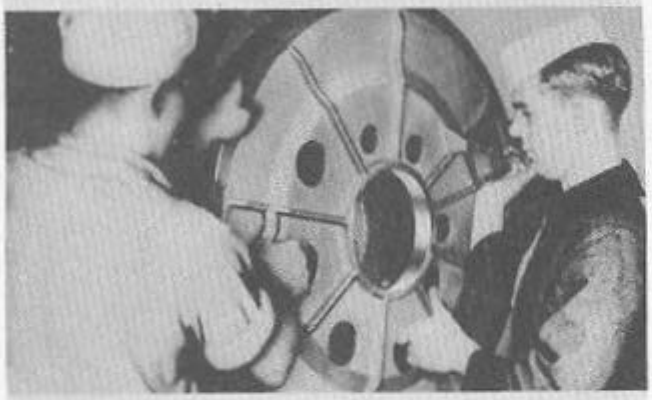


. . .and screw it in. The housing plate and its securing collar are not put in place until the unit is installed in the main housing. The reason for this is to permit access to the adjusting nut so that lost motion may be eliminated.

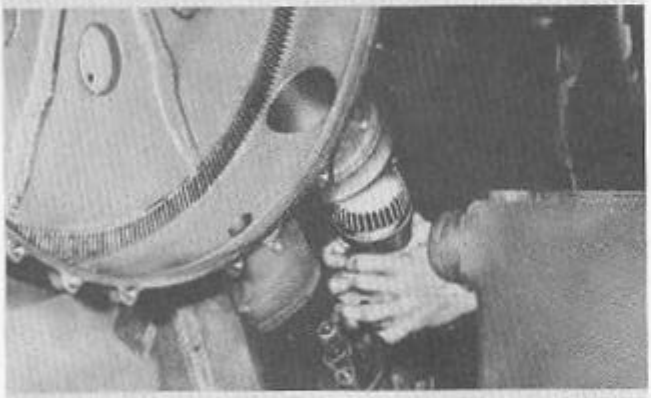




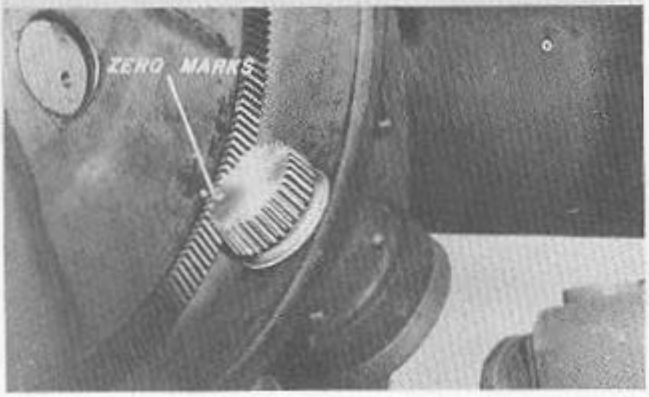
Before assembling the parts back in th housing be sure that the gun is still at zer degrees elevation. Then place the sigh driving gear roller bearing on the trunnio clip.



Set the main sight driving gear in positio on the roller bearing.

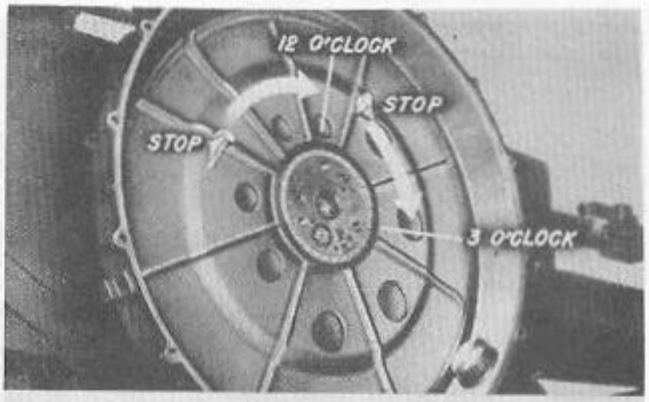


With the sight driving gear in place, positio the elevating pinion assembly in the main housing. To mesh the elevating pinion in proper alignment with the main sight driving gear. . .

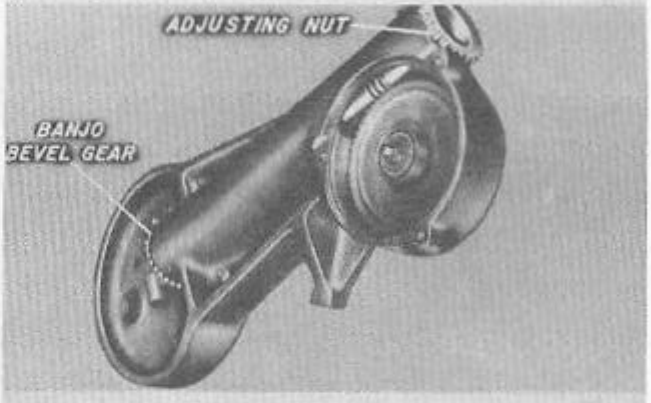


. . .line up the zero mark on the elevating pinion with the zero mark on the main sight driving gear.

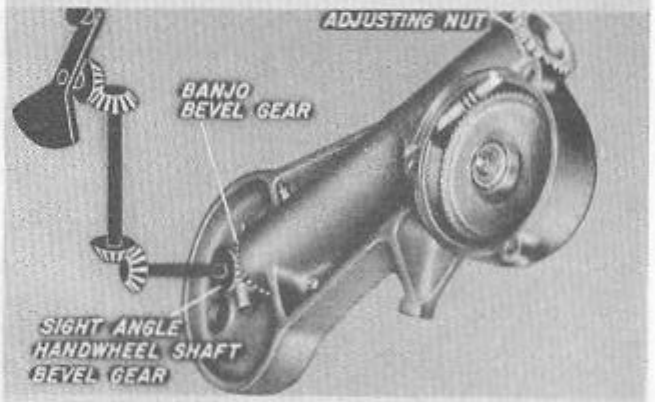
Rotate the driving gear clockwise until the stops come approximately to the twelve o'clock and three o'clock positions. The bearing unit is then temporarily attached with two bolts. We are now ready to mount the banjo.



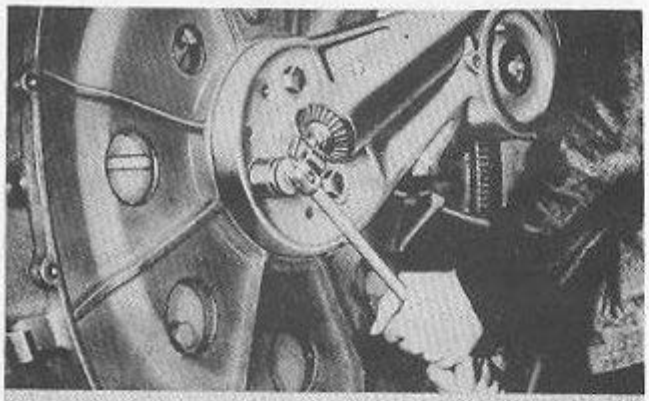
Before the banjo is mounted, a rough adjustment is made to eliminate lost motion between the banjo bevel gear and the sight angle handwheel shaft bevel gear. This adjustment is made by taking up on an adjusting nut at the top of the banjo until the bevel gear just leaves its bearing surface.



The purpose of this adjustment is to force the banjo bevel gear out with the adjusting nut so that when the assembly of the sight-setting mechanism has been completed there will be no play or lost motion between the banjo bevel gear and the sight angle handwheel shaft bevel gear. Unlike the other adjustments, this one must be made by trial and error, because it is impossible to test for lost motion until the assembly has been completed, and then, if further adjustment is necessary, the dial housing will again have to be removed in order to get at the adjusting nut on the banjo. When this adjustment of the bevel gear has been made. . .

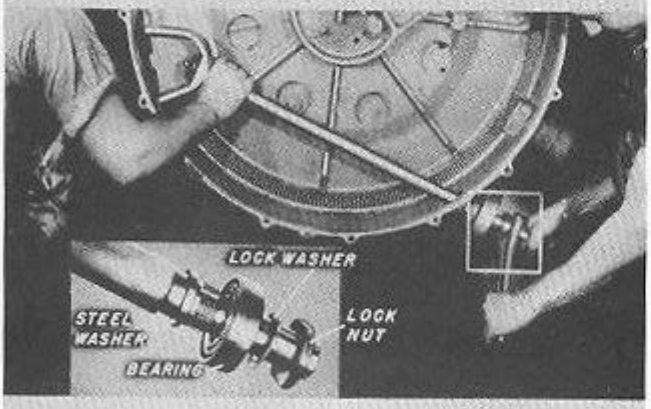


. . .we are ready to mount the banjo. The first step is to set it on the dowel pin.

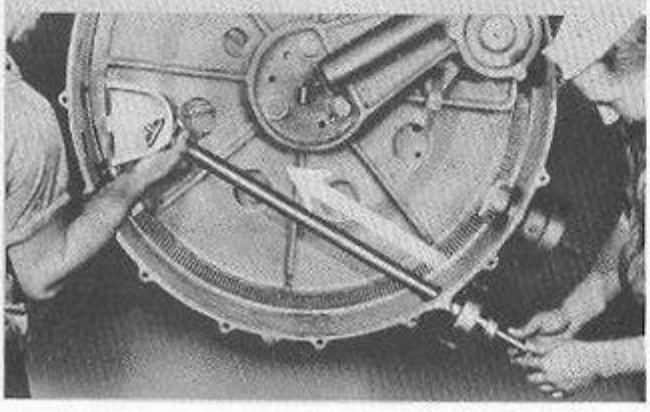


The banjo is then secured to the trunnion b screwing in the mounting bolts. These bolt are tightened in order evenly and a little a a time.

Then, to assemble the azimuth shaft, pass the lower end through its hole in the housing.

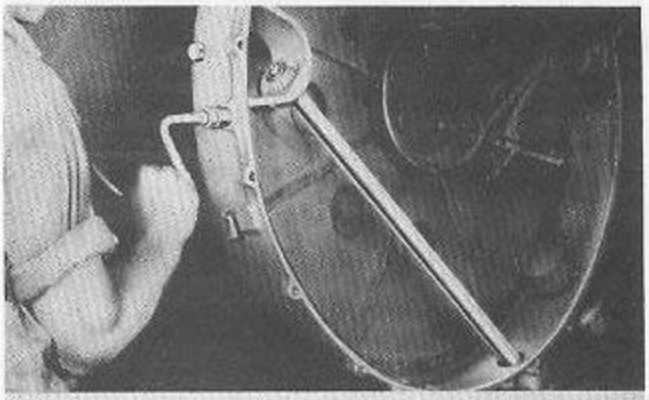


Slide the steel washer, ball bearing, and copper lockwasher over the end of the azimuth shaft and secure them in place with the bearing locknut.



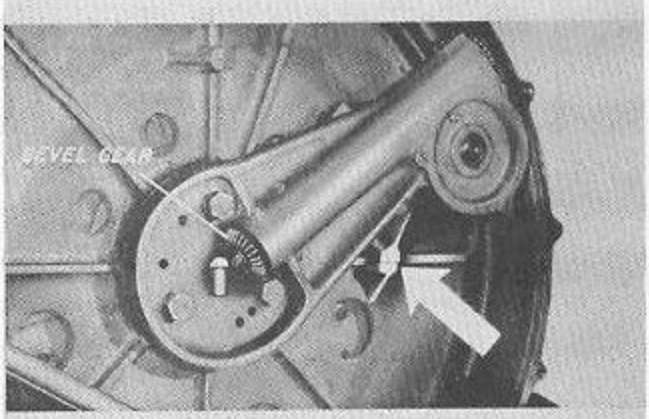
Then pull up the azimuth shaft until the bearing is seated in the housing. . .

. . .and secure the azimuth gear bracket at the upper end of the azimuth shaft to the housing.

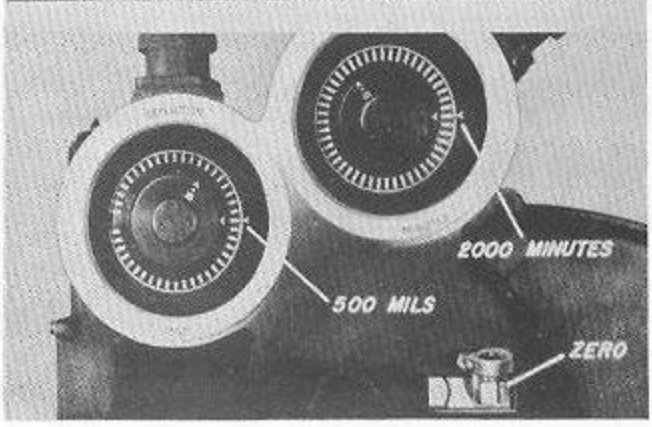


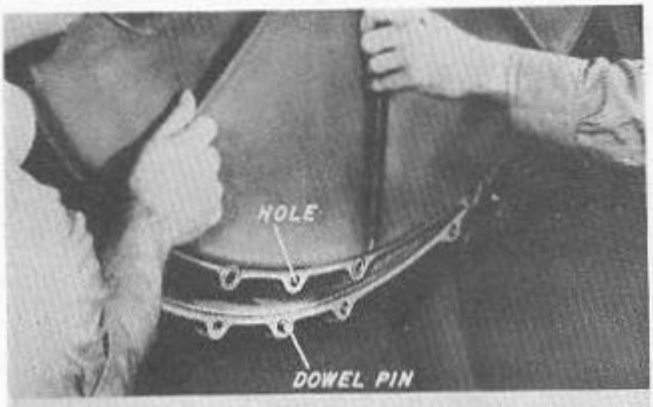
The adjusting nut is then screwed on until the shaft is seated in its bearing. Take up just enough to allow it to rotate freely without play. This completes the azimuth shaft assembly.

To assure proper alignment of the mechanism before putting on the dial housing, rotate the sight driving gear until its stop is about two one-hundredths of an inch below the stop on the banjo. To make this alignment, rotate the bevel gear on the banjo until the stops meet, and then back off one complete turn of the bevel gear.

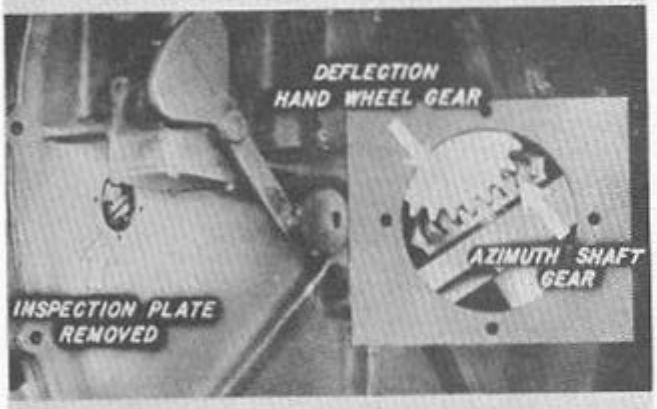


Again, see that the gun is at zero elevation and make sure that the deflection indicator is set at 500 mils, the sight angle indicator at 2,000 minutes, and the range dial at zero. When these adjustments are made. . .

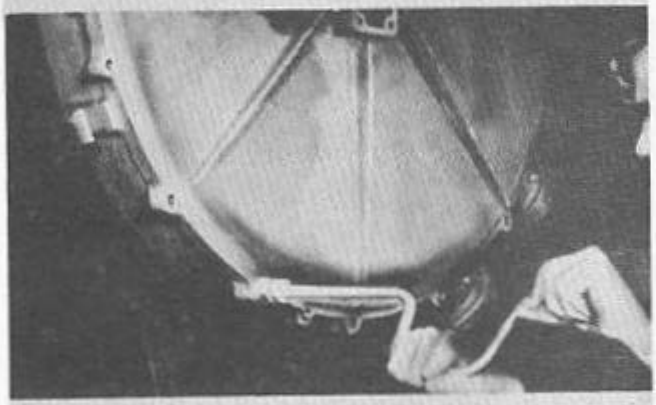




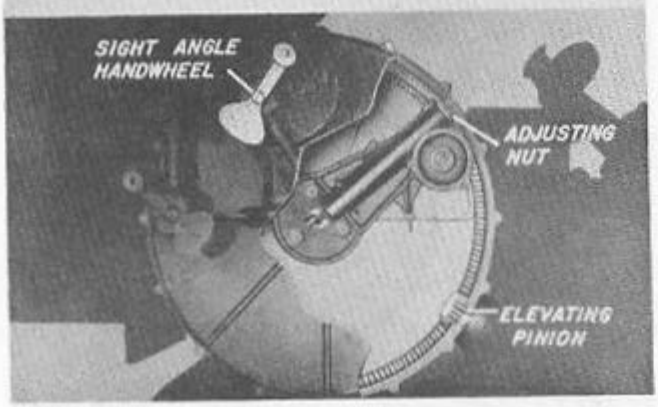
. . .seat the dial housing, matching the hole at its lower edge with the dowel pin in the main housing. This dowel pin serves to guide the dial housing to its proper position over the main housing.



With the inspection plate near the deflection handwheel removed, the bevel gear on the deflection handwheel shaft is lined up with the teeth of the bevel gear on the azimuth shaft. After this has been done. . .



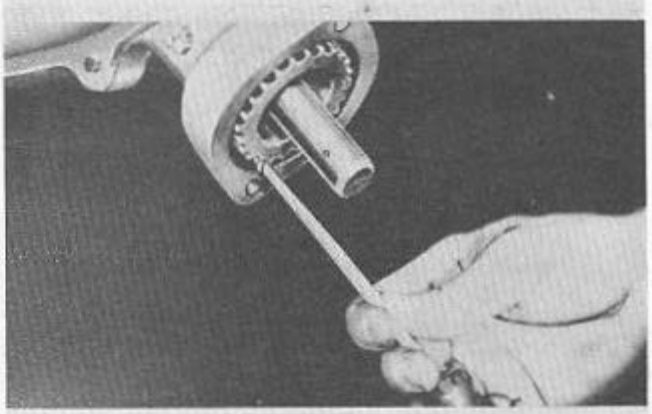
. . .the dial housing is pushed inboard and secured temporarily by three of its mounting bolts and the inspection plate put back in place.



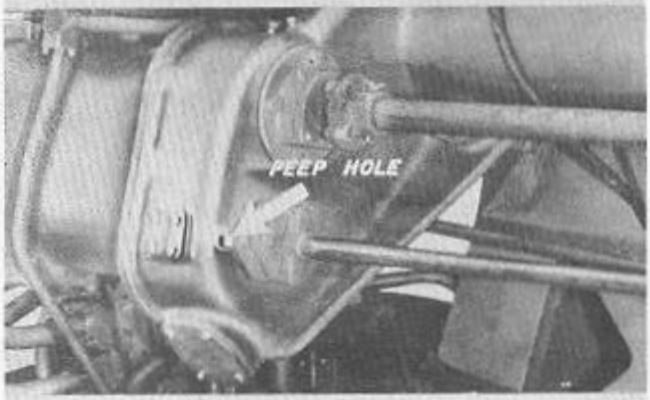
With the dial housing in place the sight angle handwheel shaft bevel gear is now meshed with the banjo bevel gear which we set roughly by means of the banjo adjusting nut when we mounted the banjo. Before securing the housing permanently, test for lost motion between these gears by holding the elevating pinion and moving the sight angle handwheel a little in each direction. The elevating pinion should move at the same instant the handwheel is turned. All other sources of lost motion have now been eliminated. So, if there is any lost motion between the handwheel and the elevation shaft it must be at this point. If the rough adjustment we made has resulted in lost motion between these bevel gears, of if it causes them to bind, the dial housing must be removed so that the adjusting nut can be taken up or slacked off to get the proper adjustment. When these two bevel gears have been properly adjusted. . .

. . .the dial housing is permanently secured by tightening all of its securing bolts.

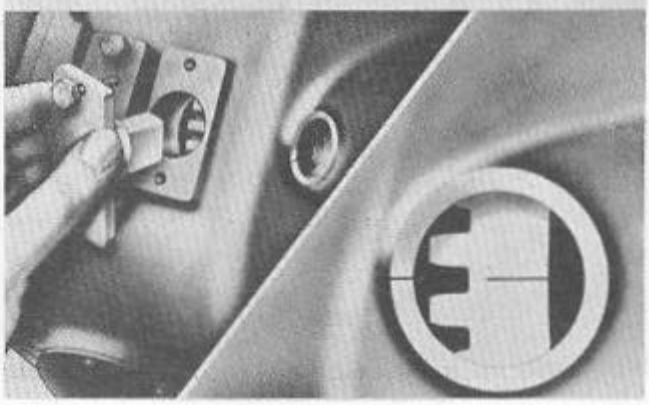
To prevent any lost motion between the bevel gears, this adjusting nut at the end of the azimuth shaft is taken up and secured by its keeper screw. We are now ready to couple to azimuth shaft to its lower section.

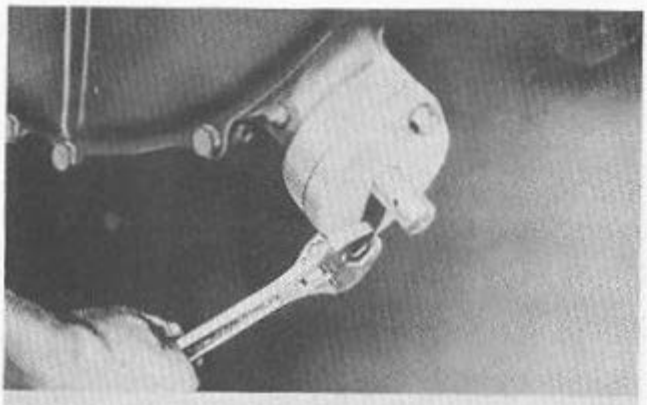


The deflection cross shaft must be lined up properly before the couplings are installed. The alignment is checked through a peep hole on the elevating gear bracket to the left of the azimuth cross shaft.

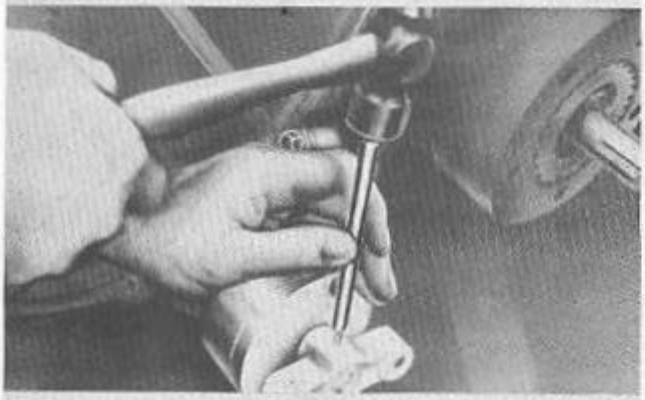


Remove the plate at the front of the elevating gear bracket and the peep hole plug at the side. The lower section of the azimuth shaft is then turned until a scribe mark on the azimuth cross shaft wormwheel matches up with a scribe mark on the edge of the peep hole. Then, to install the azimuth shaft flexible coupling, . . .



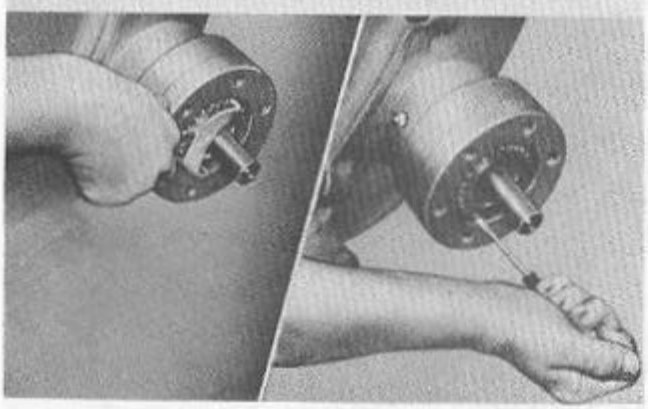


. . .slip the housing plate over the end of the shaft and bolt it on.



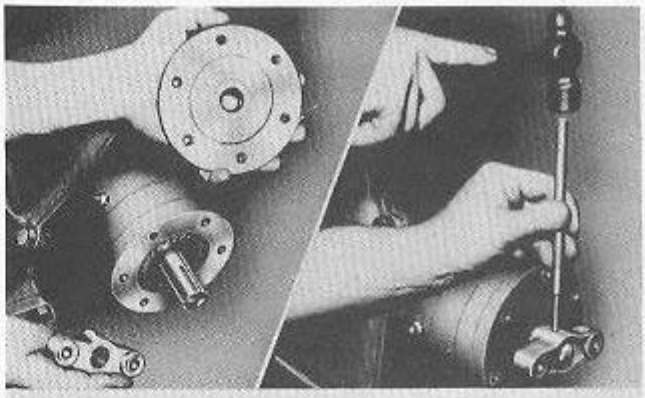
Secure the upper shoulder of the flexible coupling to the end of the azimuth shaft by its taper pin.

The flexible coupling is then secured to its upper shoulder and to the lower section of the azimuth shaft.

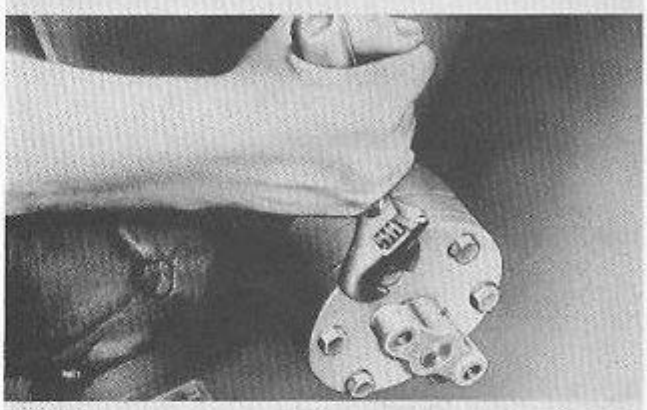


Before securing the elevating pinion shaft to the elevation shaft by its coupling, remove any lost motion between the elevating pinion and the main sight driving gear by taking up on the adjusting nut. This adjusting nut is tightened until lost motion is eliminated. Do not make it so tight it will bind. When properly adjusted, set it with the keeper screw. When lost motion is eliminated. . .

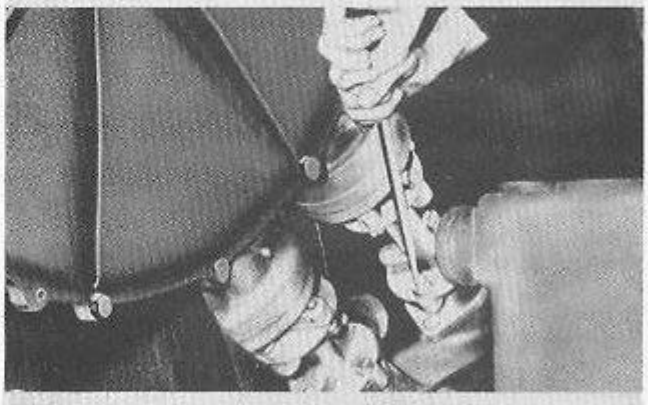
. . .the housing plate and coupling shoulder are set in place on the shaft. The shoulder is secured to the shaft with a taper pin. . .



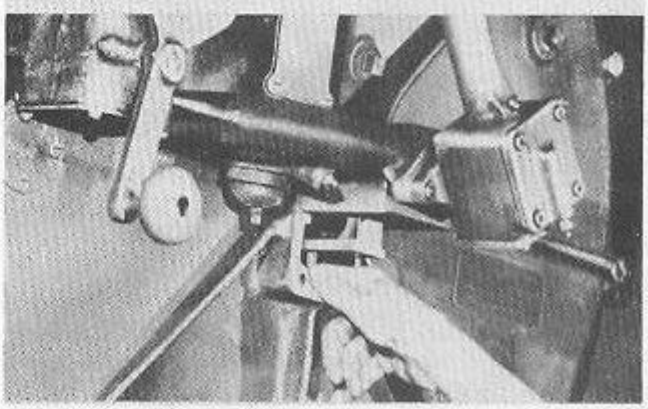
. . .and the housing plate is secured by the cap bolt.

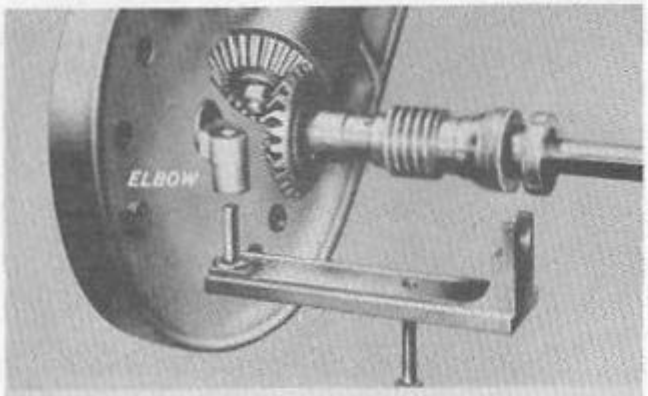


The elevating pinion shaft is then connected to the elevation shaft by the flexible coupling.

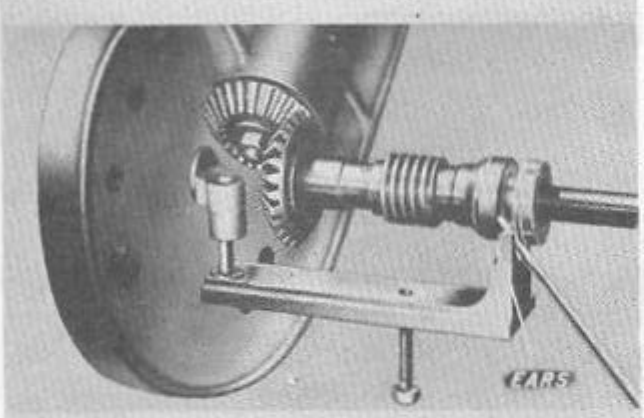


The compensator sliding bar with a bolt attached for a temporary handhold is inserted through the opening in the dial housing.

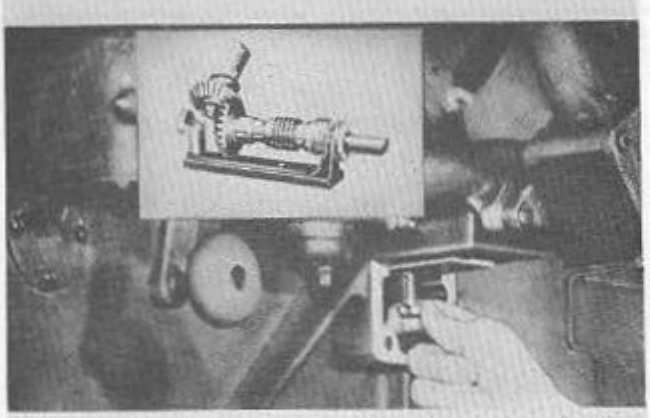




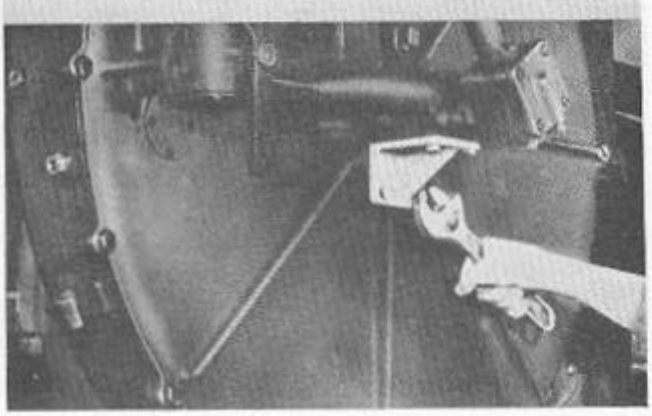
And the pin on the inboard end of the sliding bar is seated in the elbow on the compensator screw.



The ears of the sliding bar are seated in the groove of the sliding worm with the aid of a screwdriver.

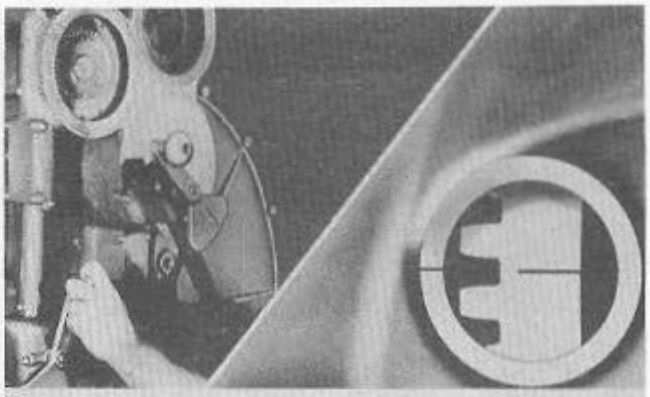


The sliding bar is then pushed upward to engage this slot on the sliding worm, and the temporary handhold bolt is removed.

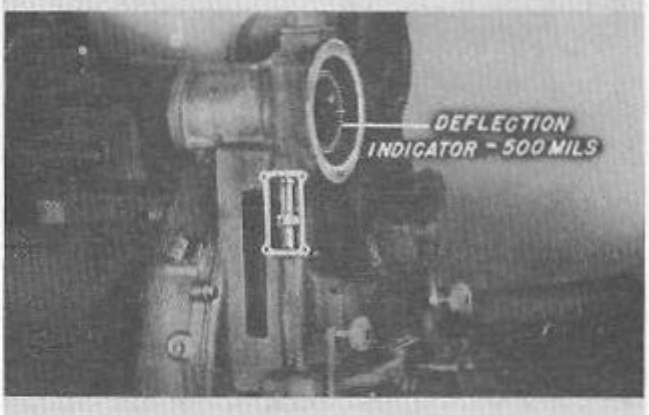


When the compensator sliding bar bracket is secured to the dial housing by its mounting bolts, the reassembly of the sight-setting mechanism is completed.

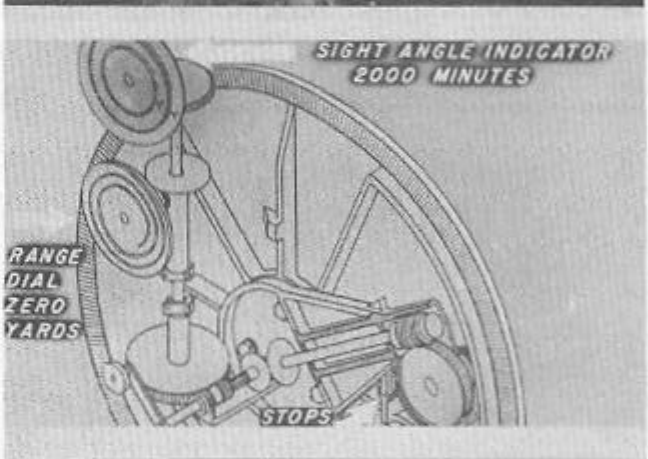
Once again, check the sight angle and deflection dials. To check the setting of the deflection indicator dial, turn the deflection handwheel to match up the scribe mark on the azimuth shaft worm wheel with the scribe mark at the edge of the peep hole.



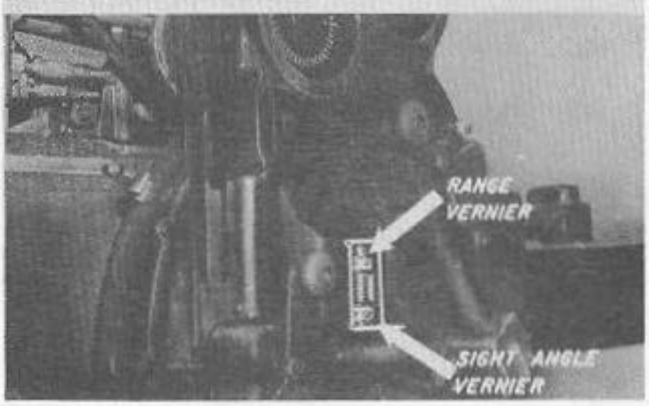
The deflection indicator should now read 500 mils. If it does not, adjust it by means of the vernier coupling on the deflection dial shaft.

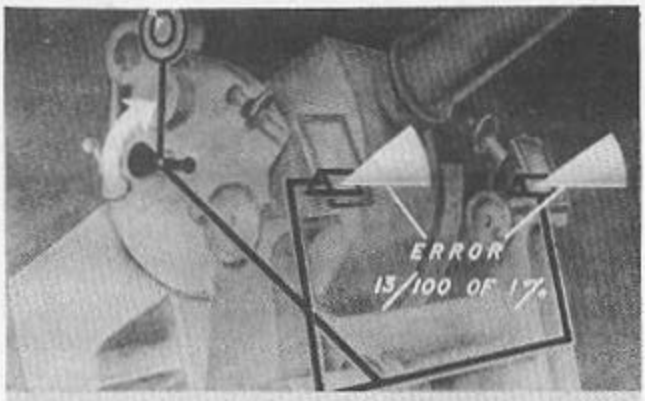


The setting of the sight angle indicator dial is checked by turning the sight angle handwheel counterclockwise until the stops prevent further turning. The handwheel is then turned in the reverse direction one complete revolution. At this time the sight angle indicator dial should read 2,000 minutes and the range dial zero yards. If these dials are off. . .

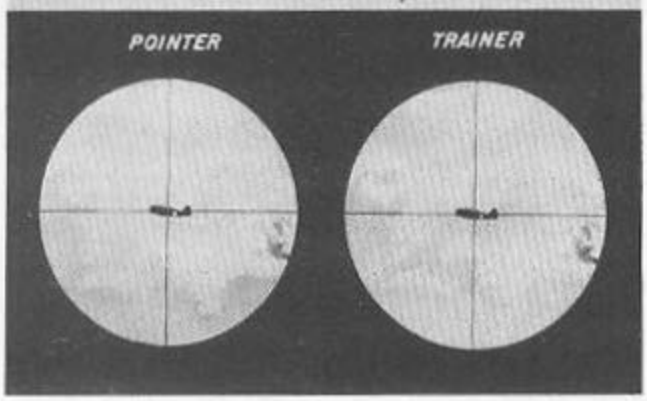


. . .adjust them by setting first the vernier coupling on the range dial shaft and then the vernier coupling on the sight angle dial shaft. When these settings have been made, the dials, the handwheels, and the prisms will be in correct adjustment. Finally, replace the telescopes and check for misalignment and lost motion in the sights and telescopes as outline in OP 735.





The sights are the eyes of the gun. To track a target accurately, the sight-setting mechanism must function smoothly and precisely at all times. We have seen that even errors of thirteen one-hundredths of one percent cannot be tolerated. To correct such an error the compensator screw mechanism is provided. With such a high degree of precision required of the sight-setting mechanism, lost motion in its gearing cannot be allowed.



To maintain the gun, so that when the pointer's and trainer's sights are on the target a hit will be assured, it is essential that the gunner's mate should be thoroughly familiar with the sight mechanism overhaul procedures.