BROWNING AIRCRAFT MACHINE GUN

MODEL OF 1918 M1
.30 CALIBER

AMI DEPOSIT 1969

SERVICE HANDBOOK

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The following publication, entitled "Browning Aircraft Machine Gun, Model of 1918M1, Caliber .30," is published for the information and guidance of all concerned. Errors discovered in it will be promptly reported to The Adjutant General of the Army.

[062.1, A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

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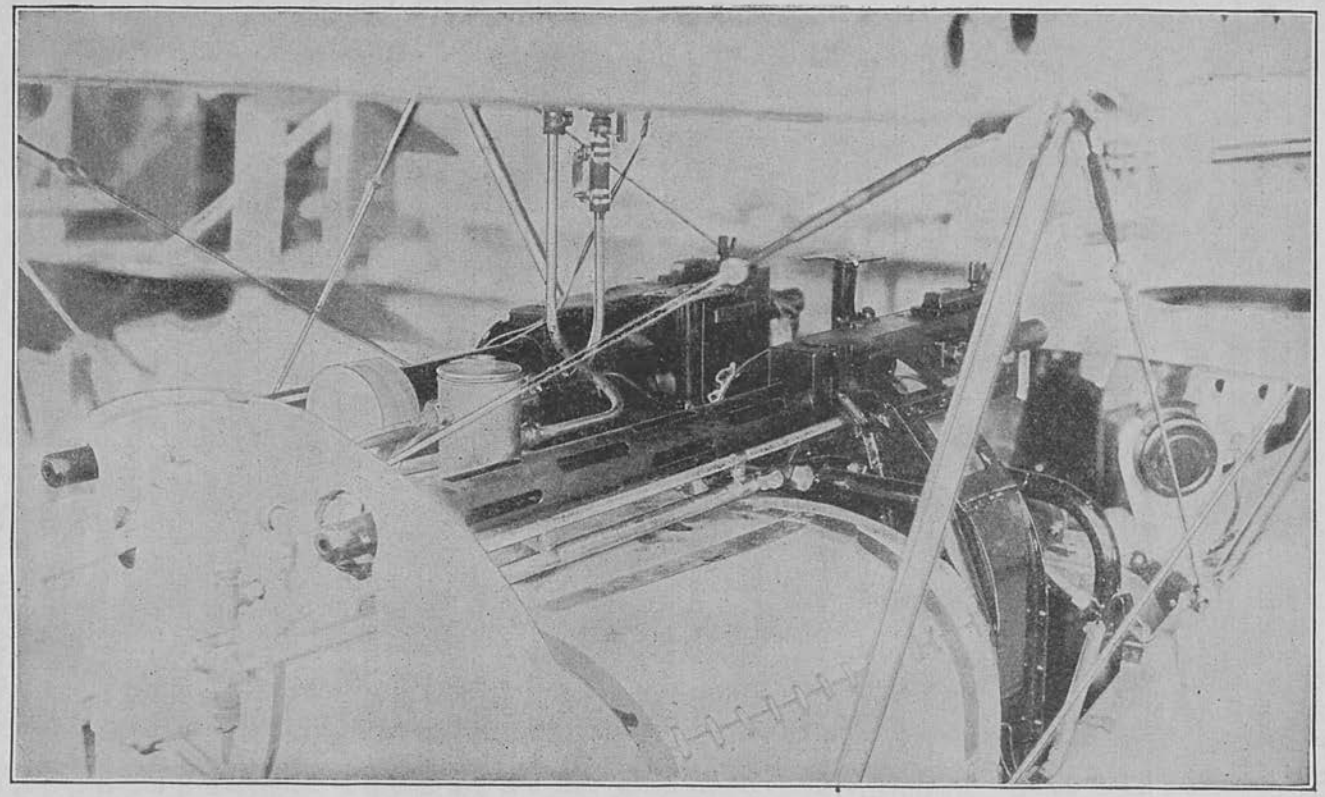


PLATE 1.—Left front view showing installation in U. S. X. B.-1A airplane.

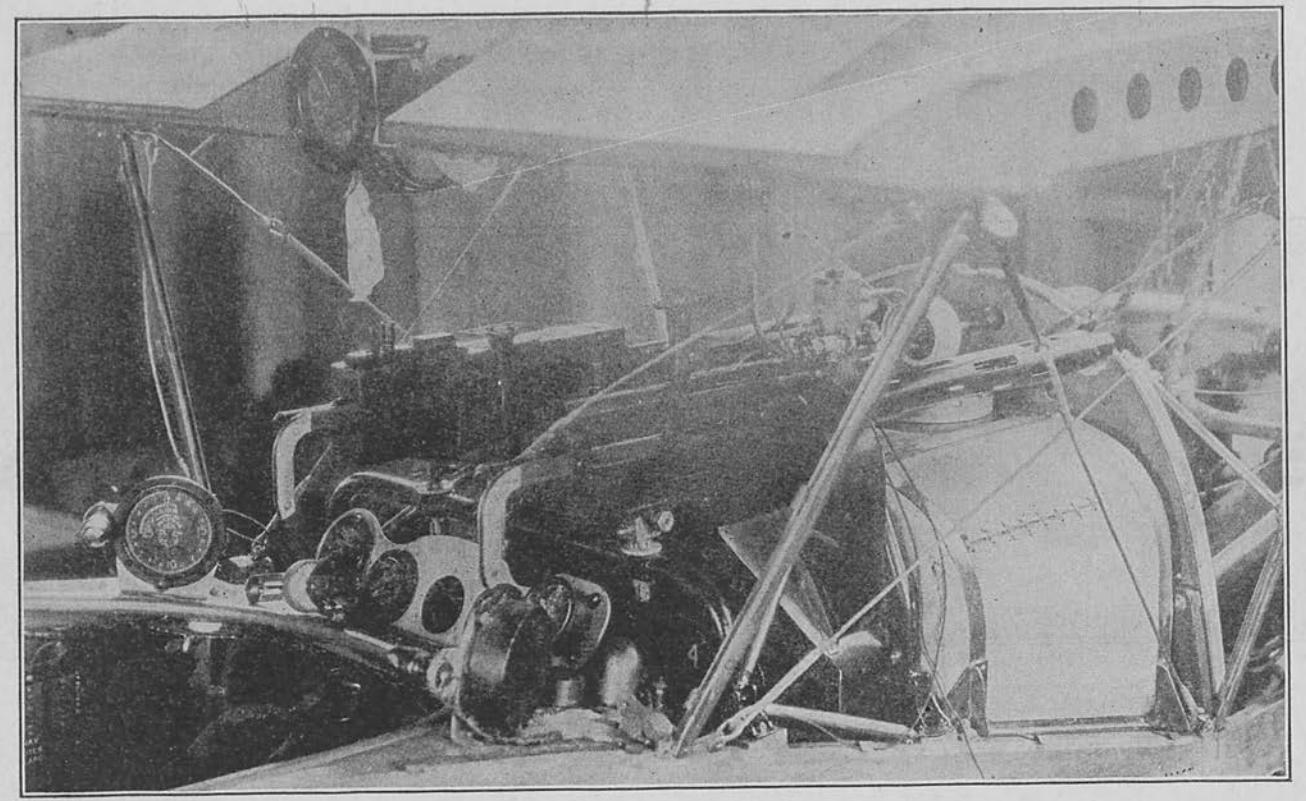


PLATE 2.—Right rear view showing installation in U. S. X. B.–1A airplane.

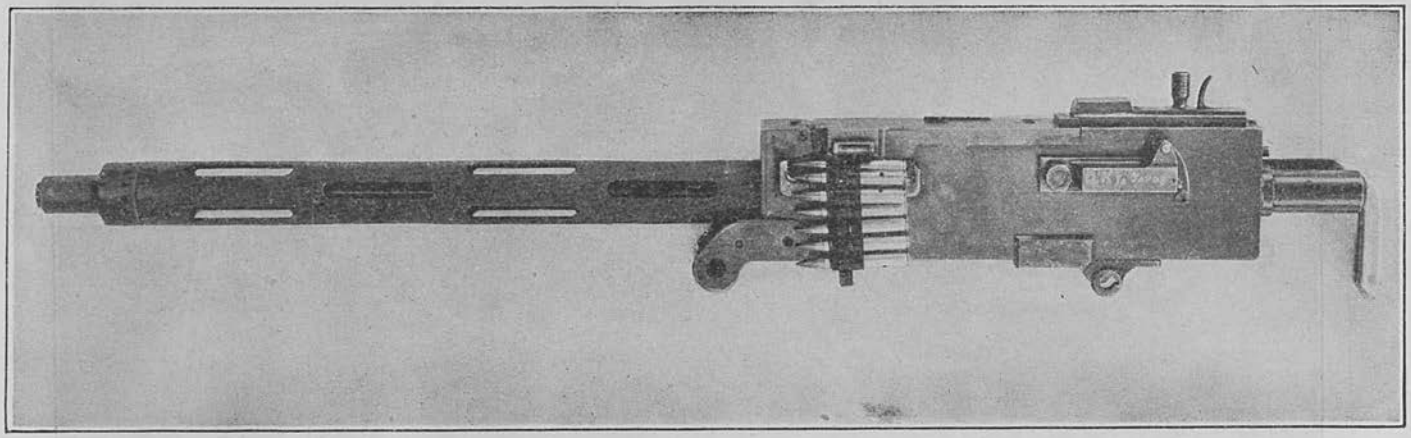


PLATE 3.—Left side view showing ammunition belt and Nelson trigger motor in place.

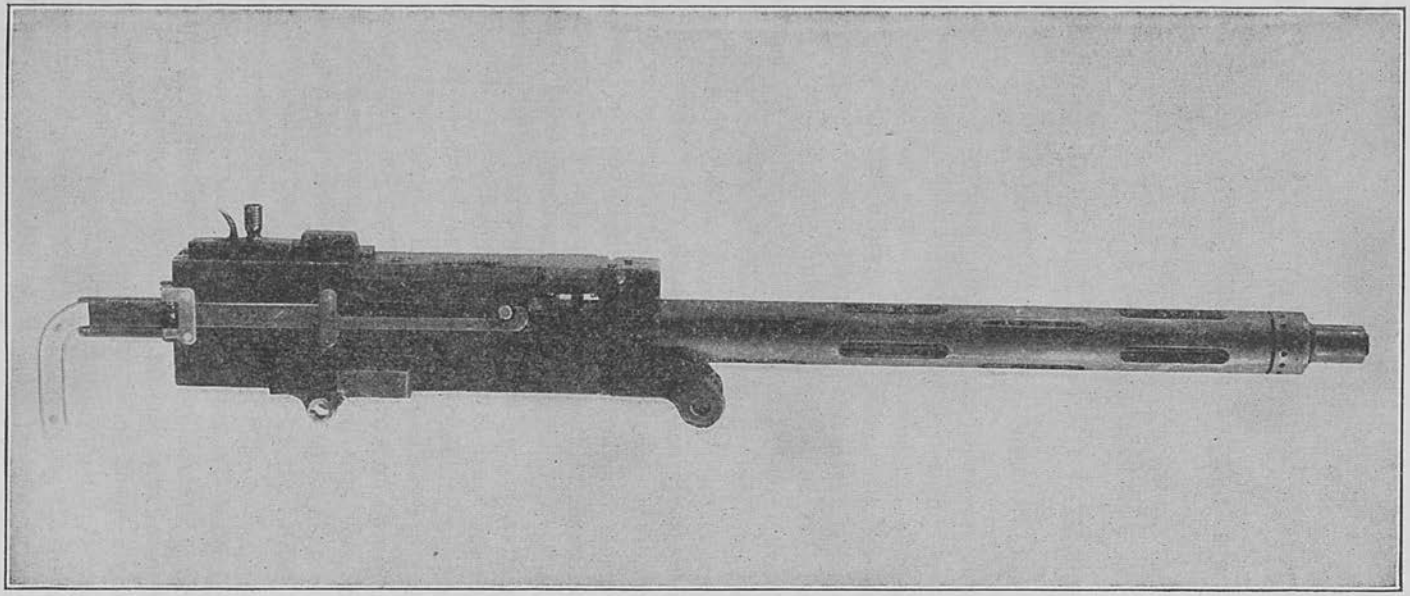


PLATE 4.—Right side view.

BROWNING AIRCRAFT MACHINE GUN.

MODEL OF 1918M1, .30 CALIBER.

CHAPTER I.

GENERAL INFORMATION AND NOMENCLATURE.

A. GENERAL DESCRIPTION.

TYPE.—The Browning aircraft machine gun, model of 1918M1, .30 caliber, is of the heavy type and is designed solely for use as a fixed, synchronized gun. Some experiments have been conducted to determine the feasibility of using it as a flexibly mounted weapon, but the results of these are not yet conclusive. It has been developed from the Browning machine gun, model of 1917, which has been adopted as the standard ground gun for the Army of the United States, and is considered the standard aircraft gun for synchronized fire, although two other types of guns (Marlin and Vickers) are also in use for this purpose and have been produced in considerably greater numbers than the Browning. In developing the aircraft model from the ground gun the changes at first considered necessary were comparatively few, consisting chiefly of substitution of a small, skeletonized barrel jacket for the water jacket, removal of sights and handle grip, and provision of means for operation of the firing mechanism by a synchronizing gear. However, as this development progressed it became evident that, in order to produce a gun satisfactory for the purpose intended, more extensive alterations would be necessary. These further changes are of two classes; those directed toward obtaining a high rate of fire, for which feature a strong demand had arisen, and those having for their objects improvement in functioning and endurance under the added stress imposed by the increased rate of fire, and provision for more convenient mounting and operation. The question of obtaining the highest practicable rate of fire was given consideration first, the means adopted for it being addition of a muzzle attachment to increase the recoiling energy of the barrel, removal of about a pound weight of metal from the bolt, lessening the firing-pin fall, increase in strength of the springs opposing recoil and operating the firing mechanism, and modification of the buffer, first by incorporating in it a heavy coiled spring, and later by use of only disks of fiber. These modifi-

cations resulted in an average rate of automatic fire of from 1,000 to 1,200 rounds per minute and successful firings were conducted experimentally at speeds as high as 1,500 rounds per minute. These experiments showed that a speed of 1,200 rounds per minute could be obtained without sacrifice of reliability, but that higher speeds could be obtained only at the expense of efficiency. Rates of fire between 1,000 and 1,200 rounds per minute have therefore been specified as satisfactory for acceptance of these guns. In the interest of improvement of functioning, many minor changes were found desirable in the course of manufacture and subsequent extended tests conducted principally at Springfield Armory. Other improvements relating to efficiency in mounting and operation have been worked out, including principally re-design of the firing mechanism in order to insure proper functioning at high speeds, application of adapters which locate the mounting pins in positions relative to the feedway for the ammunition belt corresponding to those of the pins of the Vickers and Marlin guns, and addition of an operating slide and handle to facilitate loading, unloading, and reduction of stoppages by the pilot. As a result of all these changes there are now comparatively few parts of the aircraft model which remain exactly like corresponding parts of the ground gun. Operation is of course very much the same, but the two designs have grown entirely apart.

This gun has been manufactured by the Marlin-Rockwell Corporation, New Haven, Conn., and by the New England Westinghouse Co., Springfield, Mass. Remodeling of the entire stock of about 3,000 guns on-hand has been conducted at Springfield Armory.

Operation.—Operation of the gun is effected by recoil due to the explosion of the powder charge in the chamber. The whole barrel and breech closing mechanism is so mounted in the casing that, except for the opposition offered by its recoil springs, it is free to slide a short distance to the rear. During this initial recoil of all of these parts as a unit, the breech is unlocked, the bolt given an added impetus to the rear and the other recoiling parts are latched in their rearward position. The bolt continues in recoil, and during the remainder of its travel the functions of extraction of a cartridge from the belt and the empty case from the chamber, retraction and cocking of the firing mechanism, and retraction of the belt feeding pawls, are accomplished. On the counter recoil movement of the bolt, due to action of the recoil springs, the functions of feeding a cartridge to the chamber, feeding the belt forward one step, ejection of the empty case, and, finally, closing and locking of the breech and release of the safety device of the firing mechanism, are accomplished. When fired by hand the operation of the gun is fully automatic; that is, it is self-operative within the limit of

capacity of the ammunition belt on simply keeping the trigger depressed. When arranged to be fired through the agency of a synchronizing gear, the trigger is not used and the action is then on the semiautomatic or single-shot principle, which requires a separate impulse on the firing mechanism for each shot.

FEEDING.—Feeding is by belt and from the left-hand side only. Either the fabric belt for the Browning machine gun, model of 1917, or the Marlin-Browning disintegrating metallic link belt may be used, but since the link belt is considered standard for aircraft service, it should be used in all firings of the aircraft gun. Alternate right or left hand belt feeding arrangements have not yet been developed for this feeding mechanism. Ejection of the empty end of the belt is from the right, and of empty cartridge cases from the bottom of the casing.

COOLING.—Cooling is by air, although no special means are provided for this purpose. The barrel is plain and rather light and is incased in a small jacket slotted to allow free circulation of the air. The low temperatures encountered at high altitudes, together with the great cooling effect due to the air circulation set up by the rapid motion of the plane, effectually prevent overheating of the barrel. Moreover, bursts of fire are almost invariably of short duration in aerial combat, and this fact tends to remove still further the possibility of overheating. Stoppage from this cause is very unlikely, but in some cases it has been found that extremely low temperatures lead to improper functioning. This has been remedied by the application of electric heaters, and heaters of this kind are available for use with the Browning gun. Extensive tests, however, seem to indicate that they are unnecessary for this weapon because of the large margin of energy provided for its operation.

MOUNTING.—Mounting is for fixed synchronized fire, the guns being used either singly or in pairs, and the mounts arranged to locate them either on or within the cowling. The mounts are rigid with respect to the plane, and the guns fire straight ahead, parallel, or nearly so, to the line of flight, and directly through the field swept by the propeller. Aiming is accomplished by directing the plane itself at the target. Fire is controlled so as to miss the propeller blades by action of the synchronizing gear, which is the device operating between the engine and the gun for this purpose.

B. GENERAL DATA.

Weight of gun complete	pounds	24.5
Over-all length	inches	40.2
Length of barrel	do	24
Recoil of bolt	do	4.4
Rate of automatic fire	rounds per minute	1,000–1,200

Space to rear of gun required for removing barrel——inches——	30
Space above gun required to open cover——do——	8
Muzzle velocity of bullet——feet per second (calculated)——	2,700
Weight of complete round of ammunition——grains——	395
Weight of metallic belt link——do——	65
Number of cartridges loaded in belt per pound——	15
Maximum length of cartridge——inches——	3.34
Maximum diameter of link loops with cartridge inserted——do——	.505
Length of metallic belt link——do——	1.05
Feeding: By belt, left hand only.	
Ejection: Cartridge cases, bottom.	
Ejection: Links, right-hand side.	
Trunnion reaction in automatic fire——pounds——	110
Cooling: By air.	
Type: Heavy, semi-automatic, for synchronized fire.	

C. ALPHABETICAL NOMENCLATURE.

Name of part.	Piece mark.	No. required.
Accelerator	15-A	1
Accelerator pin	8-B	1
Accelerator-pin spring	8-D	1
Accelerator stop	14-E	1
Adjusting screw	20-H	1
Adjusting-screw plunger	20-G	1
Adjusting-screw plunger spring	20-F	1
Back plate	20-A	1
Back plate dowel	20-B	1
Barrel	5-A	1
Barrel extension	7-A	1
Barrel jacket	6-C	1
Barrel-locking spring	8-A	1
Barrel plunger	15-D	1
Barrel-plunger guide pin	15-F	1
Barrel-plunger spring	15-E	1
Barrel-plunger stud	8-C	1
Belt-feed lever	18-A	1
Belt-feed lever pivot	18-B	1
Belt-feed lever pivot spring	18-C	1
Belt-feed pawl	18-D	1
Belt-feed pawl pin	19-E	1
Belt-feed pawl spring	19-D	1
Belt-feed pawl-spring stud	19-F	1
Belt-feed slide	18-E	1
Belt-holding pawl	25-G	1
Belt-holding pawl bracket	25-H	1
Belt-holding pawl-bracket rivet	25-F	4
Belt-holding pawl pin	25-D	1
Belt-holding pawl spring	25-E	1
Bolt	9-A	1
Bolt handle	11-C	1
Bolt stud	11-D	1
Bottom plate	23-B	1
Bottom-plate dowel	23-A	4
Breech lock	8-E	1
Breech-lock cam	23-F	1
Breech-lock cam screw	23-G	1
Breech-lock pin	8-B	1
Breech-lock pin spring	8-D	1
Buffer disk, thick	20-C	6
Buffer disk, thin	20-D	7
Buffer plate	20-L	1
Buffer tube	20-K	1
Cartridge stop, front	27-B	1
Cartridge stop, rear	27-C	1
Cartridge stop, rear, rivet	27-A	1
Cocking lever	10-B	1
Cocking-lever pin	11-H	1
Cover	16-A	1
Cover-extractor cam	17-A	1
Cover-extractor cam rivet, long	17-C	1
Cover-extractor cam rivet, short	17-B	1
Cover-extractor spring	17-D	1
Cover-extractor spring stud	17-E	1
Cover pin	19-C	1
Cover plate	19-A	1
Cover-plate rivet	19-B	2
Driving spring	11-E	1
Driving-spring rod	11-F	1
Driving-spring rod pin	11-G	1
Ejector	12-D	1
Ejector pin	12-B	1
Extractor	12-A	1
Extractor cam	25-B	1
Extractor-cam plunger	12-C	1
Extractor-cam plunger pin	12-B	1
Extractor-cam plunger spring	12-E	1
Extractor-cam rivet	25-C	1
Extractor feed cam	25-A	1
Extractor feed-cam rivet	25-C	1
Firing pin	10-A	1
Firing-pin spring	11-A	1
Firing-pin spring pin	11-B	1
Feed-pawl pin spring	8-D	1
Hand firing pin	13-A	1
Hand sear	13-D	1
Hand-sear slide (obsolete part)		
Hand-sear spring	13-B	1
Hand-sear spring pin	13-C	1
Latch	22-A	1
Latch spring	22-E	1
Latch-spring handle	22-B	1
Latch-spring handle rivet	22-C	2
Latch-spring rivet	22-D	2
Latch stop screw	20-E	1
Link guide	27-D	1
Lock frame, right-hand	14-A	1
Lock frame, left-hand	14-B	1
Lock-frame guide pin	14-D	2
Lock-frame rivet	14-G	1
Lock-frame separator	14-F	1
Lock-frame spacer	14-C	1
Lock-frame spacer rivet	14-G	1
Muzzle attachment	6-A	1
Muzzle-attachment plug	6-B	1
Operating handle grip, right-hand	29-B	1
Operating handle grip, left-hand	29-C	1
Operating handle-grip rivet	29-D	2
Operating handle-grip washer	29-E	2
Operating slide	29-A	1
Operating-slide guide, front	28-A	1
Operating-slide guide, rear	28-B	1
Operating-slide guide spacer	28-C	2
Operating-slide guide rivet	28-D	4
Operating-slide plunger	28-F	1
Operating-slide plunger spring	28-E	1
Operating-slide stop, front	29-F	1

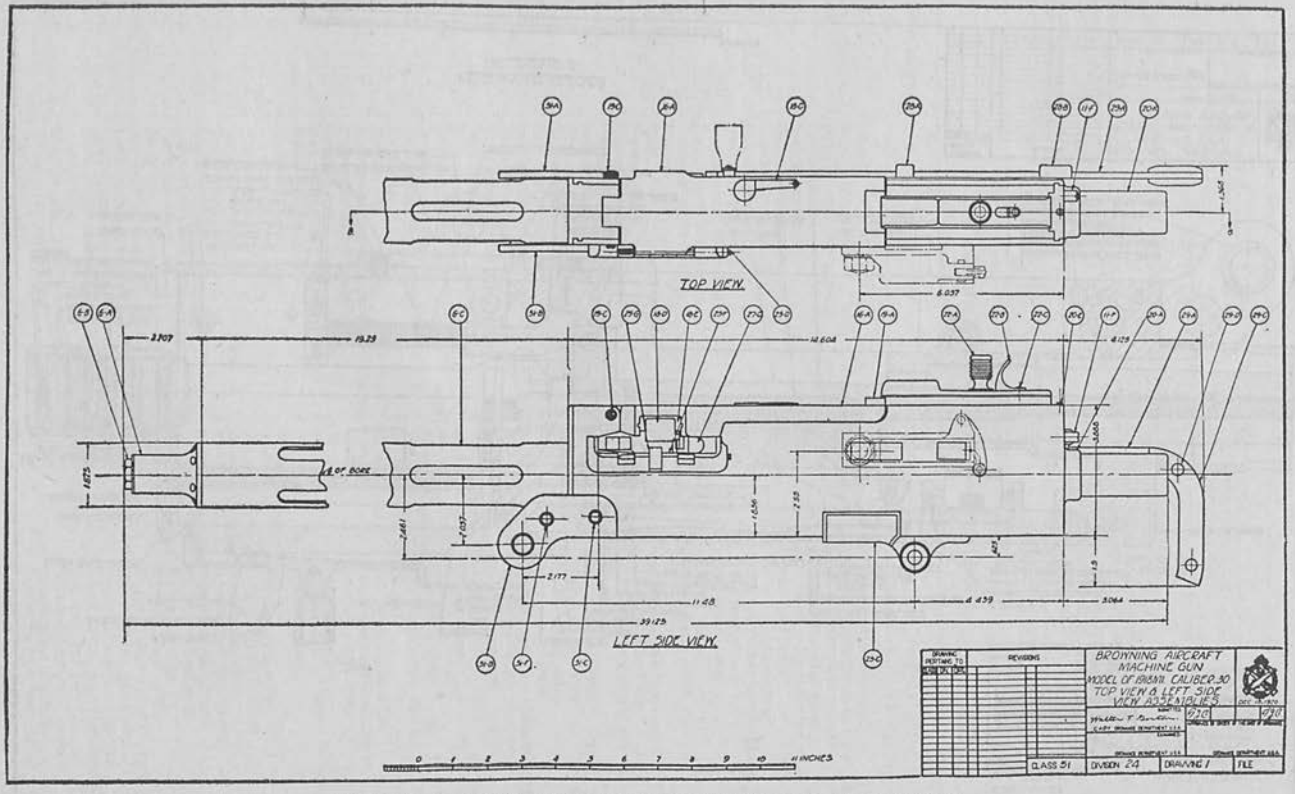


PLATE 5.—Left side view showing important external dimensions.

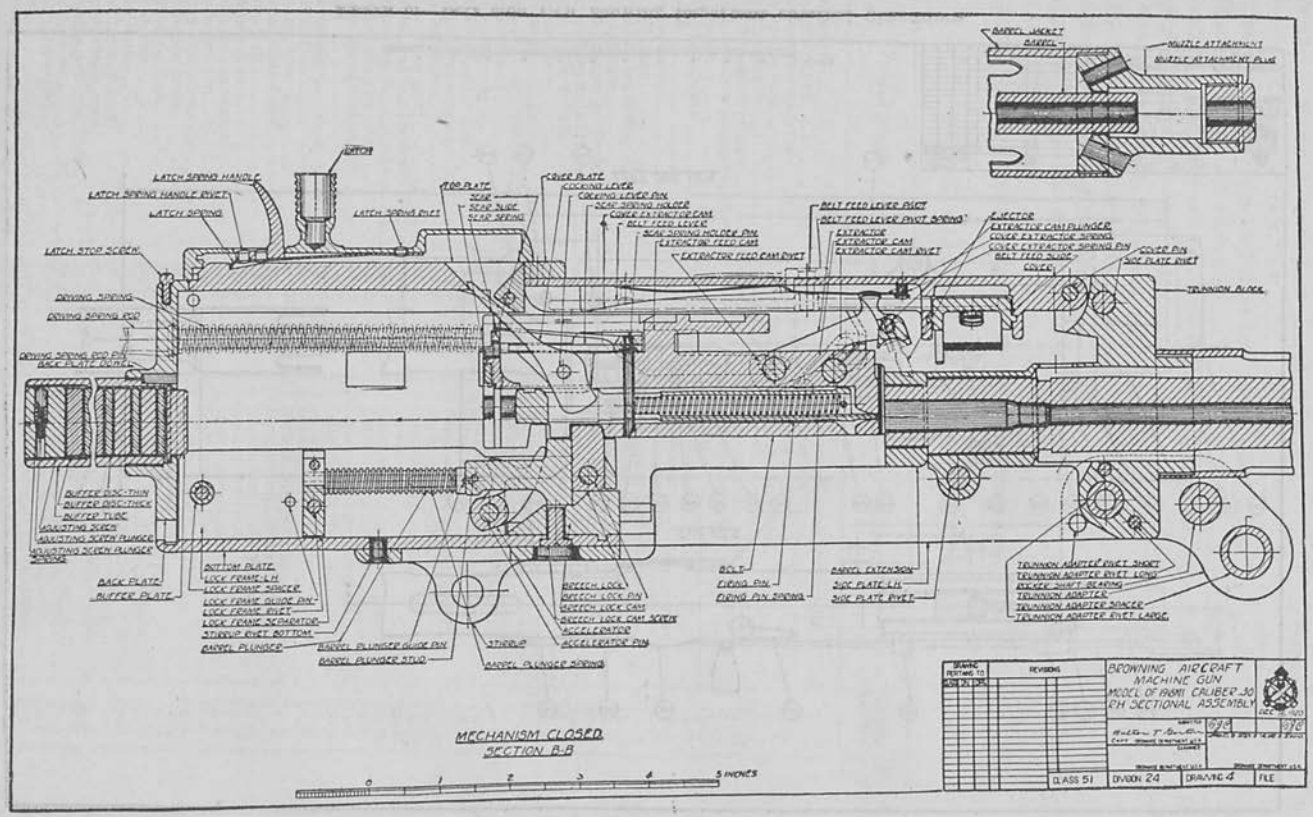


PLATE 6.—Right side sectional view showing part names.

C. Alphabetical nomenclature—Continued.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Operating-slide stop, rear	29-G	1	Top plate	21-A	1
Operating-slide plunger stop	28-G	1	Top-plate rivet, long	21-B	1
Rocker-shaft bearing	31-F	1	Top-plate rivet, short	21-C	2
Sear	10-E	1	Trigger	13-E	1
Sear slide	10-D	1	Trigger pin	15-B	1
Sear spring	10-F	1	Trigger-pin spring	15-C	1
Sear-spring holder	10-H	1	Trunnion adapter, right hand	31-A	1
Sear-spring pin	10-G	1	Trunnion adapter, left hand	31-B	1
Side plate, right hand	26-A	1	Trunnion, adapter rivet, large	31-C	1
Side plate, left hand	24-A	1	Trunnion-adapter rivet, long	31-D	2
Side-plate rivet	27-E	2	Trunnion-adapter rivet, short	31-E	2
Stirrup	23-C	1	Trunnion-adapter spacer	31-G	1
Stirrup rivet, side	23-D	4	Trunnion block	30-A	1
Stirrup rivet, bottom	23-E	2			

D. NUMERICAL NOMENCLATURE.

Piece mark.	Name of part.	Piece mark.	Name of part.
5-A	Barrel.	17-A	Cover-extractor cam.
6-A	Muzzle attachment.	17-B	Cover-extractor cam rivet, short.
6-B	Muzzle-attachment plug.	17-C	Cover-extractor cam rivet, long.
6-C	Barrel jacket.	17-D	Cover-extractor spring.
7-A	Barrel extension.	17-E	Cover-extractor spring stud.
8-A	Barrel-locking spring.	18-A	Belt-feed lever.
8-B	Accelerator pin.	18-B	Belt-feed lever pivot.
8-B	Breech-lock pin.	18-C	Belt-feed lever pivot spring.
8-C	Barrel-plunger stud.	18-D	Belt-feed pawl.
8-D	Accelerator-pin spring.	18-E	Belt-feed slide.
8-D	Breech-lock pin spring.	19-A	Cover plate.
8-D	Feed-pawl pin spring.	19-B	Cover-plate rivet.
8-E	Breech lock.	19-C	Cover pin.
9-A	Bolt.	19-D	Belt-feed pawl spring.
10-A	Firing pin.	19-E	Belt-feed pawl pin.
10-B	Cocking lever.	19-F	Belt-feed pawl-spring stud.
11-H	Cocking-lever pin.	20-A	Back plate.
10-D	Sear slide.	20-B	Back-plate dowel.
10-E	Sear.	20-C	Buffer disk, thick.
10-F	Sear spring.	20-D	Buffer disk, thin.
10-G	Sear-spring pin.	20-E	Latch stop screw.
10-H	Sear-spring holder.	20-F	Adjusting-screw plunger spring.
11-A	Firing-pin spring.	20-G	Adjusting-screw plunger.
11-B	Firing-pin spring pin.	20-H	Adjusting screw.
11-C	Bolt handle.	20-K	Buffer tube.
11-D	Bolt stud.	20-L	Buffer plate.
11-E	Driving spring.	21-A	Top plate.
11-F	Driving-spring rod.	21-B	Top-plate rivet, long.
11-G	Driving-spring rod pin.	21-C	Top plate rivet, short.
12-A	Extractor.	22-A	Latch.
12-B	Ejector pin.	22-B	Latch-spring handle.
12-B	Extractor-cam plunger pin.	22-C	Latch-spring handle rivet.
12-C	Extractor-cam plunger.	22-D	Latch-spring rivet.
12-D	Ejector.	22-E	Latch spring.
12-E	Extractor-cam plunger spring.	23-A	Bottom-plate dowel.
13-A	Hand firing pin.	23-B	Bottom plate.
13-B	Hand-sear spring.	23-C	Stirrup.
13-C	Hand-sear spring pin.	23-D	Stirrup rivet, side.
13-D	Hand sear.	23-E	Stirrup rivet, bottom.
	Hand-sear slide (obsolete part).	23-F	Breech-lock cam.
13-E	Trigger.	23-G	Breech-lock cam screw.
14-A	Lock frame, right hand.	24-A	Side plate, left hand.
14-B	Lock frame, left hand.	25-A	Extractor feed cam.
14-C	Lock-frame spacer.	25-B	Extractor cam.
14-D	Lock-frame guide pin.	25-C	Extractor-cam rivet.
14-E	Accelerator stop.	25-C	Extractor feed-cam rivet.
14-F	Lock-frame separator.	25-D	Belt-holding pawl pin.
14-G	Lock-frame rivet.	25-E	Belt-holding pawl spring.
14-G	Lock-frame spacer rivet.	25-F	Belt-holding pawl-bracket rivet.
15-A	Accelerator.	25-G	Belt-holding pawl.
15-B	Trigger pin.	25-H	Belt-holding pawl bracket.
15-C	Trigger-pin spring.	26-A	Side plate, right hand.
15-D	Barrel plunger.	27-A	Cartridge stop, rear, rivet.
15-E	Barrel-plunger spring.	27-B	Cartridge stop, front.
15-F	Barrel-plunger guide pin.	27-C	Cartridge stop, rear.
16-A	Cover.	27-D	Link guide.

D. Numerical nomenclature—Continued.

Piece mark.	Name of part.	Piece mark.	Name of part.
27-E	Side-plate rivet.	29-E	Operating handle-grip washer.
28-A	Operating-slide guide, front.	29-G	Operating-slide stop, rear.
28-B	Operating-slide guide, rear.	29-F	Operating-slide stop, front.
28-C	Operating-slide guide spacer.	30-A	Trunnion block.
28-D	Operating-slide guide rivet.	31-A	Trunnion adapter, right hand.
28-E	Operating-slide plunger spring.	31-B	Trunnion adapter, left hand.
28-F	Operating-slide plunger.	31-C	Trunnion-adapter rivet, large.
28-G	Operating-slide plunger stop.	31-D	Trunnion-adapter rivet, long.
29-A	Operating slide.	31-E	Trunnion-adapter rivet, short.
29-B	Operating handle grip, right hand	31-F	Rocker-shaft bearing.
29-C	Operating handle grip, left hand.	31-G	Trunnion-adapter spacer.
29-D	Operating handle-grip rivet.		



PLATE 7.—Method of assembling driving spring to bolt.

Chapter II.

STRIPPING AND ASSEMBLING.

Dismounting is considered to involve removal of parts to the extent required for ordinary cleaning and for minor repairs. Stripping involves complete disassembling of all components. All dismounting necessary for cleaning and replacement of parts, as well as permissible stripping, can be accomplished without tools except the combination tool provided. Practice in this procedure is very valuable in gaining a good understanding of the functions the various parts perform, but should be carried on more with the idea of training in precision of movement than that of obtaining great speed. The order of dismounting the various parts is as follows:

Retract the latch and open the cover.
Retract the bolt and lock in its rear position.
Lock the driving spring in the bolt and move the bolt forward slightly.
Remove the back plate complete.
Remove the bolt handle (or stud).
Remove the bolt complete.
Disengage the trigger pin from its seat in the right-hand side plate and remove the lock frame, barrel extension, and barrel assembly by pulling out to the rear.
Detach the lock frame group from the barrel extension by tripping the accelerator.

Assembling is in reverse order.

Stripping is carried out, following dismounting, in any order desired.

(*a*) Bolt group.—Remove extractor by rotating upward and pulling out from bolt.

Ejector, extractor cam plunger, and spring can be removed after driving out their pins.

Rotate the cocking lever fully backward and release the sear by pressing in on the left-hand end of the sear slide.

Remove the cocking-lever pin and cocking lever.

Release the sear-spring holder by pressing it in through the cut in the left-hand side of the bolt, and when free lift the sear-spring assembly out.

Remove the sear and sear slide.

Remove the firing pin.

Hold the bolt firmly, pressing the end of the driving spring rod down against a flat surface, and rotate the bolt to free the driving spring rod. Then allow the bolt to rise slowly till the rod and driving spring are freed. *Caution:* Great care is necessary to avoid injury when releasing the driving spring, as it is heavily compressed when locked in the bolt and if allowed to fly may do considerable damage. Never look directly at the rear of the bolt unless sure that the driving spring rod is properly locked in place or the spring out.

(*b*) LOCK-FRAME GROUP.—The accelerator may be removed on driving out its pin.

Remove the barrel plunger by pressing its free end inward till the guide pin is free of the lock frame, being careful to prevent the spring escaping too quickly.

(*c*) BARREL GROUP.—The barrel may be removed by unscrewing from the barrel extension.

Remove the barrel locking spring by pressing its free end outward and sliding it forward out of its seat in the barrel extension.

Drive out the breech lock pin and remove the breech lock.

(*d*) COVER GROUP.—Remove the cover pin and lift the cover free from the trunnion block. Remove the belt feed lever pivot by rotating its spring outward 90°, upon which the belt feed lever is freed.

Remove the feed pawl slide, and drive out the feed pawl pin. This frees both the pawl and its spring.

Press the middle portion of the cover extractor cam out of its seat in the cover and its rear end out of its recess under the cover extractor cam.

(*e*) BACK-PLATE GROUP.—The buffer disks and buffer plug may be removed after unscrewing the adjusting rivet.

(*f*) CASING GROUP.—Unscrew the muzzle attachment plug. The muzzle attachment and barrel jacket may be removed by unscrewing, but this must not be done except in case of necessity since it is likely to loosen the threads so that they will work loose in firing.

The breech lock cam may be removed by unscrewing its screw, but this must not be done unless necessary for repairs or replacement, as it is essential that the cam be held firmly in its seat.

The operating slide may be removed by pulling out to the rear after removal of the front stop, which is screwed in place. Care must be exercised in this to insure that the plunger and spring are not lost.

Remove the belt holding pawl pin, then the pawl and its spring. If mounted in place on the left-hand side plate of the gun, the trigger motor may be removed by loosening its holding nut.

Remove the latch complete by pulling it *to the rear.*

The remainder of the parts of the casing are assembled by riveting and are not to be removed except for repairs in a properly equipped repair base.

Reassembling for each group will in general be the reverse of stripping, but need not conform exactly to the order given.

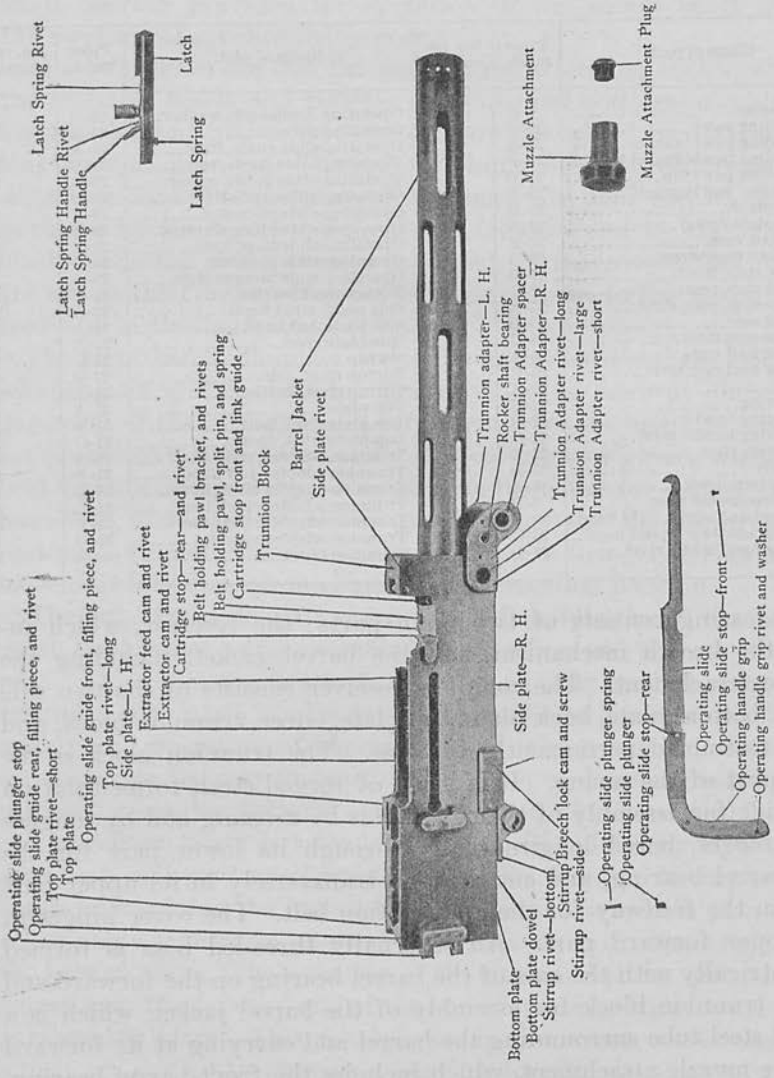


PLATE 8.—Casing group.

CHAPTER III.

DETAILED DESCRIPTION OF THE GUN.

A. CASING GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Barrel jacket	6-C	1	Operating handle-grip washer	29-E	2
Belt-holding pawl	25-G	1	Operating slide	29-A	1
Belt-holding pawl bracket	25-H	1	Operating-slide guide, front	28-A	1
Belt-holding pawl-bracket rivet	25-F	4	Operating-slide guide, rear	28-B	1
Belt-holding pawl pin	25-D	1	Operating-slide guide spacer	28-C	2
Belt-holding pawl spring	25-E	1	Operating-slide guide rivet	28-D	4
Bottom plate	23-B	1	Operating-slide plunger	28-F	1
Bottom-plate dowel	23-A	4	Operating-slide plunger spring	28-E	1
Breech-lock cam	23-F	1	Operating-slide stop, front	29-F	1
Breech-lock cam screw	23-G	1	Operating-slide stop, rear	29-G	1
Cartridge stop, front	27-B	1	Operating-slide plunger stop	28-G	1
Cartridge stop, rear	27-C	1	Rocker-shaft bearing	31-F	1
Cartridge stop, rear, rivet	27-A	1	Side plate, right hand	26-A	1
Extractor cam	25-B	1	Side plate, left hand	24-A	1
Extractor-cam rivet	25-C	1	Side-plate rivet	27-E	2
Extractor feed cam	25-A	1	Stirrup	23-C	1
Extractor feed-cam rivet	25-C	1	Stirrup rivet, side	23-D	4
Latch	22-A	1	Stirrup rivet, bottom	23-E	2
Latch spring	22-E	1	Top plate	21-A	1
Latch-spring handle	22-B	1	Top-plate rivet, long	21-B	1
Latch-spring handle rivet	22-C	2	Top-plate rivet, short	21-C	2
Latch-spring rivet	22-D	2	Trunnion adapter, right hand	31-A	1
Link guide	27-D	1	Trunnion adapter, left hand	31-B	1
Muzzle attachment	6-A	1	Trunnion-adapter rivet, large	31-C	1
Muzzle-attachment plug	6-B	1	Trunnion-adapter rivet, long	31-D	2
Operating handle grip, right hand	29-B	1	Trunnion-adapter rivet, short	31-E	2
Operating handle grip, left hand	29-C	1	Trunnion-adapter spacer	31-G	1
Operating handle-grip rivet	29-D	2	Trunnion block	30-A	1

The casing consists of two main parts; the receiver, which inclose the breech mechanism, and the barrel jacket, including the muzzle attachment. The complete receiver consists of the two side plates, bottom plate, back plate, top plate, cover, trunnion block, and parts assembled permanently to these. The trunnion block is the basic part of the casing. It is made of forged steel, formed flat on each side for assembly of the side plates by riveting and by tongues and grooves, bored longitudinally through its lower part for the rear barrel bearing, and cut through transversely in its upper part to form the feedway for the ammunition belt. The cover hinges in the upper forward part. An externally threaded boss is formed concentrically with the axis of the barrel bearing on the forward end of the trunnion block for assembly of the barrel jacket, which is a vented steel tube surrounding the barrel and carrying at its forward end the muzzle attachment, which includes the front barrel bearing. The muzzle attachment supports the forward end of the barrel and serves to increase the recoiling effect of the barrel by momentarily

restricting the escape of the gases from the muzzle on exit of the bullet.

The trunnion adapters are assembled to the trunnion block by riveting after the side plates are assembled. Their purpose is to provide a bearing for the trunnion pin and to locate this pin properly with respect to the feedway. The bearing for the pin is formed by the spacer, which is the larger of two tubular members assembled between the two adapters. The other tubular member is the rocker shaft bearing provided for operation of the rocker shaft unit of the mechanical synchronizing gear.

The side plates are two flat steel plates extending backward from the trunnion block, and between the tops and bottoms of which the top and bottom plates, respectively, are assembled by riveting and tongues and grooves. These four plates form a rectangular box which contains the working mechanism. The rear end of this box is closed by the back plate, and the forward end by the trunnion block. The top front portion is closed by the cover. Both plates are cut at their upper forward end to conform to the shape of the feedway in the trunnion block.

The right-hand side plate carries at its forward end the two stops which position the cartridge properly in the feedway during engagement of the extractor and extraction from the belt. It is slotted for operation of the bolt handle and carries two guides which support the operating slide. This slide is provided for convenience in retraction of the breech mechanism by hand and for use in loading and unloading and reduction of stoppages in firing. It may also be used to lock the breech mechanism in its recoiled position.

The left-hand side plate carries the belt holding pawl bracket and pawl, the bracket being assembled, by riveting, just beneath the feedway. This bracket acts also as a lip for guiding the belt properly in feeding. The plate is also provided with two beveled cuts for assembly and operation of the mechanical trigger motor. Two cams which govern the movement of the extractor are riveted to its interior surface in position between the trigger motor cuts and the feedway.

The bottom plate is assembled to the side plates by tight-fitting dove tails and positioned longitudinally by dowels. It carries at its inner forward end the breech-lock cam, which is held in place by its screw and a transverse tongue which engages a corresponding cut in the bottom plate. The assembly of the side and bottom plates is reinforced near the forward end of the bottom plate by the stirrup, which is riveted in place. This member carries two bosses, one at each side, which are drilled to provide a bearing for the elevating pin. The bottom of the casing between the forward end of the bottom plate and the rear end of the trunnion block is left open for ejection of the empty cartridge cases.

The top plate is of forged steel and is assembled between the side plates by tongues and grooves and by riveting. It covers the rear of the receiver, and provides the bearing against which the free end of the cocking lever operates. The upper surface of the top plate is formed to provide two longitudinal guides for the latch, the function of this member being to hold the cover and back plate closed. A transverse cut is made near the rear of the rib between the two guides for engagement of the latch spring, which acts as a lock to hold the latch in its forward position. The latch has its spring assembled to it by riveting, and is provided with a knob for convenience in operation. The spring has riveted to it a handle which projects upward through a slot in the latch in the rear of the knob. Pressure forward on this handle, which is the natural result of grasping it and the knob between the thumb and fingers, disengages the latch spring from its cut in the top plate and thus frees the latch so it may be drawn to the rear, thus releasing the cover.

B. BACK-PLATE GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Adjusting screw	20–H	1	Buffer disk, thick	20–C	6
Adjusting-screw plunger	20–G	1	Buffer disk, thin	20–D	7
Adjusting-screw plunger spring	20–F	1	Buffer plate	20–L	1
Back plate	20–A	1	Buffer tube	20–K	1
Back-plate dowel	20–B	1	Latch stop screw	20–E	1

The back plate is of forged steel and is provided with a guide at each side which slides downward into corresponding grooves cut in the inside of the side plates. The back plate is stopped in downward motion by the bottom plate. It has at the top a stop screw which limits the rearward movement of the latch on release, and carries a buffer tube screwed into its middle portion and extending to the rear. This buffer tube contains a series of fiber disks, the front end being closed by a flanged steel plug, and the rear end by a screw. The plug projects slightly forward of the inside surface of the back plate and stops the bolt at the end of the recoil of this member. The fiber disks absorb the blow of the bolt against the plug and transmit this strain more gradually to the side plates. The buffer tube is held from unscrewing from its seat in the back plate by a dowel pin. The adjusting screw serves to regulate the initial pressure between the fiber disks and is prevented unscrewing by action of the plunger and spring which it contains. The back plate is drilled to provide the seat for the driving spring rod and is slotted at the bottom for the trigger which is used in automatic firing.

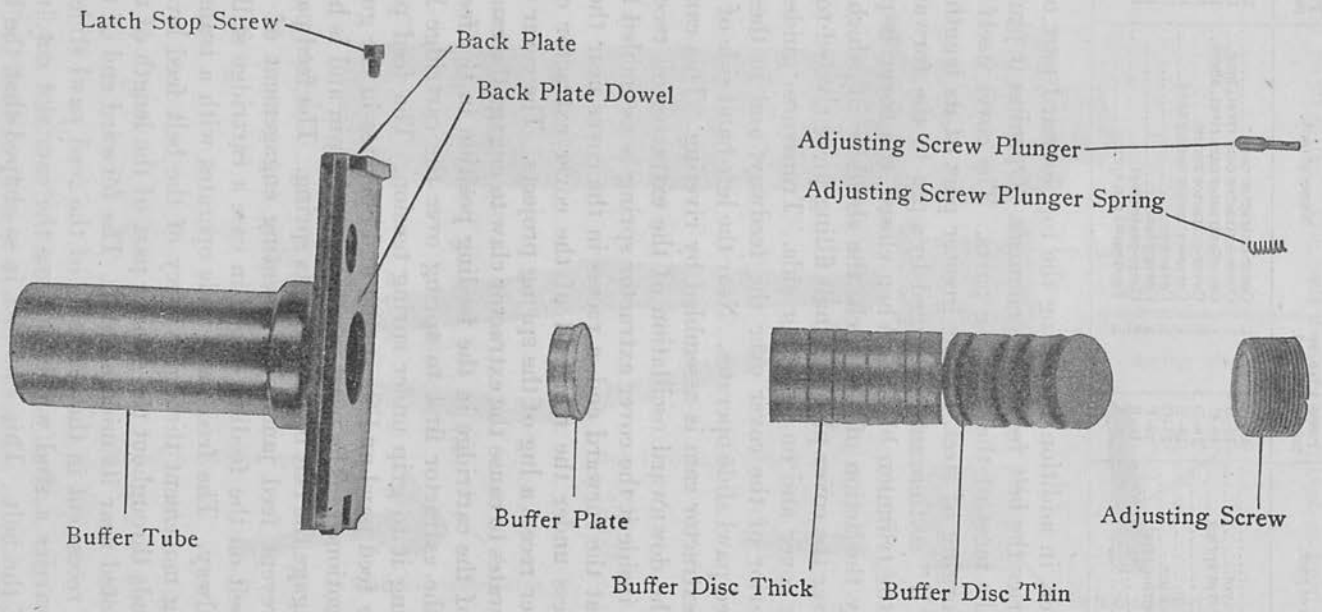


PLATE 9.—Back-plate group.

C. COVER GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Belt-feed lever	18–A	1	Cover-extractor cam	17–A	1
Belt-feed lever pivot	18–B	1	Cover-extractor cam rivet, long	17–C	1
Belt-feed lever-pivot spring	18–C	1	Cover-extractor cam rivet, short	17–B	1
Belt-feed pawl	18–D	1	Cover-extractor spring	17–D	1
Belt-feed pawl pin	19–E	1	Cover-extractor spring stud	17–E	1
Belt-feed pawl spring	19–D	1	Cover pin	19–C	1
Belt-feed pawl-spring stud	19–F	1	Cover plate	19–A	1
Belt-feed slide	18–E	1	Cover-plate rivet	19–B	2
Cover	16–A	1	Feed-pawl pin spring	8–D	1

The cover, in addition to closing the top forward part of the receiver, carries the belt feeding mechanism. Opening it provides for access to the most of the working parts. The cover itself is a rectangular forging of steel, for the greater part of its length is of an inverted "U" section, and is hinged by a pin to the forward upper corner of the trunnion block. When closed, the cover is prevented opening by the action of the latch, the shoulder of which projects forward over the cover plate, a small filling piece riveted to the rear end of the cover and on its upper side. Transverse guides are cut in the interior of the cover over the feedway, and in these guides the belt feed pawl slide operates. Near the left-hand side of the cover the cover extractor cam is assembled by riveting. This cam aids in effecting the downward oscillation of the extractor on recoil of the bolt; next inside it the cover extractor spring is assembled by means of a stud at the forward end, a recess in the cover near the middle, and a recess under the rear end of the cover extractor cam, into which latter recess a lug of the spring projects. The cover extractor spring operates to cause the extractor claw to engage the cannelure in the head of the cartridge in the feeding position in the feedway by allowing the extractor first to spring over the cartridge head and then causing it to grip under spring tension. The feed pawl slide carries the feed pawl and its spring and operates in the guides previously mentioned. The pawl is pivoted on its pin and is held down so as to engage the belt by action of its spring. The feed pawl finger acts to prevent feed jams by preventing engagement of the pawl with the belt on the feeding stroke in case a cartridge still remains in the feedway. The feed pawl slide operates with a transverse reciprocating movement through agency of the belt feed lever. This lever extends throughout the greater part of the length of the cover, and is pivoted near its middle point. The forward end of this lever engages a recess cut in the rear side of the feed pawl slide, and the rear end carries a stud which engages the cam slot cut in the top surface of the bolt. This cam slot is so shaped that the backward and forward movement of the bolt results in a movement from side

to side of the stud engaged in it. This causes corresponding oscillations of the belt feed lever and consequent reciprocating movements of the feed pawl slide. The belt feed lever pivot is held in place in

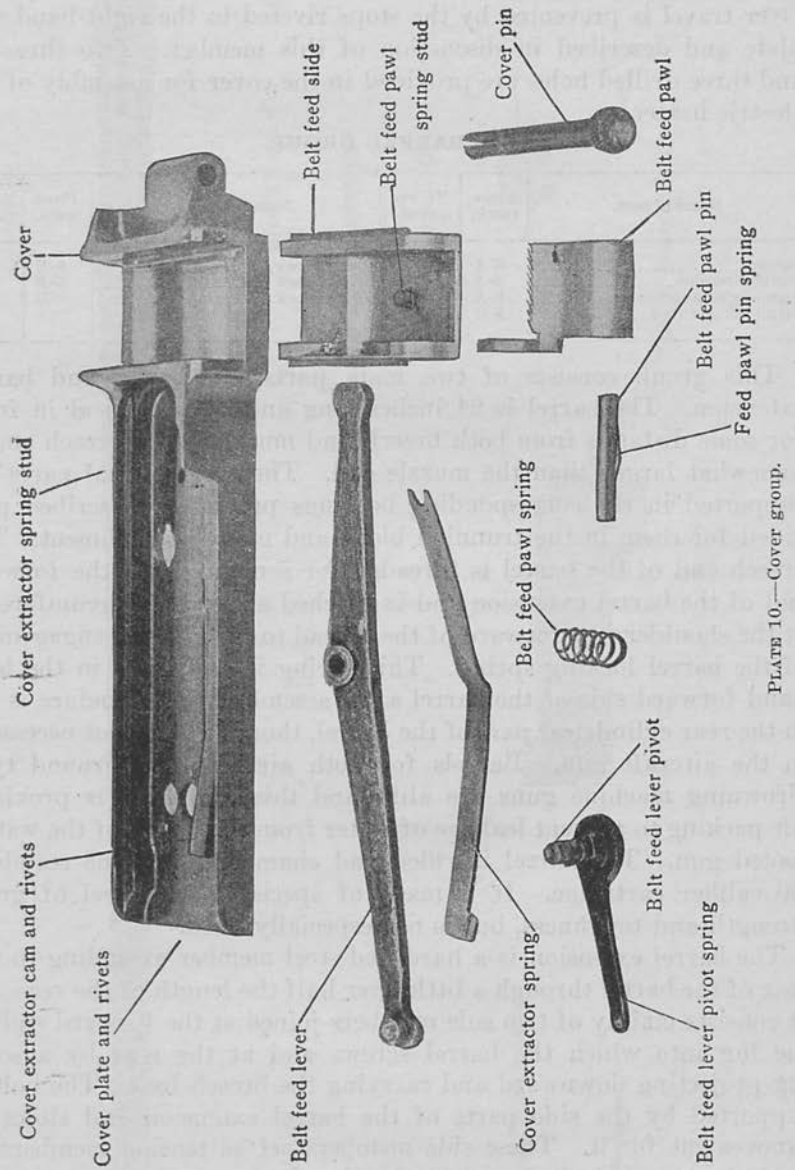


PLATE 10.—Cover group.

the cover by a "button" collar formed on its stem and action of a spring snib. Release of this snib and rotation of the stem through 90° frees the pivot and permits of its removal, upon which the re-

mainder of the belt feeding mechanism may be removed. During the feeding of the belt by the pawl action just described, slipping backward of the belt is prevented by action of the belt holding pawl previously mentioned in description of the left-hand side plate. Over-travel is prevented by the stops riveted to the right-hand side plate and described in discussion of this member. Two threaded and three drilled holes are provided in the cover for assembly of the electric heater.

D. BARREL GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Barrel	5–A	1	Breech lock	8–E	1
Barrel extension	7–A	1	Breech-lock pin	8–B	1
Barrel-locking spring	8–A	1	Breech-lock pin spring	8–D	1
Barrel-plunger stud	8–C	1			

This group consists of two main parts, the barrel and barrel extension. The barrel is 24 inches long and is cylindrical in form for some distance from both breech and muzzle. The breech end is somewhat larger than the muzzle end. These cylindrical parts are supported in the corresponding bearings previously described provided for them in the trunnion block and muzzle attachment. The breech end of the barrel is threaded for screwing into the forward end of the barrel extension and is notched around its circumference at the shoulder just forward of the thread to provide for engagement of the barrel locking spring. This spring is assembled in the left-hand forward side of the barrel after assembly. A cannelure is cut in the rear cylindrical part of the barrel, though this is not necessary in the aircraft gun. Barrels for both aircraft and ground type Browning machine guns are alike and this cannelure is provided for packing to prevent leakage of water from the jacket of the water-cooled gun. The barrel is rifled and chambered for the standard .30 caliber cartridge. It is made of special barrel steel of great strength and toughness, but is not especially hard.

The barrel extension is a hardened steel member extending to the rear of the barrel through a little over half the length of the receiver. It consists mainly of two side members joined at the forward end by the lug into which the barrel screws and at the rear by a solid lug projecting downward and carrying the breech lock. The bolt is supported by the side parts of the barrel extension and slides in grooves cut for it. These side members act as tension members to hold the breech locked against the chamber pressure due to explosion. Locking is effected by action of the breech lock, which is a solid rectangular block of steel carried in the rear lower part of the barrel extension so that it has a short vertical sliding movement. When pushed upward this lock engages a recess in the bottom of the bolt,

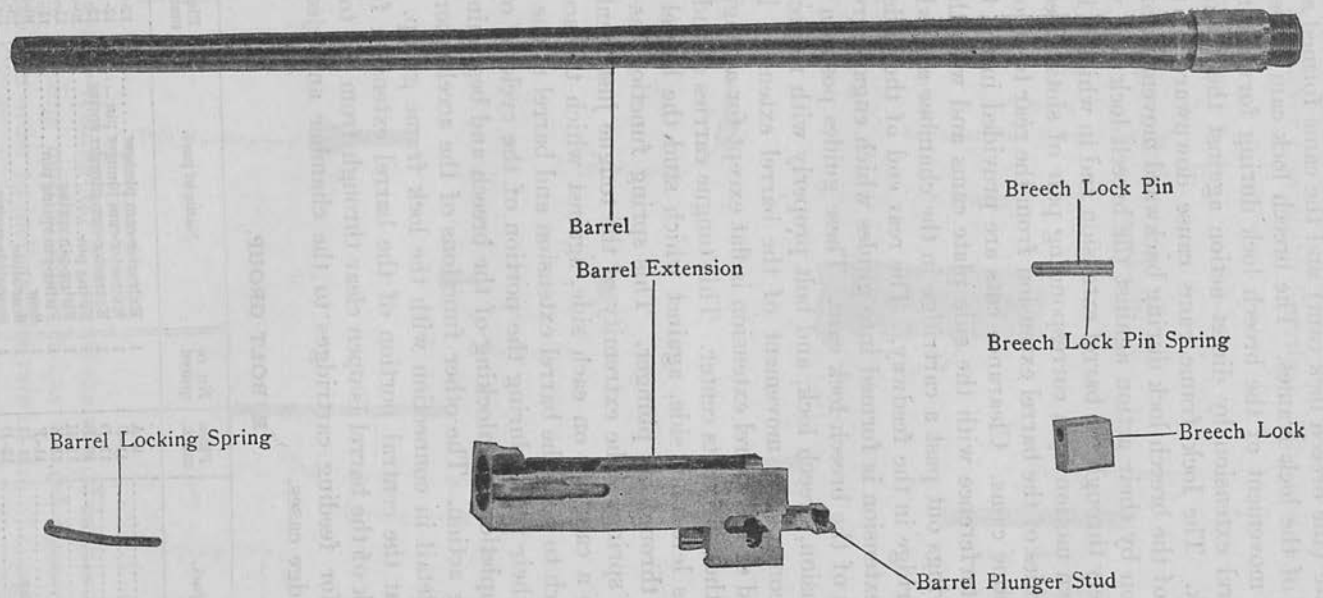


PLATE 11.—Barrel group.

thus locking it securely to the barrel extension. This lock is operated through the agency of a cam assembled to the interior of the bottom plate (the breech lock cam) and the cams formed at the forward ends of the lock frames. The breech lock cam causes upward or locking movement of the breech lock during forward movement of the barrel extension by direct action against the bottom of the breech lock. The lock frame cams cause downward or unlocking movement of the breech lock during backward movement of the barrel extension by their action against the breech lock pin, which extends entirely through the barrel extension and in which it is allowed up and down motion by a corresponding pair of slots. Recesses are cut in the sides of the barrel extension from the rear to accommodate the lock frame cams. Clearance cuts are provided in the front end to avoid interference with the side plate cams and with the ejector when it springs out past a cartridge in the chamber and when gripping a cartridge in the feedway. The rear end of the under side of the barrel extension is formed into guides which engage grooves cut in the sides of the breech lock cam. These guides position the cam, barrel extension, breech lock, and bolt properly with respect to each other and control the movement of the barrel extension in recoil. The rear end of the barrel extension is flat except for a tongue which projects to the rear at its center. This tongue carries a stud projecting from its left-hand side, against which stud the barrel plunger spring acts through its plunger. This spring functions as an auxiliary recoil spring. The extremity of the tongue just mentioned is formed into a cam lug on each side, against which the accelerator acts as a latch to hold the barrel extension and barrel at the rear extremity of their recoil during the portion of the cycle of operation between completion of unlocking of the breech and beginning of the next locking action. The other functions of the accelerator are explained in detail in connection with the lock frame group. It will be noted that the central portion of the barrel extension for some distance back of the barrel is open clear through from top to bottom to provide for feeding cartridges to the chamber and ejection of empty cartridge cases.

E. BOLT GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Bolt	9-A	1	Extractor-cam plunger	12-C	1
Bolt handle	11-C	1	Extractor-cam plunger pin	12-B	1
Bolt stud	11-D	1	Extractor-cam plunger spring	12-E	1
Cocking lever	10-B	1	Firing pin	10-A	1
Cocking-lever pin	11-H	1	Firing-pin spring	11-A	1
Driving spring	11-E	1	Firing-pin spring pin	11-B	1
Driving-spring rod	11-F	1	Sear	10-E	1
Driving-spring rod pin	11-G	1	Sear slide	10-D	1
Ejector	12-D	1	Sear-slide spring	10-F	1
Ejector pin	12-B	1	Sear-spring holder	10-H	1
Extractor	12-A	1	Sear-spring pin	10-G	1

The bolt is the main working part of the gun. All the functions of operation, except feeding of the belt, are performed directly by its parts, and even this is accomplished indirectly through the agency of the belt feed lever previously described. The bolt is a hardened

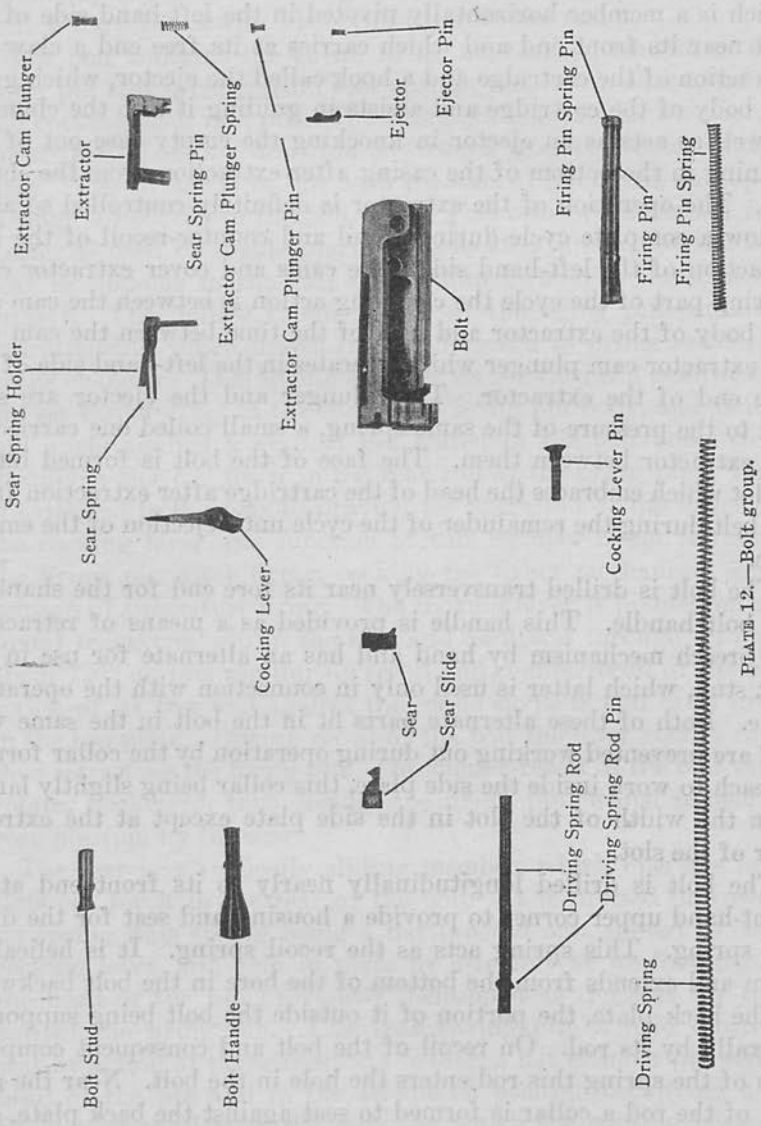


PLATE 12.—Bolt group.

steel block, nearly rectangular in general shape, and carries the firing and chamber feeding mechanisms. It has several lightening cuts which are made in order to increase the rate of fire of the gun. The bolt has a longitudinal reciprocating movement of operation, this

movement being parallel to the axis of the gun. It is supported in the barrel extension by engagement of its guides in corresponding grooves, and has freedom of movement only in the direction of these guides. The functions of extracting from the belt and feeding to the chamber are accomplished through the agency of the extractor, which is a member horizontally pivoted in the left-hand side of the bolt near its front end and which carries at its free end a claw for extraction of the cartridge and a hook called the ejector, which grips the body of the cartridge and assists in guiding it into the chamber as well as acts as an ejector in knocking the empty case out of the opening in the bottom of the casing after extraction from the chamber. The operation of the extractor is definitely controlled so as to follow a complete cycle during recoil and counter-recoil of the bolt by action of the left-hand side plate cams and cover extractor cam. During part of the cycle the camming action is between the cam and the body of the extractor and part of the time between the cam and the extractor cam plunger which operates in the left-hand side of the free end of the extractor. This plunger and the ejector are subject to the pressure of the same spring, a small coiled one carried in the extractor between them. The face of the bolt is formed into a T-slot which embraces the head of the cartridge after extraction from the belt during the remainder of the cycle until ejection of the empty case.

The bolt is drilled transversely near its fore end for the shank of the bolt handle. This handle is provided as a means of retracting the breech mechanism by hand and has an alternate for use in the bolt stud, which latter is used only in connection with the operating slide. Both of these alternate parts fit in the bolt in the same way and are prevented working out during operation by the collar formed on each to work inside the side plate, this collar being slightly larger than the width of the slot in the side plate except at the extreme rear of the slot.

The bolt is drilled longitudinally nearly to its front end at its right-hand upper corner to provide a housing and seat for the driving spring. This spring acts as the recoil spring. It is helical in form and extends from the bottom of the bore in the bolt backward to the back plate, the portion of it outside the bolt being supported laterally by its rod. On recoil of the bolt and consequent compression of the spring this rod enters the hole in the bolt. Near the rear end of the rod a collar is formed to seat against the back plate, and a pin is driven through this collar, projecting slightly beyond it on each side. The rear end of the rod is slotted and recessed to provide for turning it by means of either the rim of a cartridge head or a screw driver. When the bolt is pressed back against the back plate

and held, the rod may be pressed in and turned so as to lock it in the bolt, thus relieving the bolt of the forward pressure of the driving spring. When the rod is turned to lock, the pin driven through it engages under cut slots in the rear of the bolt at each side of the driving spring hole. Locking can be effected by turning in one direction only (clockwise when viewed from the rear).

The bolt contains the entire firing mechanism, consisting of the firing pin and spring; sear; sear spring, pin, and holder; sear slide; and cocking lever and pin. The firing pin is a tubular member, with the striker offset in a direction downward from the center of the pin body. The striker is in line with the axis of the barrel and operates through a hole cut in the bolt face. This offset construction for the striker is used to enable placing the locking surface of the bolt as near as possible to the axis of the gun (which is the axis of the barrel). The hollow tubular body of the firing pin contains the helical spring which drives the pin forward to prime the cartridge in the chamber. This spring abuts at its forward end against a small pin set transversely in the end of the firing pin body, and at its rear end abuts against a vertical pin seated in the bolt and extending through a slot cut for it in the rear end of the firing pin. This slot is extended to the rear to provide for operation of the lower end of the cocking lever, the function of this member being retraction of the firing pin after firing, cocking the firing mechanism, and prevention of premature firing. The cocking lever is pivoted on a horizontal transverse pin in the bolt and oscillates through an angle of about 120° on this pin during recoil and counterrecoil of the bolt, by action of its free end against the guide surfaces and cams provided in the top plate. During recoil of the bolt the lever rotates forward, thus retracting the firing pin. On counter-recoil of the bolt the lever rotates backward, thus freeing the firing pin, which is held in its rear position by the sear.

The sear is a vertically sliding member, which operates in guide slots cut for it in the rear of the bolt. It is pressed downward by its spring, this spring being a flat tapered one, slotted to clear the cocking lever, and held in place by assembly at its forward end to the head of the pin previously mentioned as the seat for the rear end of the firing pin. This sear spring pin is held down in its seat by action of the sear spring holder, a flat member pivoted to the head of the pin and in the assembled position occupying a cut in the bolt at the left of the recess in which the cocking lever works. The sear is provided with a nose which engages a lug formed on top of the rear of the firing pin, on retraction of that member. Release of the sear, and consequent forward movement of the firing pin

under influence of its spring, are effected by raising the sear in its guides about one-tenth of an inch. The sear is prevented dropping down behind the firing pin when the latter is in its forward position by the toe which extends forward from the sear nose and which rests on top of the firing pin lug. This toe is slotted to clear the cocking lever. The sear is moved upward by action of the sear slide. This member operates in guides cut laterally through the bolt just in rear of the sear. Its ends come nearly to the outside of the bolt. In the middle of the sear slide a 45° cam cut is provided, and is engaged by a corresponding cam lug formed on the sear. A pressure inward on the left-hand end of the sear slide cams the sear upward and disengages it from the firing pin. This pressure is supplied by action of the trigger motor (previously mentioned as being mounted on the left-hand side plate) the part which operates against the sear slide being a transversely reciprocating pawl. All parts of the firing mechanism are made of steel and hardened.

A transverse cut is made in the bottom of the bolt near its rear end to provide a locking surface against which the breech lock may act. This surface is the forward side of this cut, and is inclined at an angle of about 14° with a plane at right angles to the axis of the bolt. The breech lock is beveled to agree with this angle, the object of the bevel being to provide quick release of the lock and to prevent sticking. Back of the locking surface two pairs of lugs are formed on the bottom of the bolt. Both of these are provided on account of the action of the accelerator and will be further discussed in connection with the description of that member.

F. LOCK-FRAME GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Accelator	15-A	1	Lock frame, left hand	14-B	1
Accelator pin	8-B	1	Lock-frame guide pin	14-D	2
Accelator-pin spring	8-D	1	Lock-frame rivet	14-G	1
Accelator stop	14-E	1	Lock-frame separator	14-F	1
Barrel plunger	15-D	1	Lock-frame spacer	14-C	1
Barrel-plunger guide pin	15-F	1	Lock-frame spacer rivet	14-G	1
Barrel-plunger spring	15-E	1	Trigger pin	15-B	1
Lock frame, right hand	14-A	1	Trigger-pin spring	15-C	1

This group is assembled back of the barrel extension in the space below that required for recoil of the bolt. It consists mainly of two side plates (the lock frames, right and left) assembled by spacers of such length that the whole unit fits inside the casing of the gun and carries two working parts, the accelerator, and the barrel plunger with its spring. The rear of the lock frame abuts against the back plate. It is held in place in the casing when the back plate is out

by the trigger pin, a transversely operating plunger which engages a hole in the right-hand side plate. This plunger is held in place by a coil spring. The lock frame abuts at its forward end against shoulders at the rear of the breech lock cam.

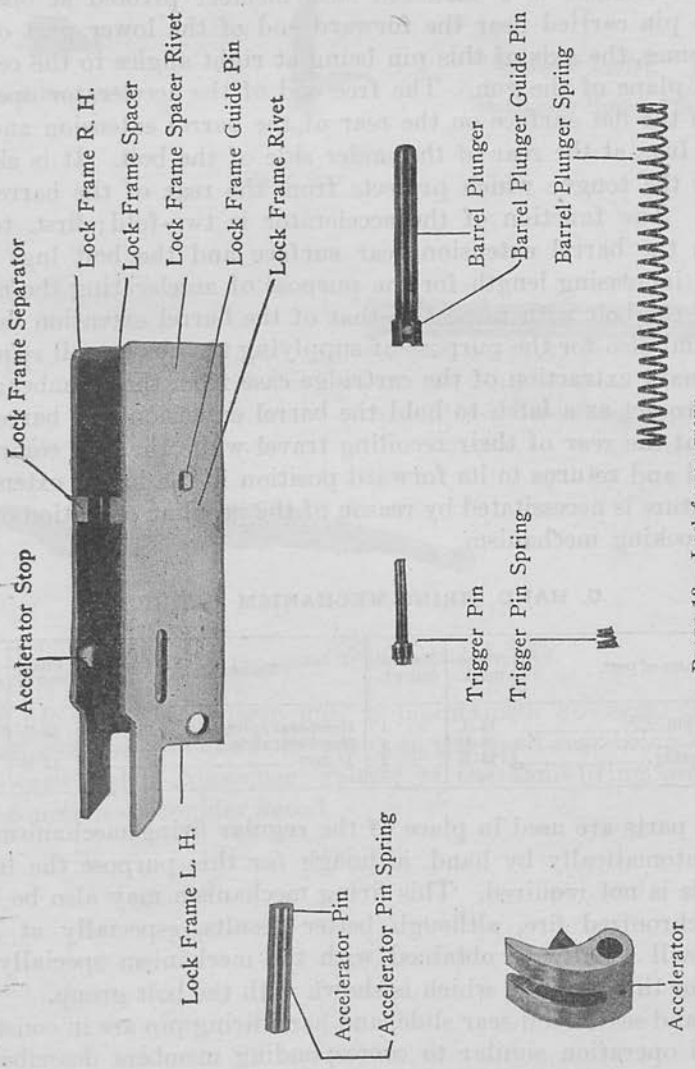


PLATE 13.—Lock-frame group.

The forward end of the lock frames at their upper sides are carried forward to form two fingers, beveled at their ends on their under sides. These act as cams in unlocking the breech lock during recoil of the barrel extension as described in discussion of that member. The main connecting member for the lock frames is drilled to form a guide for the barrel plunger and acts as the seat for the rear of the

barrel plunger spring. This spring is helical in form, is disposed so that its axis is parallel to the axis of the gun, and acts as an auxiliary recoil spring directly against the barrel extension. Its plunger acts as a guide and seat for its forward end, which end of the plunger operates against the stud provided for it projecting to the left from the rear extremity of the tongue at the rear of the barrel extension.

The accelerator is a hardened steel member pivoted at one end about a pin carried near the forward end of the lower part of the lock frames, the axis of this pin being at right angles to the central vertical plane of the gun. The free end of the accelerator operates between the flat surface on the rear of the barrel extension and the pair of lugs at the rear of the under side of the bolt. It is slotted to clear the tongue which projects from the rear of the barrel extension. The function of the accelerator is two-fold; first, to act between the barrel extension rear surface and the bolt lugs as a lever of increasing length for the purpose of accelerating the movement of the bolt with respect to that of the barrel extension during recoil, and also for the purpose of supplying the heavy pull required for primary extraction of the cartridge case from the chamber; and second, to act as a latch to hold the barrel extension and barrel assembly at the rear of their recoiling travel while the bolt completes its recoil and returns to its forward position in the barrel extension. This feature is necessitated by reason of the peculiar operation of the breech locking mechanism.

G. HAND FIRING-MECHANISM GROUP.

Name of part.	Piece mark.	No. required.	Name of part.	Piece mark.	No. required.
Hand firing pin	13-A	1	Hand-sear spring pin	13-C	1
Hand sear	13-D	1	Hand-sear slide	.....	.....
Hand-sear spring	13-B	1	Trigger	13-E	1

These parts are used in place of the regular firing mechanism for firing automatically by hand, although for this purpose the hand-sear slide is not required. This firing mechanism may also be used for synchronized fire, although better results, especially at high speeds, will usually be obtained with the mechanism specially designed for this purpose, which is shown with the bolt group.

The hand sear, hand-sear slide, and hand firing pin are in construction and operation similar to corresponding members described in connection with the bolt, except that the hand sear engages the underside of the handfiring pin. The hand-sear spring, therefore, tends to push the hand sear upward.

The trigger pivots on the trigger pin in the lock frame and when its rear end is drawn upward its forward end is thus brought down

so that the cams engage corresponding surfaces cut in the lower end of the sear. If the trigger is pulled when the action of the gun is fully forward, as for the first shot, the trigger acts simply as a lever to pry the hand sear downward out of engagement with the hand

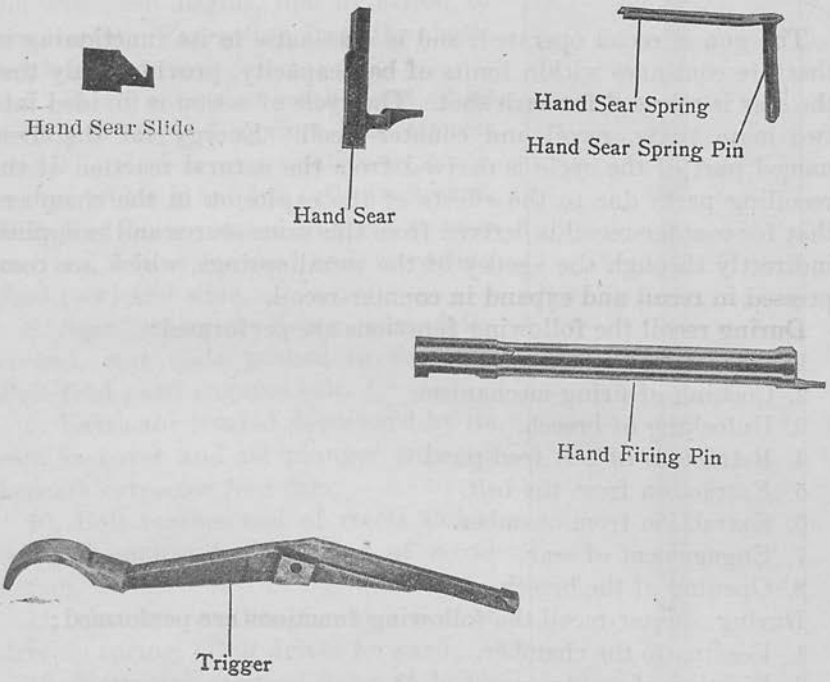


PLATE 14.—Hand firing-mechanism group.

firing pin. If the trigger pull is maintained, however, the final closing movement of the bolt results in the hand sear being cammed downward and in consequent release of the hand-firing pin as the final function of counter recoil.

Chapter IV.

OPERATION OF THE GUN.

A. PRINCIPLES OF OPERATION.

The gun is recoil operated, and is automatic in its functioning in that fire continues within limits of belt capacity, provided only that the sear is released for each shot. The cycle of action is divided into two main parts, recoil and counter-recoil. Energy for the first-named part of the cycle is derived from the natural reaction of the recoiling parts due to the effects of the explosion in the chamber; that for counter-recoil is derived from this same source and is applied indirectly through the agency of the recoil springs, which are compressed in recoil and expand in counter-recoil.

During recoil the following functions are performed:

1. Retraction of the firing pin.
2. Cocking of firing mechanism.
3. Unlocking of breech.
4. Retraction of belt feed pawl.
5. Extraction from the belt.
6. Extraction from chamber.
7. Engagement of sear.
8. Opening of the breech.

During counter-recoil the following functions are performed:

1. Feeding to the chamber.
2. Ejection of empty case.
3. Feeding of the belt.
4. Closing of the breech.
5. Locking of the breech.
6. Release of the safety device of the firing mechanism.

Release of the sear constitutes an intermediate function not included in either recoil or counter-recoil, except when the gun is fired by use of the hand firing mechanism, in which case release of the sear is a function of counter-recoil for all but the first shot.

B. BRIEF OF ACTION.

1. Sear slide drives inward, raising sear against its spring and releasing firing pin.
2. Firing pin drives forward and primes cartridge.
3. Recoil begins, against resistance of driving and barrel plunger springs, inertia of recoiling parts, and friction. Extraction from the belt begins.

4. Retraction of firing pin by action of cocking lever begins, against resistance of firing pin spring.

5. Breech lock pushed down by action of lock frame cams on its pin.

6. Recoil of bolt with respect to barrel extension begins, due to action of accelerator. Extraction from the chamber begins.

7. Barrel extension reaches end of its recoil, is stopped against lock frames, and is latched in rear position by accelerator, which is rotated fully backward. Belt feed lever rotated to right at rear end and left at forward end, retracting feed pawl and slide.

8. Sear engages, firing pin fully cocked, sear slide pushed to the left. Belt feed pawl engages belt.

9. Extractor rotated downward by its cam in cover and its plunger engaged beneath extractor feed cam.

10. Bolt reaches end of recoil and is stopped against buffer. End of recoil action.

11. Counter-recoil begins by action of driving spring. Bolt drives forward.

12. Extractor cammed down to bring cartridge in line with chamber, empty case struck off by ejector. Belt moved forward one step by feed pawl.

13. Extractor raised by its cam so ejector clears barrel extension.

14. Accelerator tripped and barrel extension released. Driven forward with bolt by action of both springs.

15. Breech lock forced up by its cam, locking bolt to barrel extension. Extractor and ejector grip cartridge in feed way. Cocking lever rotated fully backward, thus allowing full travel to firing pin.

16. Barrel extension stopped against trunnion block, ending counter-recoil.

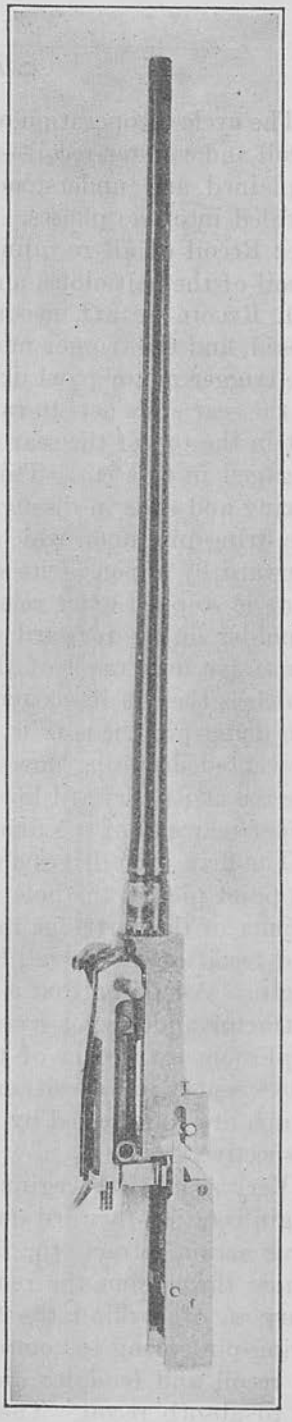


PLATE 15.—View showing relation of recoiling parts at end of counter-recoil.

C. ACTION IN DETAIL.

The cycle of operation of the gun is divided into two main parts—recoil and counter-recoil—as outlined above, but may be more readily explained and understood if each of these are considered to be divided into two phases. The four parts of the cycle then in order are: Recoil of all recoiling parts, recoil of the bolt alone, counter-recoil of the bolt alone, and counter-recoil of all recoiling parts.

1. Recoil of all recoiling parts.—Assuming the action to be closed, and the trigger motor mounted and in operation, a stroke of the trigger motor pawl drives the sear slide inward. This movement of the sear slide acts to raise the sear through the agency of the cam cut in the top of the sear slide and the cam lug of the sear which is engaged in this cut. This movement of the sear is opposed by its spring and ends in disengagement of the sear nose from its notch in the firing pin, upon which the firing pin is released and then driven forward by action of its spring. The inward movement of the sear slide is stopped after release of the sear from the firing pin by the shoulder on its forward side coming against the edge of the sear. Excessive overtravel of the sear is prevented by the cocking lever, which is then in its extreme backward position. After release from the firing pin the sear is at once pressed down by its spring and is prevented dropping down back of the rear end of the firing pin by the toe at its forward lower end, which bears against the lug on the upper rear end of the firing pin.

The firing pin drives ahead under the influence of its spring until its point pierces the hole in the bolt face and is stopped against the primer of the cartridge in the chamber. Explosion then takes place and recoil of the barrel, barrel extension and bolt as a unit at once begins. Assuming that a loaded belt is in the feedway and that the extractor and ejector have gripped a cartridge in this belt prior to explosion, extraction of this cartridge then begins. The recoiling movement is in opposition to the driving and barrel plunger springs, which are compressed by the recoil of the bolt and barrel extension, respectively.

Very soon after beginning of recoil the cocking lever is made to begin rotation forward due to action of its rear cam in the top plate. This action retracts the firing-pin point from the primer, and continues throughout the remainder of this phase of operation for the purpose of cocking the firing mechanism. The resistance of the firing-pin spring to compression in this way acts also in opposition to recoil and tends to aid in holding the mechanism forward and so to absorb recoil. The extractor is held gripping the cartridge head by action of its spring in the cover, and the cartridge is steadied by the ejector, which also grips it about its right-hand side. After

recoiling about two-tenths of an inch, unlocking of the breech begins by the breech lock being cammed down by action of the two lock-frame cams against its pin. This action is completed after about five-tenths of an inch of recoil and then the acceleration of the bolt in recoil with respect to the barrel extension begins. This is due to the action of the accelerator, the free end of which bears against the rear of the barrel extensions, so that as the barrel extension recoils the accelerator is rotated backward. After unlocking of the breech the free end of the accelerator comes against the forward side of the lugs at the rear underside of the bolt and then the combined action of the barrel extension and the accelerator is to pry the bolt back from its closed position and to give it an added impetus in recoil. This provides the strong pull required for primary extraction of the case from the chamber and transmits to the bolt the most of the remaining energy of recoil, thus making its travel to the rear rapid and positive. The barrel extension is stopped against the forward end of the lock frames, the rear ends of which bear against the back plate. During the latter part of the backward rotation of the accelerator the cams on its rear side engage corresponding lugs on each side of the tongue of the barrel extension which projects to the rear between the two branches of the accelerator and so latch the barrel extension in its rearward position.

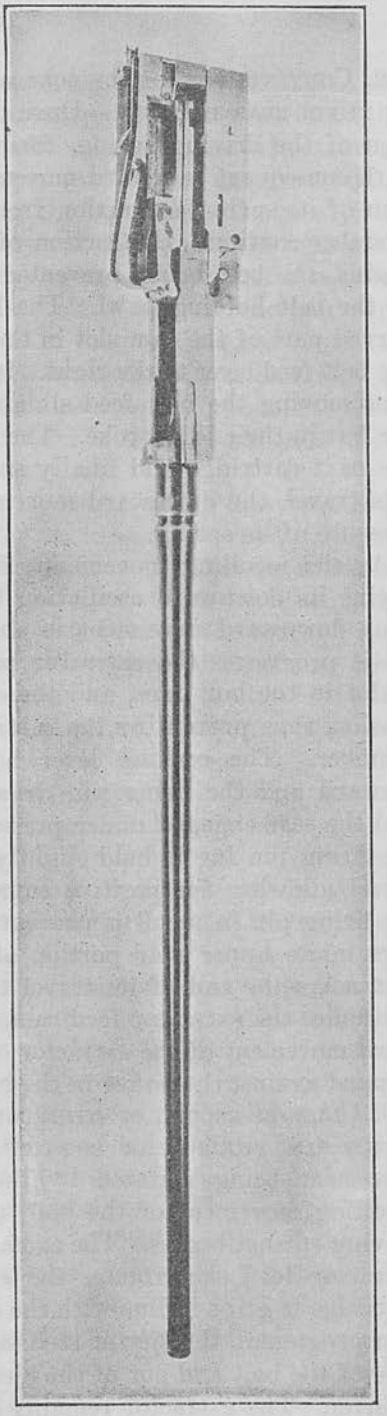


PLATE 16.—View showing relation of recoiling parts at end of recoil.

2. CONTINUED RECOIL OF BOLT WITH OTHER RECOILING PARTS LOCKED IN THEIR REAR POSITION.—During this phase of the cycle compression of the driving spring, forward rotation of the cocking lever, with consequent backward movement of the firing pin and compression of its spring, extraction from the belt and extraction from the chamber continue. Retraction of the belt feed slide and pawl then begins, the belt being prevented slipping backward by the action of the belt holding pawl. The belt feed lever stud rides into the curved part of the cam slot in the bolt, thus moving the rear end of the belt feed lever to the right. Its front end then swings to the left, thus moving the belt feed slide and with it the belt feed pawl to the left in their idle stroke. The nose of the pawl rides up and over the next cartridge and finally snaps down behind it at the end of this travel, the downward movement of the pawl being due to the pressure of its spring.

As the recoiling movement of the bolt continues, the extractor begins its downward oscillation by action of its cam in the cover. This downward movement is about half completed during recoil. As it progresses the extractor pushes the cartridge head into the T-slot in the bolt face, and the ejector drops inside the barrel extension, thus preventing the cartridge falling below the line of the chamber. The cocking lever has meanwhile been rotated fully forward and the firing pin drawn back to the rear of its travel and the sear engaged under pressure of its spring. In this position the firing pin lug is held slightly back of the sear nose, this overtravel allowing for positive engagement. Excessive overtravel of the firing pin in recoil is prevented by the forward one of the two lugs in its upper rear portion abutting against the sear. As the bolt nears the end of its travel the extractor cam plunger springs out under the extractor feed cam, thus providing for positive downward movement of the extractor on counter-recoil. The bolt is then stopped against the buffer in the back plate.

3. COUNTER-RECOIL OF THE BOLT, WITH OTHER RECOILING PARTS LOCKED IN THEIR REAR POSITION.—Immediately upon its recoiling movement being arrested by the back-plate buffer, the counter-recoiling movement of the bolt, under influence of the compressed driving spring, begins. The extractor cam plunger riding under the extractor feed cam rotates the extractor downward, bringing the cartridge it grips in line with the chamber. As this downward rotation progresses, the ejector strikes the empty case downward off the face of the bolt and out of the ejection opening in the bottom of the receiver. The extractor remains in its lower position until its forward end nears the base of the barrel, upon which it is cammed upward by action of the extractor cam plunger on the extractor cam.

Soon after the counter-recoiling movement of the bolt begins the belt feed lever stud rides into the curved part of its cam cut in the bolt, thus moving this end of the belt feed lever to the left and consequently causing the forward end to oscillate toward the right. This results in corresponding movement of the belt feed slide, pawl, and belt itself. During this feeding movement of the belt the belt-holding pawl is depressed against its spring as the cartridge next in order passes over it and later reengages the belt to prevent the belt slipping backward on the next idle stroke of the belt feed pawl. When the feeding movement of the belt is completed the first cartridge in it is held firmly against the front and rear cartridge stops by the feed pawl, as the belt feed lever stud rides in the straight part of its cam cut in the rear end of the bolt.

When the bolt has completed about one-half of its counter-recoiling movement, the upper end of the cocking lever comes against its forward cam in the top plate and the lever then begins to rotate backward. This allows the firing pin to move forward slightly under the influence of its spring until it is held by the sear. From this point onward, the cocking lever rotates free of the firing pin. When the bolt is fully forward the cocking lever is rotated to its most-backward position, and until this position is reached it is impossible for the firing pin to move forward far enough to prime a cartridge. This constitutes the safety feature of the firing mechanism which prevents explosion before the breech is locked.

As the bolt nears the forward limit of its movement with respect to the barrel extension, the extractor is rotated upward by action of the extractor cam plunger on the extractor cam. The cartridge held by it is at that time inserted past the shoulder in the chamber, and, as this upward oscillation of the extractor progresses, the extractor and ejector release their grip on the cartridge head, the ejector springing out into the recess cut for it in the inner surface of the right-hand side of the barrel extension as its claw strips past the cartridge head. The bolt, with its T-slot still embracing the cartridge head, continues to push the cartridge on into its seat in the chamber until it stops against the barrel extension, and the extractor continues to rise to its upper position. The lugs on the rear lower portion of the bolt then come against the top of the accelerator and start the accelerator rotating forward, which action initiates the last phase of the cycle.

4. Counter-recoil of all recoiling parts.—Soon after the accelerator is started rotating forward, its cams are disengaged from their lugs on the barrel extension tongue, thus releasing the barrel extension which is then driven forward with the bolt under the joint

action of the driving and barrel plunger springs. The accelerator continues to rotate forward, due to the action of these lugs on its

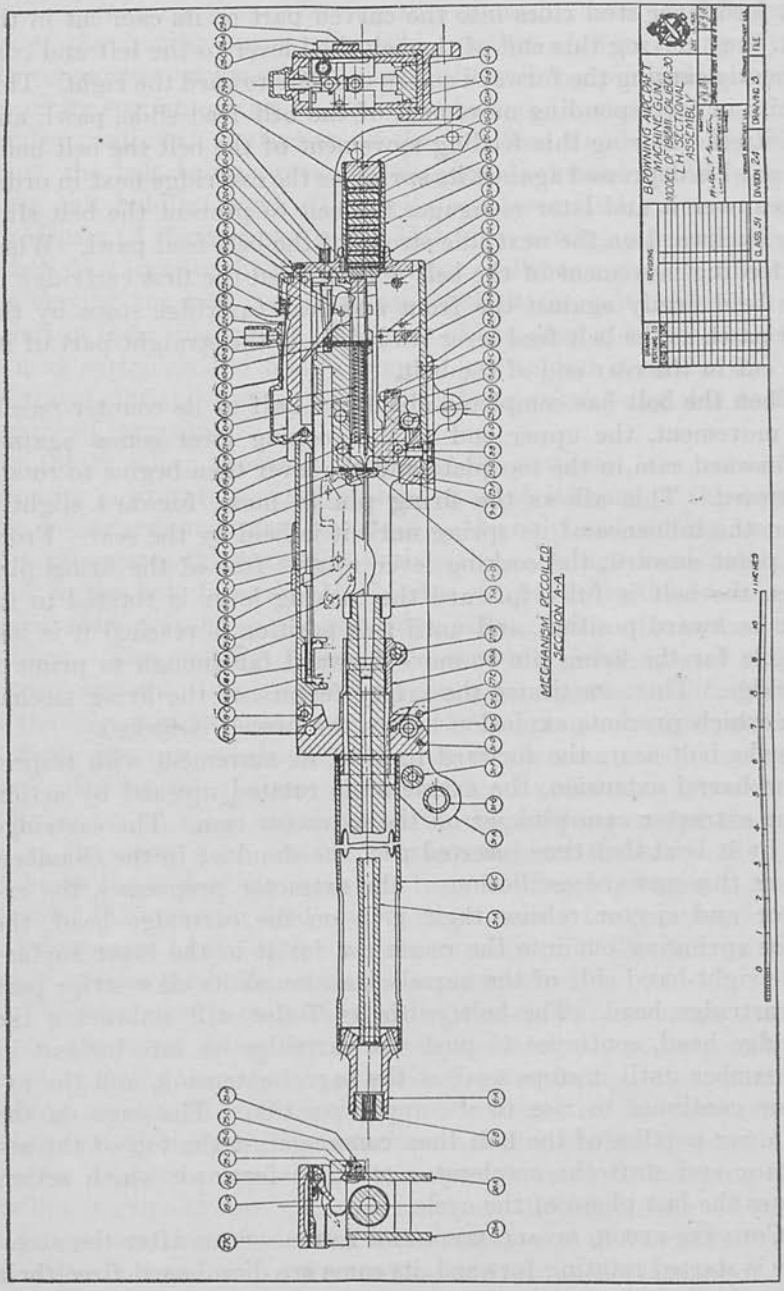


PLATE 17.—Left-hand sectional view showing piece marks.

cams, and is prevented rotating forward too rapidly by the pair of auxiliary lugs on the under side of the bolt. As the barrel extension

moves forward, the breech lock pin is released by the lock frame cams and when it has moved forward about one-tenth of an inch the cam surface at the lower forward edge of the breech lock strikes the sloping surface of the breech lock cam and the breech lock is then forced upward into its cut in the bolt. The beveled locking surfaces are thus brought into engagement, locking the breech. After the breech lock is pushed into its upmost position there remains about two-tenths of an inch of counter-recoiling movement, during which the extractor and ejector spring over and grip the head of the cartridge in the feedway, and the backward rotation of the cocking lever is completed, allowing for free fall of the firing pin when released. At the end of its counter-recoil, the barrel extension is stopped against the trunnion block. In case the trigger motor plunger is retracted when the bolt closes, the next blow of the plunger again pushes the sear slide in and releases the sear, thus initiating a new cycle of operations. If the plunger is thrown inward when the bolt closes, it is pushed slightly ahead by the sear slide and can not move the sear slide inward until it is retracted and given another impulse. It is to be noted that this action of trigger motor and firing mechanism results in semi-automatic, or single-shot fire.

In firing automatically by means of the hand firing mechanism, the operation is in all respects the same, except that in this case the sear is released by action of the trigger instead of the sear slide. This results in full automatic fire, release of the sear after the first shot being effected during the last part of counter-recoil.

D. LOADING.

Loading may be considered to include two distinct operations, namely, entering the loaded belt properly in the belt opening and, thereafter, operating the mechanism of the gun until it is closed with a cartridge in the chamber and a cartridge in the feedway gripped by the extractor for extraction on the next recoil stroke. The first of these operations may be performed with the cover either open or closed, but it is usually more convenient to have the cover open. In either case, the bolt should be drawn slightly to the rear while the belt is being inserted, and it is best held back by the operating slide, making use of the notch provided for this purpose. When the gun is installed in a plane, it is necessary to perform this preliminary part of loading before flight begins.

The second operation involves operation of the gun mechanism, and may be done either before or during flight by simply drawing the operating slide once completely to the rear and allowing the action to spring forward. This operation must start with the action fully closed and the extractor gripping the cartridge in the feedway.

E. UNLOADING.

Unloading may be considered to be of two classes: Partial, or including only removal of the cartridge from the chamber; and complete, or removal of the belt and all cartridges from the feeding mechanism as well as from the chamber.

Partial unloading may be effected by drawing the recoiling parts of the gun once completely to the rear, then allowing them to move forward far enough to chamber the cartridge extracted from the belt, but not far enough to allow the extractor to grip the next cartridge in the feedway, and next again drawing the action fully to the rear and allowing it to spring forward. The rear notch in the operating slide is provided to assist in locating the point at which the first forward movement must be arrested.

This leaves the chamber empty, but allows the belt to remain in the gun still under control of the pawls. Another complete operation of the operating slide again fully loads the gun. Partial unloading may be effected before landing if desired. Complete unloading includes partial unloading and subsequent removal of the belt from the gun. It may also be effected by opening the cover, thus allowing the belt to fall out, and then operating the operating slide twice. *In every case, when complete unloading is desired, the mechanism of the gun should be operated until there is no possibility of its still containing a cartridge.*

Complete unloading may, if desired, be accomplished before landing.

Chapter V.

FIRING.

A. SYNCHRONIZING GEARS.

As stated in Chapter I, the Browning aircraft machine gun is used solely as a fixed synchronized gun. The operation of its firing mechanism must, therefore, be properly timed with reference to the propeller, since the line of fire is always through the field swept by the propeller. This timing is effected by the synchronizing gear, which is the device driven by the engine for control of the firing of the gun.

Synchronizing gears are made in various forms, but those found satisfactory for service may be grouped in two classes—hydraulic and mechanical. Complete information on them is available in Air Service publications. Either style of gear may be used with the Browning gun, but the mechanical gear is considered preferable.

The hydraulic gear consists essentially of a pipe line filled with oil, connecting two cylinders in which pistons operate. One of these cylinders is mounted on the engine, and its piston carries a roller which, when the gear is in operation, rides on a cam mounted on either the propeller hub, the crank shaft, or cam shaft of the engine. The cam thus communicates impulses to this piston, the number of these impulses depending on the design of the cam and the engine speed, but always so timed that a shot due to any of them clears the propeller blades. These impulses are transmitted very quickly from the engine cam, cylinder, and piston, or "generator," through the closed oil pipe line to the other cylinder and piston. This piston acts directly on the firing mechanism of the gun. The return stroke of the pistons is accomplished by spring action.

Mechanical synchronizing gears operate in a very similar way except that the connection between the engine cam and the firing mechanism of the gun is entirely mechanical. In either case the part of the device mounted on the gun and acting directly on its firing mechanism is called the trigger motor, and in each system provision is made for throwing the gear in and out of action, usually by means of a Bowden control. The pilot simply operates this control when firing; the engine, acting through the synchronizing gear, actually fires the gun.

B. CLASSES OF FIRE.

Synchronized fire is of two classes—full automatic, and semi-automatic or single shot. The Browning gun belongs to the second-named class. In full automatic weapons for ground use, fire continues uninterruptedly within the limits of belt capacity so long as the trigger is depressed, while semi-automatic weapons require a pull on the trigger for each shot. These terms apply to aircraft guns as well. However, it is to be remembered that when a gun is operated by a synchronizing gear the trigger (this term is used in the general sense) is acted upon by a rapidly recurring series of impulses instead of continued steady pressure, as in the case of the automatic ground gun. In either case, the sear is released by an impulse from the trigger or synchronizing gear. In the ground gun, or gun fitted with the hand-firing mechanism, this impulse is supplied during automatic fire by the final closing movement of the bolt, and in a full automatic aircraft gun it may be supplied by either this final bolt movement or the action of the trigger motor. In the semi-automatic type of aircraft gun, the impulse which releases the sear can not be furnished by the bolt movement, but must come from the trigger motor. With this type of gun less dispersion of the shots over the plane swept by the propeller is experienced, and in case a jam or breakage of the gear occurs there is no chance for uncontrolled automatic fire resulting, a not uncommon occurrence with the full automatic arrangement.

C. SIGHTS.

Sights for fixed synchronized aircraft machine guns are considered to be plane equipment rather than part of the guns themselves, and are supplied by the Air Service. Complete information relative to them is available in publications of that department, consequently, only a brief statement concerning them is appropriate in this pamphlet.

The guns are mounted paralled, or nearly so to the line of flight of the plane, and the line of sight is adjusted practically parallel to both of these. The assumption made is that the trajectory of the bullet is a straight line in the prolongation of the axis of the bore, and this is very nearly true for ranges within which airplanes fire upon each other. Thus it will be seen that aiming can be accomplished by directing the plane itself toward the target, the only practical method of aiming yet devised for the pilot.

Since the guns fire directly forward, no correction for movement of the plane is required in the sights. The target, however, is always a moving one, and its movements are those of three dimensions. The sights must therefore include features which automatically provide

corrections for target movement, but these corrections can not be exact.

Fixed machine-gun sights are of two kinds; the ring and bead combination, and telescopic, or tube sight. Planes are usually equipped with both of these, arranged so that the pilot may use either one as desired. The ring and bead sight consists of a ring about 5 inches in diameter with a smaller ring suspended in its center placed about 38 inches from the pilot's eye as the front sight, and a bead placed between the ring and the pilot's eye as the rear sight. For point-blank fire the bead is aligned with the center of the ring and the target, and for targets crossing the line of sight the outer ring is used as the basis of estimating the proper deflection to allow for the course of the target.

Telescopic sights are used in much the same way as the ring and bead sight, but are better suited for long-range fire. They usually have no magnifying qualities, but are arranged to project upon the field of vision a series of etched radial lines and concentric circles which aid the pilot in estimating the speed of, and distance to, the target, as well as its proper location in the sight in order that a hit may be obtained.

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Chapter VI.

CLEANING AND CARE OF THE GUN.

A. CLEANING AND CLEANING MATERIAL.

Proper care of a firearm is invariably a determining factor in securing satisfactory service from it. This is especially true in case of automatic weapons, since all parts of these operate even normally under very severe conditions. An automatic machine gun firing service ammunition at the rate of 600 rounds per minute imparts energy to the bullets it fires at the rate of about 80 horsepower. The total energy developed by the explosion is much greater than this, and yet the mechanism delivering and controlling this energy weighs no more than 30 pounds. With such facts in mind it is not difficult to realize the vital necessity for proper care if satisfactory service is to be obtained.

The most important feature in care of the gun is cleaning. This is of two classes: Cleaning of the bore and cleaning of the working parts. The object of both, however, is the same, and is, first, to insure that there be no obstruction to perfect functioning, and, second, to prevent rust or corrosion. Both of these objects are vital.

In cleaning of the bore two objects must be gained, removal of powder fouling, which leads directly to rusting if not removed, and removal of nickel fouling, which is not in itself particularly objectionable in an aircraft machine-gun barrel, but which always covers powder fouling that will cause rust. The gases formed by the burning of smokeless powder attack steel very readily, and this tendency is intensified by the high pressure which drives them into the pores of the barrel, so that a considerable time is required before they work out again. This fact explains the need for repeated cleaning after a single firing.

The jacket of the bullet is composed of cupro nickel. This, while forming a very satisfactory envelope for the core, has the disadvantage that the combined effect of heat, pressure, and friction tends to deposit small amounts of nickel on the lands of the rifling, always at a point from 4 to 6 inches from the muzzle. This deposit does not increase materially with continued firing and may be readily seen if the bore is wiped bright.

The barrel should always be removed for cleaning. This is both for the sake of convenience in cleaning it well, and to prevent the cleaning solutions used coming in contact with the other parts of

the gun. Cleaning should always be done as soon as possible after firing.

Powder fouling should be removed promptly. The materials necessary are: Caustic soda, hot water, patches, cleaning rod, and cosmoline.

With a hot 20 per cent solution of caustic soda the bore should be swabbed out with patches until all evidence of powder residue is removed. The rod should then be dried and a dry patch used to dry the bore. When the bore is thoroughly dried, use enough cosmoline to color a patch, passing this through the bore several times.

In order to leave the bore smooth and free from lint, the last time the cosmoline patch is withdrawn the rod should be allowed to turn with the grooves while a constant pull is exerted. The chamber should be cleaned with the aid of a stick or rod, after which a very thin coat of cosmoline should be applied.

The following day the bore should be cleaned again as just described. Ordinarily, if the work has been properly done, two thorough cleanings, 24 hours apart, will be sufficient to preserve the bore. It should be inspected, however, for a few days thereafter.

If soda is not available the best substitute is hot water. It is necessary that barrels should be washed carefully in hot water after being cleaned with the soda solution in order to remove entirely any trace of soda, as otherwise this will crystallize and appear on the gun after assembling.

To obtain the best results from the use of the nickel-fouling solution, the proper equipment should first be provided, which should consist of the following:

1. A suitable rack for holding the barrels in a vertical position while the barrels are being filled with the solution.
2. Suitable chamber cartridges with rubber bullet plugs to prevent the solution from getting into the chamber.
3. Rubber tubes to prevent the solution from getting on the muzzle and exterior of the barrel.
4. Glass graduate for measuring the solution.
5. A strong bottle, with rubber stopper, to contain the solution when mixed.

Nickel fouling usually appears on the lands about 4 inches back from the muzzle. It never collects in such quantities as to seriously effect the accuracy of the machine gun. Ordinarily, after it has collected to a certain amount, continued firing will blow the metal fouling out.

If, however, the gun is to be packed away for a considerable length of time the metal fouling must be removed. In itself it is not dangerous to the bore, but it covers up powder fouling which will pit the bore.

To remove metal fouling use the solution prepared as follows: One-half spoonful ammonium persulphate, one half spoonful ammonium carbonate, one-half pint 28 per cent ammonia, one-quarter pint water. To be certain that this solution will not attack the steel of the bore, one-eighth spoonful of potassium bichromate may be added. The spoon referred to above is the one issued by the Ordnance Department with the mess kit. The solution is made by pulverizing the ammonium persulphate and the ammonium carbonate and adding the ammonia and water. If the potassium bichromate is used it is then added to the solution. This should be kept in a strong bottle with a rubber stopper. The solution should never be used more than twice. Never mix the solution with new, but provide separate bottles. The stock solution should not be used after 30 days.

When ready to use the solution place the chamber cartridge in the chamber. (If no chamber cartridge is available use a cork.) Be sure the rubber bullet plug is seated in the barrel to prevent any of the fouling solution from getting in the chamber. Place the barrel in the rack, muzzle up, pull the rubber tube over the muzzle, extending about 1 inch. Fill with the solution until it stands one-half inch over the end of the barrel. A small quantity of sperm oil may be put on top of the solution to prevent the ammonia from evaporating and rusting the muzzle if no rubber tube is used. While the solution is acting, small bubbles will rise to the surface, and the solution will gradually turn blue. When the bubbles stop rising to the surface remove the solution. After the solution is removed the bore should be thoroughly cleaned and oiled.

Allow the solution to stand in the barrel at least one-half hour, then pour it into the bottles, care being taken to avoid getting any on the exterior of the barrel. Place the barrel, after removing the chamber cartridges and rubber tube from the muzzle, in a tank of hot soda solution. Scour with a cleaning rod and brass brush while in the tank. If all the nickel fouling is not removed, repeat the use of the solution. Barrels should be washed in hot water and polished with cloth patches, the same as when removing powder fouling. Always remove the powder fouling before proceeding with the nickel fouling. If care is taken, in the majority of cases all the nickel fouling can be removed.

CLEANING THE CHAMBERS OF BARRELS.—Care should be taken to keep the chamber of the barrel clean. This can not be done readily with the cleaning rod provided for the bore. A short cleaning rod with a large handle is necessary so that the chamber can be well polished out by turning the rod. A suitable cleaning rod can be made by cutting off a standard rod and fitting it in a hardwood file handle,

drilled and pinned through the bushing to prevent the rod from turning in the handle. A second cleaning rod should be provided with a tapped hole in the end to fit a standard cleaning brush. It is necessary to clean the chamber thoroughly to use three or four patches in a slit at one time, in order to fill the chamber. This work should be done by careful and painstaking men and should be well supervised.

Cleaning of the other working parts may be effected in the most convenient manner, but must be thorough. This is especially true of the bolt. Dismounting and careful wiping of all parts, after which they are very lightly coated with oil, will be sufficient in most cases. However, if desired, results can be more quickly obtained by washing the parts with kerosene or gasoline, then drying and oiling them. This method is best for the bolt and feed mechanism, but when it is followed the greatest care must be exercised in drying and oiling in order to prevent rust. The muzzle-attachment parts should not be neglected in cleaning, even though the gun will still function if they are coated with the powder-gas deposit that accumulates in firing.

B. OILING.

Proper oiling is second in importance only to intelligent cleaning. It is the only means for preventing rust and in operation is a vital necessity for the working parts. When the gun is packed for shipment, all of its parts are coated with cosmoline. This, while an absolute protection from rust, is much too heavy for use as a lubricant in operation. All of it must be removed before firing, particularly from the interior of the bolt and belt feed mechanism; otherwise the gun can not function properly. This may be removed by wiping or by washing in kerosene or gasoline; in case the latter method is employed, drying and oiling must be carefully done immediately after washing.

The oil for lubrication must be very lightly applied. It must be a straight mineral oil, highly filtered and refined. No animal or vegetable products are permissible; nor is any other substance the presence of which might lead to gumming or corrosion. Oil such as used for C. C. synchronizing gears will give good results.

C. ADJUSTMENT.

When the gun is shipped from the factory all its parts are in correct adjustment. However, after considerable firing is done, some corrections may be necessary to compensate for wear. If care is exercised these can be very readily and satisfactorily made, but in no case should any adjustment be attempted without a clear under-

standing of how to do it and why it is necessary. The only major adjustment to be made in the field is that for head space.

Head space is the measure of the length of the large part of the chamber, considering the face of the bolt, or the head of the cartridge, when the breech is locked as the rear end. For the .30 caliber cartridge this dimension falls between the limits of 1.940 and 1.946 inches.

Variation from these limits is likely to result in stoppages—if shorter, through failure to breech properly; and if larger, through ruptured cases. In case of excess head space, even though there be no actual ruptures of cases, a terrific pound results, and this is very severe in its effects on the mechanism. If sufficient to cause a rupture, the gun is then completely out of action, as the forward end of the case is left in the chamber and prevents the next cartridge seating properly. If the head space is too great but still not enough so as to cause ruptures, the cases will frequently show "incipient ruptures" and "stretches." These vary all the way from a barely discernible stretching of the case to partial ruptures in which the entire case is, however, extracted. It will be seen from the above that proper adjustment of head space is very essential.

To adjust head space, remove the bolt, barrel extension, and barrel from the casing and proceed as follows:

Start the barrel threads into the barrel extension and stop at the beginning of the clicking sound of the barrel locking spring, place the bolt in its guides in the barrel extension and shove it all the way home, being careful that the extractor, if not removed, is in its uppermost position. Lock the bolt to the barrel extension by pushing the breech lock up into its seat firmly. Without using excessive force screw in the barrel until its stops. Release the breech lock and pull back the bolt and screw up the barrel one or one and a fraction notches, depending upon whether the tooth of the barrel locking spring is in a notch or between two notches. Assemble the parts in the gun and test to see that the bolt and other parts lock without any extra amount of force or jerk. If too tight, unscrew the barrel one notch. If too loose, ruptures or indications of rupture will appear on cartridge cases after firing, and these should be examined frequently for such indications.

A positive rule for adjustment that will fit all guns can not be given. The exact adjustment can only be determined by experience and test.

The head-space adjustment may be checked by gauges, providing these are available. In adjusting head space in this manner two gauges are used. One of these is of the maximum and the other of the minimum length. The two constitute a set. With correct head-

space adjustment the gun will breech easily over the minimum gauge, but will not close over the maximum one. When trying either gauge the breech must be closed gently. Never allow the action to spring shut over either gauge.

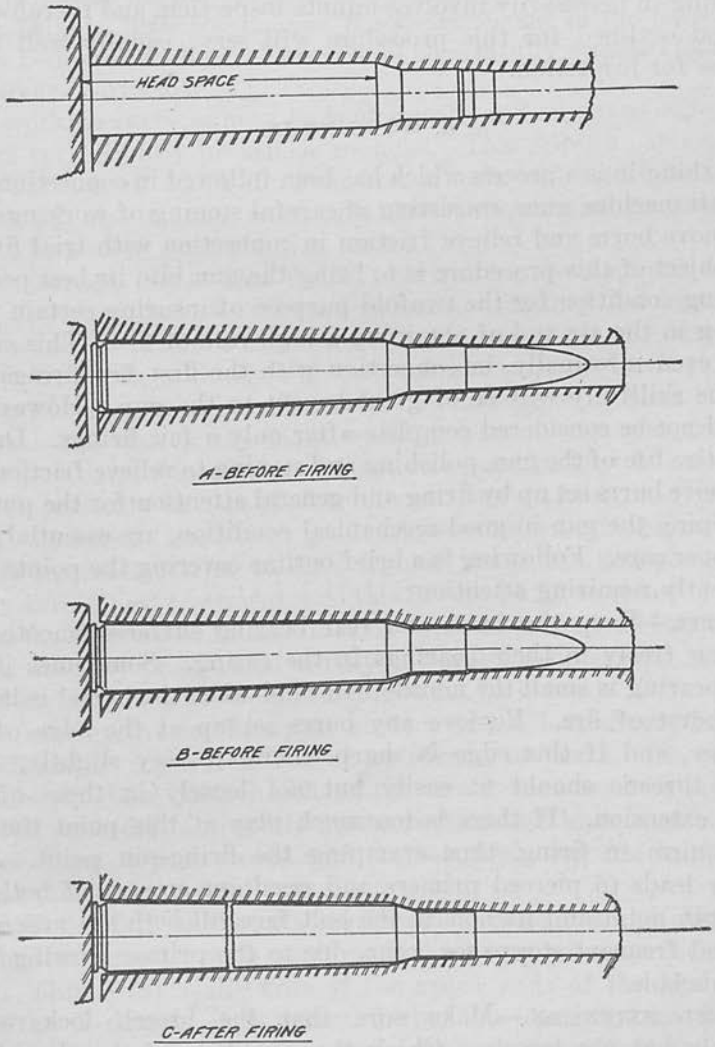


PLATE 18.—Sketch showing effect of excessive head space.

D. INSPECTION.

Inspection consists of a careful and intelligent examination of all parts of the gun, in order to determine their condition, particularly with respect to cleanliness, wear, or damage, and need for repair or

replacement. It is best carried out in connection with cleaning, and should always be as nearly completed as possible before re-assembling. All parts should be inspected for dirt, and all working parts for damage, need of repair, or replacement. This process is very closely related to that of working-in, under which heading the special points to be observed in connection with each working part are considered. Working-in necessarily involves minute inspection, and therefore the method outlined for this procedure will serve equally well as an outline for inspection.

E. WORKING-IN.

Working-in is a process which has been followed in connection with aircraft machine guns, consisting of careful stoning of working parts to remove burrs and relieve friction in connection with trial firings. The object of this procedure is to bring the gun into its best possible working condition for the twofold purpose of insuring certain functioning in the air and of obtaining a high rate of fire. This can be done, even informally, in connection with the first few firings, and if done skillfully will be of great benefit to the gun. However, it should not be considered complete after only a few firings. During the entire life of the gun, polishing and stoning to relieve friction and to remove burrs set up by firing and general attention for the purpose of keeping the gun in good mechanical condition, are essential parts of proper care. Following is a brief outline covering the points most frequently requiring attention:

Barrel.—Keep the front and rear bearing surfaces smooth and working freely in their bearings in the casing. Sometimes if the front bearing is small the muzzle will bind when the barrel is heated by a burst of fire. Remove any burrs set up at the edge of the chamber, and if this edge is sharp, round it very slightly. The barrel threads should fit easily but not loosely in those of the barrel extension. If there is too much play at this point the bolt will squirm in firing, thus cramping the firing-pin point. This usually leads to pierced primers and resultant erosion of both the firing-pin point and its hole in the bolt face till both are unserviceable and frequent stoppages occur, due to the primer blowing back into this hole.

Barrel extension.—Make sure that the breech lock works smoothly but not loosely. Check the condition of the threads as outlined above in connection with the barrel. Test the barrel plunger stud for looseness and wear, and examine the accelerator cams for burrs. Make sure that the bolt slides smoothly in its guides throughout its travel. In operation the extractor, in dropping to its lowest position, sometimes causes a burr on the top of the left-hand side

of the barrel extension, and a similar burr is occasionally caused by the ejector on the inside of the right-hand side. These should be carefully removed as soon as they appear and they should be watched for after every firing. There is sometimes a slight interference between the lower end of the ejector and the top forward end of the barrel extension during the final closing action of the bolt, due to the ejector being a little too long or the clearance cut in the barrel extension being too shallow. This should be carefully watched and any interference corrected.

All working surfaces must be kept smooth and all sharp edges and corners very slightly broken or rounded. This applies particularly to the surfaces in which the bolt, breech lock, and breech-lock cam operate, but also includes reasonable care of the exterior surfaces and edges which slide upon the side plates.

BREECH-LOCK CAM.—This member should not be removed except when necessary, but should be frequently examined for breakage, wear, or burrs. A slight looseness in the receiver is not objectionable, but should not be allowed to become too great. In removing or replacing the screw be very careful to avoid damage to its head.

BOLT.—The bolt is the main working part of the gun and deserves very careful attention. Its exterior must be kept in condition to work smoothly in both the barrel extension and the receiver, and all its components must be in good condition in order to insure satisfactory operation. Due to its irregular shape the bolt sometimes warps during heat treatment, and this is very likely to result in binding in the receiver or of the interior working parts. If this condition is not very pronounced it may be corrected by careful stoning, but if serious the bolt should be discarded.

The cam groove in the upper surface of the bolt should be kept smooth and its edges free from sharp corners or burrs. The beveled surfaces provided on each side of the cam groove must be polished smoothly in order to properly guide the belt feed lever stud into the groove if the cover is closed with the belt feed lever not in position so that the stud can drop into the groove.

The T-slot face of the bolt requires close attention and should be polished to remove rough spots or sharp edges wherever brass collects. This is especially true of the upper ends of the lips which form the T-slot, as it is essential that the cartridge head move smoothly down into this slot after extraction from the belt.

Examine the locking surface frequently. If damaged, the bolt must be discarded. Keep the lugs against which the accelerator acts smooth. Watch carefully for battering at the rear end of the bolt due to impact on the buffer. This kind of damage may result in binding of the sear or sear slide and consequent failure in functioning of the firing mechanism.

FIRING PIN.—Check for free movement in the bolt and note the condition of striker point and sear lug. Keep the point smooth. The sear lug must be in good condition, with its forward edge sharp. Note that the front surface of this lug is undercut to insure the sear holding and that clearance is provided at the bottom for the corresponding sharp edge of the sear. If either the point or the sear lug become damaged the pin should be replaced, but the condition of the sear lug is the more important of the two.

If it is suspected that the firing-pin spring is weak, as evidenced by a light blow on the primer, remove the spring and compare its free length with a new one. If short or damaged, replace it.

COCKING LEVER.—Keep all working surfaces smooth and note particularly whether the firing pin strikes the lower part in driving forward. Check the operation of the cocking lever to insure that it retracts the firing pin sufficiently to allow the sear to engage. There should be about 0.01 inch overtravel. Round the edges of the head of the cocking lever pin to prevent scraping the side plate.

SEAR, SEAR SIDE, AND SEAR SPRING.—These members are very important in the operation of the gun and must be kept in perfect condition. Care of the sear nose corresponds to that of the firing-pin lug, and it is very advisable to always consider the two together. Keep the sear working smoothly in its guide cuts in the bolt, being especially careful to insure that there is no binding or sticking at the cut for the driving spring rod pin. The top and bottom corners of the sear should be rounded and its edges, except the nose, slightly broken. If either part of the toe which rides on the firing-pin lug becomes broken it is best to replace the sear, but if this is not practicable be sure that the broken edges are trimmed to avoid damage to the firing-pin lug. Test the action of the sear slide for smoothness and make sure that it has no tendency to stick at the end of its throw. Keep all working surfaces smooth. There should be a slight play between the cam cut in the sear slide and the corresponding lug on the sear when the firing pin is cocked. If the sear slide is found to be tight, stone carefully until this slight play is obtained. The forward edge of the outer end of the sear slide must be kept square and sharp in order to work properly with the trigger motor plunger. Test the sear spring for tension and elasticity and note whether its holder and pin are in good condition. It is very advisable to occasionally check the action of the firing pin, sear, and sear slide with both the sear spring and the firing-pin spring removed.

DRIVING SPRING AND ROD.—If the spring seems weak, compare it with a new one, and if much shorter than the new one, discard it. Test the rod for straightness and the pin for proper holding in the

locked position in the bolt. Check for interference between the pin and sear when the rod is locked in the bolt. Break the edges of the hole in the bolt.

BOLT HANDLE AND BOLT STUD.—Note that the collar does not scrape the inside of the left-hand side plate. If sharp, break slightly.

EXTRACTOR.—Test for functioning with a dummy cartridge. Polish all burrs and sharp edges from functioning surfaces and the ejector. Insure that the ejector is straight and that it and the extractor cam plunger work smoothly. Polish off burrs that appear on the plunger and if a flat spot develops, replace it. Note that the lower end of the ejector does not bind on the front of the bolt when the extractor is moved to its lowest position. Keep the extractor claw in good condition, and make sure that its stud fits closely in its hole in the bolt.

LOCK FRAMES.—Keep the cams at the forward end smooth. Check the action of the barrel plunger and trigger pin. Smooth off any burrs which form on the accelerator.

COVER.—Polish the edges of cover, extractor cam, and cover extractor spring. Smooth the lower corners of the transverse ribs which support the belt feed slide and make sure that the slide moves freely in its guides. Do not let the belt feed lever pivot bearing get excessively loose before replacing the pivot. Keep the belt feed lever stud smooth and free from burrs. The belt feed lever sometimes gets bent upward and then is likely to cause stoppages due to the stud jumping out of the cam groove in the bolt. This can be readily corrected by removing the lever and carefully bending it back. See that the finger on the belt feed pawl is smooth and not bent out of shape. If bent, it is likely to strike the rear cartridge stop. Test the belt feed pawl and its spring for functioning.

RECEIVER.—Smooth out any burrs that form in the feedway for the belt. Make sure that the belt holding pawl and its spring work properly and that the cartridge stops, particularly the rear one, are in good condition.

Remove any burrs which develop around the edge of the trigger motor slots and in the path of the extractor cam plunger. The burr which is sometimes raised by the bolt handle in the rear of its slot should be filed and stoned away. Test the operating slide for smooth functioning and smooth its functioning surfaces if necessary.

The outline just given is not necessarily to be considered complete in every detail. Other points requiring attention will frequently arise, but by keeping in mind the ideas noted these can be readily and intelligently dealt with.

F. POINTS TO OBSERVE BEFORE A FLIGHT.

1. Wipe the bore and chamber.
2. Test the functioning of gun by hand, using dummies.
3. Test the functioning of operating slide.
4. Oil carefully. Only a very little oil may be used.
5. Make sure that the belts are in good condition and properly loaded.
6. Carefully place the belts in their boxes and load the gun. Loading may be complete or partial as directed.

G. POINTS TO BE OBSERVED AFTER A FLIGHT.

1. Unload completely and remove belt from ammunition box.
2. Clean the bore and all working parts. If this can not be done at once, oil carefully to prevent rust.
3. Release the firing pin spring.
4. At the first opportunity dismount the gun, clean, oil, and inspect all parts. Make needed repairs and replacements. If stoppages have occurred, their causes must be determined and corrected immediately.
5. On assembling, check the operation with dummies and release the firing pin spring, after insuring that functioning and adjustments are correct.

H. REPLACEMENT OF PARTS.

Some parts of the gun are subject to much greater strains than others, and are, therefore, shorter lived. Such parts must be replaced from time to time. Any part may become unserviceable through gradual wear or sudden failure, either of which may be due only to itself or to imperfections in operation of some contiguous working part. This, too, shows the necessity for frequent and careful inspection. When a part is broken or damaged enough to prevent proper functioning it must be replaced. However, it may be advisable to replace parts before they actually fail. This is a matter requiring sound judgment and thorough knowledge of the gun. If the exact life of each part could be predicted, replacement prior to failure would be a simple matter; however, this can not be done. Variation in operating conditions and ammunition, high rates of fire, etc., introduce added uncertainty in the question of probable life of parts, so that only general approximations can be given.

The minimum serviceable life of the gun is considered to be 10,000 rounds. Many of its parts—in fact, the most of them—will last much longer than this, but some, principally bolt parts, will not

as a usual thing last as long. It is advisable to replace the following parts after a maximum of 5,000 rounds of firing:

Belt feed lever and pivot.
Feed pawl spring.
Belt holding pawl spring.
Extractor cam plunger and spring.
Firing pin and spring.
Sear.

Any of these parts may last much longer, but this can not be counted on. The one vital point to remember is that the whole object of care and replacement of parts is to keep the gun in action. Hence it is preferable to occasionally discard a part which may still be serviceable if experience shows it has reached the average life of such parts rather than to delay replacement until actual failure occurs. Whenever a new part is put in every precaution must be taken to insure that it fits and functions properly. If one part of a pair is damaged, both must be replaced.

I. AMMUNITION AND ITS INSPECTION.

Ammunition for aircraft service must be of the highest quality, both with respect to functioning properties and uniformity of external dimensions. The most important point with regard to functioning is that there be no hangfires. The percentage of these can be determined only by firing test lots, but is seldom high enough to cause material difficulty. The important external dimensions can be checked by readily improvised gauges, and this should be done whenever practicable. These dimensions are: Over-all length, fit of the head in the bolt face (test by stripping through a spare bolt), and length of body (test by inserting in the chamber of a spare barrel). Looseness of bullets, dents, cracks, or other damage to the case, thin or thick heads, inverted primers, and similar defects can be detected in this way and by visual inspection. The uniformity obtained in loading belts is an additional indication of correctness of conformation of the cartridges. The same points must be observed also in case of special tracer, incendiary, and armor-piercing ammunition as with that of the service type. Special ammunition must have the same external dimensions as service ammunition in order to function satisfactorily either in the belt or gun.

J. METALLIC BELT LINKS.

The Browning gun may be fed from either a fabric or disintegrating metallic link belt. However, only the link belt is used in aircraft service. Weather conditions affect the fabric belt adversely,

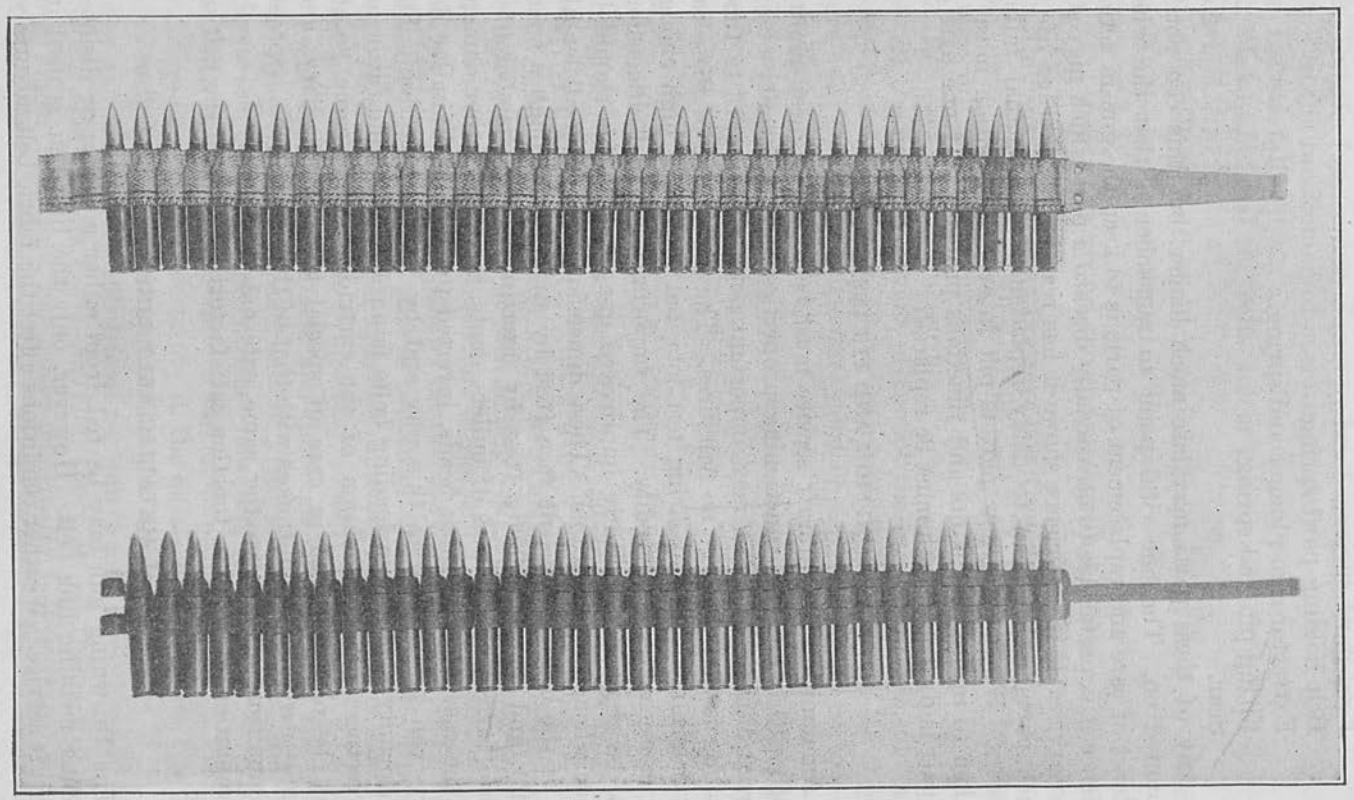


PLATE 19.—Loaded fabric and metallic link belts.

and its use requires means for storing the empty end as firing progresses. Link belts have more uniform extraction pull regardless of weather conditions, and the ejected link can readily be disposed of. This is usually done by conducting them through a chute, where they fall clear of the machine. Both fabric and metallic belts are shown in Plate 19. The metallic belt is composed of a series of links all exactly alike and connected by the cartridges themselves, acting as pivots. As the belt is fed into the gun, step by step, and each successive cartridge extracted, the links are freed from the belt, one by one, and are pushed out of the belt exit in the feed box. The chute then carries them clear of the machine.

Belt links are made of a spring-tempered steel, protected from rust by either parkerizing, sherardizing, zinc plating, or copper plating. They should be inspected before loading in order to insure perfect functioning. If rusty, they should not be used. Failure is usually due to the link being too hard or too soft. If too hard, there are likely to be incipient cracks in the corners between the web and the single loop. These should be carefully watched for and any links having even the slightest of such defects discarded. If the link is too soft the middle loop is likely to stretch out, and if this occurs stoppage is certain to result. Such links can be discovered by testing each link. To do this, grasp the double loop end with one hand and the single loop with pliers. A sharp twist will invariably show whether the link is too soft. The severity of the twist to be applied will be apparent after a few trials, especially if the test is applied first to properly tempered and then to soft links, so that a comparison may be made. Any link whose middle loop shows a permanent distortion under this test must be discarded. The middle loop is the weak point in the link. The front loop is loose on the cartridge neck and acts as a guide, while the gripping which holds the cartridge in the belt is provided by the rear loop.

Link belts should not be left loaded for any considerable period, as tension of the gripping loops is apt to change and excessively hard extraction may result. If links are trapped on exit from the gun, instead of allowed to waste, there is no objection to their being used repeatedly. They should be inspected each time, however. Belts when loaded must be free from kinks or tight hinge loops. Cartridge heads must be well aligned in order to feed properly. The belt may enter the gun with either single or double link loops leading, as there is no difference in functioning.

K. GUN BOOK.

A complete record should be kept showing the history of each gun. This is most conveniently kept in a gun book. The exact form of this book is not important, but it should include the number, name, model,

type, and caliber of the gun it relates to, with the name of its manufacturer and inspector's mark. Each part of the gun's history from acceptance should be covered briefly but exactly. There should also be a complete record of firing, including dates, rounds fired at each time, types of ammunition used, stoppages and means employed for their correction, breakages, and replacements, with total rounds fired

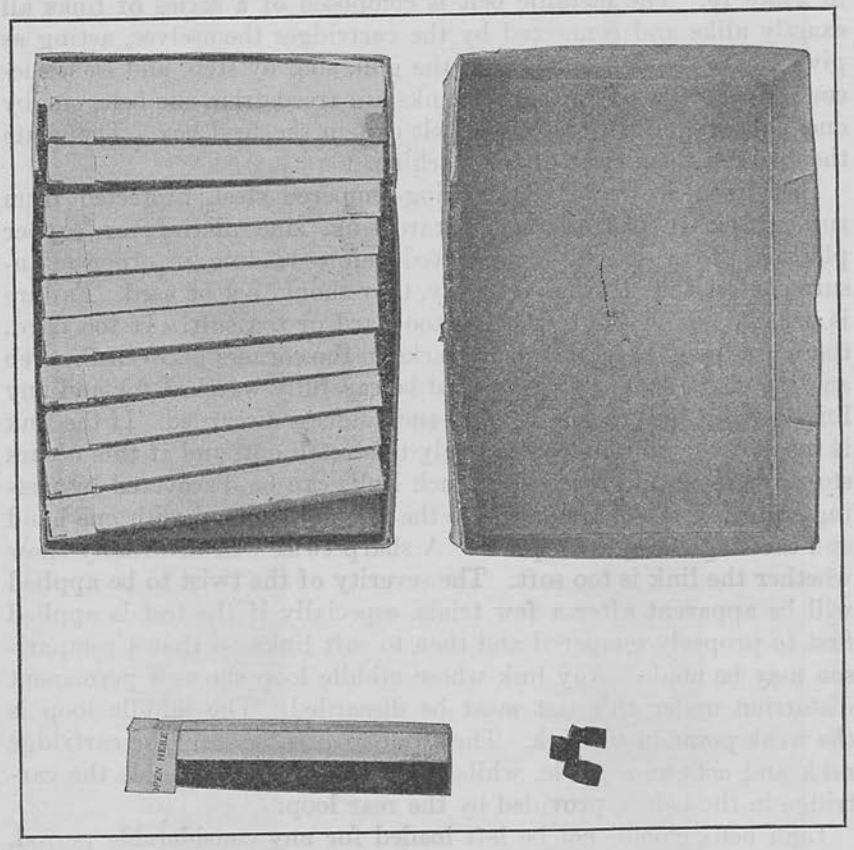


PLATE 20.—Metallic link-belt packing strips and carton.

by each part replaced, conditions and object of each firing (action, ground test, air test, etc.).

When reporting breakage or difficulty the above data should be supplied as completely as possible, especially the gun number, manufacturer's name, and inspector's mark. Intelligent action in remedying the difficulty is largely dependent on the information contained in the report of its occurrence.

CHAPTER VII.

SPARES, ACCESSORIES, AND REPLACEMENTS.

A. SPARES.

These are extra parts provided with each gun and shipped with it. They are for replacement of the parts most likely to fail, for use in making minor repairs, and in general care of the gun. Every effort should be made to keep a supply corresponding to the list below on hand for each gun to insure that it may be depended on for action at any time.

SPARES.

1 barrel.	1 hand-firing pin.
1 belt-holding pawl pin.	1 hand sear.
1 belt-holding pawl spring.	2 hand-sear springs. } Assembled.
1 belt-feed pawl spring.	2 hand-sear spring pins. }
1 bolt handle.	1 operating-slide stop, front.
1 cover-extractor spring.	1 operating-slide plunger.
1 driving spring.	1 operating-slide plunger spring.
1 ejector.	1 sear.
2 ejector pins.	1 sear slide.
1 extractor-cam plunger spring.	1 sear spring.
1 firing pin.	1 sear-spring holder. } Assembled.
2 firing-pin springs.	1 sear-spring pin.
2 firing-pin spring pins.	

B. ACCESSORIES.

These include tools for dismounting and cleaning the gun and making adjustments, as well as such auxiliary equipment as belt loading machines, electric heater, and metallic belt links. Following is a list of accessories supplied with each gun (Pl. 21):

1 cleaning rod.
1 combination tool (wrench, punch, and screw driver).
1 oil can.

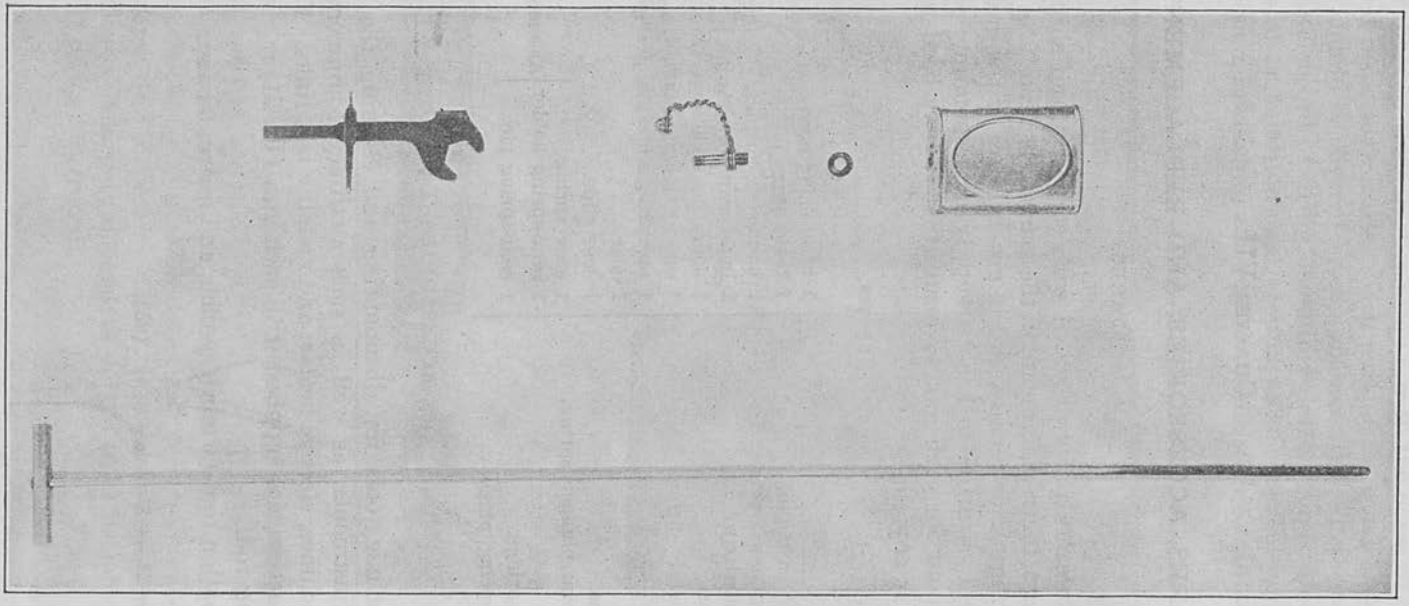


PLATE 21.—Accessories supplied with gun.

C. BELT-LOADING MACHINE.

Metallic link belts can be loaded by hand; however, a machine provided for this purpose is a great convenience and indispensable to rapid loading or loading in a considerable quantity. The machine consists of three parts—bed, pusher, and handle. To operate, it should be firmly fastened to a bench or box by screws. The links are then placed in position on the bed (they may be emptied from the

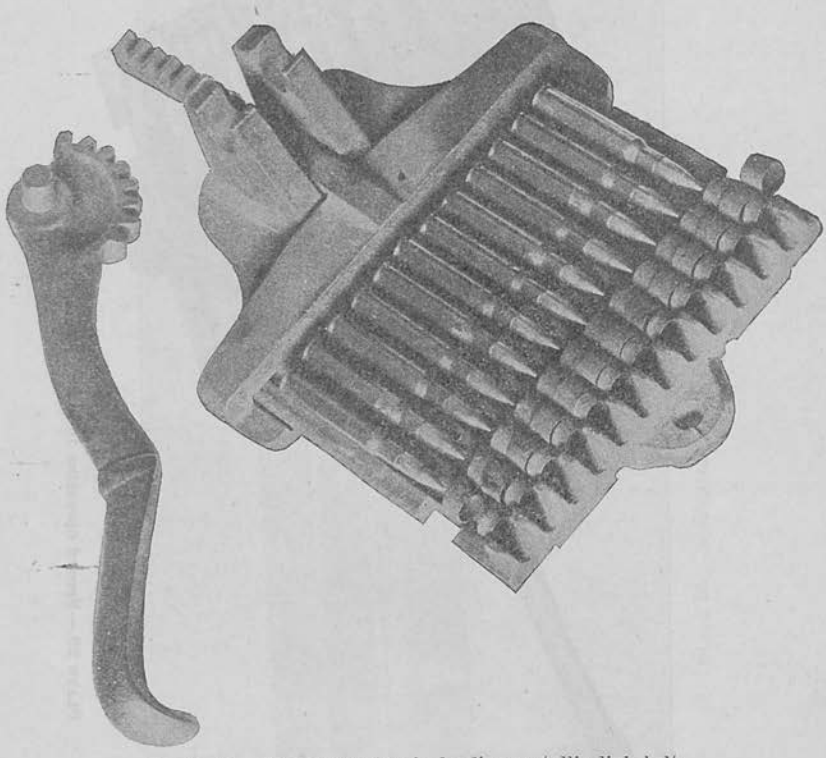


PLATE 22.—First operation in loading metallic link belt.

strips in which they are packed directly in place for loading), and the proper number of cartridges placed in the grooves corresponding to each link. The pusher is retracted while this is done. The cartridges are then pushed into the links by the pusher, which is actuated by the teeth of the handle sector engaging its rack as the handle is forced down. With reasonable care belts may be rapidly and accurately loaded in this way. Plates 22 and 23 show the various steps in the operation of this machine.

D. ELECTRIC HEATER.

The extreme cold of high altitudes is very likely to cause stoppage by freezing either the oil in the gun parts or moisture which may

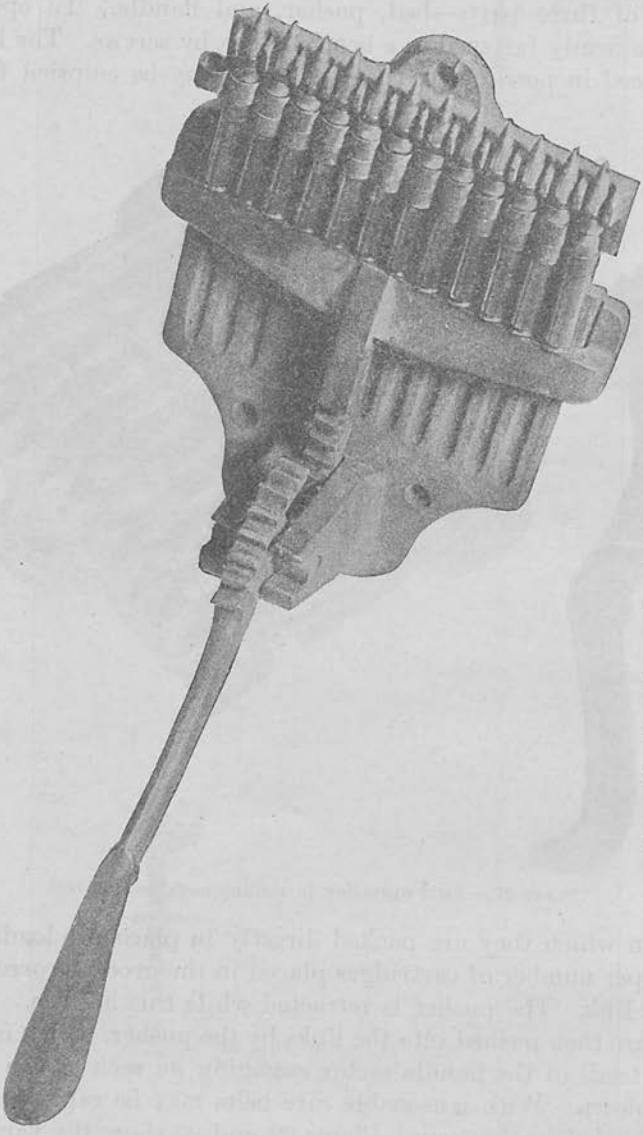


PLATE 23.—Second operation in loading metallic link belt.

have collected upon them in flight. This is very serious, inasmuch as when called upon for action it is vital that the gun respond instantly and certainly, and, consequently, electric heaters have been devised

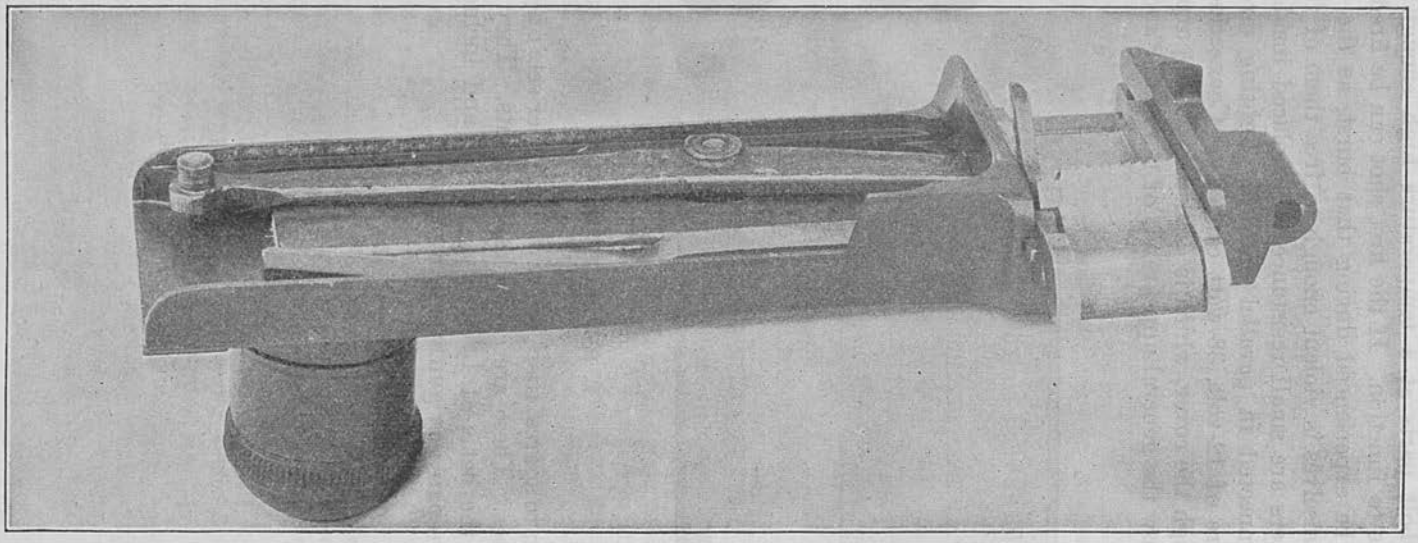


PLATE 25.—Application of electric heater.

to keep the bolt parts at a temperature high enough to prevent such a failure to function. If the first shot can be fired no further trouble will be experienced during that burst, as the working of the parts themselves is violent enough to free them of frost.

These heaters are small resistance units placed inside the cover. They are connected in parallel with the lighting circuit of the plane, and are of 12-volt, 36-watt capacity. Connecting terminals project through the cover, which is drilled for that purpose. Plates 24 and 25 show the general appearance of the heater and method of installation.

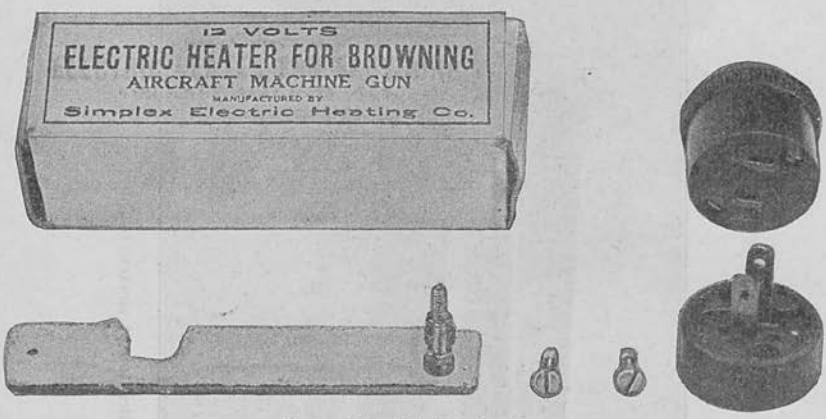


PLATE 24.—Electric heater.

E. REPLACEMENTS.

In addition to spares, there are provided other sets of parts for use at repair bases. These are called replacements. They are usually supplied on the basis of 1,000 guns per set and include all parts necessary to repair any gun worth repairing.

List of replacements required for 1,000 Browning aircraft machine guns, model of 1918M1, caliber .30.

Accelerator	90
Accelerator pin	200
Accelerator stop	100
Adjusting screw	100
Adjusting-screw plunger	200
Adjusting-screw spring	200
Barrel	2,000
Barrel jacket	60
Barrel-locking spring	100
Barrel-plunger stud	200
Barrel-plunger spring	600
Barrel plunger, Barrel-plunger guide pin	60
Barrel extension	750
Back plate	25
Back-plate dowel	60
Belt-feed slide	60
Belt-feed pawl	90
Belt-feed pawl pin	300
Belt-feed pawl spring	300
Belt-feed pawl-spring stud	300
Belt-feed lever	150
Belt-feed lever pivot, Belt-feed lever-pivot spring	300
Belt-holding pawl	300
Belt-holding pawl bracket	25
Belt-holding pawl-bracket rivet	75
Belt-holding pawl pin	500
Belt-holding pawl spring	1,000
Bolt	500
Bolt handle	1,000
Breech lock	90
Breech-lock pin	90
Breech-lock pin spring	500
Breech-lock cam	300
Breech-lock cam screw	600
Buffer plate	90
Buffer tube	150
Buffer disk, thick	500
Buffer disk, thin	500
Cartridge stop, rear	500
Cartridge-stop rear rivet	500
Cartridge stop, front, with link guide assembled	100
Cocking lever	100
Cocking-lever pin	100
Cover	25
Cover-extractor cam	25
Cover-extractor cam rivet, long	60
Cover-extractor cam rivet, short	60
Cover-extractor spring	100
Cover-extractor spring stud	100
Cover pin	30
Cover plate	25
Cover plate rivet	60
Driving spring	1,200
Driving-spring rod, complete, with pin	500
Driving-spring rod pin	400
Ejector	180
Ejector pin	90
Extractor	600
Extractor-cam plunger	90
Extractor-cam plunger spring	90
Extractor-cam plunger pin	90
Extractor feed cam	100
Extractor feed-cam rivet	200
Extractor cam	75
Extractor-cam rivet	200
Firing pin	800
Firing-pin spring	500
Firing-pin spring pin	500
Latch	25
Latch stop screw	200
Latch spring handle	300
Latch spring	300
Latch spring handle rivet	60
Latch-spring rivet	300
Lock frame, right hand	25
Lock frame, left hand	25
Lock-frame guide pin	25
Lock-frame separator	25
Lock-frame spacer	25
Lock-frame rivet	25
Lock frame spacer rivet	25
Muzzle attachment	250
Muzzle-attachment plug	300
Operating slide, with rear stop and grips assembled	50
Operating-slide plunger	100
Operating-slide plunger spring	100
Operating-slide plunger stop	100
Sear	500
Sear spring, Sear-spring holder, Sear-spring pin (Assembled)	1,000
Sear slide	500
Side-plate rivet	500
Top-plate rivet, long	50
Top-plate rivet, short	100
Trigger pin	500
Trigger-pin spring	500
Trunnion-adapter rivet, long	500
Trunnion-adapter rivet, short	500

Chapter VIII.

STOPPAGES AND IMMEDIATE ACTION.

JAMS, MALFUNCTIONS, STOPPAGES.

Distinguish carefully between these terms, and use them correctly. Any accidental cessation of fire is a stoppage. It may be due to a misfire, or to the fact that the magazine has been emptied, etc. In this case it is not a malfunction.

A malfunction is an improper action of some part of the gun, resulting in a stoppage. For example, a failure to extract the empty cartridge case.

A jam is some malfunction which causes the mechanism to stick or bind so that it is difficult to move. Do not use the word "jam" too much. Most troubles with the guns are merely temporary stoppages due to some malfunction, and real jams are comparatively rare.

Very few stoppages can be remedied in the air. Nevertheless, it is of vital interest to the gunner to know as much as possible about the cause of, and remedies for, various stoppages, particularly those which are susceptible of correction by simply operating the loading handle. Stoppages are attributable to three causes:

1. Lack of proper care, or improper methods of operation.
2. Mechanical causes arising from the fact that no mechanism can be made to function perfectly.
3. Faulty ammunition.

The first of these can be entirely overcome by proper training and discipline. Care in inspection will aid greatly in elminating the other two, but no amount of care can entirely overcome them. Stoppages may be temporary or permanent. Temporary stoppages are those susceptible to correction in flight. Those which can not be readily corrected are called permanent and necessitate an armorer's attention. Only the more frequently encountered stoppages are considered here. Range firing practice will occasionally show others of more rare occurrence. The notes given here on malfunctions are to be considered primarily in relation to practice firing on the ground, as it is in such firing that the fundamentals of the operation of the gun are learned. The gunner may subsequently apply the knowledge of stoppages thus gained to operation in flight, and then will be able to quickly determine whether any particular stoppage can be readily corrected or if it necessitates more extensive repairs than he can make. The remedies specified for each stoppage need no ampli-

fication on the point of whether they can be applied in the air. Immediate action is the process employed by a gunner in remedying a temporary stoppage or determining the existence of a permanent stoppage.

Stoppages are conveniently classified according to the position of the bolt handle as follows:

First position. Bolt handle fully forward.

Second position. Bolt handle near fully forward position.

Third position. Bolt handle near end of recoil.

The immediate action necessary to remedy stoppages is indicated by the position of the bolt handle, which may stop in one of three positions, known as the first, second, and third positions.

The cover must never be lowered with the extractor raised.

When a stoppage is experienced, first note the position of the bolt handle. *Never push the bolt handle forward.* The cover should be raised in order to make the mechanism accessible for observation or manipulation. It should never be thrown upward and forward, but should be raised quickly.

SUMMARY OF CAUSES OF STOPPAGES.

Position.	Stoppage.
First	Misfire, defective ammunition.
	Short or broken firing pin.[1]
	Weak firing pin spring.[1]
	Gummed firing pin.[1]
	Excessive friction on firing pin.[1]
	Trigger locked.
	Belt unevenly loaded.
	Belt links stretched.[1]
	Belt feed pawl spring weak or out.[1]
	Belt feed lever pivot pin out, broken, or worn.[1]
	Belt feed lever weak.[1]
	Belt holding pawl out (pin out or spring weak or out).[1]
	Cover extractor spring weak or broken.[1]
Second	Tight belt links.
	Broken extractor.
	Broken ejector.
	Ruptured cartridge case.
	Bulged cartridge.
	Barrel breeched up too tight.
Third	Battered rim of cartridge.
	Extractor cam plunger behind extractor feed cam (can not happen with cover latched).
	Failure to extract shell from chamber.
	Broken cannelure or thick rim of cartridge.
	Broken or damaged grooves on face of bolt.
	Set back primer.

[1] Recurring stoppages.

Position.	Stoppage.
Sundry	Broken barrel extension.
	Faulty trigger (too short or bent down) sear and trigger engaging bevels burred (gives uncontrolled automatic fire).
	Driving spring held compressed in bolt.
	Excessive friction or dirt on any of the moving parts of the gun.
	Failure to cock firing pin.
	Faulty holding of sear.
	Sear slide sticking.

The following table of stoppages affords a clear indication of the methods to be employed in teaching the practical side of the mechanism.

Column 1 shows the three positions of the bolt handle when the gun stops firing. The second and third positions are variable. These positions, which afford a ready indication of the correct immediate action to be performed, should be recognized instantly.

Column 2 deals with a description of the immediate action to be performed as soon as the position of the bolt handle has been noted after the gun has stopped firing.

Column 3 deals with the probable causes of these stoppages. A thorough knowledge of the causes of temporary stoppages will not only afford a practical knowledge of the manipulation and action of the gun, but it will also be an aid in the discovery of the cause of any unusual breakdown which may occur.

Immediate-action table.

Position of bolt handle.	Immediate action.	Probable cause.
First	1. Pull the bolt handle to the rear, release it and continue firing.	1. Misfire, defective ammunition.
	(*a*) If stoppage recurs on next round, pull bolt handle to the rear and if a cartridge is ejected, change bolts and continue firing. If spare bolt is not available examine the one taken from the gun for broken or damaged parts or defective action. Replace damaged part and continue firing.	(*a*) Short firing pin. Broken firing pin. Gummed firing pin. Friction on firing pin. Weak or broken firing pin spring. Faulty engagement of firing pin and sear shoulders. Faulty action of cocking lever. Broken sear spring.
	(*b*) If a cartridge is not ejected, raise the cover and correct the fault in feed. Continue firing.	(*b*) Belt improperly loaded. Stretched belt. Belt feed lever pin out, broken or worn. Belt feed pawl spring weak or out. Belt holding pawl out. pin out, or spring weak or out Cover extractor spring weak or broken. Belt feed lever weak (stud on lever jumps out of cut in top of bolt).
	(*c*) If at any time the trigger can not be raised the cause of its sticking must be removed.	(*c*) Trigger locked, defective trigger lock, or carelessness while firing.
Second	1. Raise the cover with the left hand and pull the bolt handle to the rear with the right hand. If there is a cartridge on the face of the bolt with the front portion of a separated case adhering to it, remove the obstruction and continue firing.	1. Separated case, too much head space.
	(*a*) If the cartridge on the face of the bolt is not fastened to a separated case, remove and examine it. If the cartridge is not bulged, remove the separated case from the chamber by using the defective cartridge extractor, being careful not to remove the extractor. Continue firing.	(*a*) Separated case, too much head space.

Immediate-action table—Continued.

Position of bolt handle.	Immediate action.	Probable cause.
Second (con.).	(*b*) If the cartridge on the face of the bolt is "bulged," remove it and continue firing.	(*b*) Battered or bulged cartridge.
	(*c*) If there is no cartridge on the face of the bolt, examine for broken ejector or tight loop in belt. Replace the broken part or remedy the defect. Continue firing.	(*c*) Broken ejector, broken extractor, tight loop in belt.
	(*d*) If the barrel will not go home, adjust the gun properly.	(*d*) Barrel breeched up too tightly.
Third.....	1. Pull the bolt handle to the rear, raise the center, raise the extractor. Push the cartridge up from the bottom and let it drop out or lift it up and out. Lower the extractor, lower the cover, load and continue firing.	1. Battered rim of cartridge. Thick rim of cartridge. Broken cannelure. Set back primer.
	(*a*) If stoppage recurs, proceed as in (1) until cartridge is removed. Examine cut in face of bolt. If grooves are broken or burred, replace with spare bolt and continue firing.	(*a*) Broken or damaged grooves on face of bolt.
	(*b*) If upon raising the cover it is noted that the extractor cam plunger is caught behind the extractor feed cam, lower and latch the cover and continue firing.	(*b*) Cover not latched.
	(*c*) In all third position stoppages except (*b*), glance at the chamber. If it contains a cartridge case, remove the case by the best method available, probably by using the cleaning rod. Continue firing.	(*c*) Small cartridge head. Failure to extract empty case from chamber.

CAUTION.—After any stoppage which appears to be caused by insufficient recoil, make sure that the bore is clear before continuing firing. It is possible that such a stoppage as, for instance, one caused by incomplete ignition of the powder charge, may result in the bullet lodging in the bore, and in case this happens and another round is fired before the bore is cleared, the gun will certainly be wrecked.

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[Dated Dec. 15, 1920.]

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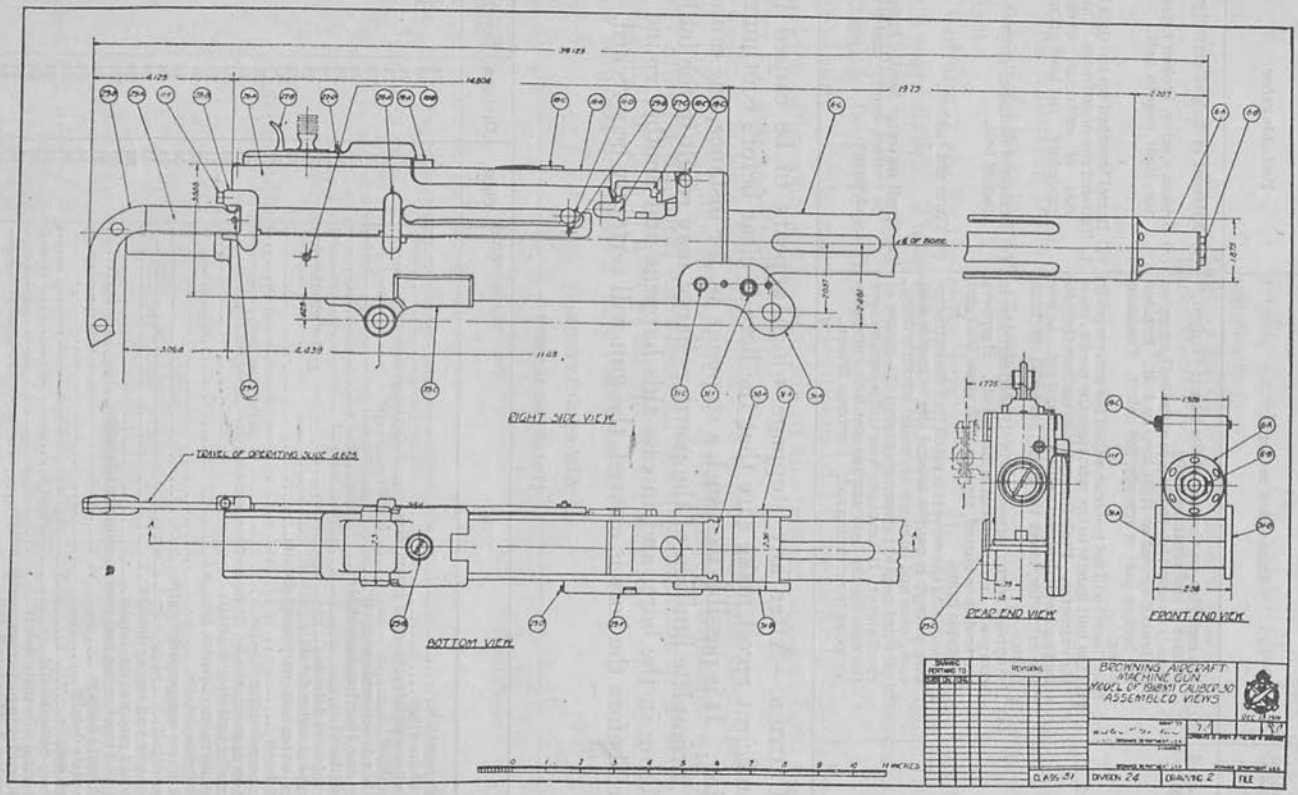


PLATE 26.—Exterior side and end views.