

# FG-42 MACHINE GUN

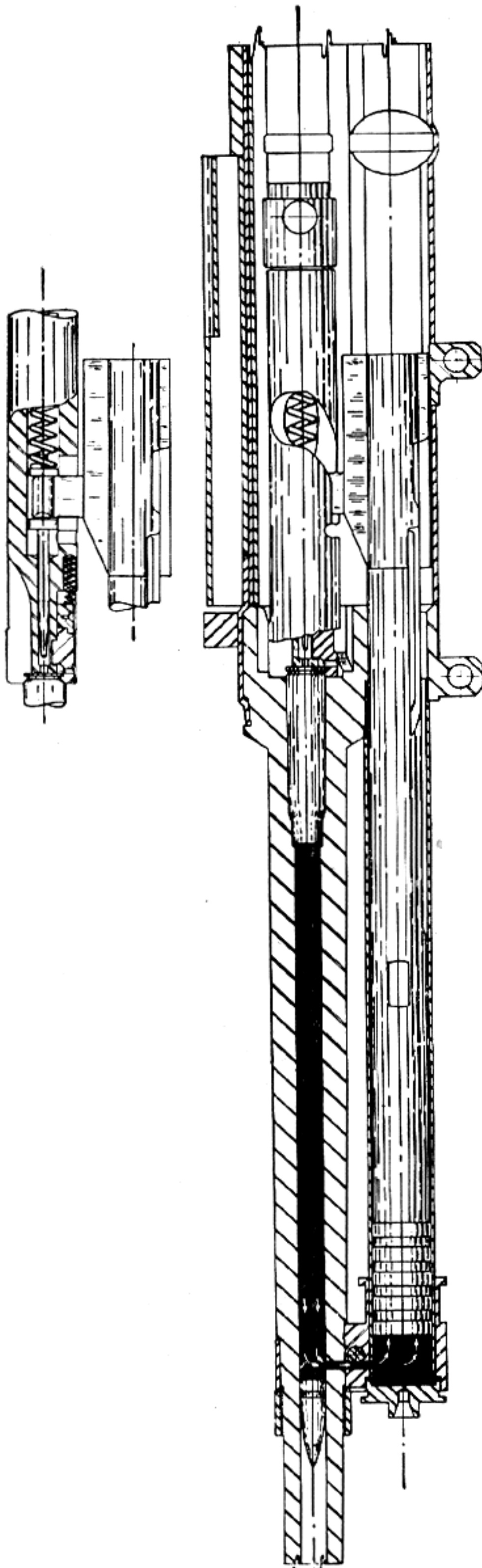
German military and industrial leaders, believing they had taken care of infantry armament needs, next turned their attention to a machine gun on which consideration had to be given to balance and lightness of weight. This weapon, manufactured by Heinrich Krieghoff Waffenfabrik, Suhl, Saxony, was intended for air-borne soldiers, a mode of warfare so far untried. With the invasion of Crete by air the Germans introduced the new paratroop machine

gun, called the FG-42. It was promptly confused with the MG-42 by observers reporting the incident. The designation given the air-borne weapon represented the initials for Fallschirm Jaeger Gewehr (paratroop machine gun).

The gas-operated, air-cooled, bipod-supported weapon had a large ventilated fore-arm grip and an unusually light and short shoulder stock. It weighed only 14 pounds with bipod and a loaded clip magazine that held 20 rounds. The



Machine Gun, Model FG-42, 7.92 mm.



Section Drawing of the Machine Gun FG-42, Showing the Action Immediately After Firing. Gas from the Barrel Is Acting on the Piston Which Will Rotate and Unlock the Bolt.

receiver body, which contained the slideway for operating parts, was stamped out of sheet metal. The fixed barrel was permanently fastened both fore and aft by having the receiver swaged circumferentially in a recess around each end and then further secured by the locking pin. A projection on the left side opened to permit insertion of a fresh loaded magazine when all cartridges were expended from the previous one. When not in use, it was closed by two metal spring-loaded flaps which flew open when their latch was shoved forward.

A combination flash suppressor and muzzle brake was screwed on the muzzle end of the barrel, being held in place by a spring latch attached to the front sight. This device absorbed a high percentage of the recoil forces. A gas cylinder beneath the barrel was held in place by a locking nut. An orifice selector permitted the gunner to regulate the amount of gas going into the cylinder from the port in the barrel, center punch marks showing him in advance whether the movement would position a large or small orifice.

The gas cylinder had four equidistant ports located far enough away from the forward end to permit the piston rod to unlock before uncovering the ports. It then discharged the expanding powder gases at the end of its rear stroke and took in air on the return movement. The gas piston consisted of a tube closed on the forward end. Its rear portion had a recess machined in its upper side in which a rear-searing device engaged. Two D-shaped holes were machined at its middle to contain a cocking handle. The driving spring, held in place by a guide, was inserted into and housed by the gas piston. A rather strong spring-recoil buffer at the rear of the receiver, just aft of the gas piston, was designed to stop the latter on completion of its recoil stroke. The rear-inserted bolt assembly operated in a slideway in the receiver, while a cartridge guide stamped in the receiver, held the cartridge in alinement for chambering.

The two halves of the sheet-metal trigger mechanism were welded together. This unit housed the sear, selector switch, and safety latch. A sear protruding through the receiver acted against the underside of the gas piston and permitted the gunner freedom to fire either single



shot or full automatic. The short wooden stock was held in place by a spring-loaded catch and could be readily removed by depressing the locking latch located at the right rear.

The Germans, being on the receiving end of the very efficient Lewis gun during World War I, developed a great respect for this fine and reliable mechanism. It is natural that, when possible, many experiments were conducted in order to incorporate any single feature or the whole basic action for their own advantage. The FG-42 was the result. However it was so highly refined and modified to meet special needs that it was hardly recognizable. The most unusual feature was the cleverly designed triggering mechanism that enabled the operator by a turn of the selector switch to fire full automatic or single shot. At the same time it gave the gunner the privilege of firing with either a closed bolt for accuracy when used single shot, or of leaving the bolt in the open position for cooling purposes at the completion of a burst of full automatic fire.

This weapon represented the highest degree of refinement the Lewis type of automatic firing mechanism had ever attained and was well designed for its intended purpose.

To fire the FG-42 full automatic, a loaded 20-shot magazine is inserted after the spring-loaded flaps over the feedway are opened by releasing the catch. The safety lever, locked in the up position, is pushed down and the selector switch swung forward to *Full automatic*. The cocking handle, grasped on the right side, is pulled smartly to the rear until the gas piston and bolt are held there as the rear sear engages its locking notch beneath the piston. The weapon is now cocked and a cartridge is positioned for firing.

When the trigger is pulled, the driving spring thrusts the bolt and piston forward. The face of the bolt engages the base of the first cartridge in the mouth of the magazine. As the round is forced forward, it leaves the magazine and is directed by the cartridge guide for alinement with the oncoming bolt and chamber. As the

bolt reaches the end of its forward motion, the extractor lip snaps over the cartridge rim and the bolt face seats against the breech end of the barrel. The locking recesses are in position with the lugs on the bolt. However, the piston can still continue to travel and, in its attempt to do so, the beveled projection riding in the curved slot in the bolt body causes the bolt to rotate the lugs in their recesses and lock the piece. This act removes the obstruction that has been holding the action rearward. The added free travel permits the gas piston to drive the firing pin through the bolt face into the primer which in turn fires the powder charge.

The bolt remains securely locked supporting the cartridge while the bullet is in the bore. However, when it has passed the gas orifice, a portion of the expanding gases is let into the gas cylinder through one of the four regulating orifices. Pressure is exerted on the gas piston which starts to move rearward, carrying with it the firing pin held by the yokelike section on the rear part of the piston. The bullet is now clear of the muzzle and the yoke, after having had a free travel inside the bolt for over an inch, starts to act against the cam causing the bolt to rotate and become disengaged from the barrel extension.

When unlocking is complete, the bolt is free to be speeded back by the high residual pressure in the chamber. As it continues rearward, the empty cartridge case is withdrawn by the extractor and its rim brought into contact with the ejector operating through a slot in the bolt body. The empty case pivots about its extractor and is knocked through the ejection slot in the right side of the receiver, where it is deflected forward by a curved piece that is fastened rigidly to the outside of the receiver for this purpose. Additional movement rearward during the recoil stroke compresses the driving spring. The remainder of the energy of the operational parts is absorbed by their striking the heavy spring buffer. The latter, assisted by the driving spring, deflects the action forward to repeat the cycle of operation.

# PART V

## AUTOMATIC AIRCRAFT CANNON

After reviewing the material on the more recent large-bore automatic-firing mechanisms, it seems quite obvious that future armament of aircraft for years to come is to be found in this type of weapon. While quite ironically the bulk of our source material is in this particular field, due to security reasons the amount that can be openly discussed has become less and less. Only features that have been well known over a period of years are mentioned. All other models having peculiarities of construction that might reveal possible improvements in future design have been purposely deleted from this publication.



## DAVIS NONRECOILING GUN

When representatives of the great powers affixed their signatures to the treaty in St. Petersburg, Russia, in 1868, their main purpose was to eliminate the possibility of using explosive and purposely deformed bullets on personnel in warfare. In order to insure that no such projectiles be employed against the individual soldier, they collectively agreed to set 450 grams as the legal minimum weight for a projectile and its explosive content.

This simple specification made it impossible for any nation to put a bursting charge in any bullet of small dimensions. In fact, at this time no firearm existed which could utilize successfully a projectile based on these figures. It remained for the weapons manufacturer, B. B. Hotchkiss, then producing manually operated machine guns in Paris, France, to design the minimum size in artillery shells to be effective and still come within the legal requirements. This Hotchkiss projectile had stability of flight, penetration, and great destructive power from blast. When gaged up, it was found to be 37-mm in diameter.

The humanitarian intentions of the delegates who attended the convention resulted in a great restriction on aircraft armament all through World War I. For any plane that carried guns other than those in the rifle-caliber class had either to use a solid nonexploding projectile or mount at least a 37-mm cannon. As the cannon's slow rate of fire did not warrant employment of the nonexplosive shot, armament designers turned their attention to adapting shrapnel-firing cannon to the flimsy aircraft of the time. As a result, World War I saw aircraft weapons with bores equal in size to those used in another war some 25 years later.

The first recorded method of firing an artillery piece in the air was the invention of Commander Cleland Davis, an Annapolis graduate with a brilliant career, including a citation for

bravery in commanding machine gunners in the Manila campaign of 1899. His simple but unorthodox idea was so far advanced beyond the times that it reappeared as a "new discovery" in the latter days of World War II. In attempting to overcome the terrific recoil forces of artillery mounted in aircraft, he applied on 22 August 1911, for a basic patent on recoilless artillery and electric primer ignition. His wording in the patent claims bears repeating in order to show just how prophetic his conception was:

"It having been demonstrated that it is practicable to navigate the air under normal atmospheric conditions, and while as yet the practice is too hazardous for ordinary commercial



Cleland Davis When He Was a Lieutenant, USN.





A Davis Gun Mounted on a Naval Seaplane. The Gunner Has Pivoted the Breech to the Open Position for Loading.



purposes, still aircraft have already become a part of the military equipment of most of the civilized nations. . . . They have, however, so far developed little, if any, offensive value, it being practically impossible to strike a comparatively small target, such as the deck of a battleship, the vulnerable part of a fort, or even a large building, by merely dropping explosive from a high altitude. . . . Furthermore, the mere dropping of a high explosive on the deck of a ship, or a fort, would occasion very small damage, for the force of the explosive would ordinarily, aboard ship, be confined to the region above the protective deck and little damage would be done. . . .

"In order to secure the desired velocity to penetrate even thin armor, or a protected position anywhere, the explosive would have to be contained in a projectile, and this projectile would have to be propelled with sufficient velocity to penetrate said armor. . . .

"In order for a gun to be effective for such purposes, it must comply with the following conditions: (1) It should be of caliber sufficiently large to discharge a projectile carrying a considerable quantity of explosive. (2) It should be capable of giving a muzzle velocity to the projectile that would enable aimed shots to be fired at distances of 2,000 yards, or more. (3) It should be so designed that the shock of recoil will bring little or no strain upon the structure of the aeroplane."

"In order to meet the above condition, I have devised the apparatus . . . to which reference will now be had. . . ."

The invention was provided with an electric primer operated by a suitable source of electricity, such as a battery. The gun itself consisted of a barrel open at both ends to the atmosphere, a projectile and a propellant charge for the missile, and a recoil weight in the rear of said propelling charge. The weight was adapted to be expelled from the gun into the air when the charge was fired, thus neutralizing the backward thrust incident to the expulsion of the projectile. The shell was to be held in the gun by some friable connection and the resistance of shearing the set screw slightly exceeded the resistance required to start the shell in the bore. Thus the shell would move forward before the gun started to the rear.

By this arrangement of having the projectile and gun bring forces in opposite directions, a comparatively small amount of shock would be brought on the framework of the airplane. The resistance to the rearward travel of the gun in its sleeve obviously would be approximately equal to the resistance of the projectile in its passage through the bore of the gun. Then these two forces would neutralize each other, thereby relieving the gun support of any heavy strain.

Commander Davis did not stop with the conception of this novel weapon, as he demonstrated a working model at the United States Naval Academy at Annapolis, Md., several years before he actually put what he considered a perfected recoilless cannon into production.

The *Scientific American* on 21 April 1917, after its reporter had witnessed a factory demonstration of the weapon, published a glowing account of what it would make possible in aircraft use. In conclusion, the possibility it would offer as artillery for ground troops was described:

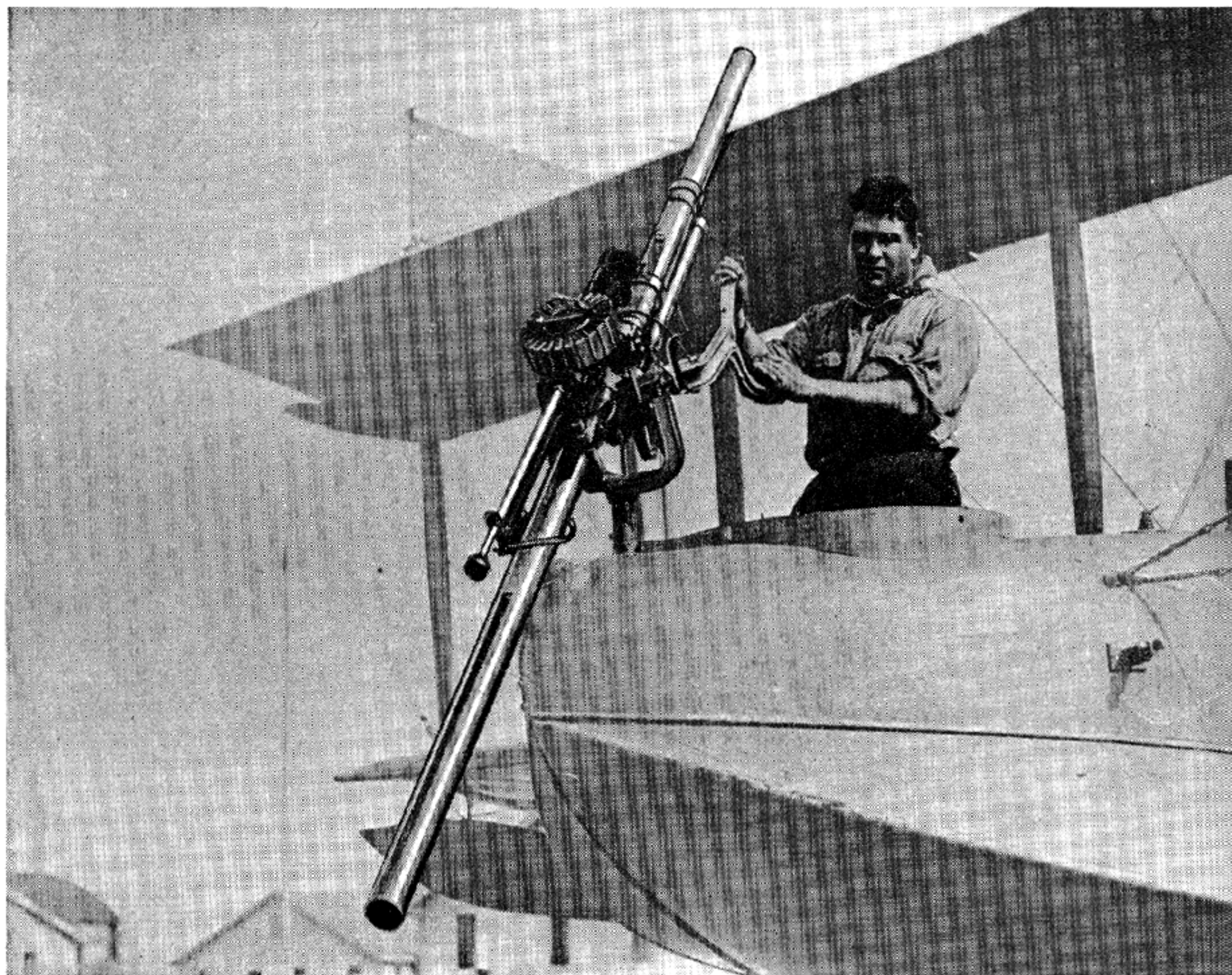
"Nonrecoiling guns of large size may also be mounted upon dirigibles, armored cars, or actually be carried by hand, greatly increasing offensive power without increasing the size of the vehicle or impairing the mobility of the infantryman in any way."

Like numerous other inventions of radical design, the possibilities of this new kind of aviation cannon were not realized except to offer a token demonstration of its capabilities during the last days of the war. On 2 August 1917, the largest gun yet fired from an airplane in America was tried out at the Curtiss Aircraft Co.'s testing range at Buffalo, N. Y. The weapon was a 75-mm Davis nonrecoiling gun, manufactured by the General Ordnance Co. of Derby, Conn. It was mounted at the front of the cockpit of a Curtiss J-N twin tractor operated by a factory test pilot, named Carlstrom, the company's representative, Mr. F. B. Towle, acting as gunner.

This pioneer performance of firing successfully such a large cannon from an airplane caused considerable comment in the newspapers and predictions of its effect on all artillery were freely made.

The velocity given for the big projectile was 1,175 feet per second and its accuracy was as good





Davis Gun Mounted for Anti-Submarine Patrol.

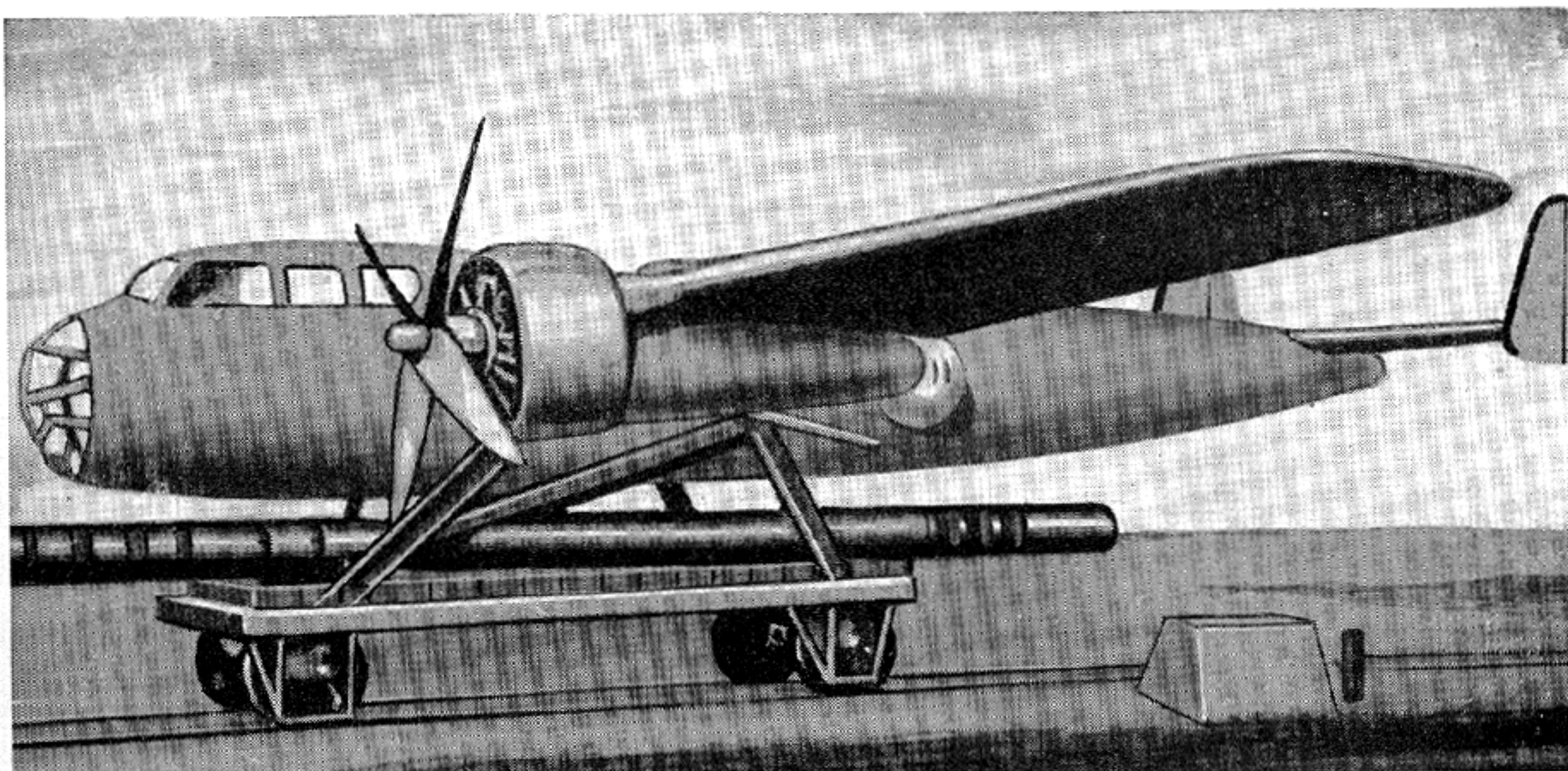
as that expected from a rifled barrel. A unique means of sighting the gun was employed. A Lewis gun was fastened on top and in the middle of the long tube and, as the pilot approached within range of the target, the gunner pressed one of a dual-trigger arrangement. This fired the Lewis gun and the gunner could observe where his bullets were hitting. When he had corrected his aim, by watching the bullets strike, until he felt he was on the target, the lower trigger was pulled back and by means of electric ignition the large cartridge in the Davis cannon was fired. This type of sighting was especially effective against submarines.

The Navy, which alone of the military services showed interest in the cannon, mounted it on seaplanes in three different calibers, 47-mm,

65-mm, and 75-mm, firing from six- to nine-pound projectiles. The Davis gun was distinctly an American Naval accomplishment, in that none of similar construction were developed, or even experimented with, by any other nation during the war. Both France and England were furnished the recoilless cannon by the Navy and it was put to limited use during the conflict. The Army made no attempt to utilize it as a land gun.

Actually the Davis gun practically dropped out of existence with the signing of the Armistice only to be rediscovered at a later date. During the course of World War II both the United States and Germany were working on secret projects relating to recoilless artillery. An American Army adaptation of the Davis gun was put





The Davis Principle Applied in World War II. The Germans Attempted Firing a 1500-Pound Shell from this Dornier 217.

in operation, called the recoilless rifle. It was used effectively as highly portable artillery.

Rheinmetall-Borsig developed two types of the Davis gun. The first (the Device 104) had a bore of 14 inches. It fired forward a naval gun projectile of armor-piercing type, weighing 1,500 pounds, and ejecting backwards, as the counter-recoiling projectile, a cartridge case of the same weight. Its muzzle velocity was over 1,000 feet a second. The whole round was loaded on the ground. The tube was 37 feet long and the complete unit (tube, projectile, and cartridge case) weighed 7,500 pounds. Its function was to improve the striking power of aircraft against capital ships. The cannon was mounted on a Dornier 217 attack plane.

The main difficulty the Germans experienced resulted from the muzzle blast. To lead the blast away from the fuselage, a deflector was fitted to each end, but even this did not prove sufficient and armor had to be installed on the bottom of the plane.

The other type of nonrecoiling aircraft cannon used by the Germans was mounted vertically in batteries and was known officially as the SG-113A (*Sonder Gerat* or *special purpose equipment*). The counterprojectile in this arm was

also the cartridge case. It was designed primarily to attack tanks from the air. The FW-190 was used to mount these 45-mm cannon. An armor-piercing projectile was fired straight down against the relatively thin roof armor on the tanks. The aiming and firing of the salvo was controlled by the disturbance of the earth's electric or magnetic field caused by the presence of the tank. Fortunately for the Allies this ultra-modern armament was never produced in quantity. By the time the Nazis were satisfied with the performance of this installation, volume production could not be reached because of the concentrated bombing of German industrial plants.

Also under construction at the same time was another vertical-firing cannon, known as the SG-116. It fired a 3-cm shell straight up and was fitted into the fuselage of a fighter plane. It was sighted and fired by radar when a bomber formation was directly overhead.

The Davis recoilless cannon was not used to more advantage in World War II because the United States between wars did not see fit to exploit the principles originally outlined in the Davis patent, and Germany, although desperately trying to make use of it after being convinced of its possibilities, could not do so following the bombing out of her industry.



## VICKERS AIRCRAFT CANNON (C. O. W. AIRCRAFT CANNON)

The first mounting and firing of a conventional type of cannon from an airplane was in July 1913. The Vickers Ordnance Co., which was conducting a series of tests on the effect of recoil on plane construction, suspended an airplane built by Short Brothers, Ltd., from the interior of a hangar. It was a large pusher biplane and mounted in the front of the cockpit was a two-pounder cannon, a naval quick-firing gun that had been modified for the occasion. Vickers engineers found that the airplane to a certain extent acted as its own recoil cylinder.

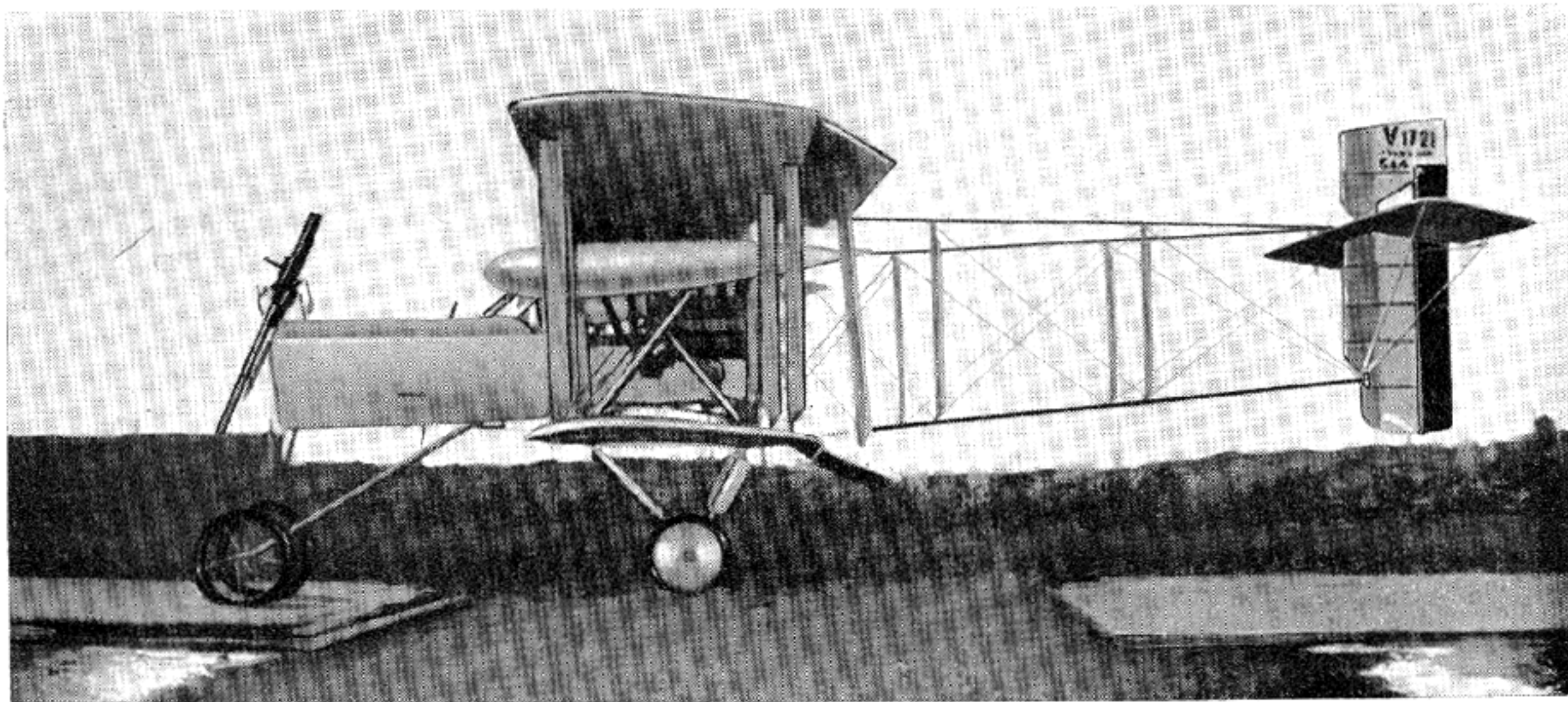
As a result of these studies, a test hop was undertaken by a young naval officer, Robert Clark Hall, who successfully fired the altered cannon. He reported that, while there was no damage to the aircraft, "there was a blinding flash and the plane actually seemed to stand still during the explosion of each round."

As the weapon itself was only a worked-over deck cannon, it does not warrant description or

cycle of operation. It had to be loaded manually and its place in aviation ordnance history is simply that of being the first air-borne cannon to be fired without disaster.

The United States became interested in the demonstration and sent a representative abroad to witness the next scheduled firing. This trial was not, however, a success and all work on the gun was stopped in favor of a full-automatic 37-mm cannon then in experimental development by the Coventry Ordnance Works, Coventry, England. The firm's initials were used by British flying officers in naming it the C. O. W., or "Cow," gun.

The cannon proved to be much more usable than the previous one. Upon completion, it was tested at the government range at Shoeburyness. The purpose of the experiments was to determine whether or not the automatic mechanism would function at all angles of elevation and depression.



C. O. W. 37-mm Automatic Aircraft Cannon Mounted in a Voisin Battle Plane, 1915.



Three cannon were used. They were first elevated to an angle of  $85^{\circ}$  and fired. Two out of the three emptied the five-shot clip without malfunction. One, however, would not go back to battery, the return spring not being strong enough to position the operating parts. The two guns that fired properly were then depressed until the barrel was vertical. The performance took place on a pier and the weapons functioned well, although the shooting was so close to the water that it drenched both guns and ammunition during the test.

The C. O. W. cannon were used to a very limited degree by the British Navy in the latter days of World War I. They were never popular because of their habit of delivering the terrific impact of recoil into the body of the light plane carrying it. In one instance the gun was mounted in a Voisin plane and, after four shots, the wings came off the fuselage. As a result, the plane plunged into an airdrome, killing all occupants. Such accidents and the common-sense fact that a plane carrying such a weapon in that period

was overloaded contributed to its early abandonment.

The gun operated by what is known as the long-recoil system. The barrel and breech lock were held securely locked together until the distance of the recoil movement was greater than the over-all length of the incoming round. The lock was then freed and remained held to the rear while the counterrecoiling barrel went into battery, literally pulling the chamber off the empty cartridge case. This type of action, which was simply a scaled-up version of the Chauchat long-recoil-operated machine rifle, was quite commonly used on large-bore automatic weapons. While slow, it was reliable and solved such problems as the necessity of opening the breech under high gas pressure if short recoil were used. The gun had an air-cooled barrel, was magazine fed, and fired both semi- and full automatic.

To fire the C. O. W. automatic cannon, the five-round clip is first put into position with the bolt forward. The gunner, with the aid of a crank, jacks the operating mechanism to the



C. O. W. 37-mm Automatic Aircraft Cannon Mk III.



rear until the holding device stops the rammer and carrier frame. Upon release, the barrel returns to battery and at the instant of doing so releases the carrier. The latter strips the first round from the feeder. Upon chambering it, the rotating bolt is locked behind the round.

The weapon now being loaded and ready for firing, the trigger is depressed. The force of the exploding powder starts the barrel, the breech lock, and carrier to the rear, all rigidly locked together. After the assembly has traveled a distance greater than the over-all length of the incoming round, the breechblock is cammed a partial revolution and the carrier to which the extractor is attached is engaged by its holding sear. The barrel can then start back to its former position, while the carrier and extractor remain stationary with the extractor claws over the rim of the fired cartridge case. The barrel, in going forward, separates the chamber from the empty case.

Just before the barrel completes counterrecoil movement, a dog is cammed in that releases the carrier to start forward. On the first movement the ejector pivots the empty case through the ejection slot in the bottom of the receiver. Continued travel causes a rib on the carrier to push the loaded cartridge in the feed mouth into the chamber. The rim of the live case, upon being seated, strikes a device that rotates the bolt, rigidly locking it to the barrel extension. The carrier then completes full movement forward and the extractor claws are forced over the rim of the loaded round. If the trigger is held to the rear, the striker will again fly forward to discharge the weapon.

At the same time, the British developed a few larger experimental models with 47-mm and 75-mm bores. The latter were made for the French at their request.

Since the conventional rifle-caliber machine guns played the dominant role in early air warfare, these pioneer cannon, as far as the British were concerned, did not see too much action and in the years following the Armistice they met with little or no official encouragement for future development.

During the twenties and early thirties the Vickers Armstrong Co. copied the design of the C. O. W. 37-mm gun and proceeded to refine it,

keeping the bore at 37 millimeters and adapting it for installation in large seaplanes. The Blackburn "Perth" flying boat first mounted the gun.

It employed the identical system of long recoil for operation. In contrast with the original C. O. W., this air-cooled clip-fed gun had separated recoil and counterrecoil casings below the barrel and the mainspring had been housed. A crank was used to retract the mechanism for loading.

Upon orders from the Royal Air Force, the Vickers Co. produced a 40-mm cannon, using the same cartridge as the antiaircraft batteries with a muzzle velocity of 2,500 feet a second. Although British military authorities gave Percy R. Higson of Vickers much credit for the design of the Vickers-Armstrong 40-mm cannon, in reality it was fundamentally the firing mechanism of the Coventry Ordnance Works gun of a much earlier date.

Test firing was first done in August 1939 and the results were considered satisfactory. A Wellington bomber was soon equipped with one such gun in the nose. It was contemplated placing another in a power-driven turret then under consideration, but this project was dropped in favor of rifle-caliber machine guns. It was possible to have six cartridges ready to fire, if desired, one in the chamber and five in the cylindrical magazine. In this type of feed a center coil spring pushed each round into place for feeding.

After the design was considered acceptable, the Birmingham Small Arms Co. was also engaged by the government to make the weapons and carry on additional development. July 1940 was set as the delivery date for the first guns off the assembly line.

In arming twin-engine planes with large-bore automatic cannon having an extremely high muzzle velocity, Great Britain was following the example of the Russians. These high priority cannon were to be used offensively against shipping, submarines, power plants, and large storage tanks; and defensively on invasion barges and shipping in general. All development work was actively supported by the Coastal Command and the Fleet Air Arm, which had found from experience that smaller bore cannon, even in multiple installations, lacked sufficient striking power against these targets.





Vickers-Armstrong 37-mm Automatic Aircraft Cannon, Mounted in a Blackburn "Perth" Flying Boat.



The next progressive step was the use of a predictor sight which triggered the operating mechanism when on the target and the whole clip of five rounds was fired automatically.

Against shipping it was decided to concentrate fire on a vessel's boilers. All patrol pilots using aircraft so armed were provided with drawings, diagrams, and photographs of various types of ships showing boiler locations.

Again following the Russian pattern for ground support, the Ministry of Aircraft Production authorized the immediate design of a single-engine monoplane for low-altitude use against tanks, small ships, and similar land and sea targets. The aircraft was to be fitted with twin 40-mm Vickers automatic belt-fed cannon, mounted in the nose of the fuselage. A single Rolls Royce Model 45 low-altitude engine with pusher-type propeller powered the plane which had a top speed of 250 miles an hour.

The engine and the pilot's compartment were heavily armored against small arms ground fire, with no defensive armament for use against enemy aircraft. This special objectives plane had only a three- or four-hour patrol range. Operational use of the craft was dependent upon the protection being afforded at all times by an adequate "umbrella" of fighters. The Air Staff felt

that such an aircraft would form an important element as an Army support weapon.

There is also a record that the Ministry of Aircraft ordered 12 Hurricane fighters equipped with two 40-mm cannon, one mounted underneath each wing for firing outside the propeller arc. These planes, upon being modified, were shipped to the Middle East to be used against tanks.

Colonel Moore-Brabazon, the Minister of Air Production, was responsible for the air-borne cannon program and the passing years have proved it to be broad, intelligently conceived, and done in a manner that produced the greatest results in critical times. The Air Ministry, however, conceded it was following closely Russian strategists in this field, as these early advocates of big-bore ordnance, both ground and air-borne, were setting the pattern on the eastern front in supporting their infantry with cannon-bearing planes.

The British, in the latter days of World War II, turned to an even larger cannon. This time Vickers scaled up the same battle-tested mechanism and produced a 57-mm automatic gun that was placed in the nose of the Mosquito plywood bomber. This six-pounder, as the British always referred to it, had terrific powers of destruction and saw considerable active service before the end of the war.



# REVELLI AIRCRAFT CANNON

The Italian Air Force, having some of the largest bombing planes of World War I (the Caponi and Savoia-Pomilio), made an attempt to arm them with air-borne artillery. It turned to the well-known inventor, Bethel Abiel Revelli, to answer this problem. The result was a semiautomatic 25.4-mm cannon, chambered for a 1-inch projectile. Revelli claimed that work commenced on this cannon as early as 1913. It was classified as light (99 pounds), air cooled, long-recoil operated, magazine fed, and capable of firing its contents of eight cartridges in 2 seconds. The muzzle velocity was in excess of 1,320 feet a second. The cannon was strictly a flexible gun and was easily adapted for mounting on a Scarff ring.

The Fiat Co. at Turin, Italy, after making 200 of these guns, then officially called the Revelli (or Fiat) model 1917, sent one of its officials, Francisco Negri, to England in order to interest that government in arming bombing planes with the gun. British air officers, after witnessing the demonstration and examining the mechanism, pronounced it to be a copy of their own Vickers 37-mm, which they felt was a superior piece of ordnance that could also fire an explosive projectile without violating international law. In fact, Vickers officials were highly critical of the Italian company's ethics in sending this alleged copy of one of their own guns to England for testing.

Thereafter the Fiat Co. made only the original order and destroyed the manufacturing drawings, devoting its time to producing an aircraft machine gun.

Commander Garnier, of the French arsenal at Puteaux, at the completion of a trial of the Revelli conducted by his government, stated that he did not believe the weapon met the needs of the French Air Force for the following reasons: (1) For incendiary use the 11-mm Vickers machine gun was entirely satisfactory; and (2)

the manufacture of a supersensitive fuze (or for that matter a fuze of any sort) was a difficult thing for so small a projectile as the 25.4-mm one.

Even Italian Air Force officers complained about mounting this gun with fuzed ammunition, as a jam in the act of feeding with an up-to-now-unproved fuze would result in disaster if a malfunction took place while in flight. All attempts to produce a bore-safe fuze resulted in failure of the projectiles to explode on the target on an average of two out of every ten tested.

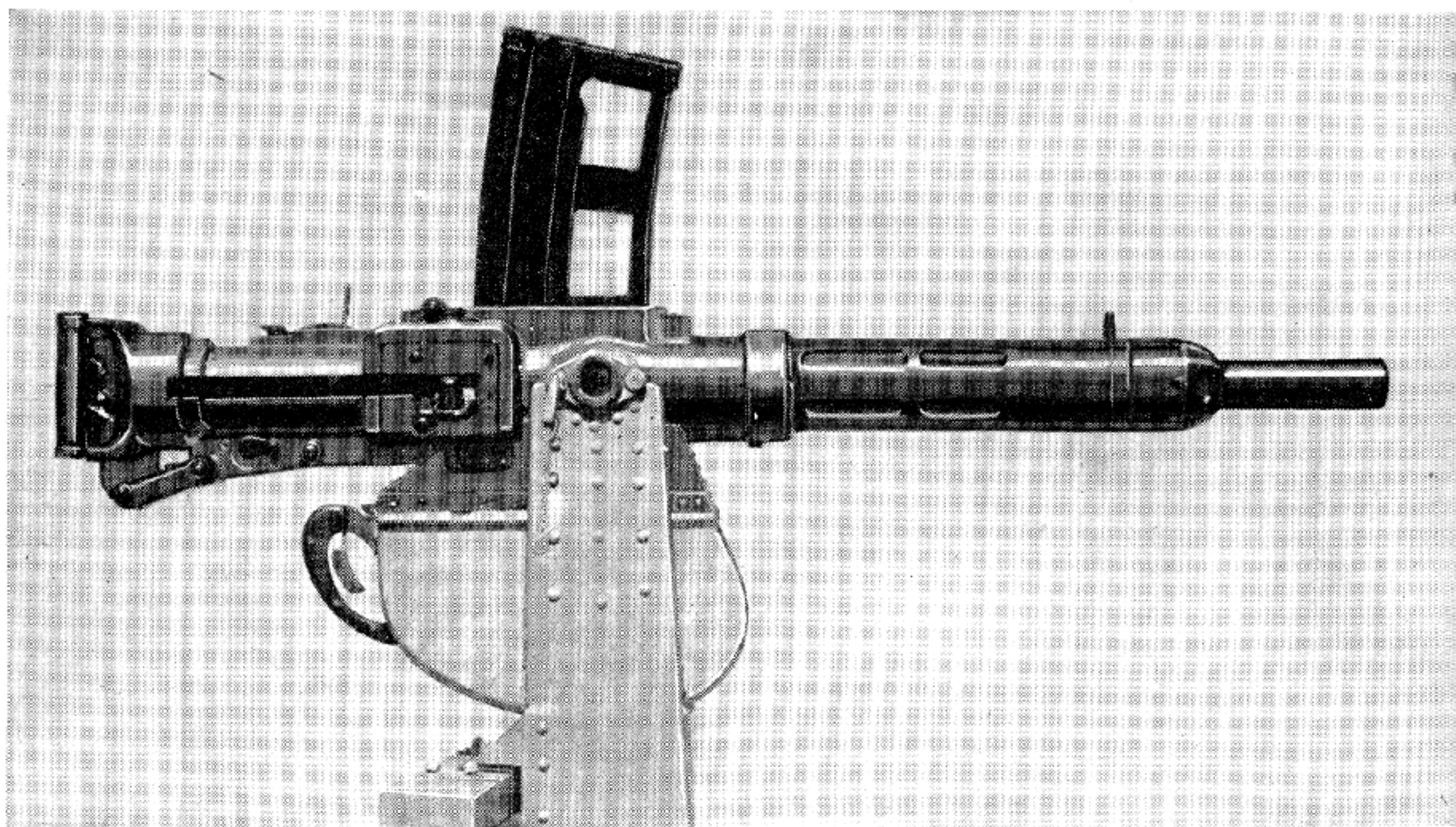
After 12 Caponi bombers were armed with the Revelli cannon, an order was issued not to equip planes with cannon of any sort, as machine guns were considered better all-around armament. The consensus was that, while the weapon itself was undoubtedly reliable in its action, it had a bore that seemed too small for causing explosive damage and too large for high-speed machine-gun work.

To fire the Revelli 25-mm aircraft cannon, the operator first installs the loaded magazine in position and pulls the cocking handle all the way to the rear. Being released to go forward under spring tension, it chambers a round, locks the bolt, and cocks the piece. When the firing button is pressed, it lifts up the sear, the nose of which lets go of the striker. Driven forward by its own spring, the latter fires the cartridge. The barrel and bolt recoil together securely locked for three-quarters of an inch at which point the cocking handle hits the vertical arm of the opening lever.

This arm pivots and the horizontal arm engages under and raises the cocking handle, freeing the bolt lugs from the resisting shoulders. The barrel is then brought forward by its return spring, butting against a shoulder on the body casing, which limits its movement.

The bolt continues to recoil, the extractor withdrawing the empty cartridge case and hold-





Fiat (Revelli) 25-mm Aircraft Cannon.

ing it until its base strikes the ejector and is pivoted out through the ejection slot in the bottom of the receiver.

The final recoil movement of the bolt fully compresses the driving spring. The hitting of the rear buffer absorbs the surplus energy and sends the operating parts into counterrecoil. The feed rib on top of the bolt strips a round out of the magazine and starts it into the chamber. When the striker makes contact with the nose of the sear, it is held in the cocked position while the bolt continues on into battery.

Three-quarters of an inch before it is fully home, the cocking handle engages the vertical arm of the operating lever. This arm pivots and engages under the retracting handle, causing it

to raise and rotate the locking lugs into their recesses in the receiver. The final movement now makes it possible with a push of the firing button to repeat the cycle again.

In the event of a stoppage, the gunner can hold the mechanism in the rear-seared position for inspection or maintenance by a very unique method—the charging handle is pulled all the way to the rear and the tail of the ejector pushed down by the thumb, causing this piece to pivot and hold the assembly to the rear. To close the action, all that is necessary is to give the charging handle a smart pull rearward and release it. The spring-loaded ejector then lifts out of the way, permitting the operating parts to go forward.



## PUTEAUX 37-MM AIRCRAFT CANNON

Although the British Royal Air Force was the first to fire a cannon successfully from an airplane, it remained for the artillery-minded French to achieve the major development on cannon for aircraft during World War I. These very realistic people approached the problem in the most practical way imaginable. The wheels of a reliable field piece were simply removed and it was bolted in the forward part of the cockpit of the latest Voisin plane. The aircraft was also armored, a fact which, in itself, was quite revolutionary. This combination made its initial appearance in June 1914.

Arrangements had all been made in secrecy and the experiment was first disclosed when a cannon projectile ploughed through a French farmhouse early one morning, fortunately without injury to anyone. An alert reporter solved the mystery which had puzzled the nearby countryside. No explosion had been heard and the farmhouse was miles away from any possible naval firing. Everyone, except the careless gunner and the military authorities, was satisfied when it was discovered that a large airplane manufactured by Gabriel Voisin, was being tested at Issy-les-Moulineaux, where military



Puteaux 37-mm Aircraft Cannon (Semiautomatic) Mounted on a French Bombing Plane, 1916.



personnel had been air-firing this large-bore aerial cannon for several months.

The weapon was a 37-mm Hotchkiss Model 1885, and, while not automatic in principle, it was referred to, in a complimentary way, as a "quick-firing gun." A whole squadron of Voisins was equipped with this aerial artillery and immediately assigned to the defense of Paris. Upon declaration of war by Germany a few months later, more such planes were sent to bases behind the lines to act as bomber escorts.

The performance of the *avions-cannons* was considered satisfactory from the start, and the protection they offered the bombers was so good that losses through attack by German aircraft were almost negligible. The French had a great advantage in the awesome aerial armament they carried at the very outbreak of the war, at a time when German aviators were carrying nothing more than pistols and repeating rifles.

The freedom of bombing squadrons from attack at the beginning of hostilities was taken by the French to mean that opposing flyers were over-awed by the cannon-bearing escort. There is no question that the enemy had great respect for the French Voisins and did not go too far out of its way to engage them until the mounting of rifle-caliber machine guns in its fighters became prevalent. Thereafter aerial cannon played a secondary role to machine guns, though the French Air Force never stopped development of aircraft cannon as offensive aerial weapons.

Many spectacular kills have been credited to this innovation in warfare. As early as 1915 such a gun was mounted in the rear seat of a plane piloted by Norman Prince, an American member of the famous Lafayette Escadrille. Bob Scanlon, an American negro and an ex-boxer, acted as the gunner. On 10 January of that year, Prince and Scanlon scored their first victory by making a direct hit on an enemy plane with their 37-mm cannon.

Mounting of armament of such size naturally produced serious and often insoluble problems, such as stresses, shock from recoil, and vulnerability after firing before the single-shot weapon was reloaded. The French, however, continued to attempt correction of these things, and many inducements were offered inventors. Things remained in an uncertain status until early in 1917

when Marc Birkigt, chief engineer for Hispano-Suiza, evolved an entirely new method for utilizing cannon in aerial fighting.

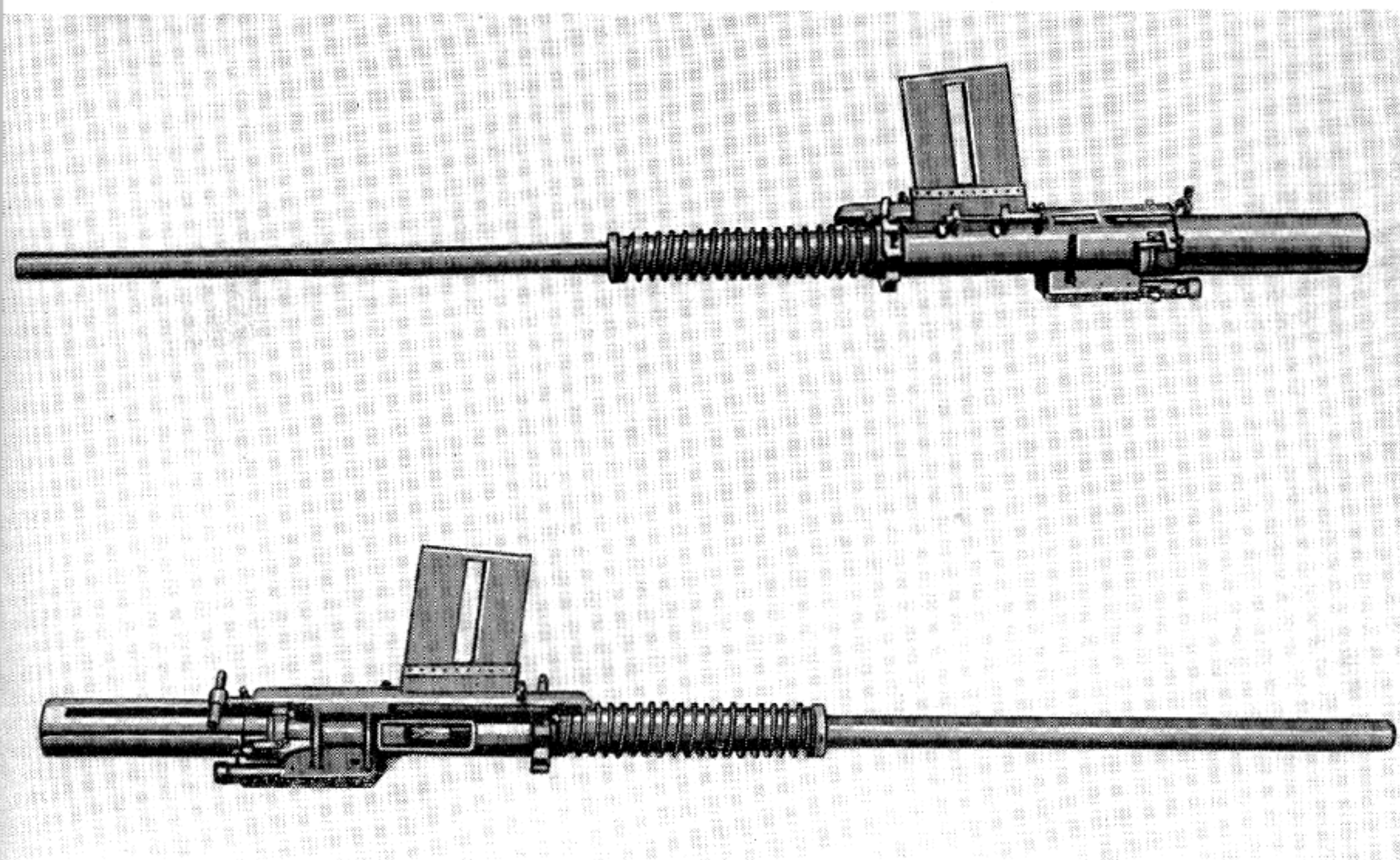
Birkigt, familiar with aircraft engine design, created a motor whereby a gun could be mounted in the engine block and the projectile fired through the propeller hub. With a cannon so installed, the plane, which up to this time had been only a gun platform, now became the object to be pointed at the enemy. The pilot now had only to line up fixed sights that were parallel to the center line of the bore in order to aim his gun. The French greeted this achievement with renewed effort on the part of their ordnance developers to better the gun that would be a part of the new system.

The weapon decided upon was a 37-mm semi-automatic cannon, manufactured by the Puteaux Arsenal originally as a highly mobile fast-firing field piece. It had been modified to use a recoil-operated breech opening and lightened for aircraft use. The cannon was mounted in the V of the motor that drove the propeller by means of a reduction gear. The muzzle could thus project through the hub. The recoil ejected the empty case, cocked the firing mechanism and remained in the ready position for the pilot to close the breech manually. The breech consisted of a sliding block with a rotary motion in the breech housing that not only locked and unlocked but likewise operated in an open position.

Functioning of the Puteaux 37-mm aircraft cannon is as follows: As the barrel and bolt recoil, a cam turns the lugs allowing the bolt to be freed and to drop until it strikes the base of the extractors. The latter are pivoted in such a way that their upper parts are forced backwards, after the empty case is thrown out through the opening in the receiver. The pilot takes a loaded cartridge from a rack at the right of his seat and positions it in the chamber, at the same time rotating the breech with his fingers. Reloading and locking are thus accomplished manually and he is again ready to fire.

The guns were fitted with two types of barrels that were interchangeable. One was a smooth bore; the other rifled. Ammunition consisted of canister for the smooth bore and an explosive projectile with an extra-sensitive fuze for the rifled barrel.





Puteaux 37-mm Automatic Aircraft Cannon.

The projectiles containing high explosives in reality had double fuzes, a contact one and a delayed firing arrangement in the event the target was missed. The latter exploded the charge before reaching the ground, a needed precaution since so much air fighting at the time took place over friendly territory.

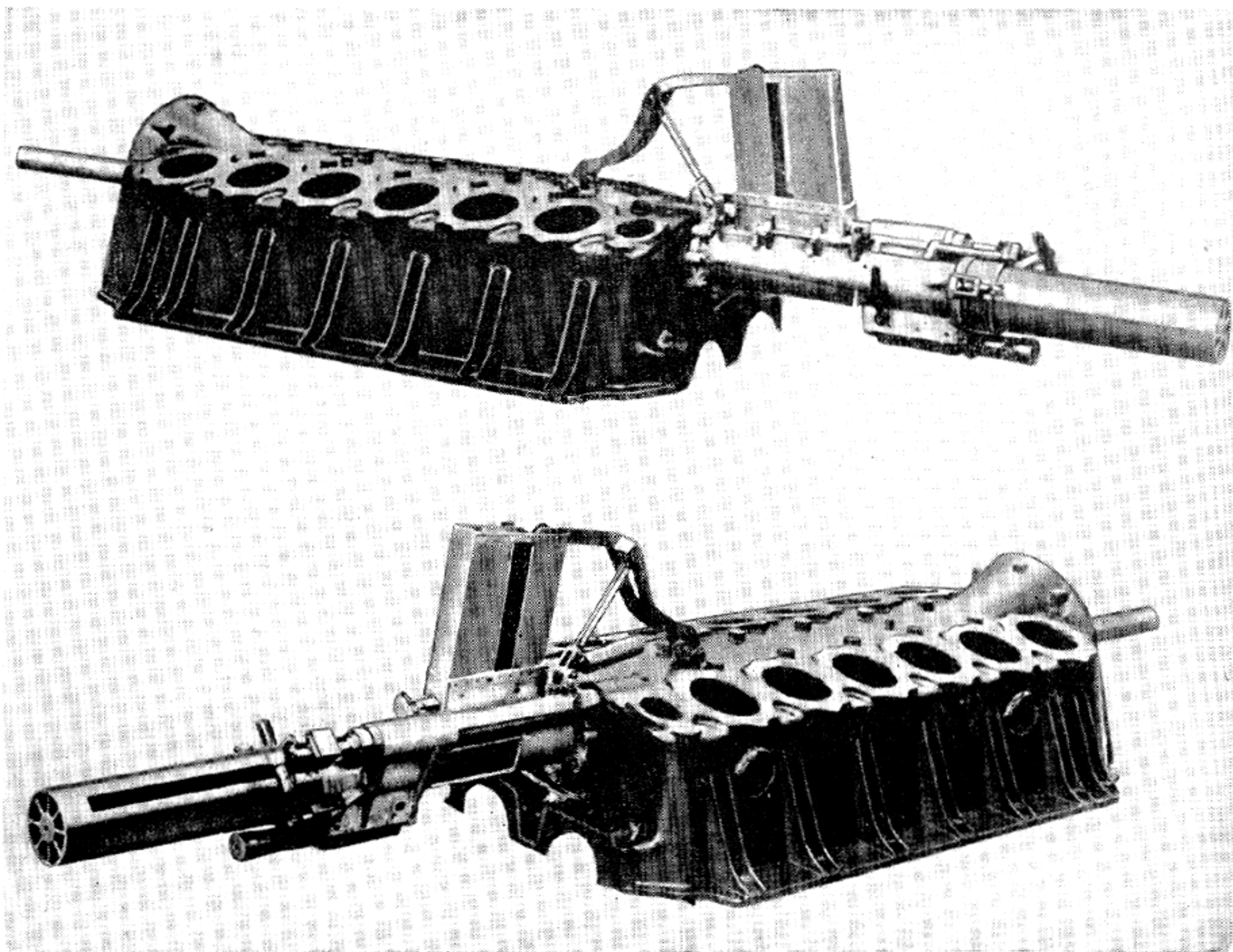
Two of France's greatest aerial fighters in the First World War, Major René Fonck and Georges Guynemyer, were credited with officially destroying several enemy planes with cannon fire. Guynemyer originated the canister or shot shell used in a smooth-bore cannon, which was actually an overgrown shotgun. There is no question about the deadliness of such an arrangement when in range. These two aces, however, after much experimentation, finally dropped cannon in favor of high-speed machine guns for their own personal employment. French pilots, in general, did not like the semiautomatic cannon too well and they looked forward to the impending prospect of a full automatic Puteaux that would discharge projectiles at the maximum rate of 60 a minute.

The system of operation of this new cannon was more that of a scaled-up Chauchat automatic rifle than anything else. Activated by long recoil, the large return spring encircled the barrel aided by a smaller one in a cylinder. It also had a breech-recoil spring in a housing very much like the Chauchat. It was mounted in the V of the motor exactly like the earlier Puteaux.

In order to fire the improved full automatic cannon, the gunner first drops five rounds in the hopper on the receiver and then opens the breech by means of a handle. A cartridge is inserted in the feedway through the ejection port. The sear is released by pulling a chain leading back to the cockpit. The bolt is driven forward by the strong driving spring and pushes the positioned round into the chamber. The breech-lock then rotates to fasten the bolt to the barrel at the moment of firing.

At the explosion the barrel and bolt recoil together and at a distance greater than the over-all length of the loaded cartridge the rearward movement stops and the barrel starts into counterrecoil. The bolt, meanwhile, is held to the





Puteaux 37-mm Aircraft Cannon, Mounted in the Cylinder Block of a Hispano-Suiza Engine to Fire through the Propeller Hub.

rear after the lugs on the breech lock have been rotated, thus freeing the two pieces. As the barrel starts to batter, two extractors, one on each side of the breech lock, cling to the rim of the cartridge as the counterrecoiling chamber is literally pulled off the empty case.

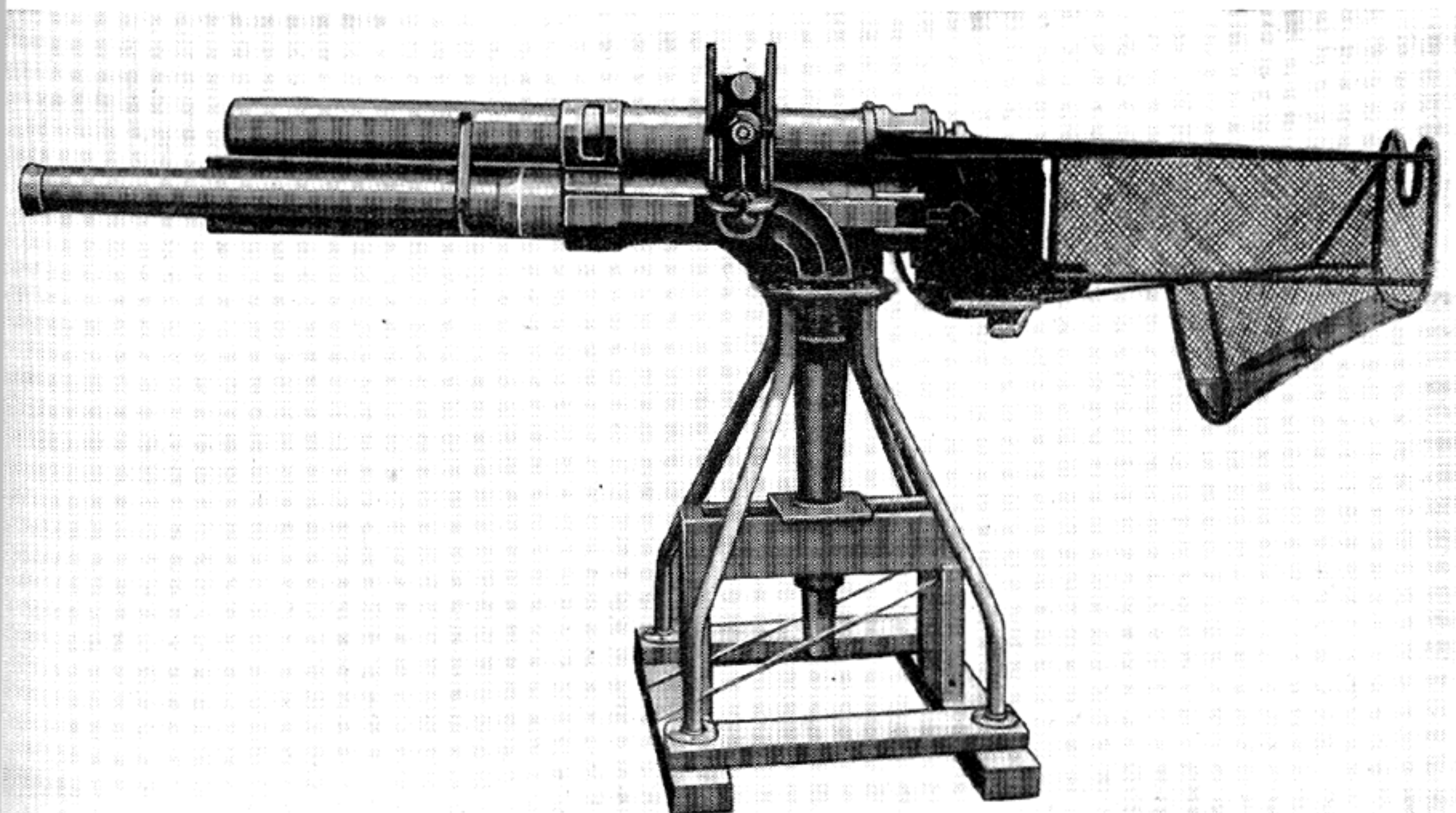
At a point approximately three-quarters of the way home, a stud on the barrel causes one extractor to be disengaged. At the same time it brings the ejector to bear on the base of the newly released cartridge and pivots the empty case out the ejection port. If the trigger remains depressed a tenth of a second after the barrel reaches battery, a sear is tripped that starts the bolt into counterrecoil. A round that by now has dropped in the feedway by gravity is chambered and the piece is again locked and fired.

The delay before the bolt was put into coun-

terrecoil made this system of operation notoriously slow, but as high speeds were seldom demanded of cannon, it was quite popular with designers as a reliable method of operating big-caliber automatic mechanisms. Not until 7 November 1917, did firing reach a state that the weapon was thought capable of successful air application. Leading French airmen, while looking forward to using perfected automatic cannon, still mounted the inferior semiautomatics as they felt the former weapon was still not sufficiently proved.

Commandant Garnier and M. Stalporte of the Puteaux Arsenal are credited with the devisement of the full automatic aircraft cannon but, like many other things in process of development at the time, it never saw service in the war. It was not until 7 September 1918, that the French





Puteaux 47-mm Aircraft Bombardment Cannon.

Minister of Armament informed the United States Army Automatic Arms Division that the automatic 37-mm Puteaux cannon was acceptable for aircraft installation. He doubted that enough would be manufactured before 1 April 1919, to arm any appreciable number of planes.

Two guns were ordered from France by the United States Army for experimental purposes and contracts were offered to encourage American manufacturers and designers to submit bids. It was stated that any company, turning out a copy of this weapon capable of passing the standard Army test could start immediate large-scale production.

The United Shoe Machinery Co., of Beverly, Mass., agreed to produce two trial cannon under this arrangement. These guns were successfully tested at Aberdeen Proving Ground in November 1918, but by this time the war was over and the whole project dropped by mutual agreement.

For use against ground targets and small shipping, even larger cannon were placed in aircraft by the French. These were also made at the Puteaux Arsenal and, like the original model, were semiautomatic. One was a 47-mm cannon,

called by the air force "bombardment cannon." It was so installed that, in vertical flight, the angled gun could be brought to bear on railway stations, trenches, wagon trains, troop columns, etc. This type of weapon was used quite effectively during the war. At the end of the hostilities an even larger gun (75-mm) was mounted in a plane, so placed that it fired straight down through the floor. But while successfully air fired, it did not have actual combat use.

The origin of the 47-mm gun was interesting. The French, being thrifty people, had on hand great stocks of Hotchkiss manually operated revolving cannon with 47-mm barrels. As they were very light in construction and highly available, reliable locking mechanisms were attached to these barrels of another generation for renewed service.

The French continued with development following the war whenever time and money would permit and, until they were overrun by the Germans in the early part of World War II, experimental work was still being done on the Puteaux automatic cannon.



# BECKER-SEMAG-OERLIKON AUTOMATIC AIRCRAFT CANNONS

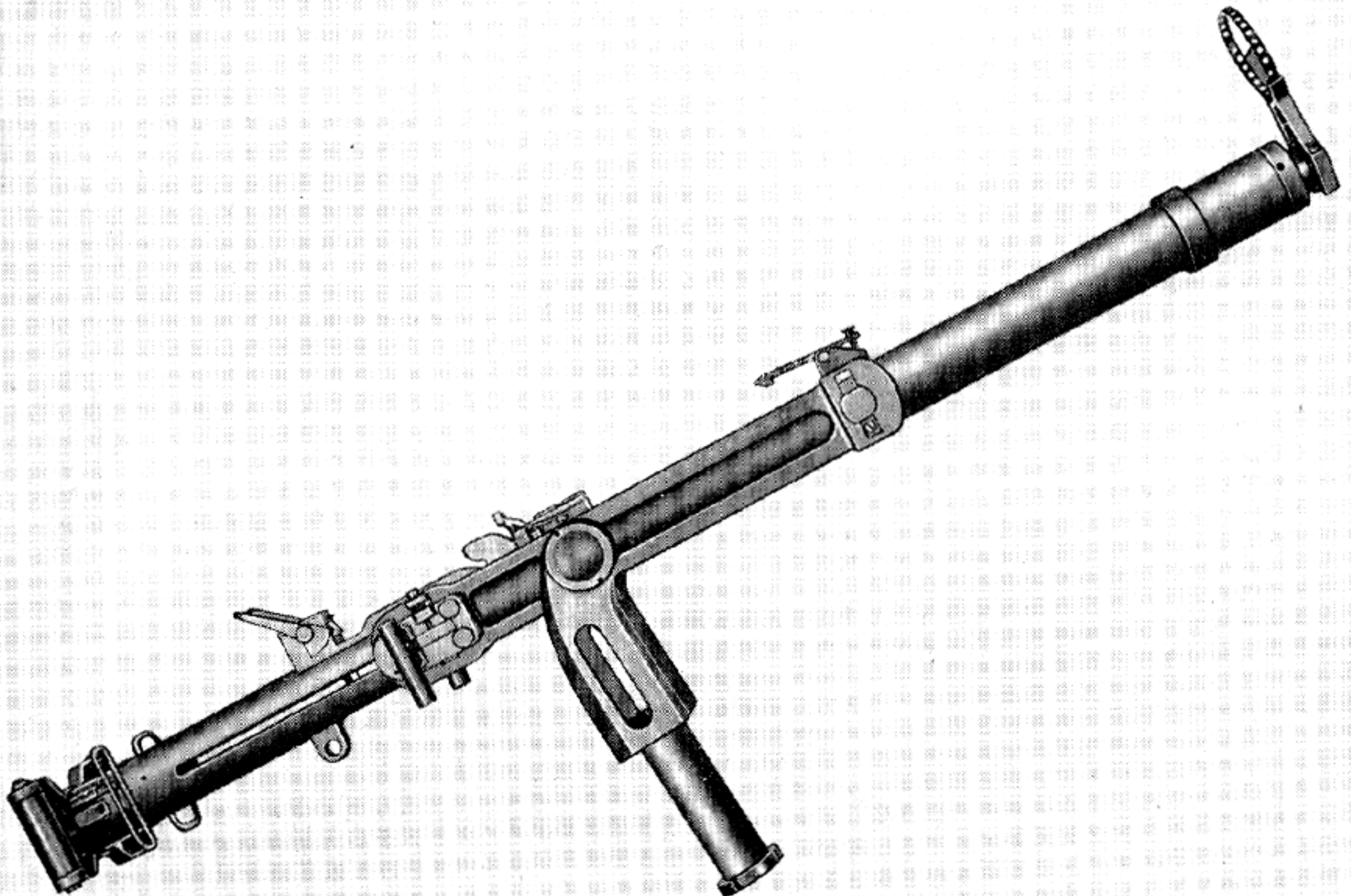
## Becker Cannon

When the leaders of the German Air Force, during the latter days of the first World War, ordered the placing of armor around the vital parts of their huge Gotha bombing planes, they realized that they had not only made the rifle-caliber machine guns of the Allies obsolete but their own as well. In order to find some suitable weapon that would deal adequately with the situation and still not violate the St. Petersburg Treaty relating to small-bore explosive projec-

tiles, they turned to the invention of Reinhold Becker, of Krefeld, Germany, who was then producing an aircraft cannon at his own firm, the Becker Stahlwerke at Willich am Rhein. His patent had been applied for in 1914.

The 20-mm Becker cannon was extremely light in weight, magazine fed and used straight blow-back for its operating power. It was full automatic, with a rate of fire given as 400 rounds a minute and, when first used by the Germans, employed a nonexploding solid projectile.

It consists principally of a barrel which is



Becker 20-mm Automatic Aircraft Cannon, Model 1918 (Flexible).

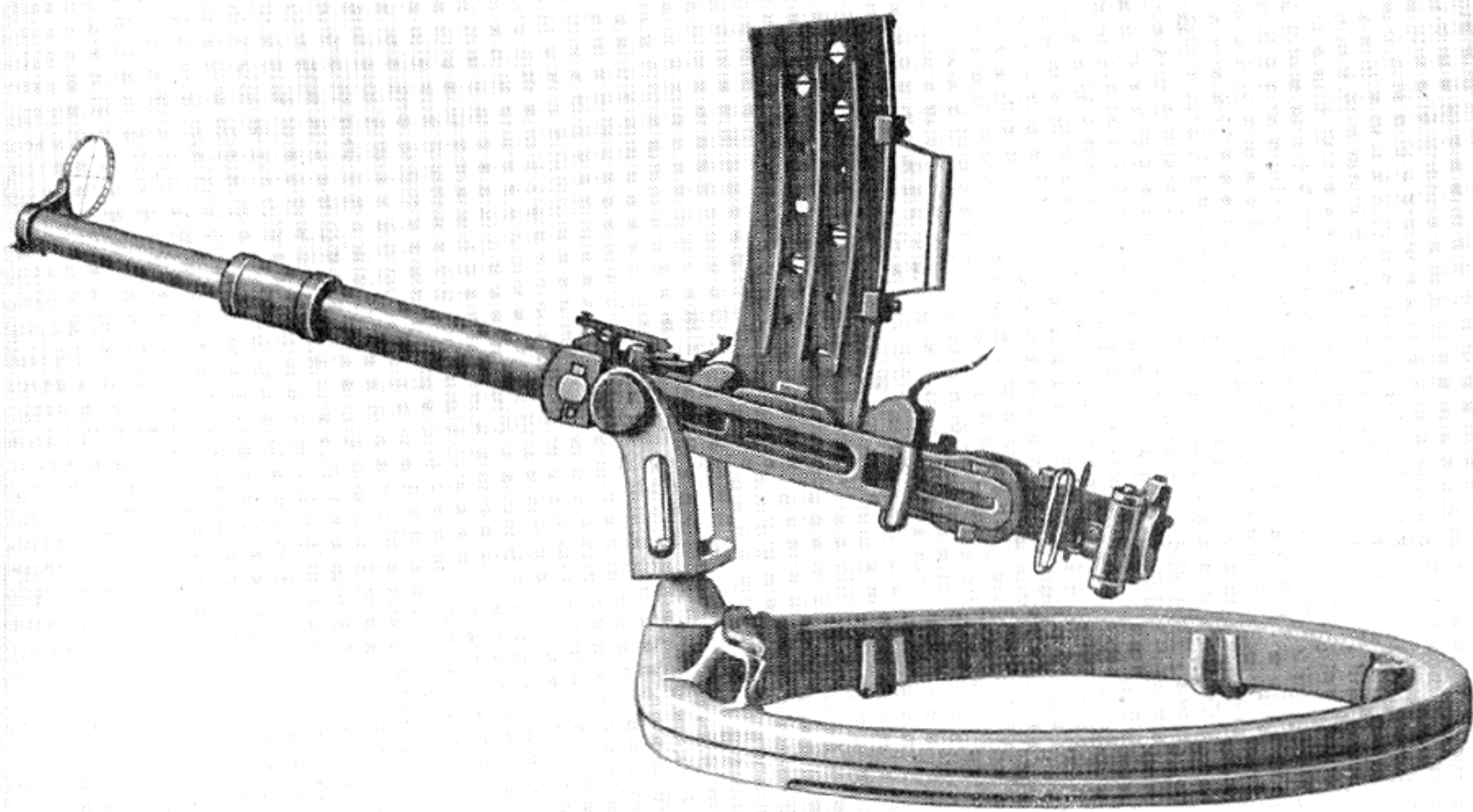


forged to trunnions that rest in the pintle. A cylindrical receiver having a magazine latch on top and an ejection slot in the bottom is firmly screwed to the barrel. The rear end of the receiver is closed by a portion which houses the sear notch and a round end block which contains the trigger, safety, and buffer mechanism. These parts do not recoil. The barrel is partially covered by a sliding sleeve which houses the driving spring. This spring is seated at its rear end against a shoulder of the barrel, and at its forward end on an adjustable position in the shoulder of the sleeve. This in turn has at its lower end trunnions for two side bars that connect the sleeve and the bolt. The connection with the bolt is made by a flat key which passes all the way through this member and projects out of each side through slots in the receiver. The charging handles are riveted to the side pieces. The bolt rides in its slideway in the receiver and contains the firing pin. The latter is actuated by a bell-crank arrangement, pivoted in the

bolt, which strikes a step in the receiver during its forward motion.

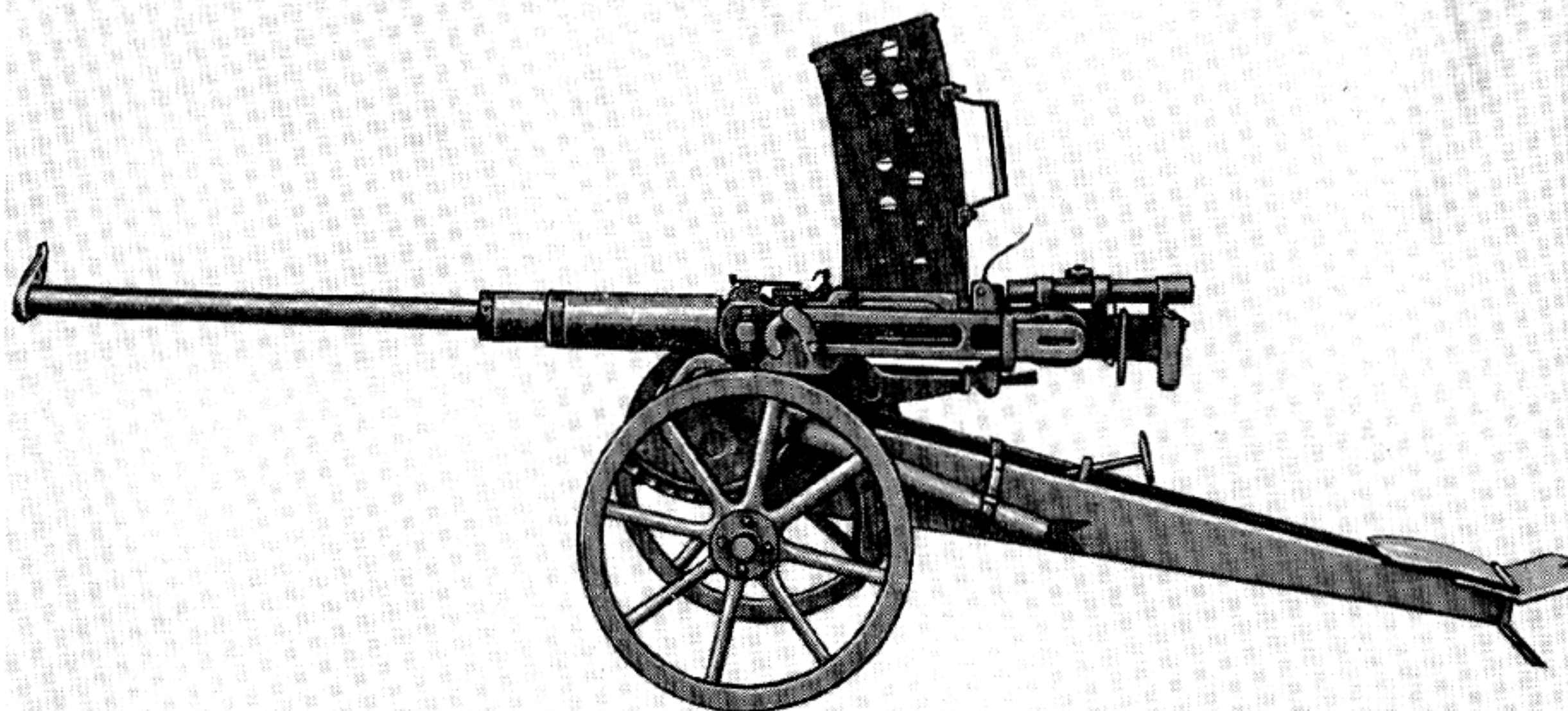
A rather unusual safety feature is embodied in the Becker. In the chamber at the rear of the projectile but well forward of the point where rupture is most likely to occur, a plunger passes through the top of the chamber which bears a spring-loaded pawl at its outer end. The case, when positioned, presses the plunger flush with the chamber walls and the pawl is raised. If the case is ruptured or fails to extract, the catch will engage a special hook fastened to the sleeve when that part is in its full recoil. In this manner the gun is stopped until the unextracted case is removed.

As another unique feature the bolt continues to move forward during the firing of the shot by virtue of its kinetic energy. This insures an absolutely gas-tight closure of the rear end of the barrel and a minimum of recoil, which, after absorbing the terrific forward speed of the heavy bolt assembly, is then only sufficient to drive the bolt to its rearmost position. The cartridge case,



Semag 20-mm Automatic Aircraft Cannon (Flexible).





Semag 20-mm Automatic Cannon for Infantry.

while not supported by a locked bolt, is inclosed in the chamber during the instant of explosion and the rearwardly acting gas pressure cannot burst it.

The primer is ignited well before the bolt has reached battery position. With this arrangement the chamber pressure acts on a member of considerable mass which is moving forward. The energy of this fast traveling piece must first be overcome before it can be put in recoil movement by the exploding powder charge.

The cannon had hardly been mounted by the Germans when one of the planes armed with it was shot down by a French fighter. There was great excitement among Allied ordnance specialists at having such an advanced weapon fall into their hands. Although the plane fell in flames and all ammunition was destroyed, the gun itself, mounted flexibly on a single yoke pintle, was salvaged and displayed to high-ranking officers.

After the Armistice the Allies had at their disposal enough captured ammunition to conduct a fair test of the piece. Most of this work was done at the range of the French Puteaux Arsenal. On 31 March 1919, one Becker automatic 20-mm aircraft cannon was brought to the Army's Ord-

nance Department in Washington, D. C. This weapon was marked "2 CMM FLZ. K.—Becker—Typ 2—1045" (the FLZ. K. meant *Flugzeugkanone*, or *Aircraft cannon*).

The Ordnance Department did not show any interest in the cannon other than placing it in its museum at Aberdeen, but France experimented with the mechanism for a number of years, and the conclusions of the board at the Puteaux Arsenal were to the effect that it was very formidable for air combat but could not be classed as such against tanks or heavily armored units.

### Semag Aircraft Cannon

During the attempt to demilitarize Germany after the Treaty of Versailles, Becker formed a connection with the Seebach Maschinenbau Aktien Gesellschaft, a well-known automotive concern, located near Zürich, Switzerland. This move was sponsored by the supposedly non-existent German ordnance office. By starting production of this advanced air cannon in a neutral country, outside the jurisdiction of inter-Allied control and with capital provided by Germany, it felt it would be possible to rearm its forces



with the latest and most improved weapons when the need should arise.

Semag, the name being coined from its initials, manufactured the Becker gun and sold it as an aircraft weapon. In 1921 it introduced its own version, which was a modified Becker. The bore was 20 millimeters, but the barrel and cartridges were longer, giving a higher muzzle velocity. This weapon was called the Semag infantry gun. By early 1923 the company had built and fired a new 25-mm model, using the same action. The Semag 25-mm was mounted on a wheeled carriage and, although it fired successfully, it was considered too heavy. The firm failed before the redesign was completed.

A number of guns were sold to such countries as China and Spain. Long after this firm was but a distant memory, Semag cannon turned up as armament in the fighting between the Chinese and Japanese in the 1930's and during the Spanish Civil War.

### Oerlikon Aircraft Cannon

The financial failure of Semag resulted in its being taken over by the Werkzeug Maschinenfabrik Oerlikon, a machine-tool factory located in Oerlikon, Switzerland, a manufacturing village near Zürich. German capital and management dominated this company too. An ex-German army officer, Emil Buhrle, was the manager of the plant. Its modern, one-story saw-tooth type buildings were set up primarily for the production of automatic arms. The plant has often been confused with an older Swiss firm, Oerlikon-Zürich, which produced heavy machine tools, electric locomotives, automobiles, and similar equipment.

The arms plant at once started development and experimental work on 20-mm automatic cannon, based on Becker's patents. The models at hand were provided with official designations to prevent confusion with future production. All guns made on the straight Becker principles were called Type F; weapons based on the Semag design were known as Type L; and Oerlikon development was identified as Type S.

The characteristics of each of the three are summarized as follows:

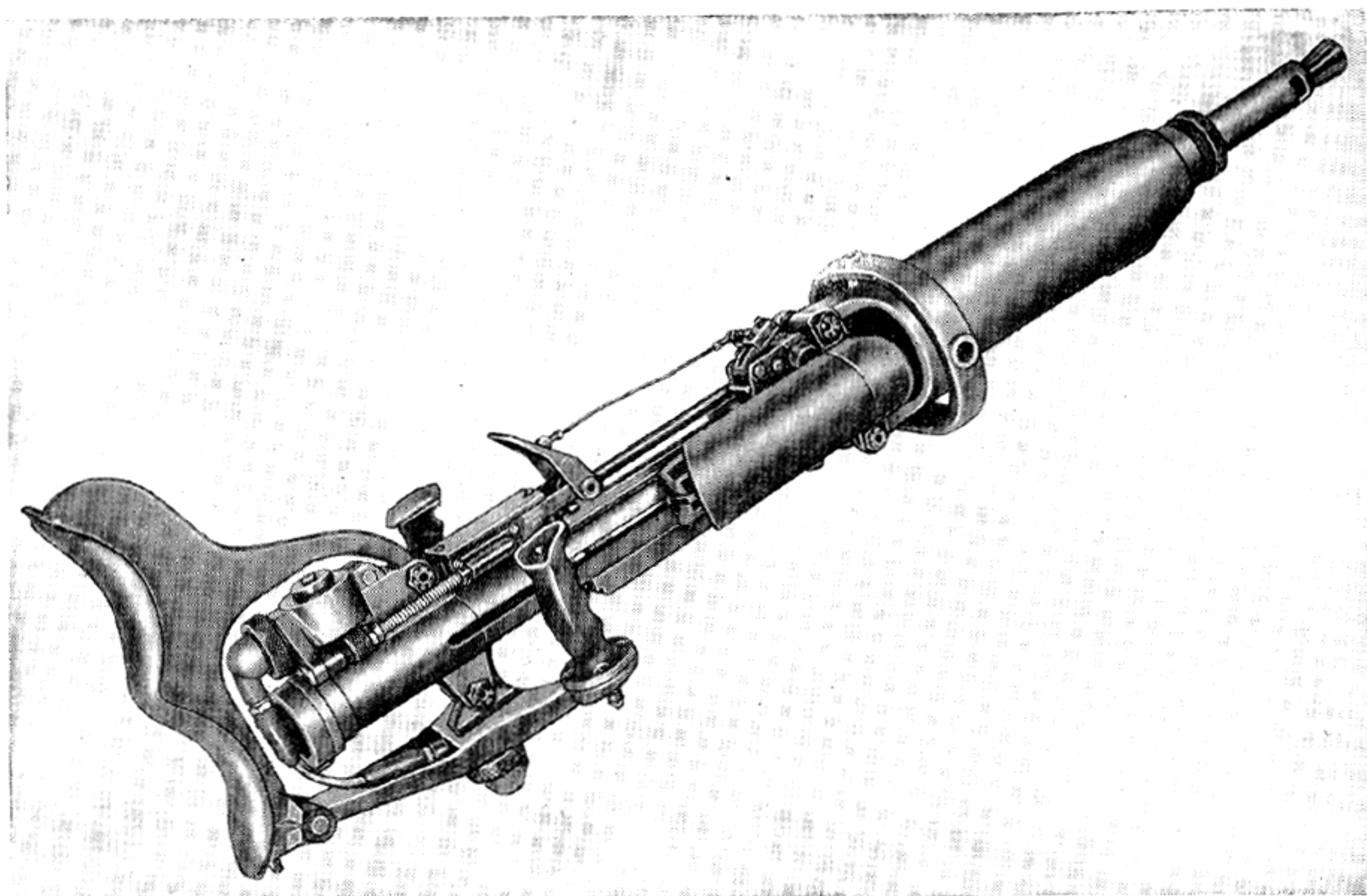
|                                       | F       | L       | S       |
|---------------------------------------|---------|---------|---------|
| Muzzle velocity<br>(M/sec) . . . . .  | 550-575 | 670-700 | 835-870 |
| Rate of fire . . . . .                | 450     | 350     | 280     |
| Recoil force (kg) . . . . .           | 60-70   | 115-120 | 140-150 |
| Weight (kg) . . . . .                 | 30      | 43      | 62      |
| Barrel length<br>(calibers) . . . . . | 40      | 60      | 70      |

By early 1935 designs for each of the three types were completed and several new Oerlikon-developed models were constructed and designated respectively FFF, FFL, and FFS. The first model weighed 25 kg complete, including a compressed air charging mechanism, and had a muzzle velocity of 600 M/sec. The cyclic rate was roughly 550 a minute. The FFL and FFS had a proportionately higher velocity and were consequently heavier in weight. In other words, if a prospective customer had need for an extremely lightweight low-velocity cannon with a fairly high rate of fire, the refined Becker gun was the logical choice. However, if high velocity and low rate of fire were demanded, the Semag or Oerlikon type would adequately fulfill the needs.

The specifications naturally made the Becker gun a formidable aircraft weapon, while the Semag and Oerlikon models were very popular with ground forces that had armor to contend with. The successful use of other automatic cannon mounted in the engines of planes to fire through the propeller hubs led also to a wave of predictions by military forecasters that the day of the rifle-caliber machine gun had passed. Another war, they said, would see only the use of automatic shell guns, as the cannon were called on the continent. It was to these ends that the Oerlikon plant turned its full efforts.

Associated with Emil Buhrle at Oerlikon was Antoine Gazda, a former Austrian fighter pilot in World War I, who took over the duty of sales promotion. He saw to it that much secrecy surrounded the procurement of the Oerlikon aircraft guns. Each country dealing with Gazda doubtless thought that it alone was making aviation armament's most progressive step. The world has known few salesmen who were his equal.





Oerlikon 20-mm Automatic Aircraft Cannon, Model F, (Flexible), Adopted by Germany.

England bought Oerlikon guns as early as 1935 for testing at Enfield, ostensibly for anti-tank work, but in reality for adaptation to aviation use. The United States in 1936 conducted similar trials at its Aberdeen and Dahlgren proving grounds. The cannon was called at the time an antiaircraft gun, but it was installed in a Hispano-Suiza engine, the engine and gun having been procured from France at the suggestion of the Navy for test purposes.

The French Air Force also began to place Oerlikons in Hispano engines and experimented with them in many of its fighter planes. The possibility of its outright adoption looked so promising that the Hispano Co. negotiated a license to produce the weapon at its own plant near Paris. By 1938 over 400 of this engine-mounted type were in service in the French Air Force. All such guns produced by the Hispano-Suiza Co. were referred to as types 7 and 9 in order not to confuse them with another aircraft cannon on which it contemplated production.

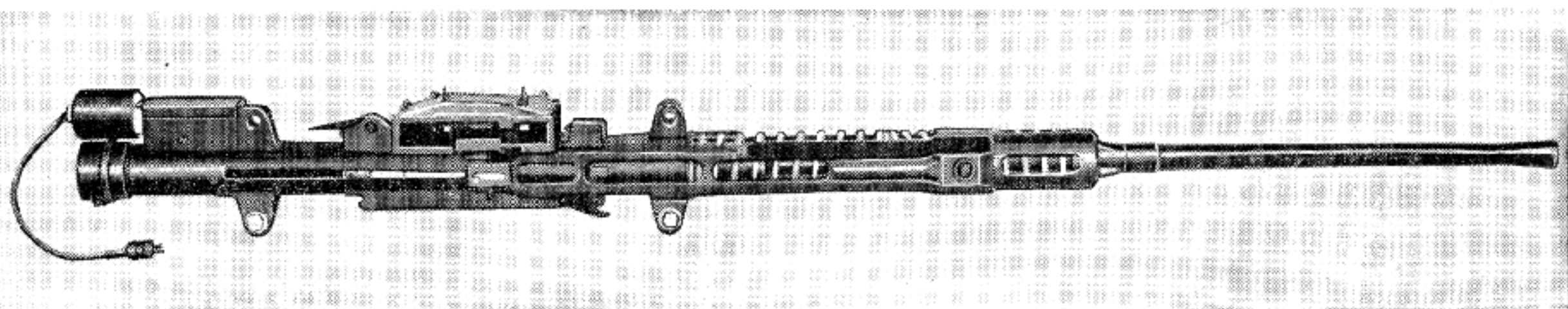
In this same year the British, running their

second trials on the gun at Enfield, turned in a very favorable report on its ability to use deformed or poor quality ammunition. The Royal Navy, desperately in need of a reliable automatic cannon for antiaircraft use, hastily adopted the FFS for shipboard use and ordered 500,000 rounds of ammunition to be made up immediately. The development of high-explosive projectiles had long been proved successful and all orders carried a stipulation that these be made in proportionate numbers.

Our Government, after years of experimenting on defense against low-flying attack planes after World War I, had not produced anything remotely resembling a reliable automatic cannon to replace the outmoded rifle-caliber machine guns. It quickly followed Britain's example and adopted the model FFS. Manufacture was begun in this country for both Great Britain and our own forces.

Antoine Gazda, never one to restrict his talents geographically, had early turned his attention to the pressing need of the Far East for reliable





Oerlikon 20-mm Automatic Aircraft Cannon, Model 99 (Fixed). This Belt-Fed Weapon Was Manufactured in Japan and Used by Its Naval Air Force.

armament. As early as 16 July 1934, he visited Japan where he remained until 8 November of the same year. On this trip he spent his time in Tokyo negotiating with the Japanese War Department and private interests, principally in behalf of the French Société Aeronautique Lorraine relative to granting a license for Lorraine mosquito torpedo speedboats. At the same time he lost no opportunity to point out to the Japanese the devastating possibilities of the Oerlikon machine cannon in aircraft. He advised them of the experimental work and development being done at the Swiss plant.

In June 1935, Gazda returned to Tokyo. This time, after setting up headquarters in the Hotel Imperial, he proceeded to consult such notable industrialists as the Barons Okura, Watanabi (then director of the Okura interests), and Ishihara (head of the Mitsubishi Co.). Gazda's purpose was to advocate the Oerlikon 20-mm aircraft cannon mounted in the wings of fighter planes. While on this mission he had frequent occasion to be called into consultation by the Japanese War Department, and especially by the air corps.

The Japanese, open to such technical advice, placed their first order for 32 Oerlikon aircraft cannon on 17 September 1935, which upon arrival were immediately installed in the wings of 16 Mitsubishi Type 96 fighter planes. On 8 November of the same year, the Japanese Air Force ordered and acquired eight more such guns. A short while later a license agreement was signed, granting rights for Japanese manufacture of the 20-mm Oerlikon Aircraft Cannon Type FFF and construction plans were drawn for the Dai Nippon Heiki Munitions Works. Following the signing of this agreement, Gazda left on 6 June 1936 for Switzerland.

After a site at Tamioka was chosen for the

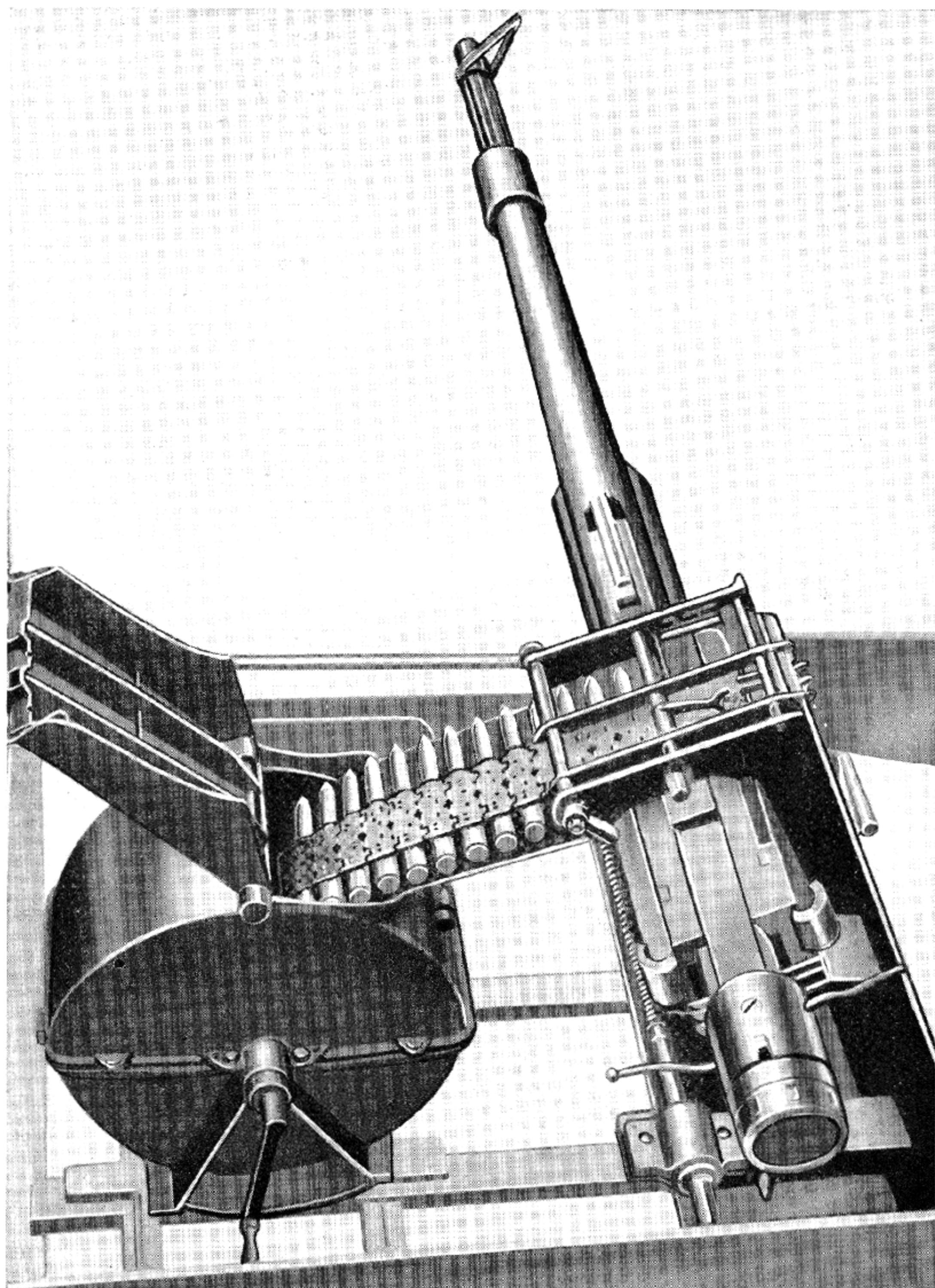
Japanese arsenal, machinery was installed by the Oerlikon firm that was capable of producing 200 aircraft cannon a month. Before starting on the new plant, two engineers were sent from Japan for a year's study of cannon manufacture and installation. One of them was Mr. Ishihara, the leading tool expert of Japan, who was formerly associated with the Mitsubishi tank factory at Tokyo. Upon their return, the Swiss technicians in charge of installing Oerlikon machinery at the Jap plant reported to their company that the two engineers brought with them better drawings of company machinery than those possessed by Oerlikon.

On 25 August 1937, the Japanese War Department, pleased with the performance of the aircraft gun and with the progress of their engineers in studying the techniques of the parent plant, sent Prince Chichibu, brother of the emperor, accompanied by Viscount Maeda and Major Yamaguchi, to discuss with certain prominent Oerlikon officials the granting of licenses to Japan for manufacturing the FFS type guns for anti-tank service. The weapons eventually produced in Japan ranged from aircraft to antitank cannon and were very popular with the Jap military leaders, being considered first-line automatic cannon by all branches of the service.

The German Army, Navy, and Air Force likewise adopted the gun and used it, in the early days of Hitler's power, when the nation began seriously to arm for the impending war. Since the Oerlikon arms plant was controlled by Germany and its head was an ex-army officer, there can be no doubt that the best interests of the Wehrmacht and Luftwaffe were considered. The navy was also served, as the Oerlikon was used on shipboard by the thousands.

At the beginning of World War II, the German Air Force had the gun mounted in almost





Oerlikon 20-mm Automatic Aircraft Cannon, Model S. Wing Installation with Belt Feed of 125 Rounds  
Adopted by the German Air Force.



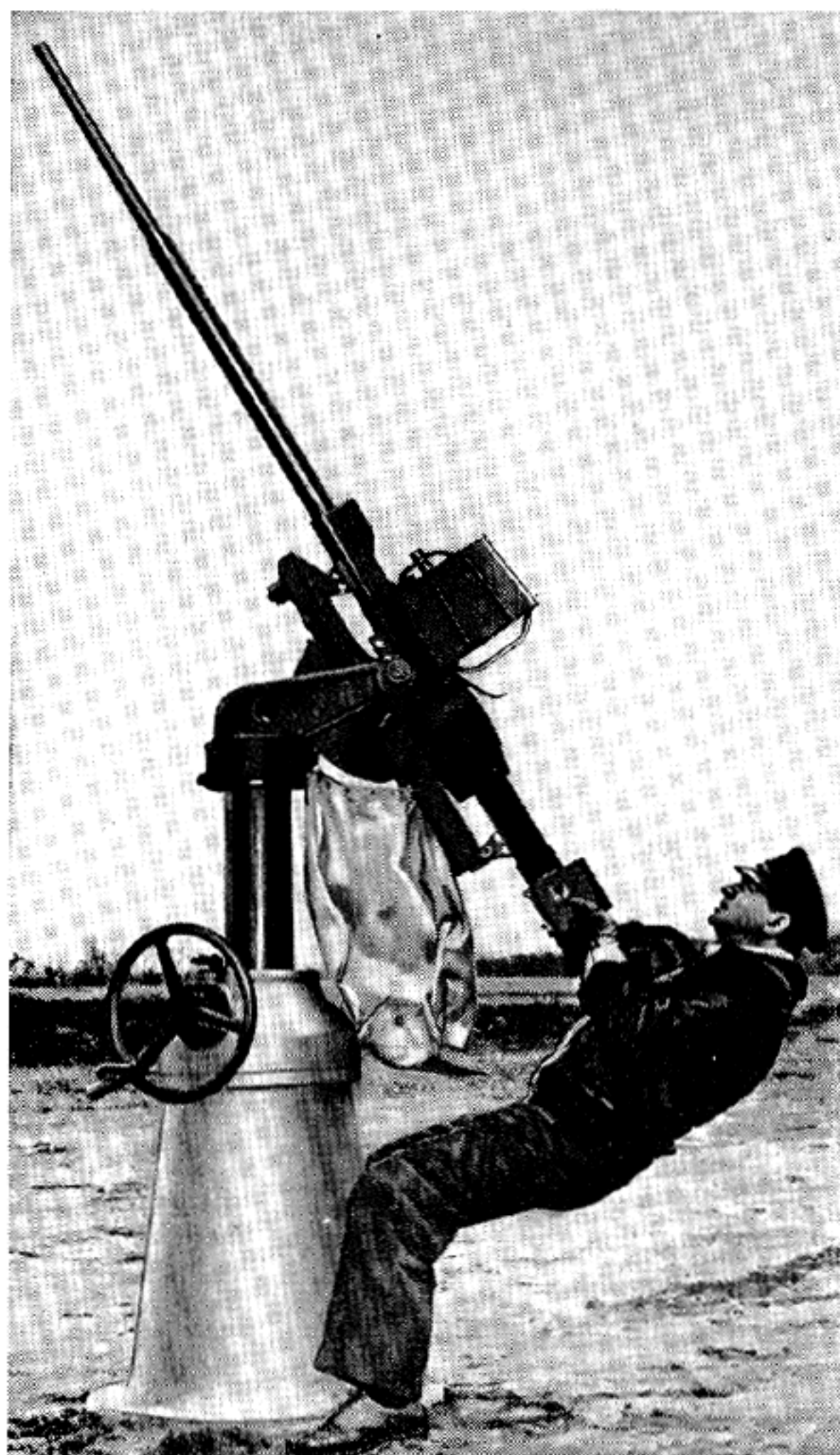
every conceivable manner, flexible, wing, and engine installation. Up to and during the Battle of Britain, it was the main Nazi aircraft cannon. Its most objectionable feature, according to the Germans, was the 60-shot drum feed. To overcome this, a metallic link-belt feed system was successfully used by the Luftwaffe. With the inevitable improvement of aircraft cannon occasioned by the war, the Oerlikon aircraft cannon was replaced, but not before it had served Germany well. Great dividends were paid to those officials who had had the foresight to keep alive and improve the Becker gun of the closing days of World War I.

### Gazda Aircraft Cannon

After the fall of practically all of western Europe to the Germans and the United States had assumed the role of "arsenal of the democracies," Antoine Gazda made his appearance in this country and was promptly detained by the authorities for questioning. Gazda produced an already prepared paper entitled "Facts of How an Austrian Gave Great Britain and America the Most Powerful Weapon against Dive Bombers, the Oerlikon-Gazda Anti-Aircraft Cannon." This paper, now in the Army's possession, negligently failed to mention that the dive bomber was likewise armed with Oerlikon guns.

As further proof of his loyalty to the Allied cause, he carried plans for a revolutionary 23-mm automatic cannon that would "make all other aircraft cannon obsolete." In due time he presented literature with drawings showing the systems of other cannon in comparison with the Gazda four-stroke flywheel inertia-locked automatic cannon. The United States, being in a very precarious position, gave him an opportunity to present his gun and drawings. A booklet was delivered to the Navy Department which showed the flywheel Gazda gun (designated Model AS-43) in detail. Close study revealed nothing beyond the original Oerlikon that justified development, although a rate of fire of 1,140 rounds a minute using the same Oerlikon cartridge cases was claimed. A velocity of 3,100 feet per second was also declared possible without altering the powder charge.

Gazda has never been known to undervalue

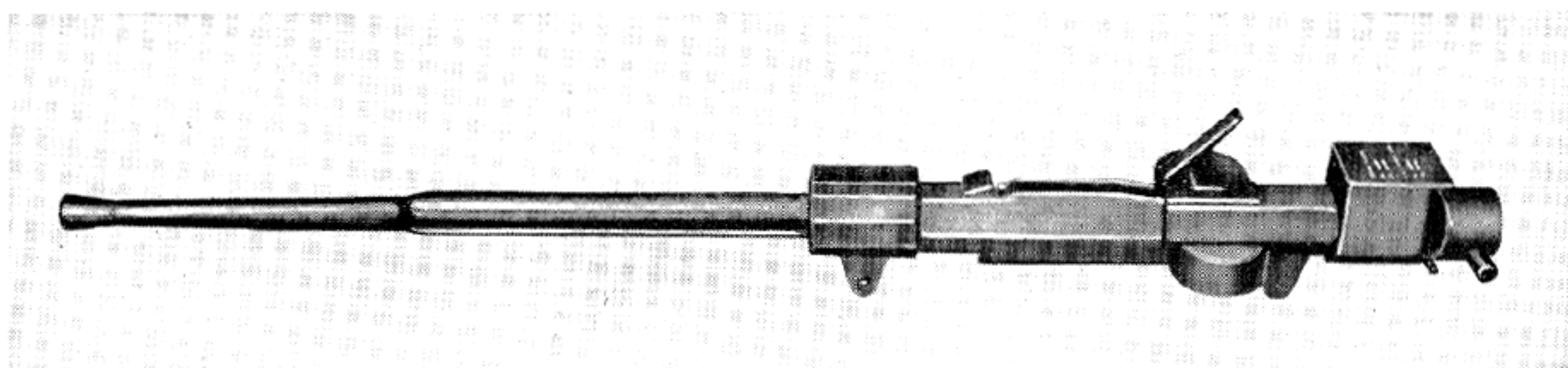


Antoine Gazda Firing the Gazda 20-mm Automatic Cannon.

the features of any gun he has had a hand in promoting, with respect to its individual feats as a combat weapon or its over-all responsibility for the successful conclusion of a global conflict.

It was stated in the descriptive booklet that the Gazda gun was entirely different from any other automatic cannon in that it employed "pre-percussion, whereby ignition takes place at a point where the forward moving breech, impelled by a simple recoil element, has almost reached its furthestmost position, but is still in full motion. . . . Much of the kinetic energy accumulated in the moving breech is absorbed by the rapidly increasing gas pressure, thereby losing about half of its recoil impulse, whilst the remaining energy





Gazda 23-mm Automatic Cannon.

drives the breech against the recoil element. This characteristic shows that the Gazda system locks the breech, and by means of pre-percussion reduces the ultimate recoil pressure to about half of the amount necessary without pre-percussion."

What Gazda overlooked in his claim for a new system was that every Becker and Oerlikon gun made since 1918 had used exactly the same principle. It was perhaps the most outstanding single feature of this type of gun. As evidence, a quotation is made from Reinhold Becker's patent application of 27 October 1914:

"The ignition is adapted to take place before the breech piece reaches its foremost position, that is to say, when it possesses its greatest kinetic energy, and before the cartridge inclosed in the cartridge chamber has attained its final position, the breech piece continues to move forward during the firing of the shot, by virtue of its kinetic energy and thus insures an absolutely gas-tight closure of the rear end of the barrel and reduces the recoil, which is then only sufficient to return the breech piece to its rear position."

After much correspondence the whole project was dropped as far as the United States Government was concerned, as there simply was not enough difference to warrant further investigation or expenditures at this particular time.

### Polsten Cannon

One of the most unusual developments or versions of the Oerlikon resulted from the German invasion of Poland. That country, in common with practically all others, had become interested in the weapon for ground use and had assigned its head engineers to redesign many parts for simplified manufacturing procedures. When this task was nearly completed, the German invasion began and the Polish engineers, carrying with

them their drawings of suggested improvements, escaped to England where the plans were shown to the chief superintendent of armament design. He was greatly impressed with the intended modification and this group, known as the Polish Design Section, was ordered to complete the details. When this was done, the finished plans were turned over to the British Sten Co. to make two pilot models with the understanding that, if the weapon passed the acceptance test, an order for 40,000 would be forthcoming.

One of the principal differences between the Polish-designed gun, known officially as the Polsten 20-mm Automatic Cannon Mark I, and the original Oerlikon was the built-up receiver of welded construction which had heretofore added greatly to the machining problem in mass production. The Polsten gun was also lighter in weight, but as the weapon was intended for shipboard and ground use, this did not seem of too much importance to the British. It could be fed both by clip or drum magazine, and could only be fired full automatic.

The following particulars compare the Oerlikon and the Polsten to show how much actual difference existed between the two guns:

|                                                | Oerlikon  | Polsten |
|------------------------------------------------|-----------|---------|
| Weight of complete gun (pounds) . . . . .      | 152       | 121     |
| Weight of barrel only (pounds) . . . . .       | 45        | 29½     |
| Over-all length of gun . . . . .               | 7' ½"     | 7' 1¾"  |
| Over-all length of barrel . . . . .            | 57"       | 57"     |
| Inboard length of gun . . . . .                | 28"       | 32½"    |
| Total number of parts . . . . .                | 195       | 108     |
| Total number of machining operations . . . . . | 1000-1200 | 550-600 |



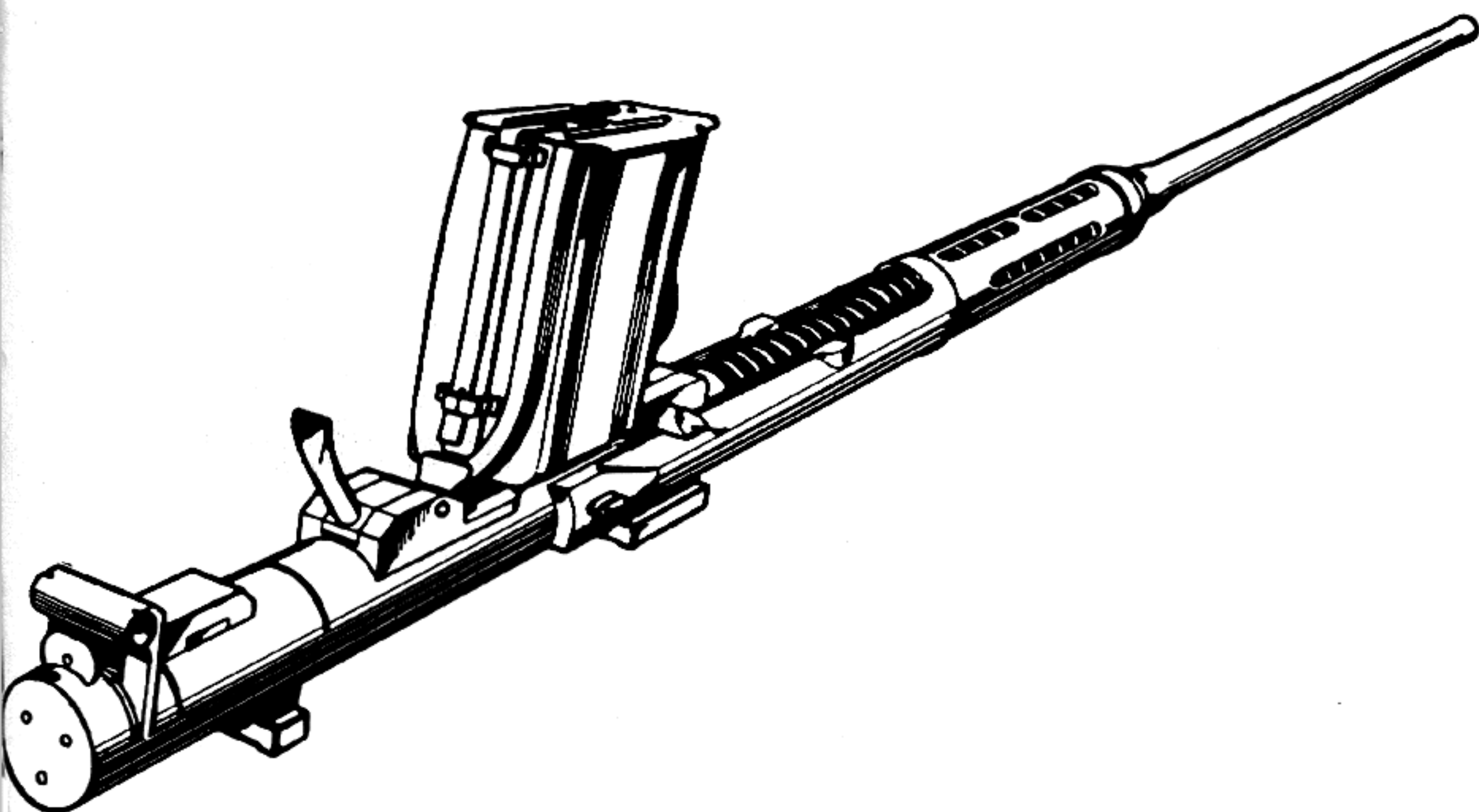
Tests conducted at the armament design section at Cheshunt and the experimental establishment at Pendine showed that an average of 9,000 rounds could be expected on all components of the Polsten except for the mainspring and buffer assembly, which was given a life expectancy of 6,000 rounds. This was considered quite satisfactory. The same report, however, showed that a great deal of trouble was had with the 30-shot spring-loaded clip-type magazine. As this was considered an accessory to the gun, rather than an integral part, the malfunction was taken up with its producers.

The Pendine experimental establishment also went farther and proved that the accurate barrel life of this modified version of the Oerlikon was 1,200 rounds when fired as fast as the magazines could be changed, and 3,000 when 5-minute pauses were permitted after 600 rounds of continuous fire.

The Polsten 30-shot magazine is of the box type, rectangular in form and tapering at the bottom to neck with the conventional feed mouth. When filled, it presents two double columns,

each being operated by a separate platform and spring. The pressure on the platform is produced by two separate multileaf springs, which automatically place the correct pressure on the cartridge resting in the feed mouth, making any additional outside tension unnecessary. An L-shaped lever is issued with each magazine to assist filling. When not in use, it fits into slides at the rear. A web-strap carrying handle is fitted to the front.

When this magazine is used, each platform is pressed down almost to its limit of travel, fully compressing the leaf springs. When placed into position on the gun, the cartridges in the right-hand column will first feed out rounds 30 to 15, while rounds 1 to 13 are being forced into the recess of the partition. As the right-hand platform moves down and finally reaches the end of its travel, a cam on the inner side pushes number 13 out of the recess and thus permits the left-hand platform to feed its column rounds 14 to 1, with number 14 being held against number 13 by the passage of the cartridges from the opposite column.



Polsten 20-mm Automatic Cannon Mk I. Drawing Shows 30-Round Magazine.



## Cycle of Operation

To fire the Becker, Semag, Oerlikon, Gazda, Japanese Model 99, Polsten, or whatever else the action may be known by, the gunner pulls the charging handle to the rear until the sear engages its recess in the bolt, and then places the loaded feed into position on top of the receiver. After turning the safety catch forward to the *Fire* position, the trigger is pressed back.

The breechblock is then released from the sear and travels forward under the influence of the barrel spring. The horns on the breechblock head come into contact with the base of the first round in the magazine, forcing it forward and downward towards the chamber.

The mouth of the chamber is shaped to guide in the nose of the round. The projectile is thus aligned with the axis of the bore, and the base of the cartridge slides down the face of the breechblock head until the rim of the cartridge rests in the extractor lip.

Forward movement continues until the round is about a half inch from the fully home position. Then the rear toe of the hammer comes into contact with the rear face of the hammer cam. The hammer is rotated on its axis pin thus forcing the firing pin forward and firing the primer. No locking of the breech takes place.

On firing, the forward movement of the breechblock is arrested by the building up of the chamber pressure, which forces the empty cartridge case against the face of the breechblock head and carries the block to the rear, compressing the barrel springs.

At the commencement of the rearward movement, the front toe of the hammer rides against the front face of the hammer cam, thereby rotating the hammer rearwards and withdrawing the firing pin.

The empty cartridge case is supported by the lip on the breechblock head until the top edge

of the base of the case comes into contact with the projection underneath the magazine catch which forces the case downwards through the ejection opening in the underside of the body.

The breechblock continues rearward movement until the buffer at its rear comes into contact with the body plug. Any surplus energy possessed by the recoiling parts is now absorbed by the buffer springs housed in the breechblock.

The barrel springs then reassert themselves and drive the breechblock forward again as the cycle is repeated.

## Conclusion

The Oerlikon system, as it is commonly designated, represents the fullest known exploitation of a sound operating principle for automatic cannon. Utilization of the terrific speed forward of the bolt as a substitute for a securely locked breech not only allowed the construction of a lightweight cannon but also dampened out to a considerable degree the abnormally large recoil forces that were an important consideration in mounting automatic cannon in aircraft.

While this system met these requirements, it still left many things to be desired. One feature, in particular, limited its use as an aviation weapon. In order to compensate for firing the cartridge at variable distances in the chamber, it was necessary that the ammunition be heavily lubricated with oil to insulate the case from the chamber walls. This permitted the empty case to slip to the rear by blow-back forces to exert necessary operating energy on the bolt face. This feature, which was so bad that it practically canceled out all the good ones in the gun, as far as aircraft use was concerned, was a byproduct of the Oerlikon type of action. It could only be eliminated by use of a positively locked breech, which, in turn, would produce greater recoil forces with their attendant difficulties.



## SZAKATS 20-MM AIRCRAFT CANNON

When the Inter-Allied Control Commission inspected German armament plants shortly after the armistice, it found an aerial cannon being developed for intended use against the Allies. It was the Szakats 20-mm belt-fed, air-cooled automatic cannon, having a rate of fire of 450 shots a minute. It was designed primarily for aircraft use although two experimental models did have a provision for water cooling. This weapon was the invention of a Polish arms designer named Gabriel Szakats, then serving as an ordnance engineer at the Fahrzeug Fabrik of Frankfurt, Germany.

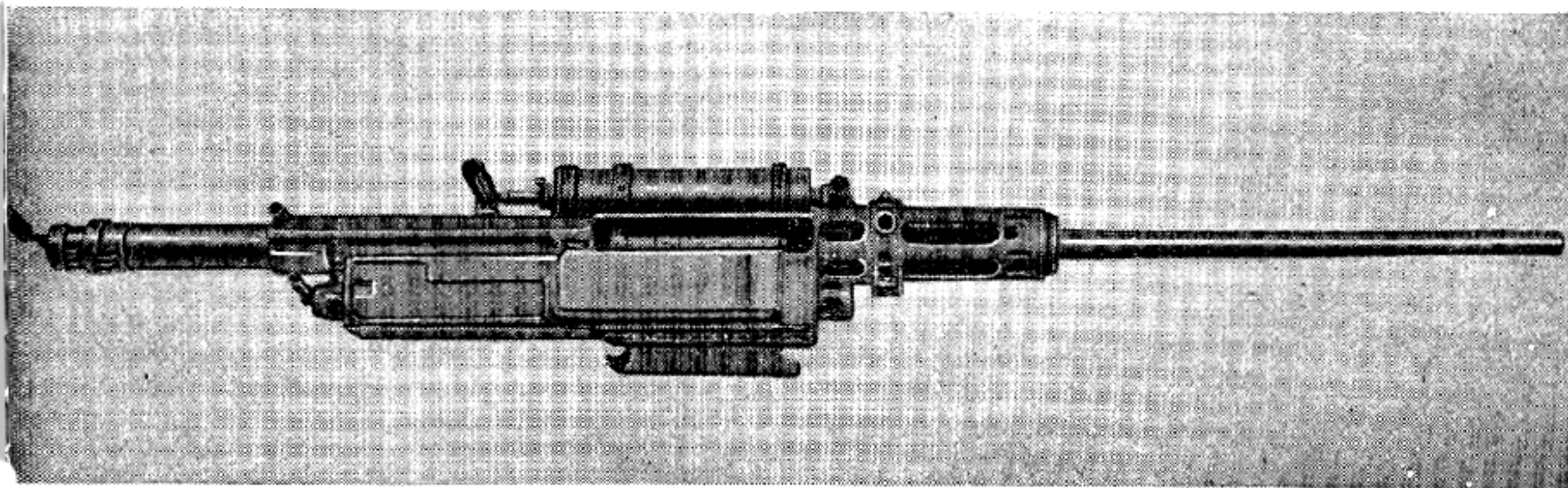
The first successful model was produced by this company late in 1918, but, although manufactured under high priority, none were completed in time to get into combat. In all, four distinct types (SZA-1, SZA-2, SZB, and SZC) were made in the early development of this gun. The SZA-1 and SZA-2 could both be water cooled, if desired, the only difference in their construction being in the housing for the unusually large barrel return spring. The SZB was made much lighter than the original guns and was air cooled only. It had radial fins on the barrel and an air brake for checking recoil, made in the form of a "dash pot," to dampen out the sudden shock. In this design a device was incor-

porated for rotating the feed, thus facilitating the loading of the first cartridge. No provision was made for single rounds to be fired, the selector switch being on either *Safe* or *Full automatic*. The SZC represents the final improved model and its modified components were finished in bronze to eliminate undue friction.

Each Szakats cannon was based on the operating principle of blow back and employed a push-out-type metallic link belt. The most novel construction feature was the revolving feed that, actuated by a lug on the bottom of the bolt during recoil, rotated a cartridge into position for chambering. By utilizing the powerful recoil stroke to index the round, the weapon had enormous belt pull.

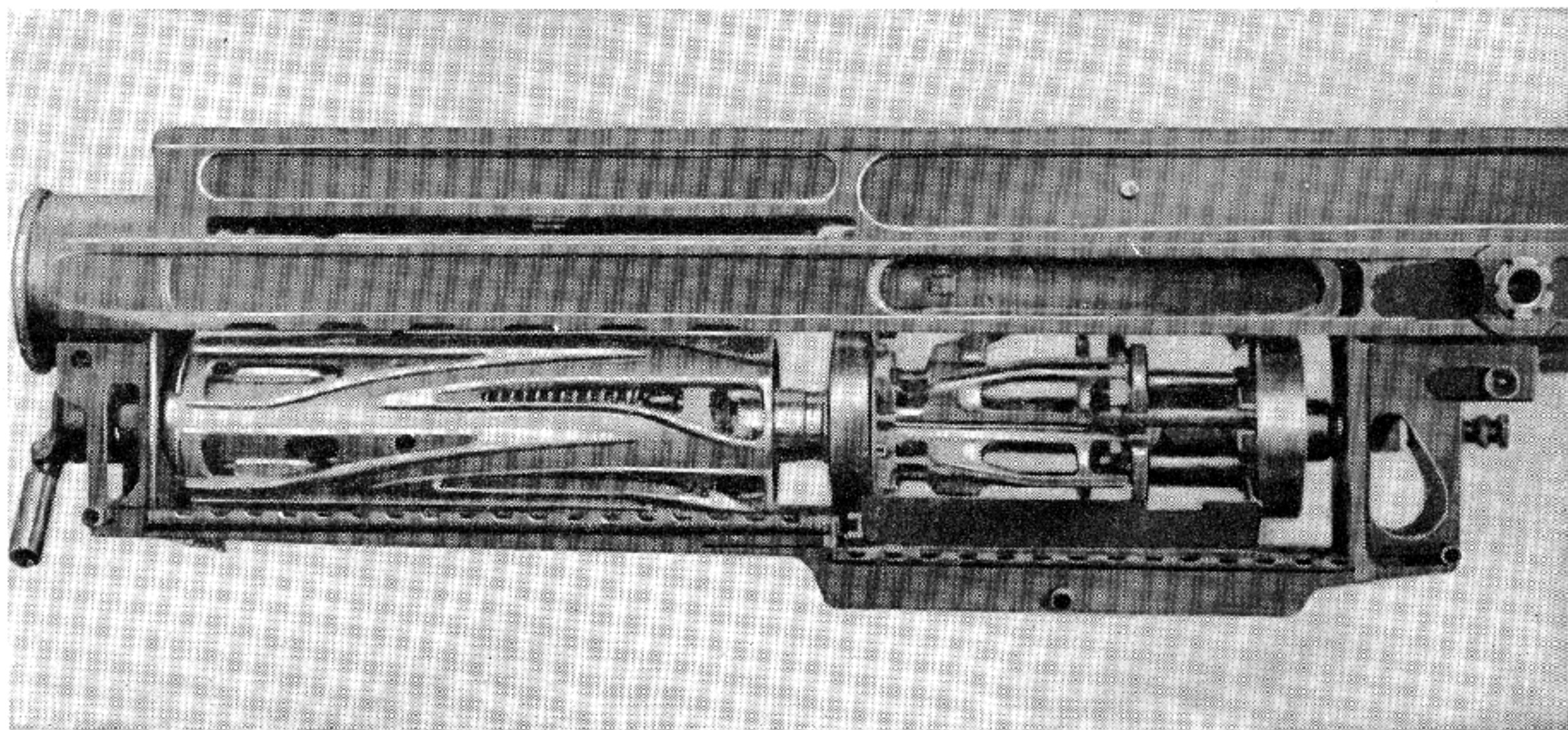
The buffing system was also extraordinary. A heavy spring arrangement bore the brunt of the shock but, if it could not absorb it completely, the back of the bolt then made contact with a piston. The resulting sudden air compression gave the recoiling parts their final check. This system of buffing, known as "dash pot," has been used extensively since Szakats first introduced it in his cannon.

The spring-loaded firing pin release was so timed that it was tripped a few thousandths of an inch before the cartridge was all the way home



Szakats 20-mm Automatic Aircraft Cannon, Model SZB.





The Feed Mechanism of the Szakats Automatic Aircraft Cannon.

in the chamber. This allowed the forward thrust of the bolt to back up the cartridge when the explosion took place. As the weapon was not locked at the instant of firing, it was necessary to grease the cartridges used with the cannon. The inertia of fast traveling bolt and spring pressure served as the only lock. The action was straight blow back, no provision being made for retarding the movement.

The weapon could be mounted either flexibly or fixed in aircraft. When installed in the wings, it was possible to synchronize its front-seared action to fire through the propeller arc. When so installed, an ammunition box holding 100 cartridges was seated near it.

To fire the Szakats, the linked cartridges must first be brought out of the container and the first round placed in the fluted portion of the revolving feeder. This part of the feed must be disconnected from the rear portion by means of a throw-out device. The flutes can then be rotated by hand until charging of the gun indexes it into place.

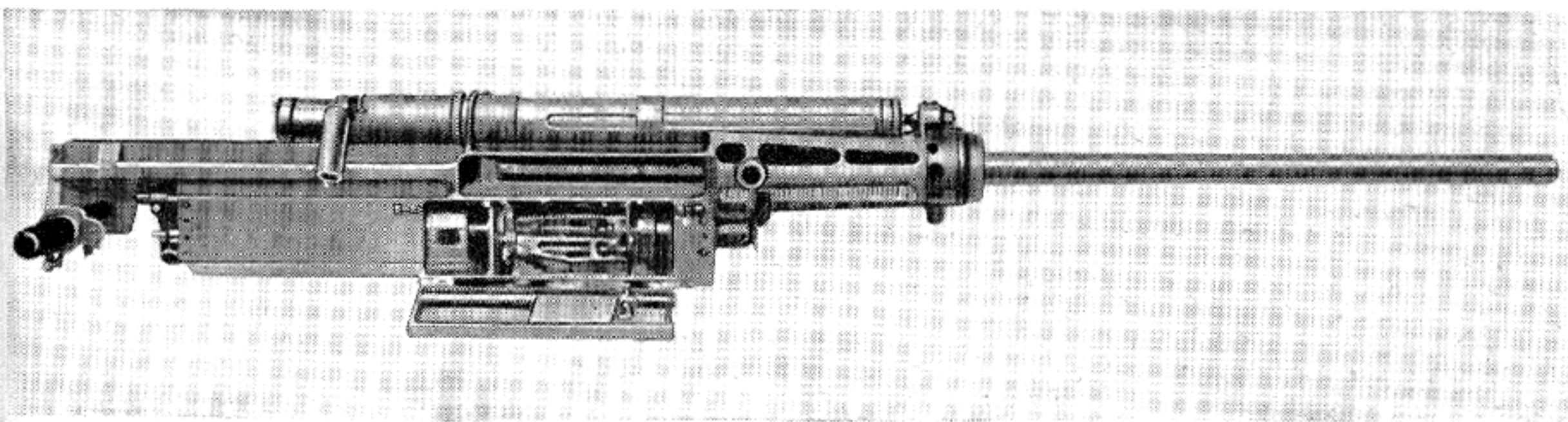
The fore and aft members of the feed are again connected and the gun is ready to be manually cocked. This is done as the operating parts are pulled as far as possible to the rear and then released to go into battery. The positioned round is now chambered and the firing pin cocked. By turning the left-hand grip, the trigger bar with

its ball-shaped end is pulled rearward, camming the sear out of engagement with the projection on the rear of the firing pin. The latter flies forward, firing the gun.

The projectile clears the bore before the case is withdrawn and the chamber pressure is reduced far enough to prevent rupture from the initial shock of explosion. Having been lubricated, the empty case slips back with the recoiling bolt, being held in position by the extractor claw until it strikes the ejector, located  $8\frac{1}{2}$  inches to the rear of the chamber. At this point the ejector pivots the case around the extractor and knocks it to the left through the opening in the receiver.

The stud on the bottom of the bolt that actuates the feed rides in comparatively free movement, for the first 5 inches of recoil, but now the angle is accelerated. The flutes on the feed wheel are rotated rapidly one space, rolling a cartridge up through the floor of the feedway. The round is then held in place by its link and the nose of the projectile. This is slightly behind a guide ramp that leads it into the chamber. The bolt, in finishing its recoil stroke, compresses the buffer spring. It also starts a sudden compression of the dash pot and then begins counterrecoil. The rib on the bottom of the bolt contacts the base of the indexed cartridge, shoving it out of its link and starts to chamber it. At a distance





Szakats 20-mm Automatic Aircraft Cannon, Model SZC.

$\frac{3}{4}$ -inch from complete battery, the sear engages the lug on the firing pin, holding it there by commencing to compress its spring.

If the trigger is still held back, the sear device will rock out of engagement at a few thousandths of an inch before full counterrecoil is completed, allowing the firing pin to explode the powder charge. Thus the peak pressure in the bore coincides with the full force of the forward traveling bolt. This not only insures a better support be-

hind the fired cartridge, but also prevents collision of parts on counterrecoil from the fast-shuttling mechanism.

As the Szakats did not get much beyond prototype stage and the Allied Commission prevented future development, the only trace left of its existence lies in its many good features that have since been copied. The Soviets, for instance, have used a similar feed system in practically all of their aircraft cannon.



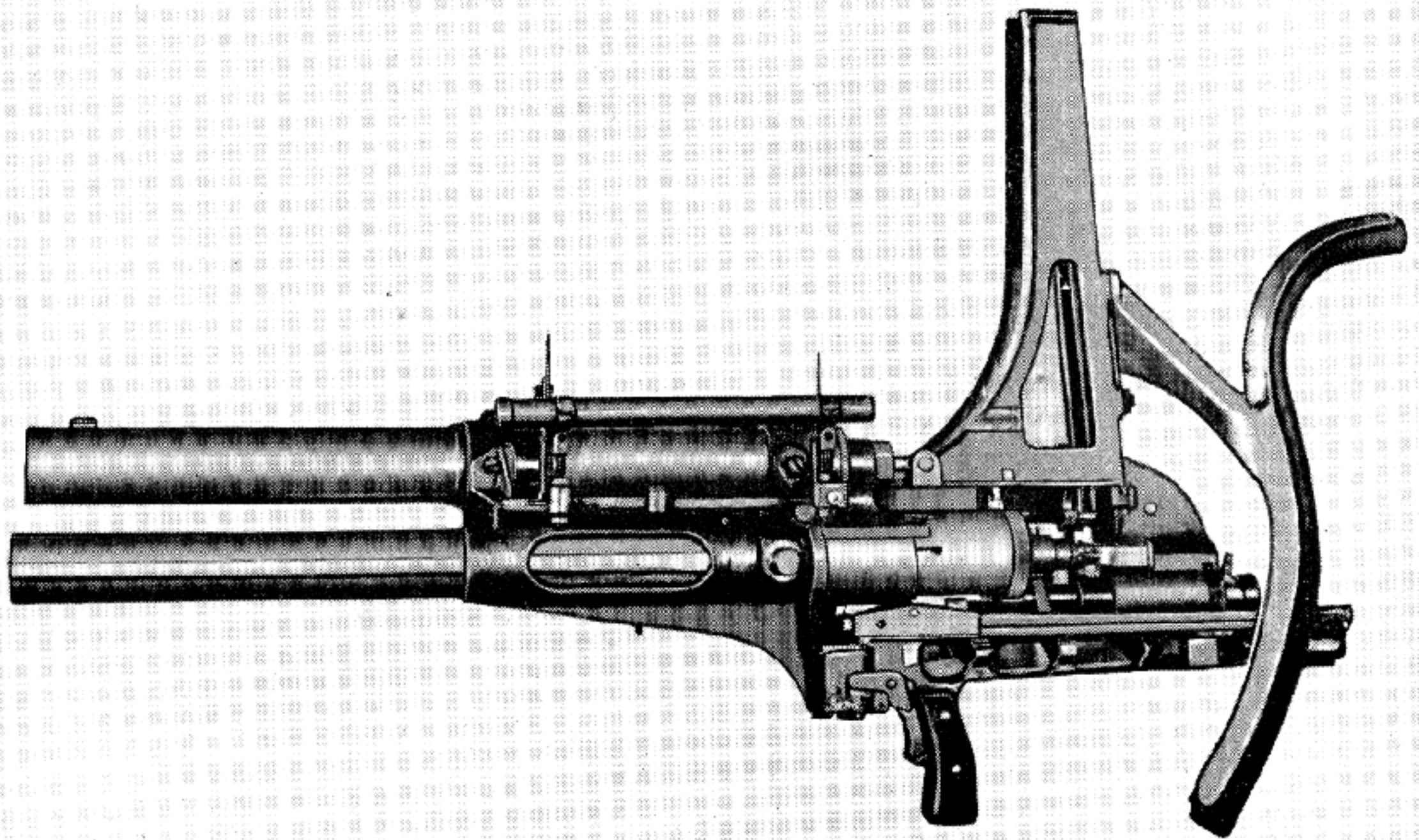
## BALDWIN AIRCRAFT CANNON (37-MM)

During World War I, an American engineer, A. S. Baldwin, was authorized by our Government to work on the Puteaux aircraft cannon sent to this country from France for the purpose of adapting them for use on American planes. From the wealth of experience gained during the early days of development and the wide reputation he enjoyed as a thorough ordnance man, he was the natural choice of the Army to design an aircraft cannon for use on a flexible mount or a motor cannon to be fired through the propeller hub.

Baldwin interested the Poole Engineering and Machine Co., Baltimore, Md., in contracting with the Government for producing a gun for test and with the assistance of one of Poole's en-

gineers, a Mr. Metz, he started work on the first automatic aircraft cannon sponsored by the Ordnance Department. The influence of the Puteaux was most certainly evident, as the Baldwin aircraft cannon was but a refined version of the French gun, which in turn closely followed the Vickers. The speed in which it made its initial appearance is proof enough of its having been copied from some already existing mechanism.

On 4 September 1919, at McCook Field, Dayton, Ohio, the first trial was held. The gun was mounted on a plane and ground fired not only to test the action but to observe at the same time the effect of recoil forces on the structure of the ship. After a sufficient number of single shots, the plane was taken up. The report stated th-



Baldwin 37-mm Automatic Aircraft Cannon.



shots fired one at a time were negligible in their effect on flight, but that automatic firing did increase the difficulty of piloting the plane. Still it was not hazardous in any sense of the word.

The weapon's performance was far from satisfactory, only one burst of eight rounds being accomplished. Failure to feed was the most prevalent malfunction.

The Ordnance Board recommended that the cannon and mount be given a more exhaustive test on the ground as soon as conditions would permit and that it be further tested in the air. It was concluded from the trial that the plane was strong enough to withstand the force of recoil of the cannon. However, considerable firing on this mount was urged to make certain that continued use would not disturb the latter and cause the gun to jam.

Testing took place periodically with little or no improvement shown. The feed continued to provide a major portion of the malfunctions. Baldwin requested the Ordnance Department that he be allowed to prepare an altogether new design, but it was denied on the grounds that he should first make the gun at hand work satisfactorily.

Army Ordnance became so impatient with the lack of results that it engaged John M. Browning and Fred Moore, of Colt's Patent Fire Arms Co., Hartford, to inspect visually the mechanism, hoping that these two outstanding ordnance men could suggest something that would better its performance or increase its efficiency. If need be, they were to send the weapon to Colt's for further development. On 29 November 1920, Browning and Moore visited the Aircraft Armament Division in Washington, D.C., to view the gun.

After peering into the mechanism intently for minutes and looking through the bore, Browning made a statement that more aptly described the Baldwin cannon than anything else could possibly do. Looking very perplexed, he asked Maj. Julian Hatcher, who was also present, "Where do they put the bait?" When asked what he meant, he replied, "This thing surely is some kind of a rat trap, as it can't possibly be an automatic gun."

Needless to say, such an expression from Amer-

ica's greatest master of ordnance did not enhance the standing of the Baldwin cannon. Time has proved the correctness of his evaluation, as attempts to convert it to a reliable mechanism met with one failure after another.

The Navy also fired the weapon at its proving grounds, with the usual negative results. On 22 November 1921, the Army Ordnance Department officially discontinued all developmental and experimental work on the Baldwin aircraft cannon, and nothing was ever done to revive the project.

The Baldwin's chief claim to fame is that it interested John M. Browning in developing a 37-mm aircraft cannon for the Government and showed the Air Force the definite need for a reliable cannon having a bore of this diameter.

The cannon weighed 140 pounds with the magazine empty and employed the system known as long recoil. It fired the 1-pound projectile at the rate of 120 shots a minute with a velocity of 1,350 feet per second.

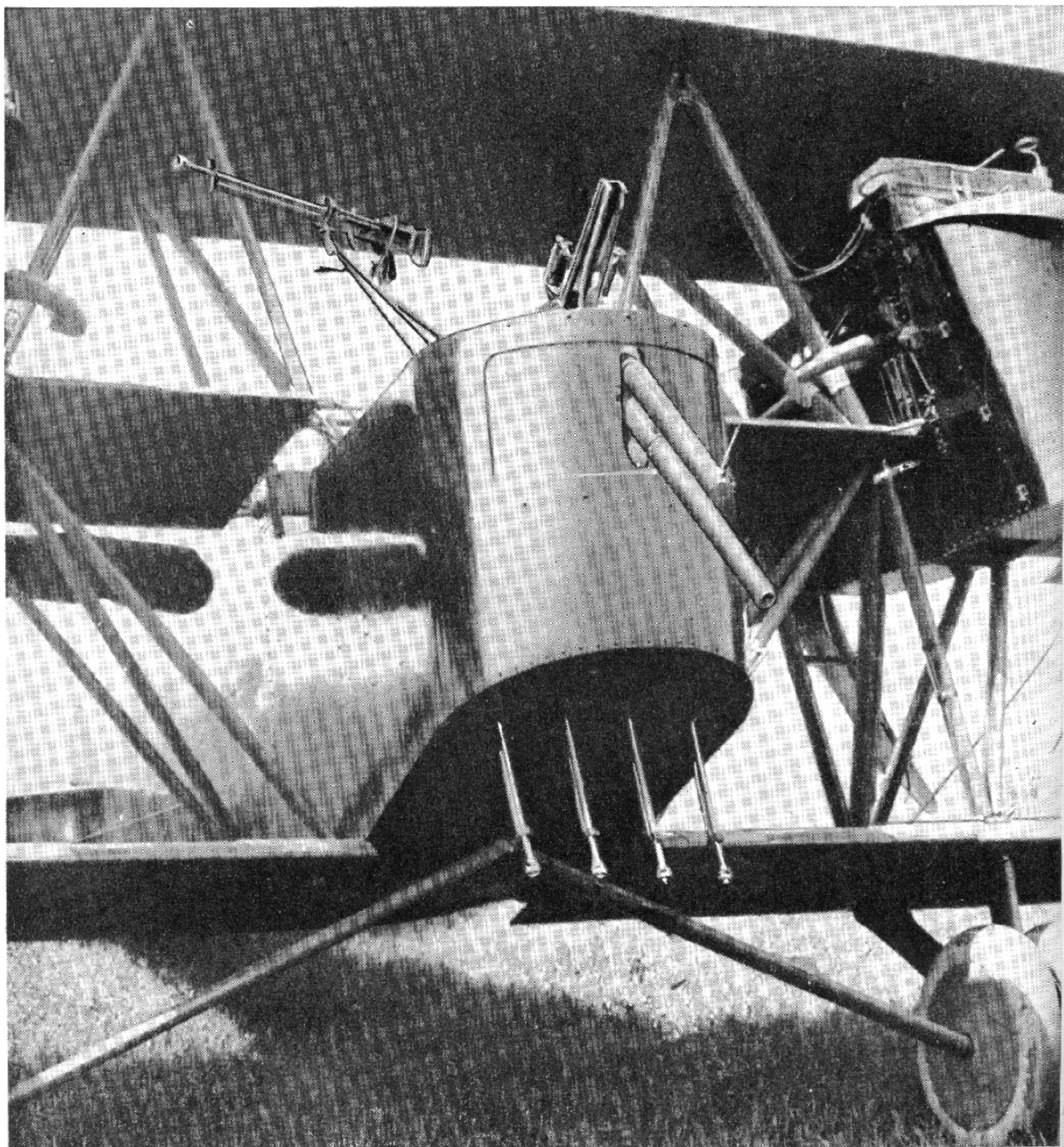
The recoil cylinder, like that of the Puteaux, is located on top of the barrel. A short charging handle at the end of the receiver is attached directly to the rotating bolt that locks with the turning of the interrupted threads when the operating parts are in battery. The trigger arrangement is housed by a pistol-grip affair located beneath and slightly to the right of the bottom of the receiver.

The barrel has four longitudinal ribs cut on it. Two of them engage slideways in the receiver and act as a track to guide the barrel during the long stroke back and forth. The feed system, the poorest design to be found on any automatic weapon, is simply a piece of heavy metal crimped in such a manner as to present a T slot to hold the rims of eight cartridges as they drop into position for chambering by the bolt.

To aim the piece, the gunner rests his shoulder against a curved shoulder piece. This is well offset in order to miss the charging handle that returns with the bolt. For air firing, a heavy canvas bag is fastened beneath the receiver to catch the empty cartridge cases.

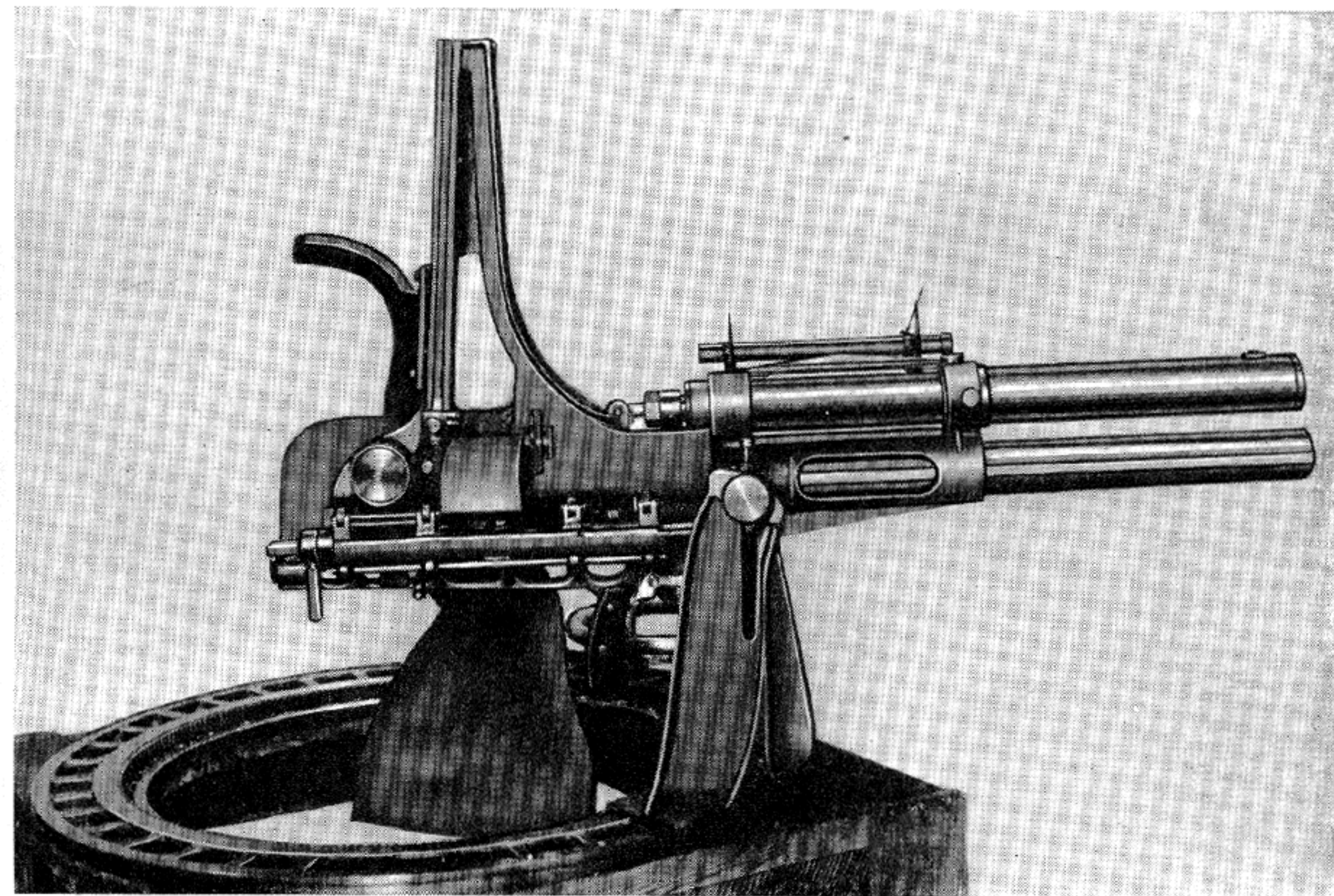
To fire the Baldwin automatic aircraft cannon, the gunner grasps the charging handle and pulls it all the way to the rear. Release of the handle





Baldwin 37-mm Automatic Aircraft Cannon Mounted for Test in a Martin Airplane.





Baldwin 37-mm Automatic Aircraft Cannon. Picture Shows the Method of Mounting in Aircraft.

allows the mechanism to fly forward, chamber a round, cock, and lock the piece. By pulling back on the trigger in the pistol-grip handle, the spring-loaded firing pin is disengaged from its sear, and it flies forward and detonates the primer.

The barrel and bolt start to recoil locked together until a distance greater than the over-all length of the loaded cartridge is reached. At this time the lugs on the bolt are rotated and it unlocks. The barrel returns to battery by means of a recuperator spring. The bolt is held to the rear and the extractor grasps the rim of the cartridge as the barrel goes forward, pulling the chamber away from the empty case.

The final movement of the barrel trips the bolt, which then starts home. When the bolt face is directly underneath the hopper-type feeder, the loaded round is picked up and chambering is begun, while the empty case is dropped through the opening in the bottom of the receiver. As the bolt reaches battery, its momentum and the en-

ergy of the driving spring cause it to rotate and lock the interrupted threads on the bolt body to the breech of the barrel. Final movement in this direction, if the trigger is still pulled to the rear, trips the sear and automatic fire continues.

This gun showed practically no originality and the design was cumbersome to an unbelievable degree. Mr. Browning's appraisal was not too severe for the time and expense devoted to it. With Baldwin's background and unquestionable engineering ability plus the valuable Government backing, he should have produced a better weapon.

On 1 March 1921, Baldwin severed his connection with the Poole engineering firm, but although he persistently tried to interest the Government from time to time, there was never a successful enough demonstration to warrant an adoption.

In the fall of 1922, he approached the Army Ordnance Procurement Board with drawings for an automatic cannon to operate by compressed



air. After careful investigation, the following decision was made on 26 October 1922, by the Chief of Ordnance:

"This office does not look with favor upon the utilization of compressed air for the operation of automatic cannon. Compressed air apparatus was installed on two experimental antiaircraft guns which are now at the Proving Ground. The results thus far obtained are unsatisfactory and further use of pneumatic operation of breech mechanisms on antiaircraft guns is being abandoned at this time. It is not believed that pneumatically operated cannon would be practicable for aerial use.

"Of course this office does not desire to discourage investigation of projects and constructions not specifically called for in orders issued from this office. It is believed that design forces at the Arsenal cannot be properly developed unless they feel the responsibility of developing design studies which are not specifically called for. It is believed, however, that in the present stage of development of the automatic cannon that it would be preferable to confine the energies available in the Department to the projects under consideration unless outside studies can be carried on without interference with progress along lines already laid out."



## BROWNING AIRCRAFT CANNON

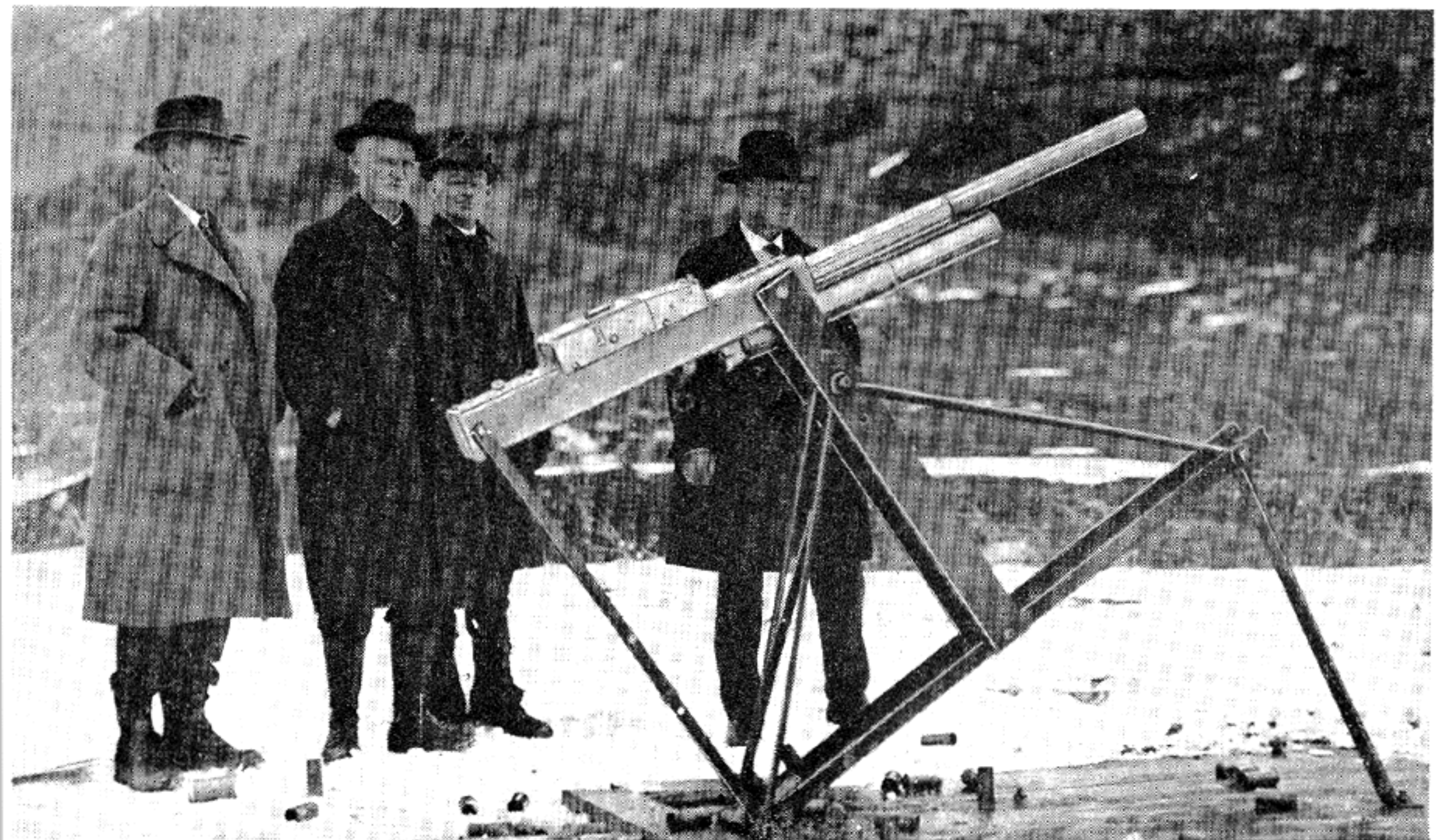
Not satisfied with the results of tests on the Poole Engineering Co.'s Baldwin cannon, the Chief of Ordnance, United States Army, with the consent of Mr. Baldwin and the Colt's Patent Fire Arms Co., consulted John M. Browning. This recognized genius of automatic weapons, who had been connected with Colt's for years, was asked to check visually the Baldwin gun and make any suggestions that might increase the reliability of the weapon's action.

On 29 November 1920, accompanied by Fred Moore, production manager of the Colt Co., Browning came to the office of the Chief of Aircraft Armament Design in Washington, D. C., to observe the manual cycling of the Baldwin. After a close inspection, at which time Browning is

credited with a remark that showed clearly his dubious opinion of the intricate mechanism, the weapon was shipped, at Moore's suggestion, to the Colt Co. for further study.

A short while later, S. M. Stone, president of Colt's, reported that both Browning and Moore concurred in the belief that the only way to improve the mechanism under study was complete redesign. If the Army was interested, the Colt Co. would undertake the development, any fee specified by the Government being acceptable to both Colt and Browning.

This generous offer was quite in keeping with the inventor's long association with weapon development for his Government. With this simple understanding concerning remuneration for the



The First Model of the Browning 37-mm Automatic Aircraft Cannon Being Tested in the Foothills Above Ogden, Utah. Left to Right: Matt S. Browning, John M. Browning (the Inventor), John Browning (Son of the Inventor) and Ed Browning.



inventor, the Colt Co. asked the Army to write specifications on the exact needs of the Air Force.

At his experimental shop in Ogden, Browning made a prototype, that on its first attempt automatically fired projectiles weighing more than a pound at a rate of 150 rounds a minute. As this working model had a velocity of only 1,400 feet per second, he felt that the weapon needed further testing and modification at the Colt plant. In short order two more models were produced, each firing a heavier projectile with considerably more velocity. At a time when success seemed a certainty and after several demonstrations of the reliability of his cannon during the mid-twenties, interest in all military weapons in the United States became apathetic. Development work entered a period of great lethargy. Not only was money lacking to carry on the work, but the public became actually hostile towards all who were connected with such a project, referring to them as "Merchants of Death."

Even the Colt Co., one of the most outstanding automatic weapons factories in the world, turned its efforts to manufacturing electrical appliances, dishwashing machines and a variety of plastic devices in order to remain solvent. Mechanical drawings and the three successful working models of John M. Browning's 37-mm automatic cannon were filed away against the day when perhaps there might be a need.

It was England that first became interested in the further development of this gun. As early as 1929 the Armstrong-Whitworth Co. obtained from Colt's Patent Fire Arms Co. the rights to produce the 37-mm Browning mechanism. A 20-mm cannon, to be built along the same lines, was also included in the deal. However, just at the time when production on these two models had gotten well under way, the Armstrong-Whitworth Co. was taken over by the Vickers Arms Co., Ltd. The Browning end of the work was moved to the Vickers Erith plant, where a few of both the 20- and the 37-mm were produced commercially.

Practically all of the guns made at this time were sold to Spain, as Great Britain, somewhat like the United States, was also undergoing a strong reaction against any kind of weapon development. Without government support, the Vickers plant soon had to stop production after

its limited sale to Spain. The Spanish promptly called the weapons the Colt 20- and 37-mm automatic guns, a designation that has been very confusing to those interested in following European development of the Browning gun.

In 1935 the United States again became interested in an automatic gun of large caliber for aircraft. By this time the finished Browning cannon was practically at the Government's disposal, for the weapon had been tested and improved to a point of absolute reliability. The first Army Air Force venture was officially known as the M4.

This 37-mm gun weighed 313 pounds without feeder and 406 pounds with 15-shot loaded magazine attached. A 65-inch barrel weighed 55 pounds and the muzzle velocity was 2,000 feet a second. The action was known as the long-recoil type, utilizing spring-actuated ramming to load each round. The cyclic rate was given as 135 shots a minute. The feed was the endless-chain open-loop type, the cartridges being forced downward from the open links onto the feedway.

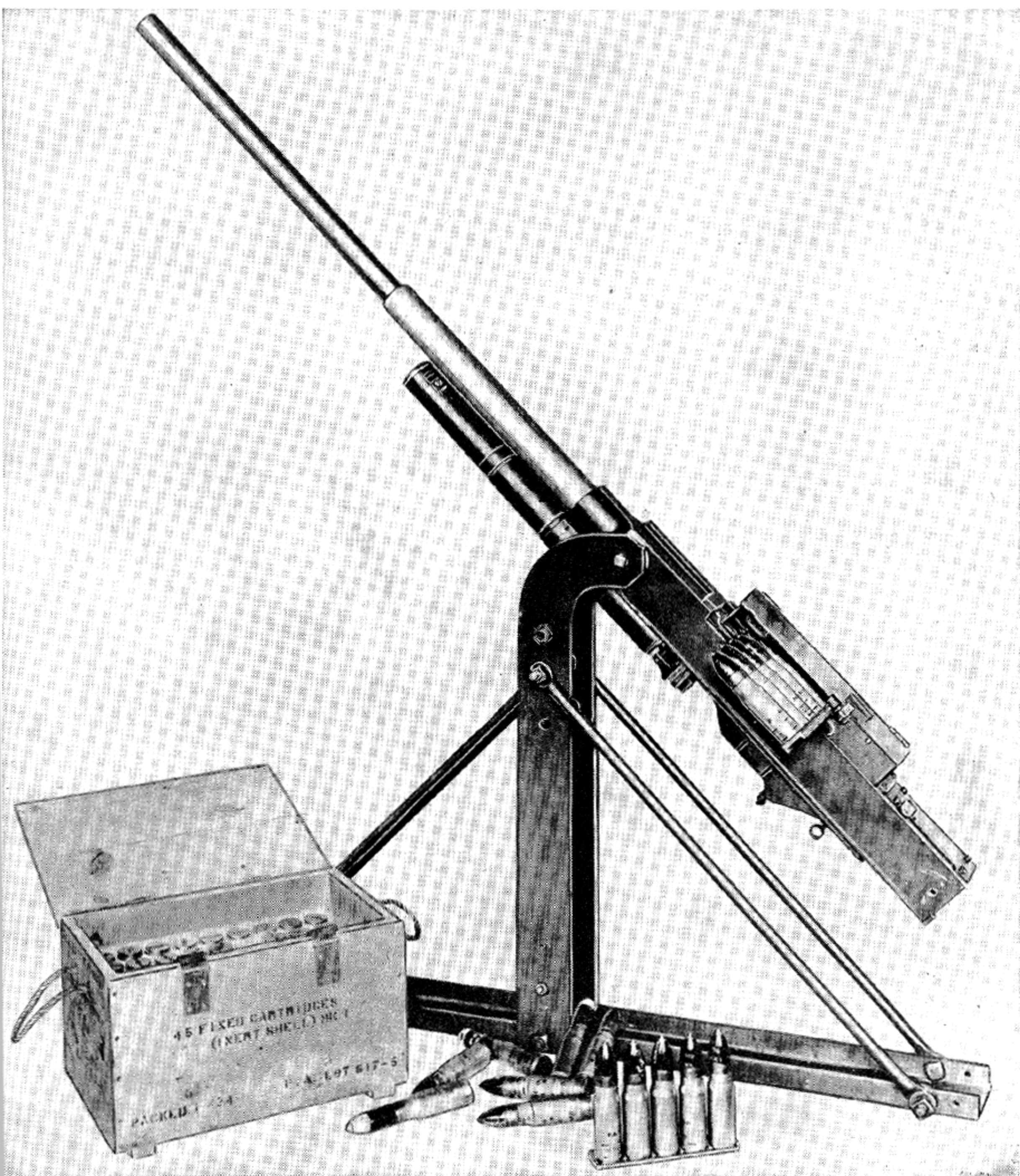
While its performance was reliable, it was far too cumbersome in design and the velocity entirely too low. Continued work on refining the action and making a better profile took place from time to time until American entry into World War II required the standardization of what is now known as the M9.

The full-automatic, high-velocity 37-mm automatic cannon M9 operates on what is known as the long recoil principle, and is designed primarily for aircraft use. It is mounted to fire either through the propeller hub, or outside the plane of the propeller arc, as the gun cannot be successfully synchronized. Triggering is accomplished by remote control by means of an electric solenoid.

The feed can be adapted to either left or right hand but it necessitates the changing of the box. When this is done, however, the parts inside can be made to operate the mechanism in either direction. The cartridges are fed into the side of the box and the empty links are ejected through a slot on the opposite side. The empty cartridge case is ejected through a longitudinal opening between the bottom of the receiver and the side plates.

The mechanism depends upon the unusually long recoil movement (greater than the over-all





Early Model Browning 37-mm Automatic Aircraft Cannon.



length of the loaded round) for its operational power. Both recoil and counterrecoil forces are controlled by means of a hydro-spring buffing mechanism.

The weapon, although admittedly heavy (405 pounds), has unusually clean lines, the weight being necessary to handle the high-velocity (3,050 feet per second) round of ammunition. The breech lock is of the vertical sliding-wedge type and represents the simplest form yet conceived for an automatic weapon to insure not only position locking but control of the vital measurement of head space. A manual air charger made it possible to load the initial round easily for firing either by hand or by remote control if the gun is mounted in such a manner as not to be easily accessible to the gunner. The cartridges are linked between the shoulders of the rounds halfway up the projectile, which is very unusual in itself. The links, however, are lifted by a stripper leaving the cartridge free to be positioned.

To operate the Browning 37-mm weapon when engine-mounted for firing through the propeller hub of a plane, the pilot first pushes in on the charger button. This actuates the loader for jacking the mechanism to the rear. A round is stripped from the belt and is chambered as the mechanism goes forward. The gun is now cocked, loaded and locked, ready to fire.

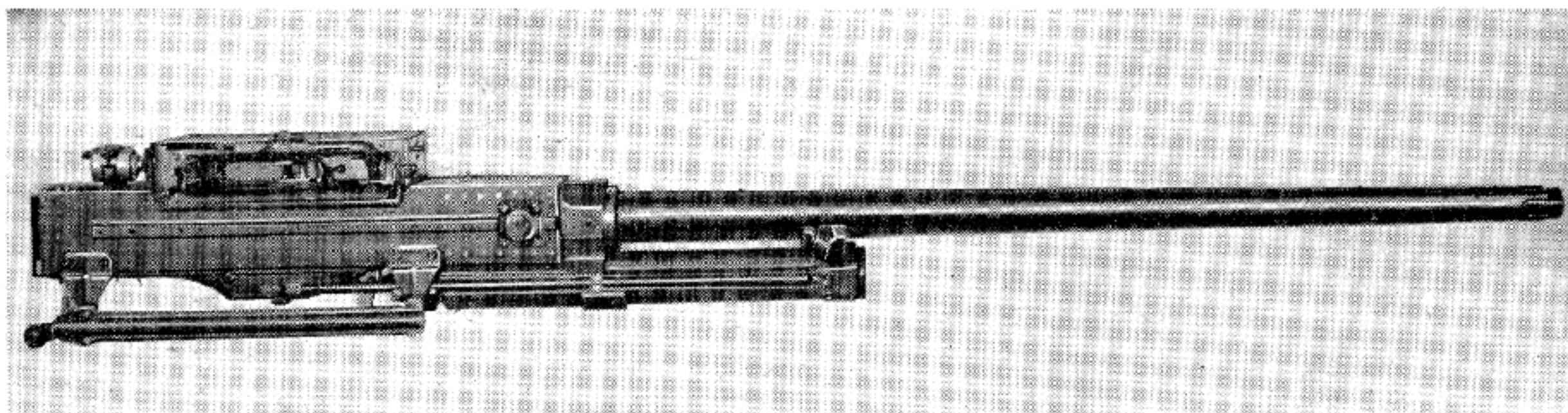
By closing the circuit on the firing switch, the trigger is pulled through the use of an electric solenoid. When the cartridge is fired and the projectile is driven down the bore, an equal force is applied in the opposite direction against the face of the breechblock. Thus the barrel, barrel extension, breechblock, and lock frame, all securely locked together, go rearward during 10 $\frac{3}{4}$

inches of recoil, at which point the operating lever guide pin, following its front cams, causes the pin to rotate and bring the breechblock downward.

This movement also throws the lower end of the cocking lever forward. The hammer spring is compressed thereby and the latching hook forced back on its sear to cock the hammer. The rearward movement is controlled by what is called the recuperator, a cylinder with a spring-loaded piston and oil being used to accomplish this end. The fluid behind the piston is forced through slots to the front side as the piston goes rearward. The orifice diminishes in area as it approaches the end of its stroke, thus giving a positive buffing action.

The lock-frame assembly is not affected by the retarding action of the recuperator since it is unlocked from the barrel extension by the dropping of the breechblock. Consequently, when the barrel and its extension are near the end of their rearward travel, the lock frame separates from these parts and continues to recoil, speeded up by the accelerator. This part is actuated by a cam mounted on the rear of the side plate. The accelerator rides upwards on an inclined surface of a cam while its lower part pushes backwards against a lug on the lock frame body. This suddenly applied mechanical advantage gives recoil of the frame added impetus.

The rear of the lock frame then strikes the buffer plunger, compressing the ring spring and forcing the two friction pieces upward and outward against the inside of the back-plate housing. Then the remaining force of recoil is transmitted to the back-plate assembly. The frame rebounds from the buffer plunger because of the



Browning 37-mm Automatic Aircraft Cannon, M4.



action of the ring springs. After traveling in counterrecoil a short distance, a carrier dog engages its notch in the frame holding the piece stationary while the barrel and its extension continue on in counterrecoil movement.

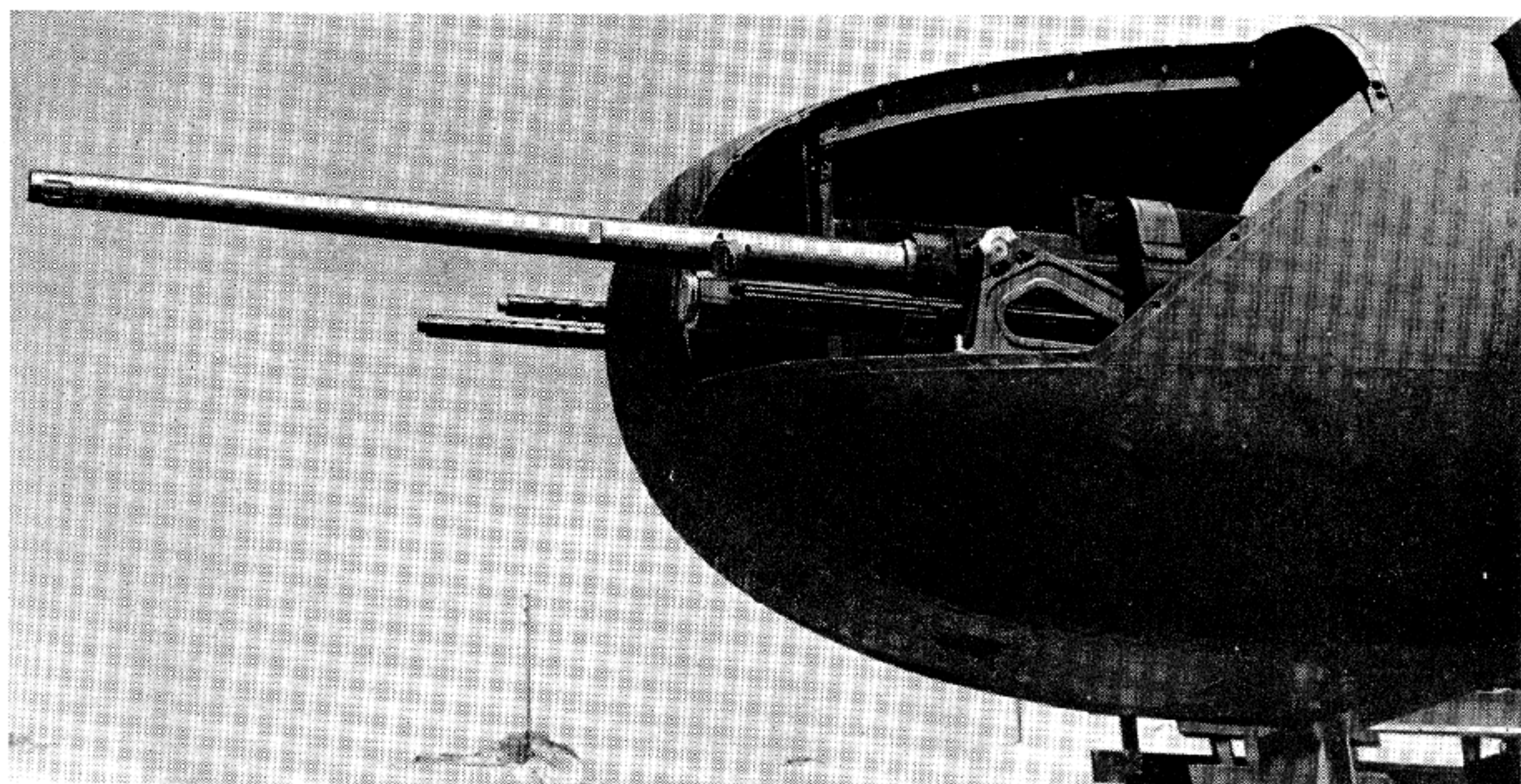
Initial extraction of the empty cartridge case occurs at the instant the lock frame separates from the barrel extension. Engagement of the rim of the case by the extractor claw fully loosens the round at this time. When the frame is held to the rear and the barrel and its chamber goes forward on counterrecoil, the empty case is entirely withdrawn from the chamber. At this point an ejector is pivoted downward by a cam on the upper flange of the left side plate. The protruding rear end of the ejector deflects the empty case downward between the side plates clear of the operating parts.

The compressed driving spring furnishes the energy to speed the lock frame towards battery. During recoil the feed lever operating stud on the side of the barrel extension contacts the lower end of the lever, pivoting it rearward. The stud passes under the end of this piece and then snaps back into position, so that during counterrecoil the operating stud pushes its lower end forward.

This actuates the feed crank, which in turn

moves over one space the feed slide containing a cartridge. The feed-slide return lever, plunger, and spring then force the slide toward the inlet side of the feedway to engage the next round. The new round having been indexed, the cartridge now releases the carrier latch from the carrier-lock frame. The barrel and extension have already reached full battery position and the lock frame, ramming the round ahead of it, starts chambering it. During this final movement the operating lever following the upper cam grooves pushes the breechblock up to lock and support the base of the cartridge during the act of firing. The gun, being cocked, loaded, and locked, will continue the cycle of operation as long as the electric trigger is actuated and ammunition remains in the belt.

While this Browning M9 was used to a very limited degree by the United States Army Air Force during World War II, it was, especially in the early stages of the war, the principal offensive aerial cannon of the Russians. Thousands were furnished to Russia by our Government, along with the Bell Aircobra plane on which it was mounted. Its installation permitted firing through the hollow propeller hub, thus eliminating the need for synchronization. The Russians found that the high-velocity armor-



Browning 37-mm Automatic Aircraft Cannon M9, Mounted in an A25.



piercing projectile was extraordinarily good when used on enemy tanks in the close ground support of their infantry. There were several instances where, in developmental work, these 37-mm automatic cannon were mounted in the wings of American planes. However, as there was no pressing need for such a cannon, as far as we were concerned, its use did not extend much beyond the experimental stations and proving grounds.

A very unfortunate accident occurred during development work on this gun, resulting in the death of Fred Moore of the Colt Co. on 31 March 1938. Being used to dummy small arms rounds being marked "Inert" when the cartridge was not loaded, he placed a 37-mm round that was so marked in the feedway of the gun during a hand-cycling demonstration. He thought that the wording meant the whole round was a dummy, when in reality this marking had

reference only to the lack of explosive charge in the projectile body. The weapon was resting on two wooden sawhorses and, when the loaded cartridge was chambered, it went off. The recoiling unmounted gun struck Moore in the side causing his death a short while later. His passing was a distinct loss for automatic weapon design.

This tragic incident shows how easily accidents can occur even to the most highly trained professionals when the least confusion exists as to the meaning of ammunition markings. It proves once more that "familiarity breeds contempt." Working in constant danger, even the most skilled ordnance man sometimes becomes careless.

Shortly after the tragedy, this method of marking was abandoned and a system of boring holes in the empty cartridge case to signify a dummy round was adopted.



## MADSEN AIRCRAFT CANNON

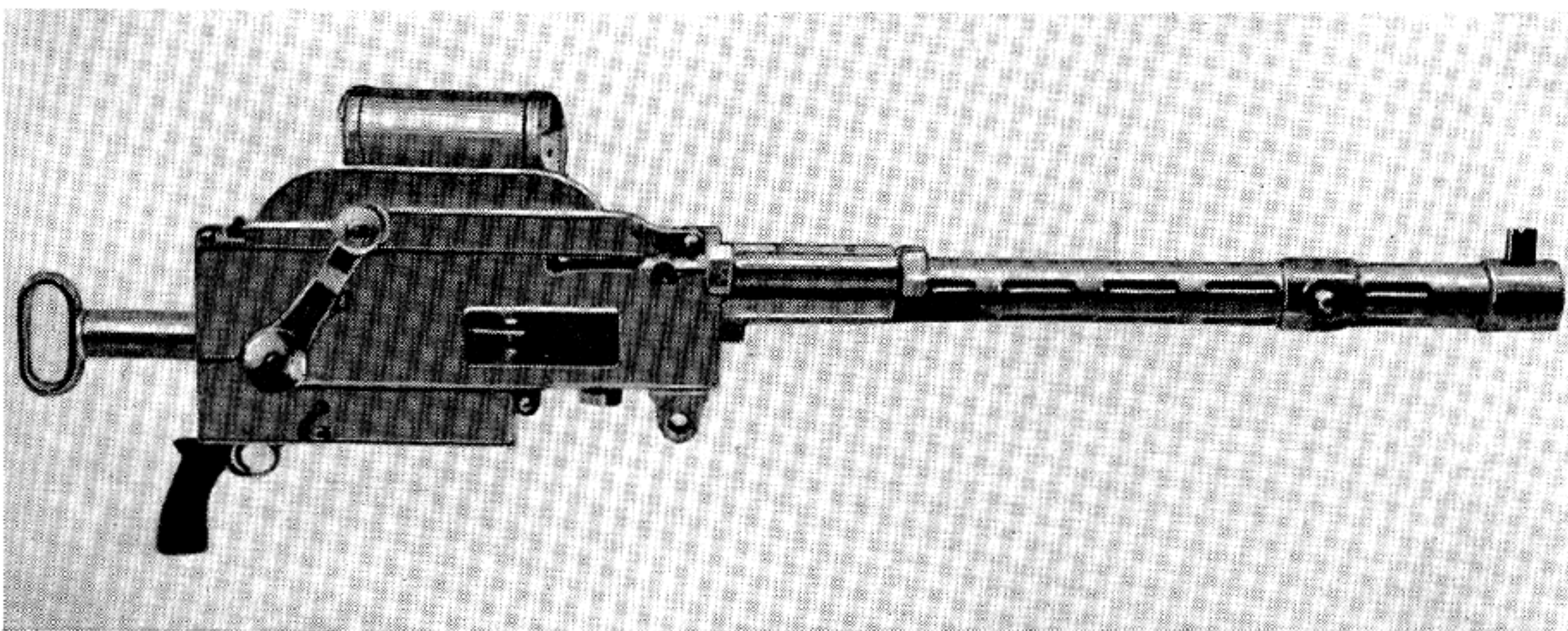
The Dansk Industri Syndikat of Copenhagen, Denmark, in 1926 announced to military attachés of all nations that its company had produced the pilot model of what it considered to be the ideal automatic cannon for aircraft armament. The weapon, which was given the name Madsen, was 20 mm in bore, employing a rimmed cartridge. Its rate of fire was listed as 180 rounds a minute; it was magazine fed, air cooled, and operated from short recoil; and it was identical in principle with the already well known rifle-caliber Madsen machine gun. The only feature different from the earlier model was the employment of a hydraulic buffer cylinder to absorb excessive recoil brought about by the larger powder charge. The ammunition was specifically designed to be used both in the air and, if necessary, on the ground as a defense against tanks.

This Danish company was very fortunate in that its plant was in a free port which allowed the custom-free importation of an unlimited supply of materials. This gave access to the world's best metals. For instance, Sweden, which had long been internationally famous for her

high-grade steel, furnished blanks for the Madsen barrels, the work of boring, reaming, and rifling being done at the Copenhagen plant. In some instances, the finished barrel was also purchased in Sweden.

The weapon was designed, according to the company, for wing and flexible mounting only, and it was not recommended for engine installation. This was believed dangerous since its employment of a specially designed high-velocity cartridge would lead to excessive vibration during automatic fire. Although the announcement of the prototype Madsen cannon was made in 1926, actual development of the weapon beyond the crude stage was exceedingly slow. It was 2 years before it had been refined enough to permit foreign observers to witness a demonstration. According to reports, the performance was far from impressive.

Well realizing that it was by no means far enough advanced to interest aviation authorities, the company's next step was to promote it for antitank and antiaircraft use and to this end it directed all its efforts. The transportation problem for ground work was settled by mounting it



Madsen 20-mm Automatic Aircraft Cannon, Model 1926 (Prototype).



on a two-wheeled mount with a trail somewhat like a field piece. It could be put into action to fire against attacking aircraft in a matter of minutes. A piece fixed at the top of the tripod arrangement allowed the weapon to be raised on its mount and pointed upwards in any direction.

After the first few years no major power paid any interest in the weapon other than to purchase one or two to test at its own proving grounds. In fact, so little interest was shown that it was with the greatest of difficulty that the weapon was kept in existence until the revival in aircraft cannon began in Europe in the late thirties. Then any automatic cannon capable of being mounted in a plane was worthy of consideration by the leading nations of the world.

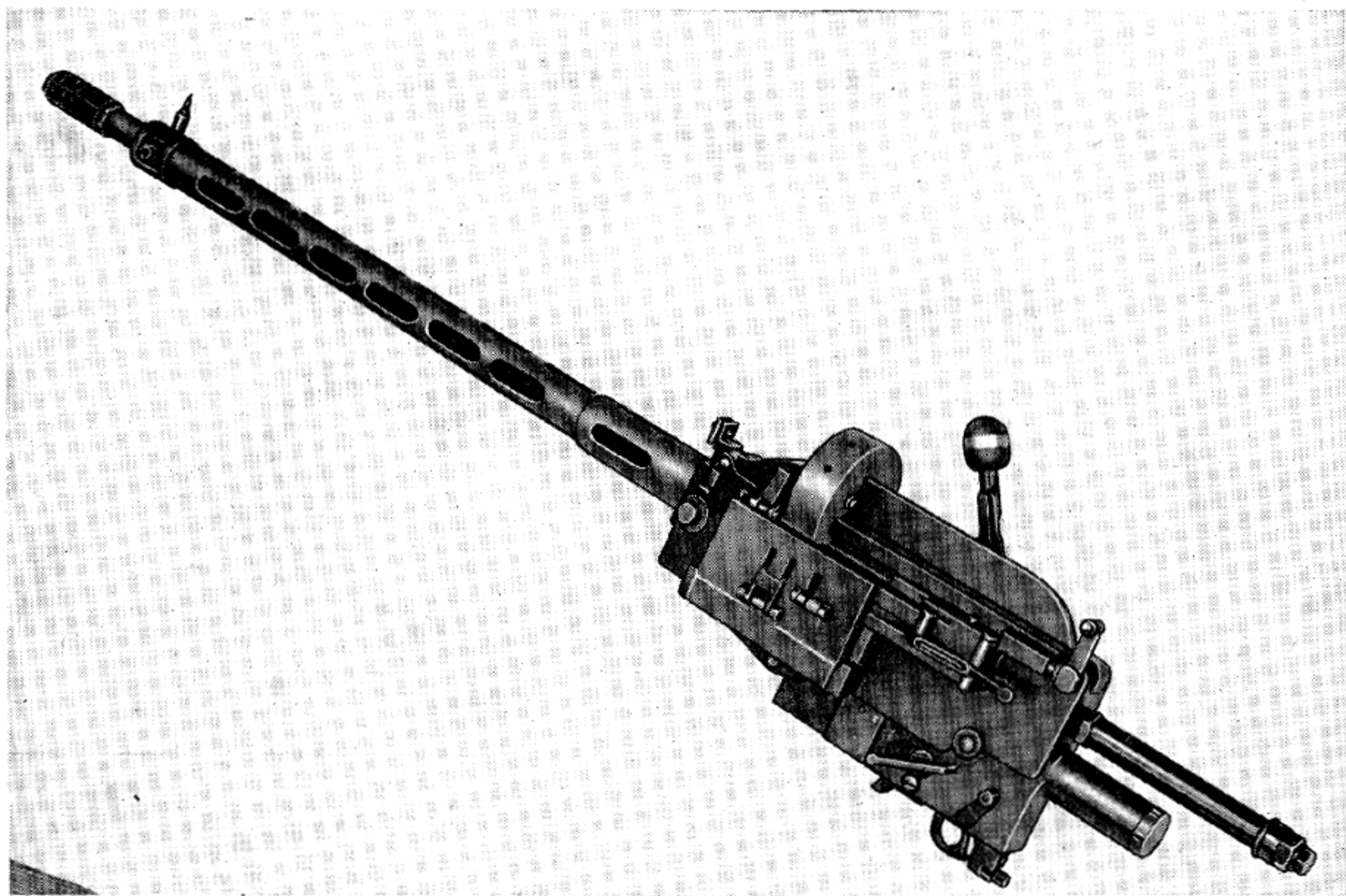
The Danish firm increased the bore of the gun and it was given great impetus when at the Paris Exposition in 1936 a Fokker G-1 airplane was displayed with a Madsen 23-mm gun installed in each wing. One hundred rounds of ammuni-

tion per gun were carried and fed to the weapon by means of a metallic disintegrating link belt. The ammunition represented the most modern armor-piercing, high-explosive and ball-with-tracer types.

This display not only aroused the interest of military authorities on the Continent but likewise of the United States. Our attachés were requested to forward to the Chief of Army Ordnance all available data on the weapon and also to ascertain the price of four guns, plus necessary accessories and 5,000 rounds of high-explosive ammunition.

The Dansk Industri Syndikat on 18 May 1937, contracted to furnish the weapons, with ammunition and accessories for the sum of \$28,611. The 18th of August was set as the date of delivery, but it was not until 1 October that the inspection of the first cannon took place at Copenhagen.

Of the guns presented, only one met contract specifications. The cannon was accepted and



Madsen 23-mm Automatic Aircraft Cannon (Flexible).



shipped to New York on the *Scanstates* in November 1936. It was immediately sent to the Army Proving Grounds at Aberdeen, Md. There the tests to determine reliability met with negative results and the Danish firm was notified that the feed was not functioning satisfactorily. The low rate of fire, combined with the failure of the feed, made the Ordnance Department feel it could produce or find a more suitable weapon for aircraft use, and all interest in this country stopped.

The cannon was sent to Wright Field by the Army for study and eventually the other guns passed inspection and were delivered. Two of the guns were given to the Navy, which fired them at the Naval Proving Ground at Dahlgren, Va., with little satisfaction.

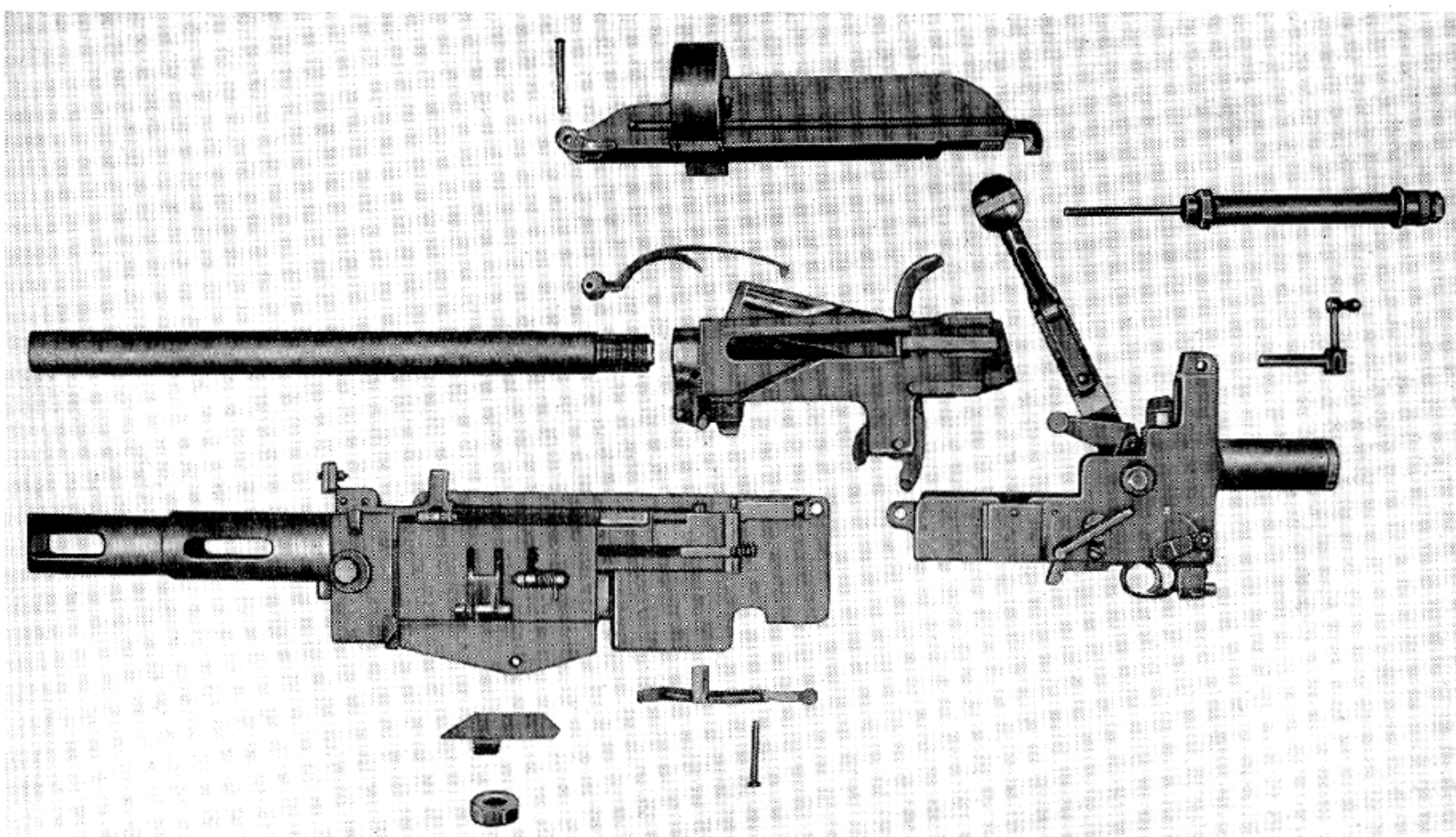
The French Air Ministry purchased a few 23-mm Madsens in early 1938 and according to its report the feed system had been improved and the operation as a whole was reliable. The Chilean Government ordered 20 of the weapons the same year to put in the wings of its Italian-made (Breda) airplanes.

Even with the improved reliability of action, installation in planes was discouraged by the

low rate of fire inherent with all automatic weapons that employed such a long delay during the operation of the feed. The action was so slowed by this system that to get a substantial rate of fire was an engineering impossibility. As there were so many other cannon by this time that gave both reliability and high cyclic rate, the Madsen dropped out as a serious contender as far as aircraft armament was concerned.

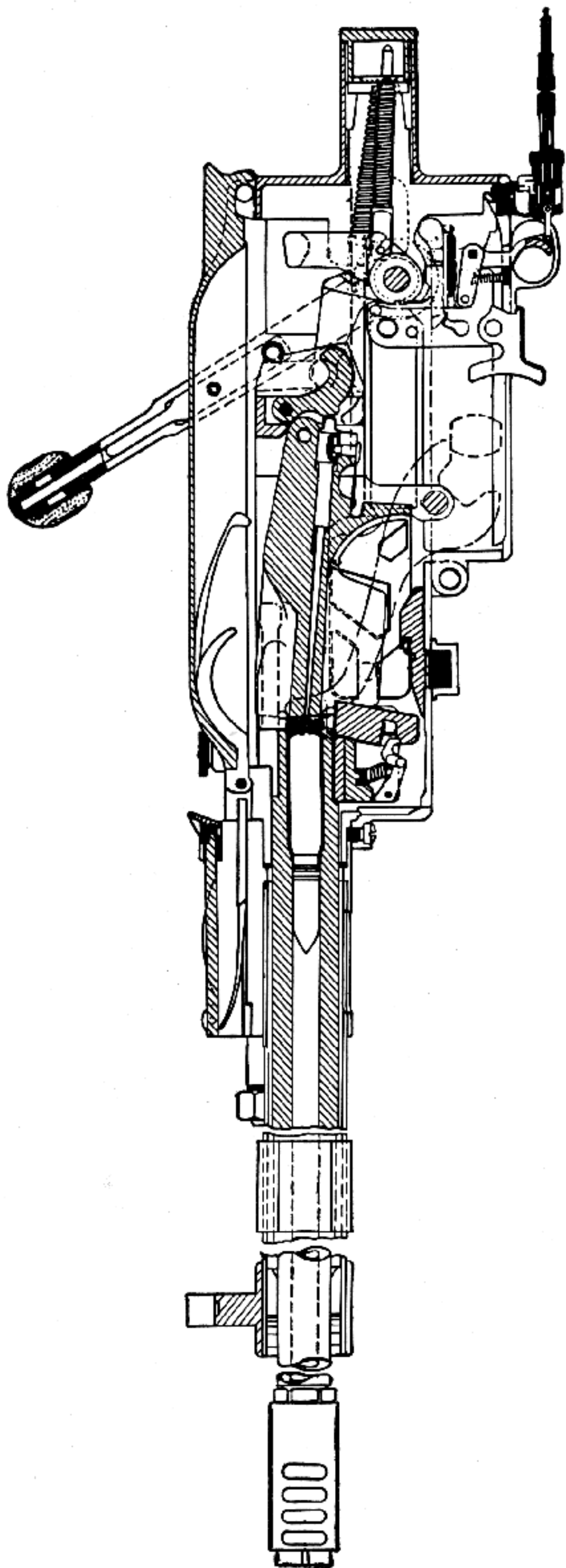
On this model there was fastened to the barrel jacket at the forward end a combination muzzle brake and device to trap the blast after the projectile cleared the bore. This was done by a controlled orifice that permitted the projectile to clear along with some of the still-expanding gases. The remainder acted on the face of the barrel somewhat on the order of a piston, accelerating the recoil forces and resulting in an increased rate of fire plus an added amount of belt pull.

The cycle of operation for the Madsen 23-mm cannon is identical with that for the same firm's automatic machine guns. When the belt-fed cannon is prepared for firing, the ammunition belt is started into the left side. The front of the disintegrating link used in the belt fits over the



Components of the Madsen 23-mm Automatic Aircraft Cannon.





Section Drawing of the Madsen 23-mm Automatic Aircraft Cannon.

shoulder of the round which has to be pulled through it by the feed action. The rear portion of the link is of the type known as push-out, or half-link, since it does not go all the way around the case of the cartridge. A sharp claw of spring steel holds the case firmly until it is finally withdrawn.

Once the weapon is cocked and the first cartridge is placed under the belt-holding pawl, the large charging handle on the right side is pulled back. This action moves the barrel extension a considerable distance to the rear after the bolt rises. The pawl holding the cartridge in position is carried to the right by the camming action taking place between the barrel extension and the piece supporting the incoming round until the cartridge is forced through the feed slot in the receiver.

At this time a spring-loaded claw snaps over the rim of the cartridge. The pivoting of the feed arm actuates the claw rearward and withdraws the cartridge from the belt, positioning it in the feed trough in the top of the bolt. The pivoting lever has by now taken its place behind the round. Upon release of the cocking handle the energy of the compressed driving spring sends the lever forward. The front end of the bolt is pivoted down below the bore in the barrel. Further movement forward of this lever causes it to strike the base of the cartridge, ramming it into the chamber. The final pivot movement raises the breechblock full behind the bolt and the weapon is ready to fire.

The rearward pull of a trigger releases the large striker which flies upwards in an arc against a firing pin, detonating the primer. During recoil, the barrel, barrel extension, and bolt are securely locked for one-half inch, until the trigger bar is struck by the rear of the recoiling bolt mechanism. This frees it, allowing the striker to be forced back to the cocked position and the spring-loaded firing pin is withdrawn into the bolt body. The guide stud then passes out of the horizontal groove and travels up the top cam of the switch plate to pivot the bolt face upwards. The base of the empty cartridge case is thus uncovered, permitting the recoiling extractor to apply a sudden mechanical advantage as it strikes the lug in the bottom of the receiver. The extractor claw, in one rolling mo-



tion, not only withdraws but ejects the empty case from the chamber. The case is guided out of the receiver by the curved contour of the bolt until it falls clear to the ground.

During the last of the recoil movement the barrel extension has cammed another round into the receiver feed slot, and the pivoting feed and operating arm positions it in the trough formed by the machined recess in the top of the bolt. Counterrecoil, originating in the stored energy of the driving spring when it starts the entire operating assembly back to battery, first de-

presses the bolt and then drives the cartridge into the chamber.

The bolt and barrel extension are then accelerated forward by this spring acting through the medium of the cammed pivoting of the radial operating arm. When the counterrecoil movement is almost completed and the base of the cartridge is fully covered by the rising of the pivoting bolt, a cam on the arm automatically releases a sear if the trigger is still held rearward. The striker again flies up to continue the cycle.



# HOTCHKISS 25-MM AIRCRAFT CANNON

The French Air Ministry, shortly after World War I, undertook to write specifications for a 25-mm aircraft automatic cannon that would be worthy of its superb air force and chose for the basic operating mechanism the Hotchkiss system that had served France faithfully for many years. In the opinion of the French, it was the most reliable rifle-caliber machine gun in the world.

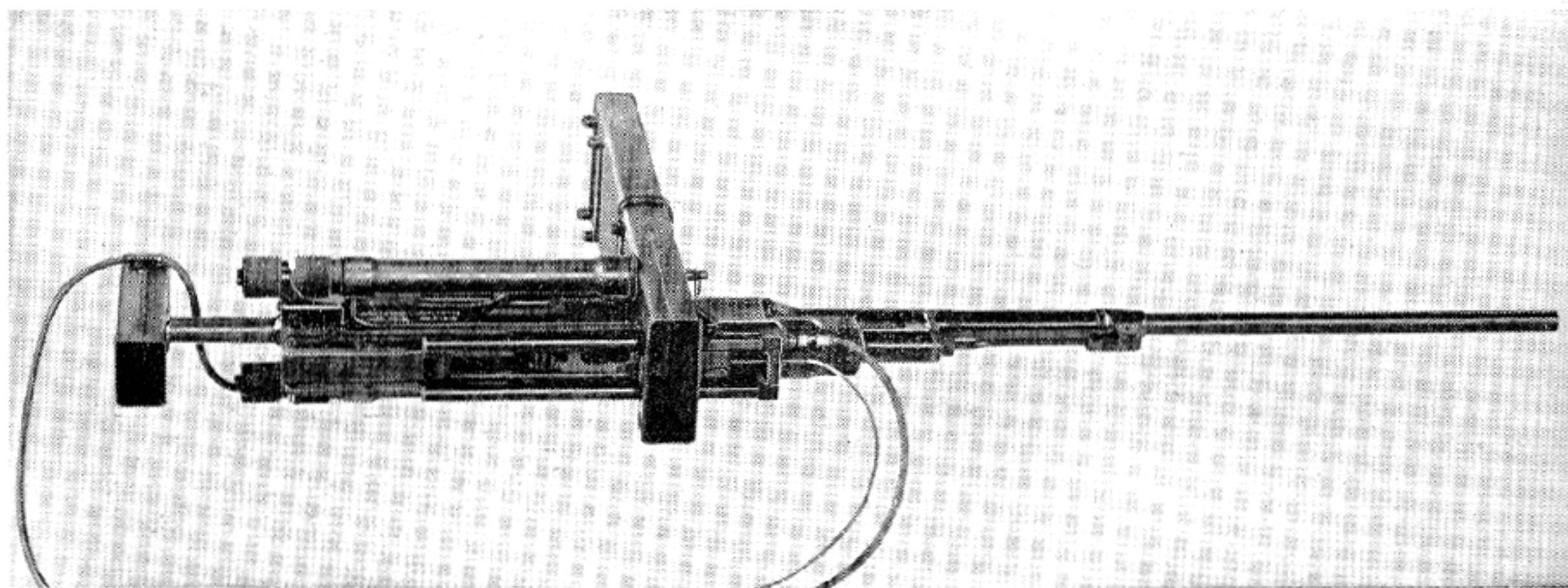
Development on the Hotchkiss aircraft cannon was done with the utmost secrecy and the work progressed very slowly due primarily to lack of finances. It was early in 1928 before the pilot model had reached a stage of development that a selected group of foreign observers was permitted to see the weapon. It was demonstrated as an antitank and antiaircraft gun having tremendous weight, and could only be mounted for shipboard use.

The first exhibition took place at the government arsenal at Calais in July 1928. Among the favorable things said about the weapon by proving ground officers was that it had less recoil than any gun of this caliber that the activity had function fired. French cartridge manufacturers had experienced considerable difficulty in pro-

ducing a satisfactory powder for the new round of ammunition but the American Dupont Co. undertook and solved this ballistic problem for them.

The weapon was gas operated, as were all Hotchkiss gun mechanisms. It was magazine fed and air cooled with an announced rate of fire of 180 shots a minute. The operating mechanism was simple in design and very rugged in construction. There were very few working parts, all of which could be easily demounted and reassembled without the aid of tools. The French considered the weapon ideal for the dual purpose of air-to-air combat and also as an anti-aircraft gun for ground mounting. When used in the latter manner, the officers in charge proudly pointed out it had a maximum altitude range of 26,246 feet, which was considered extremely good. One of the most important characteristics of this 25-mm cannon was shown when in an official test an armor-piercing projectile penetrated 1½ inches of armor plate at 700 yards and ¾ inch at 2,000 yards.

On the original model, the low rate of fire and the 10-shot magazine appeared to limit its possibilities for aircraft use. No doubt this was ex-



Hotchkiss 25-mm Automatic Aircraft Cannon (Fixed).



actly the impression the French were trying to create, as their refined version for plane mounting was being developed with very little publicity.

In 1937, after French arms plants were nationalized, the United States requested permission to buy one, plus necessary accessories and ammunition for testing. The Bureau de Cessions de Matériel à l'Étranger informed our military attachés that the request was denied since the weapon and its development were considered secret.

Nevertheless a few American military representatives did see the weapon and also observed it firing. It was cycled by means of compressed air, the French engineers having made a device for simulating firing by means of high air pressure.

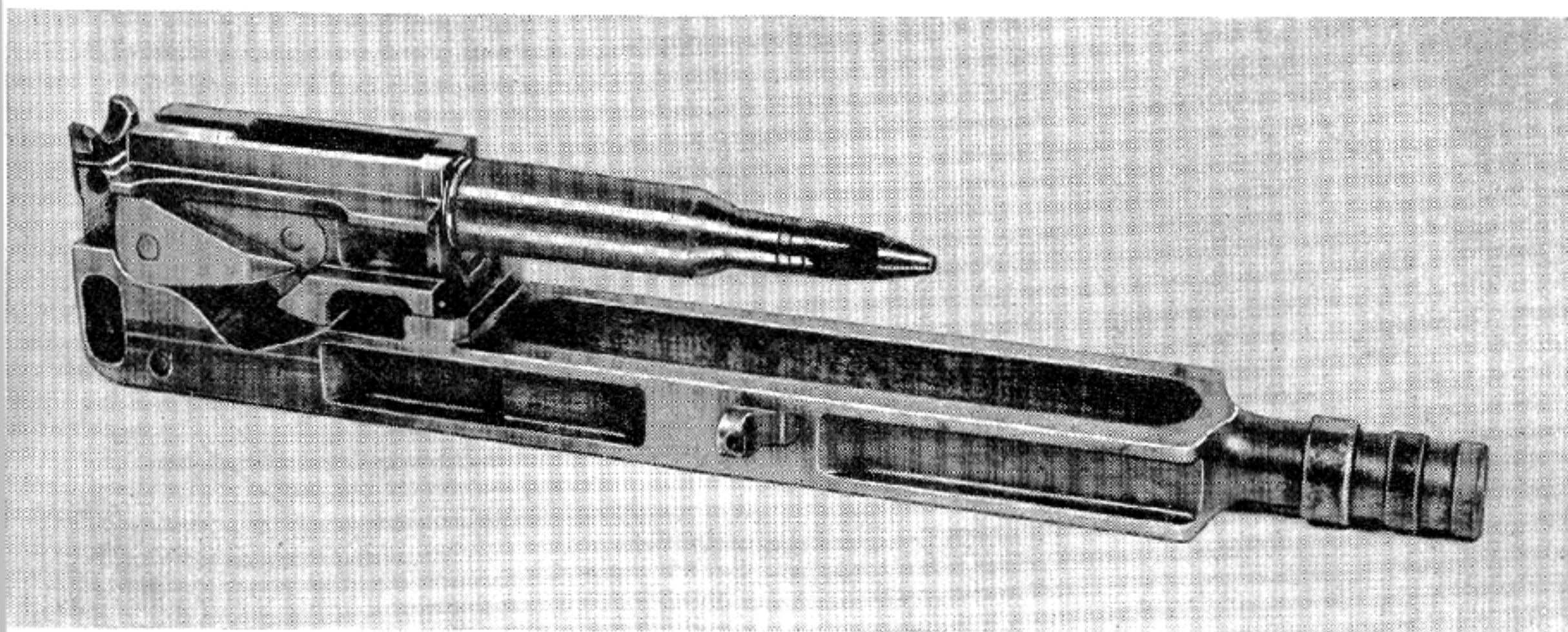
The Japanese Government, having long been a customer of the Hotchkiss Co. and having plants of its own manufacturing the firm's weapons under license, somehow secured drawings on this antiaircraft version of the weapon and made thousands of them.

Before the French could do more with the refinement and modification of the aircraft type, the Hotchkiss plant fell into the hands of the Germans early in World War II. The Nazis, recognizing it as a very serviceable weapon but not considering it as satisfactory for plane use as their own cannon, relegated these fine weapons to antiaircraft duty.

The weapon in its final design was 96.25 inches long with a muzzle velocity of 2,700 feet per second using a 0.7-pound projectile. The methods of operation for both the aircraft and the ground gun were the same, except for charging and triggering. Barrel change was a slow operation.

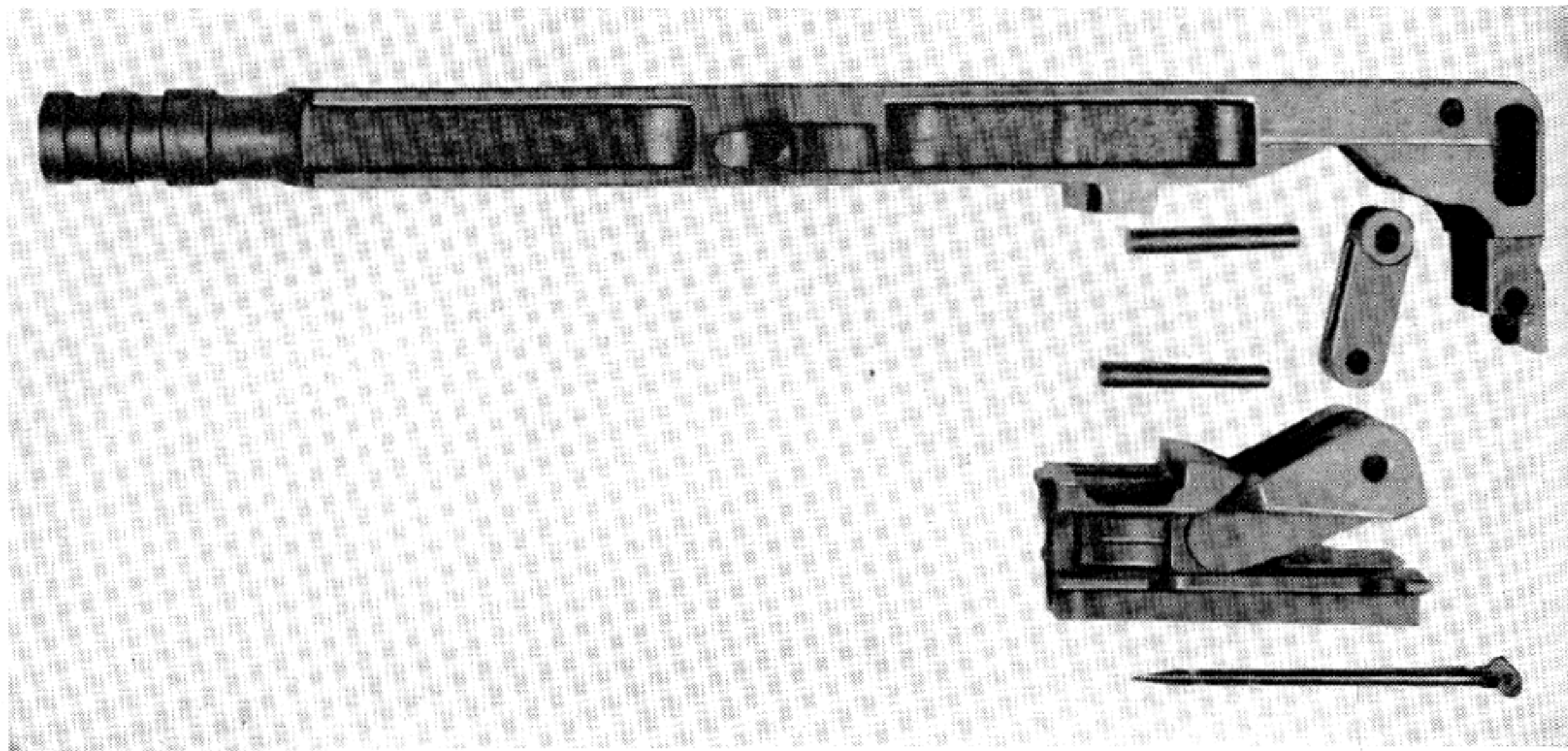
To fire the Hotchkiss cannon, the gunner first positions the loaded magazine. The bolt assembly is then retracted until the spring-loaded sear engages the gas piston assembly. In the aircraft gun, this is accomplished by the pneumatic charger while with the ground cannon the gunner uses a ratchet-type lever mounted on the right side of the receiver. The lever is connected with a gear rack and after charging it is manually returned to its forward position.

Pulling the trigger releases the bolt and piston assembly allowing them to be moved forward by the compressed driving spring. Triggering of the aircraft gun is done by remote control with compressed air. In passing under the feeder, the bolt picks up a round. As the round is chambered, the spring-loaded extractor is cammed over the base of the cartridge. The linkage-operated, positive-type lock is actuated by the piston assembly. After the bolt assembly stops in the battery position, the piston assembly is forced forward another 2.25 inches by the driving spring. This movement causes the rotation of the connecting link and the lock, which is cammed up to engage the locking recesses in the receiver. After the bolt assembly is completely



Bolt, Lock, and Gas Piston Assembly of the Hotchkiss 25-mm Automatic Aircraft Cannon.





Bolt, Lock, and Gas Piston Disassembled, Hotchkiss Automatic Aircraft Cannon.

locked, the firing pin which is carried in the piston assembly strikes the primer, firing the round.

As the projectile passes through the bore, a small portion of the expanding gases move through an orifice in the barrel and into the gas housing. These gases act on the piston assembly, driving it to the rear. This motion first retracts the firing pin and then through the connecting link rotates the lock down and out of engagement with the receiver. The bolt assem-

bly is now free to move rearward forced by both the energy in the gas piston and the blow-back pressure in the bore. As the bolt recoils, the cartridge is extracted from the chamber and when the bolt rides under the ejector the spent brass is kicked through an opening in the bottom of the receiver. The bolt and piston assembly continue to recoil together compressing the driving spring and unless the release of the trigger allows the sear to engage the gas piston, the cycle will be repeated.



# SCOTTI AIRCRAFT 20-MM CANNON

In 1928 Italy, thanks to the talents of one of her best automatic weapon designers, had available for aviation use a highly advanced 20-mm automatic cannon. Because of indecision more than anything else, the nation did not take advantage of the Scotti aircraft cannon and, by failing to do so, contributed greatly to the weakness of Italian fire power that was so evident throughout World War II.

Alfredo Scotti, the inventor of the system so named, exploited in full one principle of operation from pistol to cannon. His weapons were all gas operated. The gas piston was used only to unlock the piece, while a high residual pressure remained in the bore to furnish the energy to complete the cycle. The origination of this combination gas and blow-back system made him famous and it was widely copied by other gun designers. Scotti was strictly an inventor and in no instance did he ever manufacture weapons of his own creation. Being an Italian subject by birth, Scotti always made the provision, when patent rights were assigned, that Italy had the right to produce the weapons for her own defense.

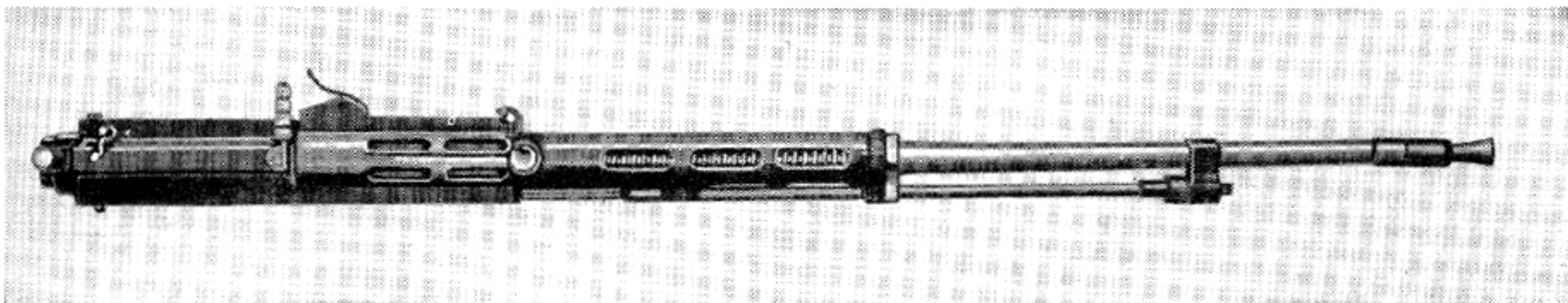
The Italian motor plant, Isotta-Fraschini, in most cases was the facility chosen for the production of the weapons. This company made the first of these guns for test by the Italian Government. The air force, however, had just had an experience with another type of aircraft cannon that resulted in a miserable failure, and that branch of the service was left hostile to any ma-

chine gun larger than rifle caliber for installation in fighter planes. At the instant of the appearance of the first Scotti cannon, all interest was centered on the development of a 12.7-mm machine gun employing an explosive bullet that had been perfected by Italian ballistic engineers.

All through the thirties practically no encouragement was given the producers of any aviation cannon to refine or improve their guns. Later, however, when it was ruled that an explosive 12.7-mm bullet was a violation of international law, and those responsible for the procurement of aircraft armament realized that they were left without an adequate weapon as a defense against bombers, it was practically too late to undertake the development of a larger gun. Shortly afterwards, Italy was engaged in war.

Had the Scotti gun been recognized from the first and a project on its refinement for aircraft use been initiated, no doubt it would have been one of the most reliable 20-mm cannon of World War II. In physical appearance it greatly resembled the Oerlikon, in which factory the first guns of this type were produced under license. In 1932 Scotti sold his patent rights to the Zürich-Oerlikon Co. of Switzerland, which made a limited number for the commercial trade, used principally by small countries both in Europe and South America, which had need for a reliable aircraft cannon that did not involve too much cash outlay.

It was described by its promoters as ideal for both aircraft installation and antitank work.



Scotti 20-mm Automatic Aircraft Cannon.





Scotti 20-mm Automatic Cannon on Antiaircraft Mount.

This double duty was attractive to the procurement authorities of second-rate powers. The cannon's main claim to fame is that it was copied basically by another company in designing what resulted in the first-line automatic aircraft cannon of two major powers.

During the latter days of World War II the Isotta-Fraschini Co. manufactured the weapon in quantity, although too late to be of use to Italy, particularly since it had had so little battle testing to evaluate its effectiveness. It is known, however, that the Italian proving grounds reported reliability of action at 600 shots per minute and a system of feeding with a metal disintegrating link belt had also been suc-

cessfully employed. This was in itself a worthwhile accomplishment.

To fire the Scotti cannon, the operator installs a loaded belt, strip, or drum, as the case may be, and pulls the firing mechanism to the rear by the charging handle. This first movement unlocks the bolt and retracts the firing pin. The assembly is held in the cocked position under tension of the compressed driving spring. By actuating the trigger, the sear is released and the bolt starts home, stripping a round out of the feedway and pushing it ahead as the two-piece bolt starts into the last phase of chambering the round. Lugs on the bolt head engage cams in the barrel extension, giving the bolt



head a fraction of a revolution turn and locking the barrel and bolt head together.

The firing pin is housed inside the bolt and is attached to slides that, upon removal of the obstructing lugs, are forced forward by both inertia and driving spring pressure. The firing pin is directed into the primer, which detonates the propellant charge. When the projectile passes a port in the barrel, sufficient gas is bled into a cylinder that houses the gas piston. This closely metered gas gives the piston a slow backward thrust movement at just the right instant to permit contiguous slides to move rearward. They rotate the bolt head while a high residual pressure remains in the bore.

The inclination of the locking lugs at a 60° angle makes unlocking require little energy, as the gas pressure acting on the face of the bolt

would rotate the lugs and unlock were they not covered by the slides. The latter having retracted the attached firing pin, the whole mechanism starts to the rear, with the operational force now coming from the remaining gas, or blow-back. The empty lubricated cartridge case, being held to the bolt face by the extractor, slips back with the recoiling bolt and is pivoted out of the receiver upon making contact with the ejector.

The bolt continues to recoil until stopped by contact with its spring-loaded buffer and compression of the driving spring. If the trigger continues to be depressed, the bolt starts on its counterrecoil stroke to repeat the cycle of operation. Release of the trigger pressure causes the sear to rise and engage the recess in the back of the bolt, holding the entire bolt assembly to the rear.



# LÜBBE 20-MM AIRCRAFT CANNON

A prominent Berlin engineer, H. F. A. Lübbe, completed in 1929 a working model of an automatic gun that he considered the last word in aircraft armament. The weapon was also held to be highly desirable for use against armored vehicles.

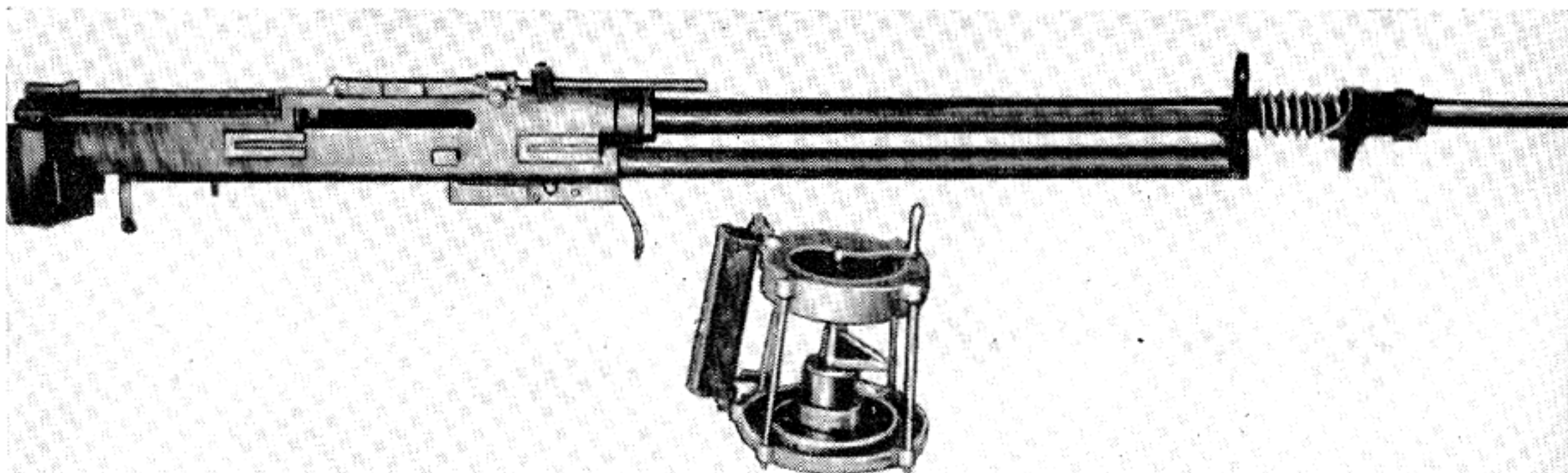
The gun in question was gas operated, had a bore diameter of 20 millimeters and had proved capable of firing at the rate of 360 shots per minute. It was air cooled, magazine (drum) fed and its weight was only 107 pounds without feeder. These features are evidence of the careful planning that went into its design. The components were so devised that they could be duplicated in mass production and the simplicity of construction is shown by the fact that there were only 50 parts in all.

Rheinmetall, Germany's big arms-producing plant, became interested in the weapon and in 1931 its leading ordnance expert gave a favorable opinion on it. The German War Office officially tested three of the guns at its proving grounds. The results were unsatisfactory and after one more attempt to revive interest in its production, nothing was done either by the inventor or the German ordnance department to promote it.

The complete assembled unit consists of the receiver, barrel, charging handle, magazine, bolt, gas piston, and push rods. The bolt is held firmly by a transverse breechlock until the projectile has cleared the bore. The barrel is quickly interchangeable (3 seconds by actual test), fastening into the receiver by means of the bayonet lock. The actuating lever in the bolt assembly has a handle protruding through the left side of the receiver for charging the piece manually and this unit must be removed first before complete disassembly.

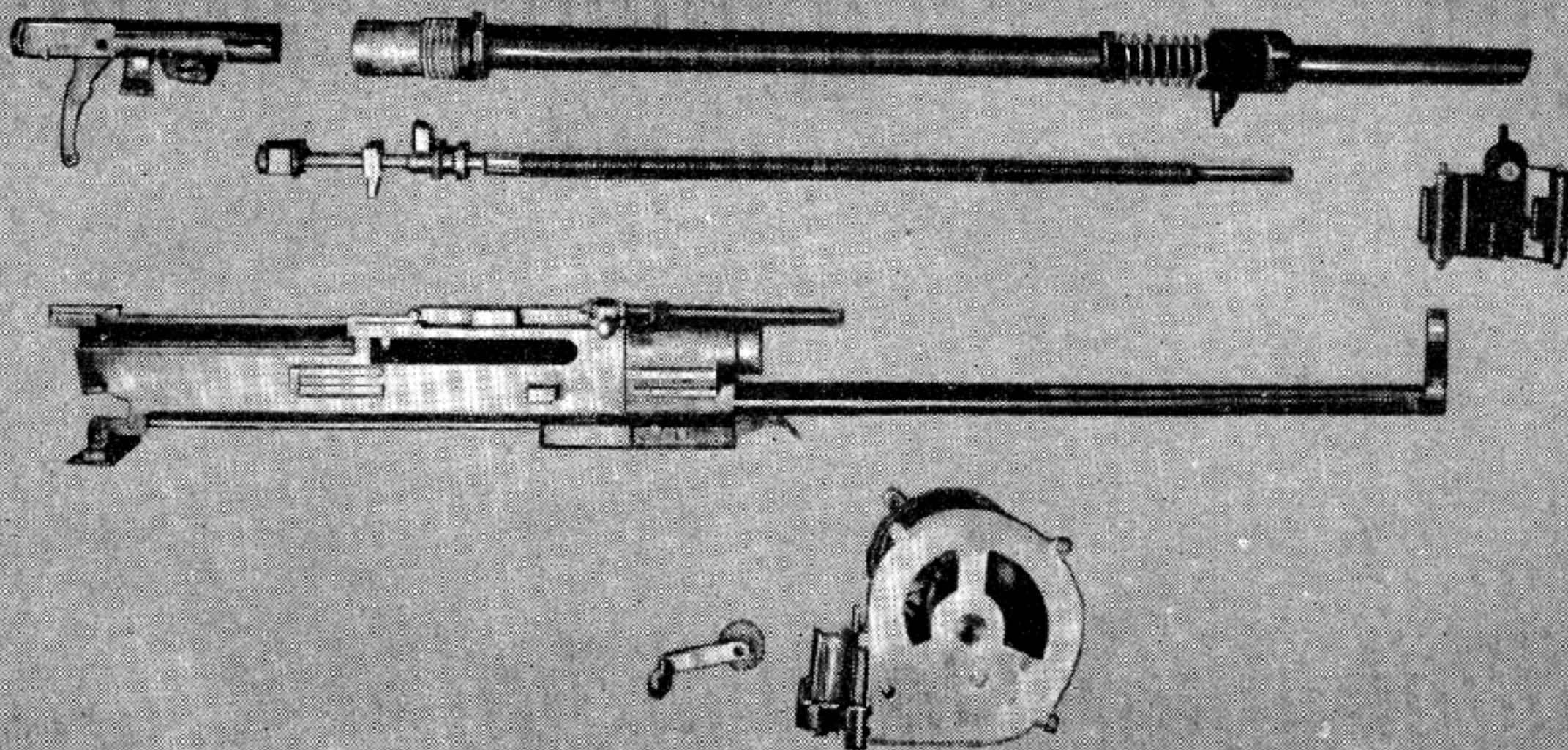
Incorporated in the bolt is the locking block which is actuated by a lever arrangement that unlocks the action upon reaching a safe chamber pressure. The gas piston which controls the lock serves as an obstruction in the path of the firing pin, making impossible the discharge of the weapon before the breech is securely locked. A heavy spring buffer located at the rear of the receiver absorbs the shock of the recoiling parts and returns them to battery.

The magazine is an open drum-shaped container holding 30 rounds that are fed in by two flat-shaped spiral springs. In order that the point of the projectile does not injure the magazine when shoved forward violently by the act of



Lübbe 20-mm Automatic Aircraft Cannon and Feeder.





Lübbe 20-mm Automatic Aircraft Cannon Disassembled.

chambering, a specially hardened piece of metal is attached to the front portion of the feed. This deflects the nose of the projectile into alinement with the axis of the bore. During firing, the barrel and receiver recoil in a cradle which serves also as part of the mount.

In the barrel there are two diametrically opposite gas ports enclosed in a cylindrical housing that is also the gas piston. The piston has a short exposed return spring. Mounted beneath the barrel is a long push rod fitted between the gas piston and the bolt-actuating lever. Around the rod is the driving spring and the two are inclosed in a tubular housing. The bolt-actuating lever is pivoted in the bolt body and the tail of the lever extends well below it. Halfway down its exposed length the lever is machined to fit into a slot in the aft end of the push rod.

When the Lübbe 20-mm automatic gun is fired, the projectile passing through the barrel uncovers the gas ports. The expanding gas strokes the piston which in turn forces the push

rod rearward. The latter, being attached to the bolt-actuating lever, swings the bottom of the lever to the rear, while an ear on the top of the rod withdraws the firing pin.

When the lever is moved in this manner, its front face is rotated in a downward direction. This face, being engaged with the lock, slides the latter down and out of the locking recess in the top of the receiver. The bolt assembly then recoils from blow-back compressing the driving spring in the push rod assembly.

At full recoil the gun can be seared. If allowed to fire again, the driving spring returns the mechanism to battery. When the bolt stops, the lock is alined with the locking recess and the driving spring continues forcing the push rod forward. This causes the lever to rotate in the opposite direction and raises the lock. The firing pin, being attached to the push rod, continues to travel forward and strikes the primer, as the cycle is repeated.



# RHEINMETALL-BORSIG AUTOMATIC AIRCRAFT CANNON

## Ehrhardt, Solothurn, and Flak 30 Cannon

At the time of the signing of the Armistice on 11 November 1918, there were in German arms plants a number of experimental weapons desperately being worked upon in order to stave off disaster. Many of them were being fabricated under the highest priority. Among these weapons was a pilot model automatic cannon, constructed at the Rheinmetall plant at Dusseldorf, and devised by the director of the firm, Heinrich Ehrhardt, who was world famous for his developments in field artillery.

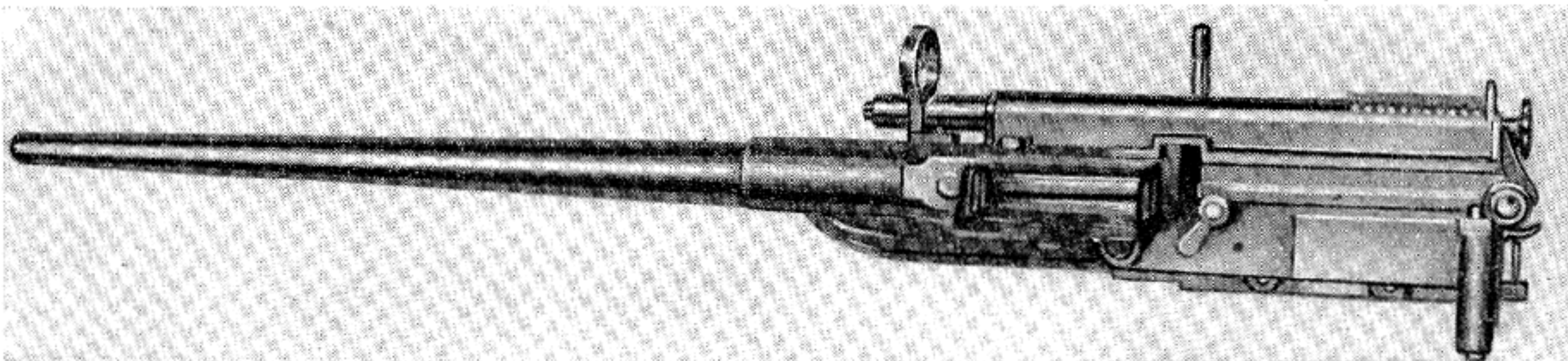
The gun in question was a 20-mm recoil-operated, air-cooled, magazine-fed automatic aircraft cannon. The locking mechanism was based on a patent by Louis Schmeisser, who as early as 1907 assigned all rights to Rheinmetall, and it was later introduced in a machine gun known as the Dreyse (MG-13). In fact, the Rheinmetall gun, sometimes called the Ehrhardt, was in reality just a scaled-up version of the rifle-caliber machine gun, having identical locking action and acceleration. For the first time in automatic cannon, the driving spring was housed in the top of the hinged cover group. This has since been a characteristic feature of German automatic weapons.

With the occupation of Germany and the tak-

ing over of ordnance plants by the Inter-Allied Control Commission, officials at Rheinmetall knew that the discovery of their new cannon would lead to its being destroyed or, worse yet, tested and copied at the Allied proving grounds. In order to forestall this, just before being taken over, the few weapons that had been made, along with all spare parts, patterns, and mechanical drawings, were shipped to neutral Holland and placed in storage until the occupation forces left and this weapon could again be produced. The move achieved its desired result. The Allied Commission's reports constantly referred to the Ehrhardt cannon but admitted that one had not fallen into its possession for study and test.

An attempt by Rheinmetall in 1929 to establish a subsidiary company in Holland under the name of Hollandische Industrie und Handels Maatschaps (HIH) turned out to be unworkable. In the same year, the firm acquired ownership of the Waffenfabrik Solothurn A. G. in Solothurn, Switzerland, also a neutral country. This plant was originally a watch-making plant, but most certainly the new German owners had other ideas in mind when, with capital furnished in large part by the government, they took over operation of the plant.

No sooner had Solothurn been established as a legitimate outlet for the parent company in



Ehrhardt 20-mm Automatic Aircraft Cannon.



Berlin than a fully developed rifle-caliber machine gun and a 20-mm automatic cannon were put on the market. The cannon, known by now as the Solothurn, was none other than the Schmeisser-Ehrhardt-Rheinmetall gun that had been kept away from the Allies after World War I.

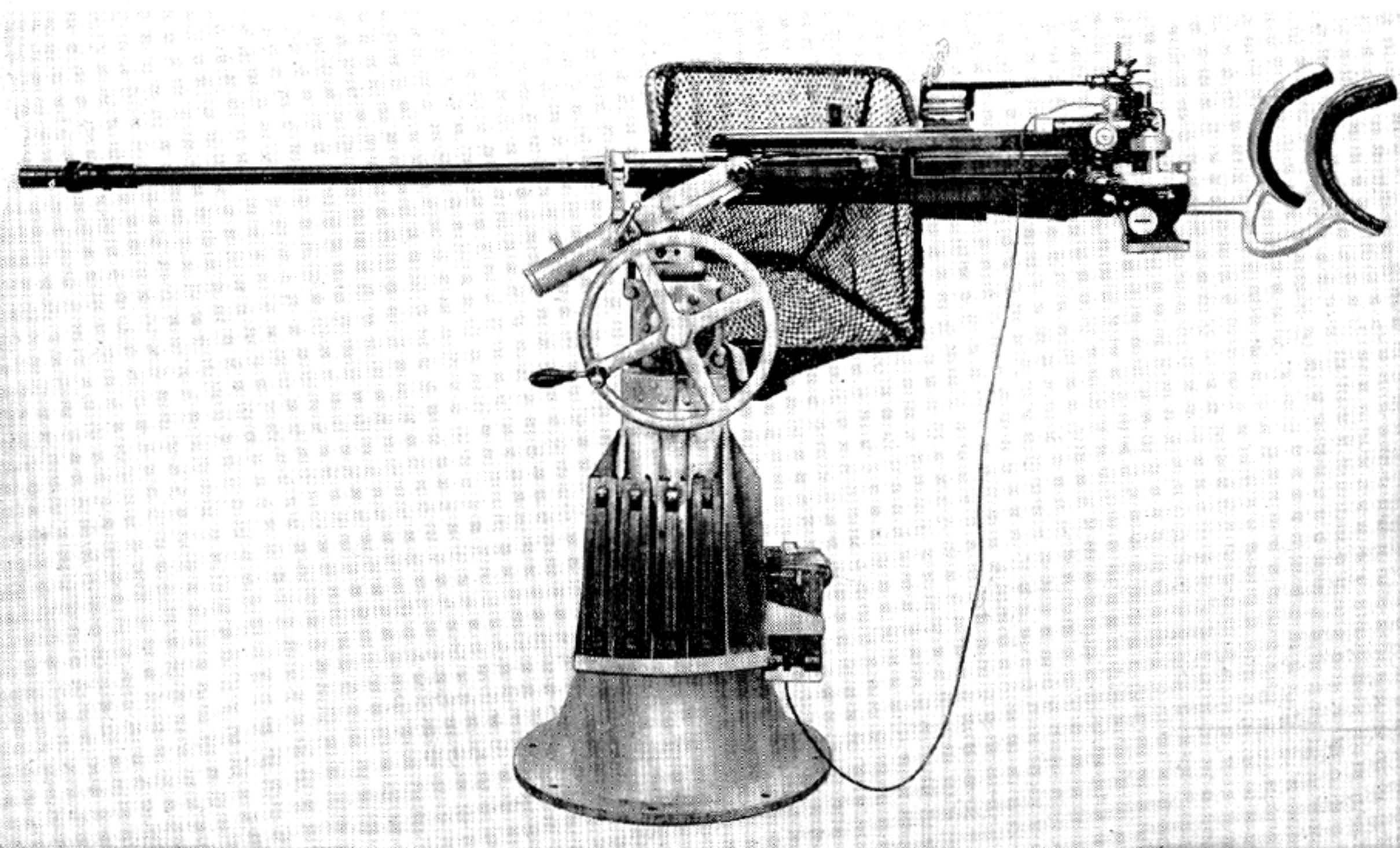
As early as 1926, two of Rheinmetall's most talented automatic-cannon specialists, Fritz Herlach and Theodor Rakula, became actively engaged in refining and modifying the weapon until it met the demands placed upon it by its producers. Both men became important officials of the company, because of their excellent work in designing automatic arms. Herlach succeeded Ehrhardt as director of the company and Rakula held the important post of chief engineer. As soon as the Solothurn plant in Switzerland was taken over, both men transferred to the new factory and worked on the Solothurn 20-mm gun with the purpose of placing it in competition with the Oerlikon gun, also of German origin and manufactured in nearby Zürich.

The cycle of operation on the Solothurn 20-mm automatic cannon consists of the following

sequence: A loaded magazine is put into position on the left side of the receiver with the bolt forward. The selector switch is then placed on *Safe*. The cocking lever is swung out and pulled vigorously to the rear. When the bolt engages the sear in its rearmost position, the lever is returned to battery. The first movement rearward unlocks the weapon and cams the striker down, cocking the piece.

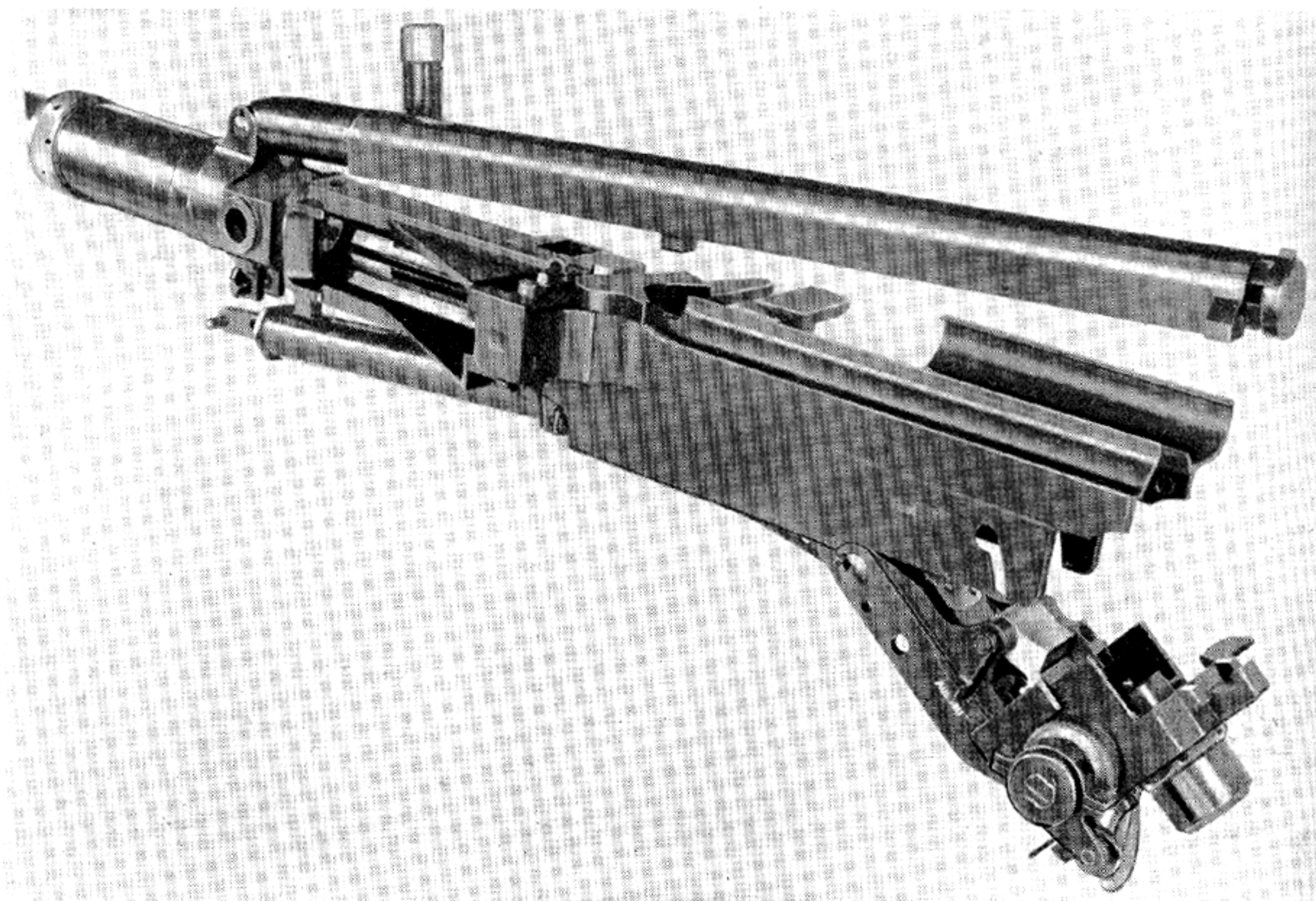
The switch is now turned to *Fire*. The weapon has two hand grips mounted on the back end of the receiver. With the right grip, single shots are fired, while the left grip delivers continuous fire. When either trigger grip is rotated, the sear is disengaged from its recess in the bottom of the bolt. This allows the assembly to be driven forward under compression of the driving spring.

In going forward, the bolt face strips a round from the feed mouth and starts to chamber it. The unlocked barrel that has been held to the rear now starts final movement forward after being released by the rising of the pivoting lock behind the bolt. This act rigidly backs up the cartridge that is being chambered. The last fraction of an inch before going into full bat-



Rheinmetall (Solothurn) 20-mm Automatic Cannon Model ST-5 on a Naval Mount.





Rheinmetall (Solothurn) 20-mm Automatic Cannon Model ST-5, Showing Ease of Disassembly.

tery position uncovers the spring-loaded striker allowing it free movement to fly up and strike the primer. The recoil caused by detonating the powder charge, which is much greater than that required to operate the weapon, is dampened out by use of a muzzle brake. The remaining energy pushes back both the barrel and the bolt with the pivoting lock holding the assembly locked together for a distance of  $\frac{7}{8}$  inch. At this point the rear arm of the locking lever carried in the barrel extension hits the inclined face of a stationary ramp in the receiver. It slides up and along this slope forcing the forward face of the unlocking arm down until it frees the bolt.

Then begins the action of the accelerator lever which is rotatably lodged in the cradle and is engaged between the barrel sleeve and the breech piece. The recoiling barrel has changed its position until it has a mechanical advantage, thereby transmitting the energy to the bolt

speeding it rearward. While the bolt continues to the rear, the extractor has withdrawn the empty cartridge case from the chamber and positions it to be struck on its base by the ejector which kicks it through the opening in the right side of the receiver. The remaining bolt energy is absorbed by compressing the driving spring and striking a rubber buffer. If the sear remains depressed, the cycle is repeated.

The aircraft gun, similar in design to the above weapon, was designated by the parent firm as the MK-ST-11. It was more streamlined and had a rate of fire of 280 rounds a minute. A ratchet-type charger replaced the straight-pull type. An odd-looking interchangeable twin-drum magazine holding 20 cartridges and an empty cartridge-case bag was used when mounted as a free gun.

The barrel was the quick-disconnect type using the bayonet lock. A muzzle attachment was always employed and rates of fire were increased





Rheinmetall 20-mm Automatic Aircraft Cannon, Model ST-11.

by eliminating the back part and substituting a flash hider. This weapon was fed through the top of the receiver and the driving-spring assembly was mounted underneath.

MK-ST-5 was the nomenclature given the antiaircraft weapon. It was adapted to shipboard as well as to land use. It differed from the basic first model Solothurn automatic only in the accessories found necessary for various types of mounting and training.

The gun was offered commercially to practically every major power in the thirties. The British Air Ministry ran tests in competition with the Oerlikon gun in 1935, resulting in the selection of the latter weapon. The United States undertook a trial at Aberdeen Proving Ground even prior to the British. On 25 September 1933, the commanding officer in reporting the results summed up the entire proceedings with the statement that "while the weapon did function reliably, there was nothing unusual or outstanding enough to warrant replacing similar weapons we already have." It was not considered an improvement on cannon then under design in American arsenals.

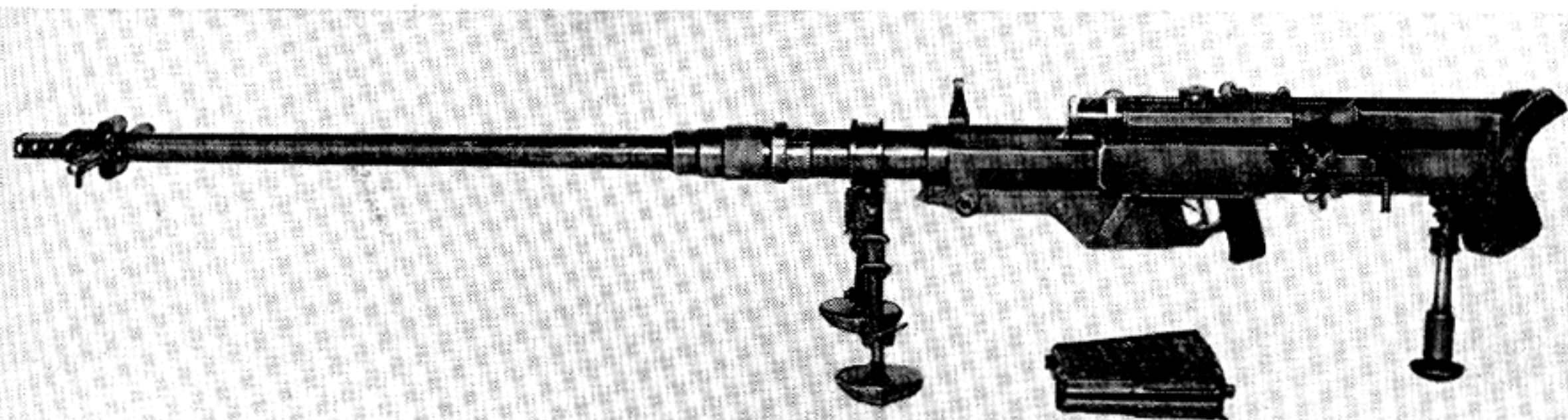
The German high command thought quite

highly of the weapon as an antiaircraft and tank gun and used thousands of them at the beginning of World War II under the official name of Flak 30. It remained in use until displaced by an improved design.

German military authorities, remembering well their plight in World War I when the British introduced the armored tank, felt that an adequate antitank gun should be in their possession in case of another war. As their needs demanded that it have a large bore with an automatic, or at least semiautomatic action, they turned the problem of a cannon of this nature to Rheinmetall for solution.

Herlach and Rakula, who took over the job, saw at once that, if the weapon had to be as mobile as desired, it must be a shoulder-operated piece with at least a 20-mm bore. The one thing most apparent to these engineers was that the MK-ST-5 could not be adapted. The locking system used in this weapon transmitted too much recoil or kick to the shoulder to make its use permissible unless the weight were greatly increased and this would defeat its purpose of being highly mobile.

As they could not employ the Schmeisser ac-



Rheinmetall (Solothurn) 20-mm Semi-Automatic Antitank Cannon, Model S18-1000.



tion, as in the earlier Solothurn gun, the next move was to adopt the Stange system of locking that had been used so successfully in rifle-caliber machine guns. It was scaled up to produce a mechanism capable of handling the high-velocity 20-mm cartridge. The working parts were designed to dampen out the recoil forces so that the explosion of the powder charge took place while the securely locked barrel and bolt assembly were still traveling forward with great speed.

The result of their efforts was the MK S-18-100 and the later refined MK S-18-1000 semiautomatic antitank gun. The Tank Buchse, as it was called by the German soldiers, was recoil operated, clip fed, air cooled and semiautomatic in action, with a quick detachable barrel that had splines cut on the aft end to facilitate cooling and a flash hider on the forward part. It used a high-velocity cartridge that, when loaded with an armor-piercing projectile, could penetrate 1½ inches of armor plate at 350 yards. The weapon became quite popular with the German soldiers as they felt it answered a long-felt need.

The Stange system of locking by rotating a sleeve between barrel and bolt was used on the MK S-18-100 and the S-18-1000, exactly as designed by the inventor. Little or no difference existed between the two weapons. A cycle of operation will not be given on these weapons as they are semiautomatic and their mention here is only because of a highly successful automatic cannon that evolved from these earlier guns.

## Flak 18 Cannon

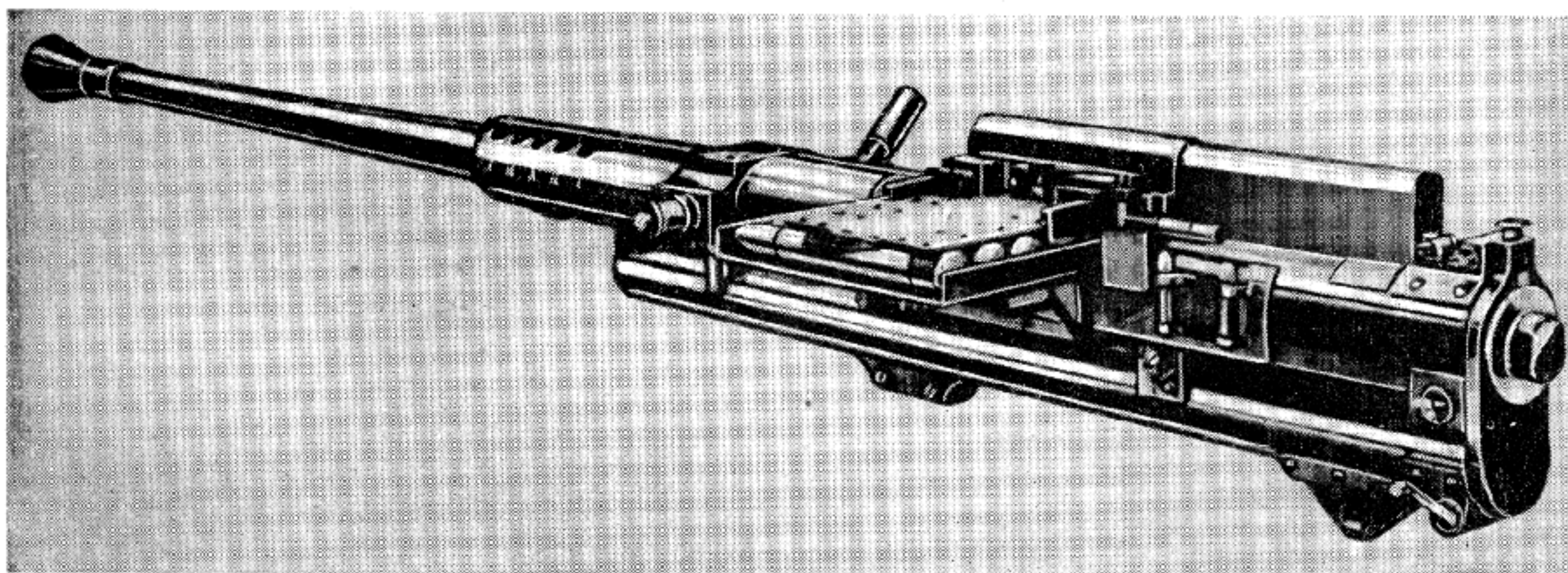
Shortly after the introduction of these single shot 20-mm semiautomatic rifles into the service, Rheinmetall engineers again turned their attention to the development of an automatic 37-mm cannon, using a centrally locked bolt that was a byproduct of their semiautomatic cannon development.

Locking was done in the simplest manner imaginable. The cocking handle that protruded from the bolt head rode in and was guided by a long slot cut in the side of the receiver. As the bolt head approached battery, the guiding slot curved quickly, rotating the locking lugs on the bolt head and locking it rigidly to the barrel. It is easy to see that with this method there was not the slightest hesitation of the action going into battery and that the full force of inertia could be utilized to dampen the shock of recoil.

The Rheinmetall designers did what so many engineers do under varying circumstances. Not being able to apply Stange's locking system as shown in the patent, they simply reversed the principle and came up with something that could be successfully used.

This weapon fired full automatic, being fed by clips of eight rounds. The rate of fire was given at 180 to 200 rounds a minute and upon its introduction was given a thorough test by the German Army in competition with a Mauser-produced 37-mm gun of similar design.

The unusually reliable action during the trial brought about its choice over its competitor. It



Rheinmetall 37-mm Automatic Cannon, Flak 18.



was promptly adopted and given the designation Flak 18. German antiaircraft regiments used it as their primary defense weapon. A highly sensitive fuze was used on the high-explosive projectile. During one test at a range of 5,000 yards it was fired against a metal wing of an airplane. The projectile, upon entering, made a very small hole and then detonated, tearing out a section of the wing over 8 feet square. The German antiaircraft gunners estimated only one hit would be necessary to bring down the largest planes.

Thousands of Flak 18's were installed before World War II by all German services. They were mounted in the fixed fortifications on the Kiel Canal, as well as along the coast, and it was considered the first-line automatic weapon for antiaircraft defense by the German Navy. Although its main purpose was against aircraft, the army always looked upon it as a dual-purpose gun that could be used effectively against armor if tanks were too heavily protected to be stopped by other guns.

### MK-101 Cannon

By the time World War II began, so much automatic cannon development work was under way in Germany by different plants that the designations given to prototypes and already adopted weapons became highly confusing. By the end of 1942, a new system was instituted of identifying each of the four plants which were handling 90 percent of all experimental and development work. Rheinmetall-Borsig was allotted the number 1; Mauser, 2; Krieghoff, 3; and Krupp, 4.

To identify a weapon, the first digit represents the plant that developed it, and the last two stand for the order or sequence in which it was developed. As several firms were given the same problem in design, the company credited with the solution had its number assigned to the project which it carried all the way through to adoption. For instance, if Rheinmetall developed a prototype for the thirteenth type of weapon specified by the military authorities, the official designation of the finished product would be MK-113. If Mauser were first to succeed in

this development, the nomenclature would be MK-213.

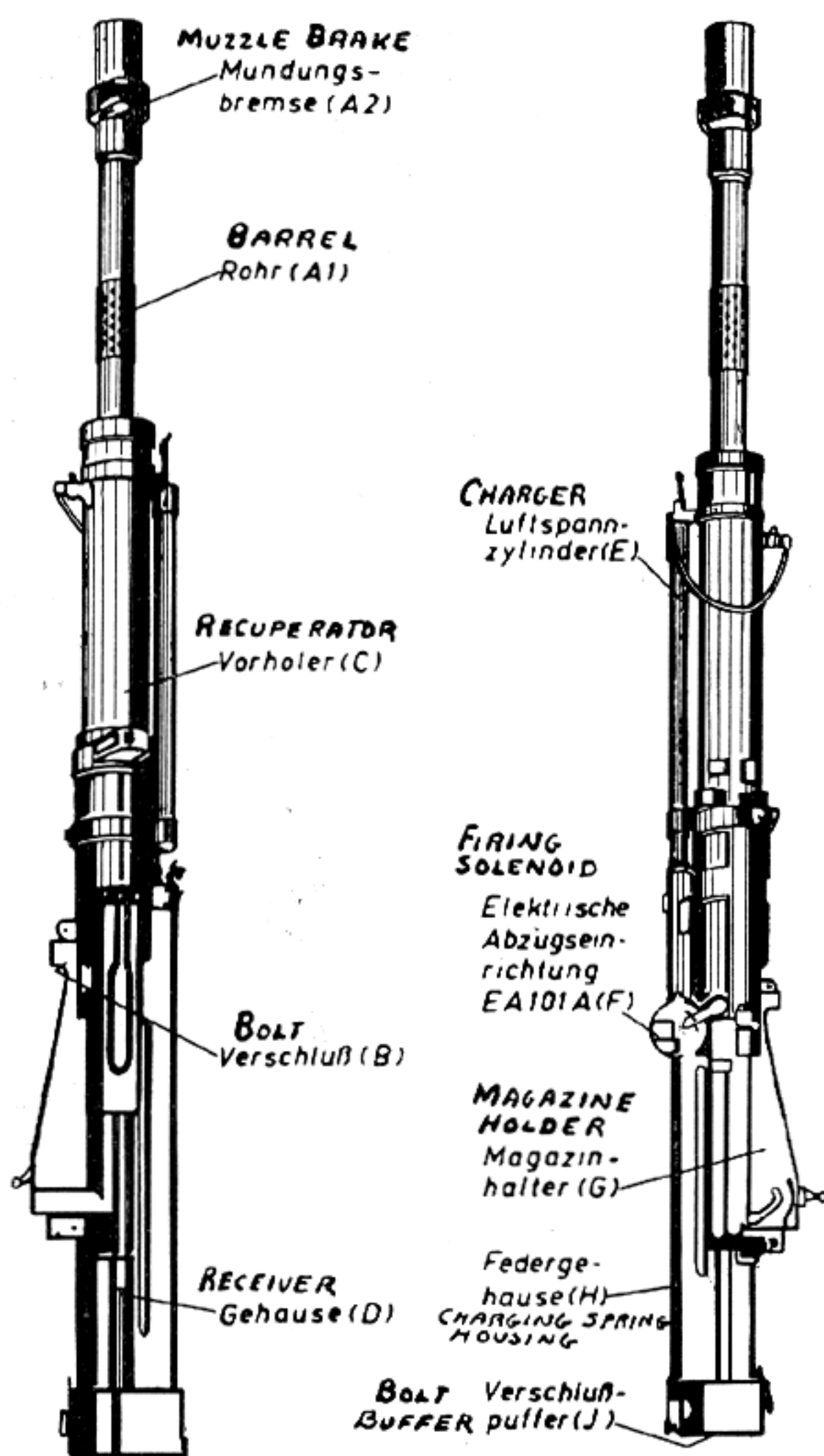
The first weapon to receive the new marking was a 30-mm automatic aircraft cannon which turned out to be merely a scaled-up version of the early 20-mm antitank gun, the Mark S-18-1000. The weapon was designated the MK-101—Aircraft 30-mm automatic cannon. It had a very long chamber and used an extremely high-velocity cartridge for an automatic aircraft cannon.

The locking system is the locking-ring principle, so successfully exploited by Rheinmetall's Solothurn plant in the production of many rifle-caliber machine guns. The in-line action has a bolt with lugs on its forward part to be driven onward by driving-spring compression; upon contact with a collar or ring it turns and locks all these members as one piece until freed by recoil movement. The weapon is electropneumatically charged. It has a means of manually retracting the bolt after it is unlocked, but the necessary rearward movement to free the bolt and barrel must be done by compressed air.

The bolt sear is disengaged from its recess in order to fire and remain disconnected until the last round leaves the feed mouth. There are two different types of magazines with this gun. One is flat; the other made in the form of a drum. In both cases, however, the cartridges are positioned by spring pressure. When the last round leaves the magazine, a spring-loaded follower strikes a latch which allows the sear to engage the bolt holding it to the rear. Cocking the gun is thus unnecessary after placing a loaded feed clip into position.

The firing circuit is designed to permit either single shot or automatic fire. When firing is interrupted by opening the electric circuit, the bolt will go home with a round in the chamber. The forward end of the barrel is fitted with a muzzle brake and recoils within the recuperator housing. Interrupted threads in the breech end allow a quick disconnect and longitudinal cuts in it furnish rigidity and additional surface for heat dissipation. The bolt is flat in design on both top and bottom with lugs on each side to engage mating interrupted threads in the locking sleeve. A spring-loaded extractor is on the under side and on top is a patented feature of





Rheinmetall 30-mm Automatic Aircraft Cannon, MK-101.

Strange's that permits an unusually short recoil stroke before picking up the incoming round. A safety lock can be so positioned as to make it impossible to depress the solenoid actuator.

To fire the MK-101, a loaded drum is attached in its fastening latches on top of the receiver. Air from a cylinder is admitted to the charging mechanism through an electric solenoid valve. This allows compressed air to enter the piston housing against the charging piston, forcing it back with the bolt assembly until it engages a rear-searing device after the contact button of the charging valve has been broken. The

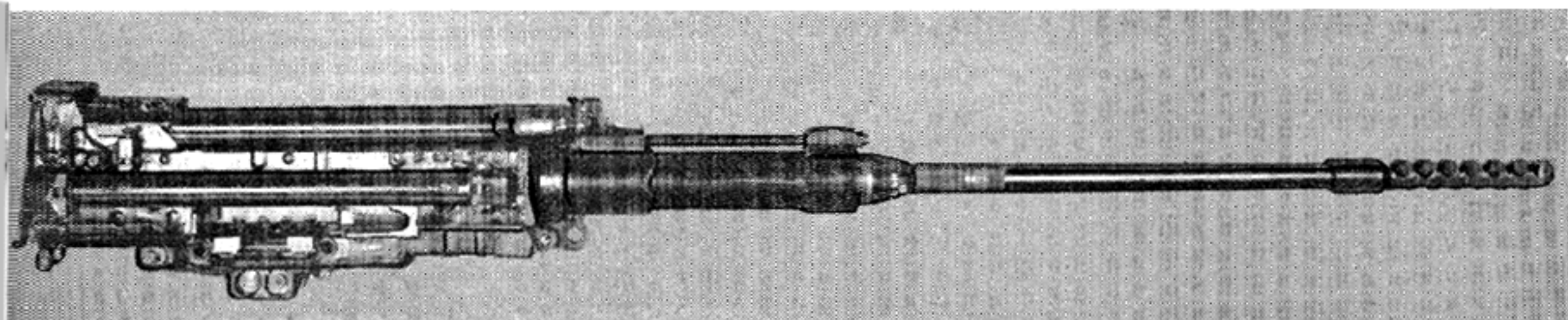
release of air depresses the sear and allows the bolt assembly to be driven forward under energy of the compressed driving springs.

The bolt face picks up a round from the mouth of the feed, chambering it at the same time the rotating sleeve locks the piece in battery. Firing is accomplished by depressing the button that engages the solenoid; this moves a lever that in turn disengages the front sear from the firing pin grooves. At this time a heavy spring drives the firing pin into the primer, to fire the chambered round. The barrel, bolt, and locking sleeve are all firmly joined while the projectile is traveling through the bore and remain that way until an inch and a half of recoil takes place.

During the first bit of travel the cocking lever is pivoted, at first withdrawing the firing pin within the bolt face and then compressing the firing-pin spring tightly until it is seared back, fully cocked. The locking sleeve, the rollers of which are guided in the cam slots, is now rotated unlocking the bolt, at which point the accelerator speeds the bolt rearward. The barrel and locking sleeve are held in a retracted position while the bolt is still recoiling. It carries the empty cartridge case, withdrawn from the chamber by the extractor, until the ejector makes contact with the rim of the case, pivoting it out the ejection slot in the bottom of the receiver.

Further recoil compresses the driving spring and the bolt hits the buffer, after which an opposite movement begins. As the bolt moves forward, the first round in the magazine is started towards the chamber. At the same time the extractor claw is cammed over the rim of the cartridge. Shortly before the bolt strikes the locking ring, the coupling lever is lifted by an inclined ramp on the bolt body. This releases the retracted barrel and locking ring at the exact instant the bolt lugs are opposite their mating threads in the ring. The rollers in the locking ring follow the camming grooves which rotate the sleeve, quickly locking the entire assembly. If the solenoid is still actuated, the firing lever moves the sear out of engagement with the button on the firing pin. The latter flies forward to fire the propellant charge in the cartridge again.





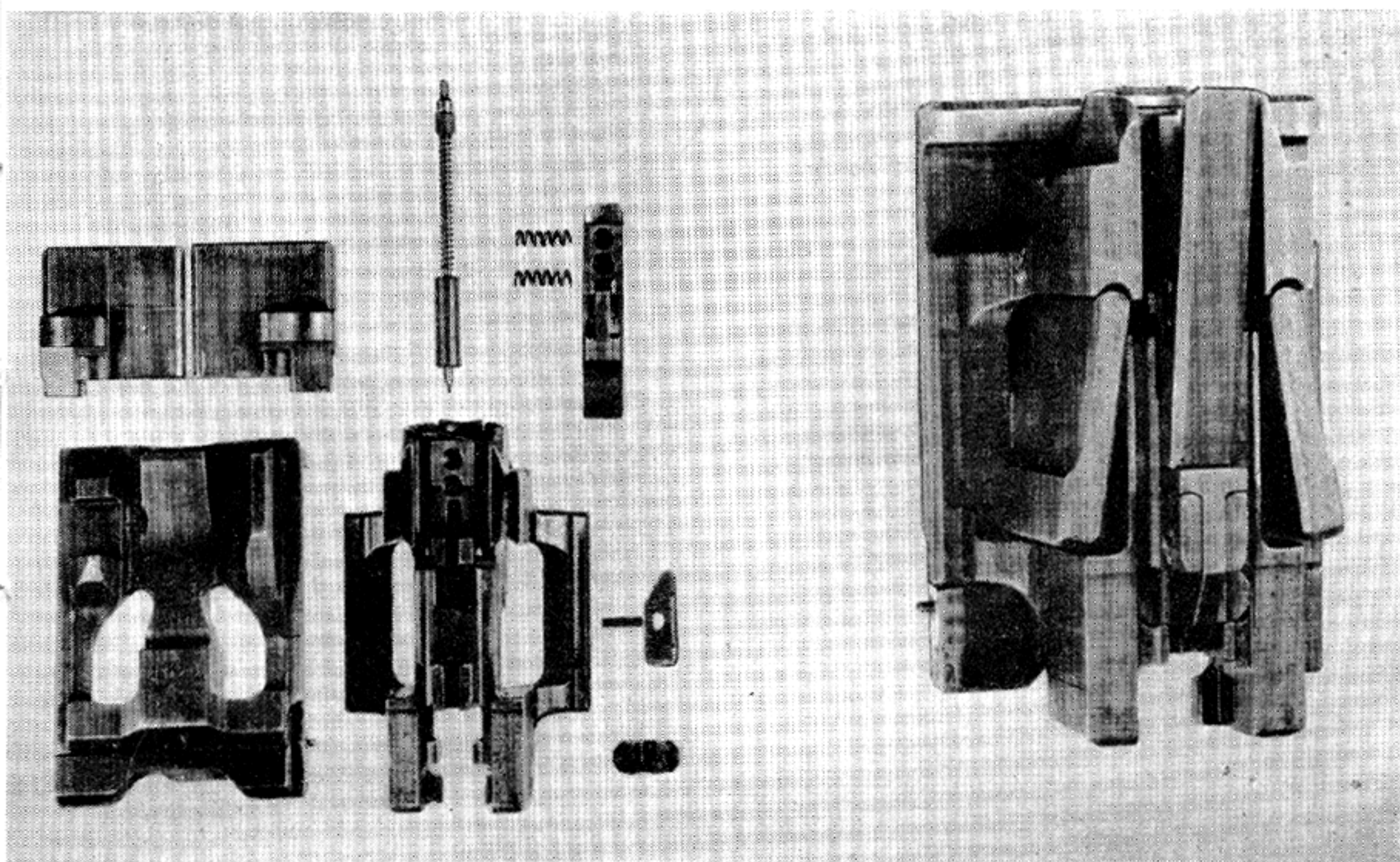
Rheinmetall 30-mm Automatic Aircraft Cannon, MK-103.

## MK-103 Cannon

While the MK-101 was used by the German Luftwaffe mostly on the Russian front in the Heinkel 129, a heavily armored plane especially designed for ground attack, this type of installation was also employed for tank-destroying purposes. And while it was designed for specific work and its over-all use was limited, it certainly called attention to the need for a 30-mm aircraft gun of this type with more fire power.

It was soon followed by another Rheinmetall development, the MK-103. This 30-mm automatic aircraft weapon was also gas operated, air

cooled and belt fed, a metal disintegrating link being used. The feed was actuated by the recoil forces of the gun. The primer was fired electrically with charging and searing being performed by compressed air. A muzzle brake was employed to reduce the shock of recoil. The rate of fire was 450 rounds a minute. Locking of the bolt was done when two swing-type locks were forced behind their locking keys in the barrel extension body. A gas piston located beneath the barrel furnished the power to unlock and drive the bolt assembly to the rear, assisted by blow-back forces. The locking arrangement on this gun was practically identical with an experi-



Bolt Assembly of Rheinmetall's 30-mm Automatic Aircraft Cannon, MK-103. Left: Bolt Mechanism Disassembled. Right: Bolt Mechanism Assembled and in the Locked Position.



mental one from an American automatic gun that never advanced beyond the prototype stage.

To fire the MK-103, the gunner places a loaded belt in the feedway until the first cartridge is behind the belt-holding pawl. Then air is turned into the charging mechanism by actuating the charger valve. The pneumatic effect on the charger's piston-like front and on the driving springs forces the whole assembly rearward carrying the bolt group with it. The sear engages the bolt and holds it in a cocked position, until another valve releasing air pressure forces the holding device down and allows the bolt to fly forward under tension from the driving spring. On the final movement rearward, the center pawls in the feed position the first round for stripping.

As the bolt is driven forward, the rammer engages the rim of the indexed round and starts to chamber it. The extractor claw is forced over the lip of the rim at this time. The upper part of the bolt is abruptly stopped as its face strikes the breech. However, a striker on the rear of the piston keeps on to force the two swinging locks out into their locking abutments into the barrel extension, thus locking the bolt securely behind the chambered round.

The cannon now being loaded and ready to fire, pressure on the trigger button closes the circuit and the electric primer in the cartridge is set off. The action remains locked for the first 2 inches of recoil, but force is transmitted to the feed pawls and they are moved over one space shoving the cartridge across the spring-loaded rammer, forcing it down. After the projectile has cleared, pressure is brought on a gas piston housed in a cylinder beneath the barrel. Being driven rearward, the piston and slide uncover the two locks, allowing them to move into the bolt body and all recoil together. The extractor pulls the empty cartridge case from the chamber and holds it until the ejector at the rear of the feedway strikes the top of the rim, knocking it down and out of the receiver. Continued recoil fully compresses the driving springs and the final movement ends with the bolt striking the buffer. The first phase of counterrecoil places the cartridge-holding pawl in the feeder over the next round. The rest of the forward travel is used to strip and chamber the new round and

to lock the action into battery. The cycle is repeated if the electric circuit is still energized.

### MK-108 Cannon

When the German Air Force was suddenly thrown on the defensive by heavy bombing raids, an automatic cannon was offered by Rheinmetall that was designed for one purpose only: air-to-air combat against big bombers. The gun was given the designation MK-108. Although design began in 1941, it was not given the highest priority in production until 1944. One direct hit from its unusually large projectile was deemed sufficient to bring down any plane.

The weapon was blow-back operated, recoil seared and belt fed, with a maximum rate of fire of 450 rounds a minute. It used electric ignition and was charged and triggered by compressed air. On the ME 109 plane the gun was mounted on its side and fired through the hub of the propeller. Sixty rounds of ammunition were fed by means of a metal disintegrating linked belt from an ammunition can that was located directly above the gun.

The system of operation employed in the MK-108 is nothing other than the original Becker-Oerlikon method, brought up to date and using a larger cartridge. The barrel and receiver do not recoil, the entire force being taken up by the rearward motion of the heavy bolt against strong springs that also act as buffers. There is no locking action between the barrel and bolt at any time.

An extra long and heavy push-out type link holds the cartridges and as the bolt goes forward upon release of the sear, a rib on top of the bolt passes through the link to push a round into the chamber. After being fired, the empty case is withdrawn and repositioned in the link, there being no ejection of the single cartridge as in most other automatic weapons.

Due to the fact that straight blow back is used, it is necessary that the ammunition be prelubricated. The most unusual feature about the aircraft model is the extremely short barrel with its resulting low muzzle velocity. The term, headspace, in its ordinary sense, is not applicable in this gun. The electric circuit leading to the fir-



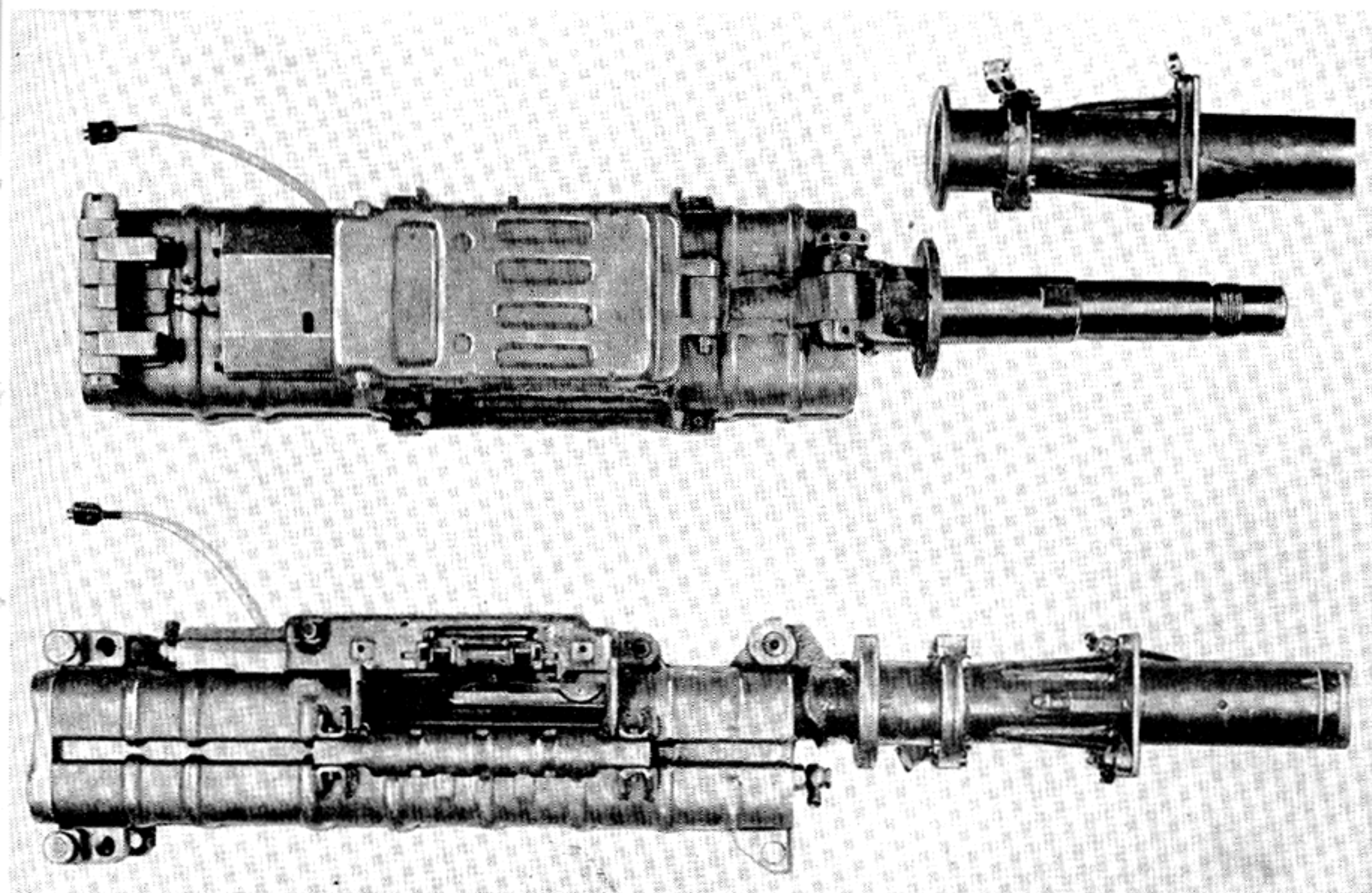
ing pin is closed the instant the round is safely inclosed, but because there is a certain time lag, the primer detonation of the charge actually takes place after the circuit is broken but while the mass of the heavy bolt is still advancing. This utilizes the tremendous force forward as a substitute for a locked breech.

Since the ignition is tripped well out of battery, the electric system is designed to make it impossible to energize the firing pin with a bolt fully home. For with a closed bolt minus the forward speed of the assembly, a round fired in this position would wreck the mechanism. The air charger consists of a fixed piston and sliding sleeve with a stout retaining spring. Air is introduced by means of a solenoid valve. After charging, deenergizing the solenoid causes a valve to open dumping the charger side of the line. The return spring then moves the assembly back to the front of the receiver.

The feed is unique, two operating lugs actuated by grooves cut in the top of the bolt working by means of linkage. Disintegrating links

are necessary for successful operation. The links enclose both the cartridge case and most of the projectile, presenting a solid chute when positioned in the receiver. Feeding is accomplished in two movements. As the bolt moves rearward, the cartridge and its link are moved outward by the ejection pawls while the incoming round and link are started over by the two feed pawls. When the bolt begins counterrecoil, the feed pawls move back in line with the chamber carrying the incoming round.

Each phase of operation produces a separate motion for the feed belt. After the cartridge is chambered and fired, the empty case is returned to its former place in the link as before feeding. This allows the linked empty cartridge to come from the opposite side of the receiver. With the projectile in a cartridge, a link could not be separated, but after it is out, the links can come apart upon leaving the gun and a metal finger on the side of the receiver accomplishes this action. Another unusual feature about this very efficient weapon is that over 80 percent of it is



Rheinmetall 30-mm Automatic Aircraft Cannon, MK-108.



constructed of stampings, making its manufacture both easy and cheap.

To prepare the MK-108 for firing, the armorer places a loaded belt of cartridges in the ammunition container and inserts the first round under the belt-holding pawl with the bolt forward. The pilot gunner, when readying the weapon for combat, pushes in on the charger button. The electric-powered solenoid opens an air valve on the charging device that throws the bolt rearward until it engages a sear that holds the assembly in a cocked position. The valve now releases the air, permitting the charger to return home from its own spring tension. On this recoil stroke of the bolt the belt-feed lever, actuated by lugs riding in grooves in the bolt body, moves a cartridge over to the edge of the feed mouth.

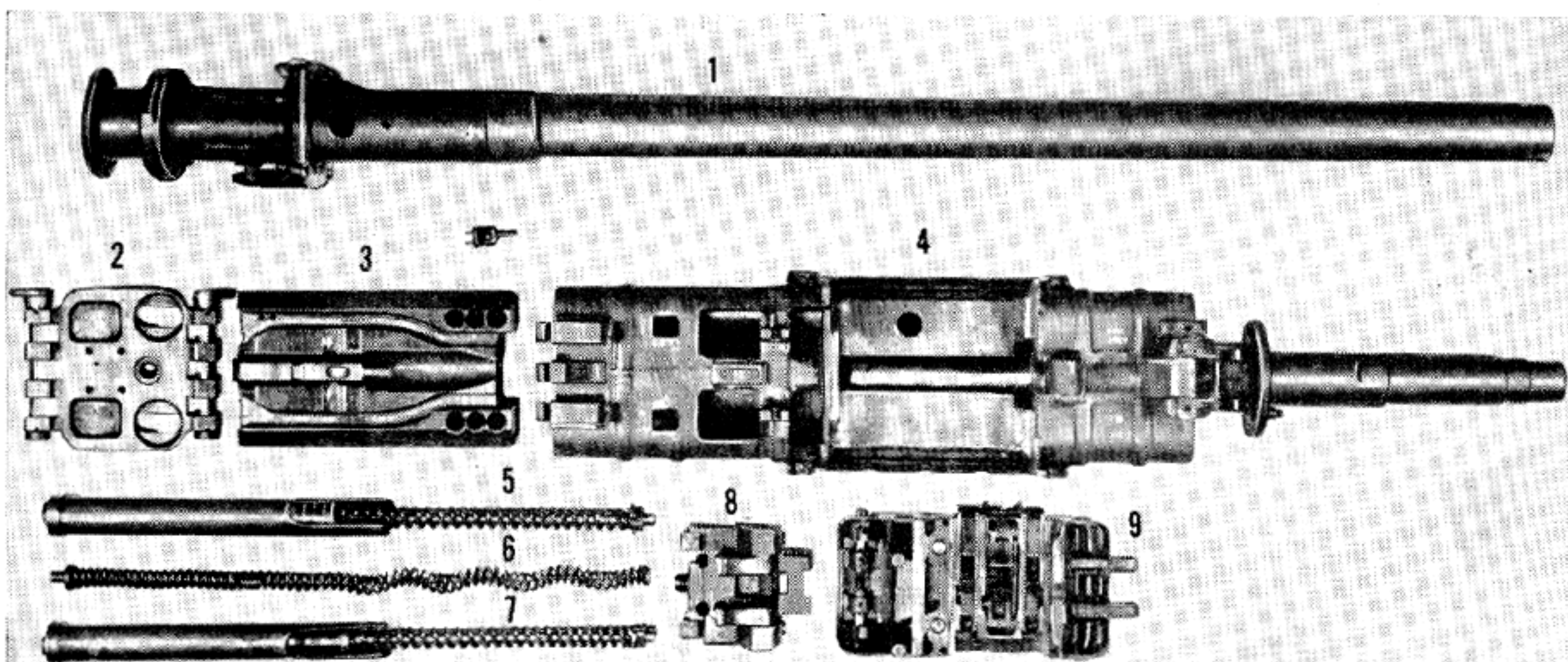
The gun is now cocked and a cartridge positioned for the next phase of operation. When the sear is released, the heavy bolt starts home under compression of the driving spring. Its first forward movement causes the incoming round to be moved over the necessary distance to be indexed. The bolt face, which is narrower than the cartridge width, contacts the base of the cartridge pushing it through the link into the chamber. At a distance of one-sixteenth inch be-

fore final movement is halted by complete chambering, an electric contact is made that energizes the firing pin.

This detonates the electric primer, but the time delay is enough to allow the bolt to go still farther into battery. Actual explosion of the propellant takes place while the bolt is still traveling at full speed forward. This permits the projectile to clear the bore of the weapon before the heavy bolt can begin recoil movement. The lubricated cartridge case is free to exert full blow-back pressure on the face of the bolt which starts recoiling immediately after the projectile clears.

The cartridge case is supported by the extractor until the bolt face clears the rear end of the link at which time a dog rises to stop travel of the empty case leaving it in link. Continued movement of the bolt to the rear causes the feed arms to move the belt over three-fourths of a space shoving the empty case and link outside the receiver. The bolt recoil is stopped by compression of the two strong driving springs which places the action into counterrecoil to repeat the cycle if the solenoid remains actuated.

The Luftwaffe's operational tactics were altered to meet the attacks of Allied heavy bombers, and fighter aircraft were required to strike



Rheinmetall 30-mm Automatic Aircraft Cannon, MK-108, Disassembled. (1) Blast Tube. (2) Back Plate Assembly. (3) Bolt Assembly. (4) Receiver and Barrel Assembly. (5 and 7) Driving Spring Assembly. (6) Charger Spring Assembly. (8) Sear Plate Assembly. (9) Feed Cover Plate Assembly.



at very short range well inside the fighter screen. For this purpose the light MK-108 gun (135 pounds) with lower muzzle velocity but with a high-capacity high-explosive projectile was very efficient.

This gun was nicknamed the "pavement buster" by American ordnance men, due to its appearance and to its slow but steady rate of fire which sounded like the very common pneumatic-power tool. All ammunition made for this weapon was either high explosive or incendiary tracer, as its low muzzle velocity ruled out the practicability of using either the ball or armor-

piercing types. The short barrel, which is a big factor in excessive muzzle flash, was compensated for by using a long blast tube in all mountings. This not only dampened out the flash, but allowed the blast to be trapped and bled off to prevent damage to the skin surfaces of planes.

The weapon represents the highest degree of efficiency that the Becker system has been brought to and was remarkable in many ways. It was most fortunate for the Allies that its production and mounting in jet planes was not started earlier, as it accounted for many B-17s during the latter days of World War II.



# BIRKIGT TYPE 404 20-MM (HISPANO-SUIZA) CANNON

## Early History of Hispano-Suiza Company

The Société Française Hispano-Suiza S. A., located in Bois Colombes, France, a Parisian suburb, emerged from World War I as one of the most famous aircraft engine manufacturers in the world. This firm was first organized in 1904 for the manufacture of automobiles in Barcelona, Spain, by a Swiss engineer, Marc Birkigt, with the financial support of the Spanish King Alfonso XIII (hence the name Hispano-Suiza, meaning Spanish-Swiss). A plant in Paris was founded the same year, which became headquarters for the organization. During World War I it played no small part in contributing to victory as its battle-tested power plants were used after August 1914 in practically all first-line Allied fighting planes. The Spad, perhaps, was the most outstanding of such aircraft. This important work was done under the

supervision and control of Marc Birkigt, the technical director, Ferdinand Foure, the company's chief designer, and Louis Massuger, the head engineer.

The firm and its officials did not confine their war efforts to the production of aircraft engines. As early as 1917, Birkigt solved one of the most intricate of all problems that faced ordnance engineers, namely, how to fire an unsynchronized gun forward without hitting the whirling propeller. Birkigt conceived a method of mounting an automatic cannon between two banks of cylinders in the engine and firing through an offset hollow propeller shaft. He not only put his idea into operation but produced it in time for fairly extensive use during the last days of the war.

This original 37-mm motor cannon was effectively used against aircraft made of wood and fabric, when supplied with a smooth bore barrel and canister shot. The shot was made up of 24 half-inch steel balls and when fired point blank at enemy aircraft, one round usually decided the contest. French aces, such as Maj. René Fonck and Capt. Georges Guynemer, logged several planes shot down with the company's new aid to aerial warfare. This method of fire power was soon temporarily superseded by high-speed larger caliber machine guns mounted in the wings outside the propeller arc.

The company continued to prosper following the war, keeping pace with the many advances made in aircraft engines, automobiles, and its other products. The corporation at this time was under the control of Marc Birkigt, his son, Louis, and Prince Stanislaus Poniatowski, the latter being the grandson of the last Polish king.

In the early thirties a revival of interest in cannon mounted in aircraft caused even the highest military authorities to predict the passing of the machine gun as aircraft armament.



Marc Birkigt, Designer of the Hispano-Suiza 20-mm Automatic Aircraft Cannon, Type 404.



The Hispano Co., owning patent rights to the accepted method of firing through the hollow propeller shaft, began to seek a suitable light-weight cannon to place in its engine mountings. It decided upon the Oerlikon gun, which was highly esteemed by the French Air Force.

This automatic cannon was of Swiss manufacture, being made at the Zürich plant of the Oerlikon Co. After some delay, the Hispano-Suiza Co., at the request of the French Air Ministry, obtained a license to produce the weapon at its Bois Colombes plant. During the time that Hispano made the gun under license, both Marc and Louis Birkigt patented improvements on the mechanism and the feed. Oddly enough, in each instance the improvement was given as applicable to machine tool and engine adaptation and the word "gun" was at no time mentioned. In this period the Birkigts applied for and received five patents relating to motor mounting of the Oerlikon automatic cannon. All weapons made by Hispano-Suiza under Oerlikon license were given the designation, Hispano-Suiza Automatic Aircraft 20-mm Cannon, Types 7 and 9, to distinguish them from those made by the parent company. The only difference in the two types made in France was in methods of mounting, the operational parts being identical with those of the Oerlikon F or Becker model.

The Hispano and Oerlikon companies, shortly after production began, disagreed over patent rights of certain features originated by the Birkigts, and business connections between the two firms came to an end. The French manufacture of the Types 7 and 9 cannon continued, however, until the expiration of the license. Marc Birkigt now turned his attention to developing an automatic cannon that would be produced and owned outright by the Hispano-Suiza Co.

### Earliest Birkigt Type 404 Cannon

In 1933 Birkigt began work on the devisement of a weapon he later produced successfully. This mechanism could in no sense rise to the dignity of an invention, the principles involved having been long known by those who followed the profession of gun design. A combination of already established methods of operation was arranged

in such a manner as to result in a shooting prototype.

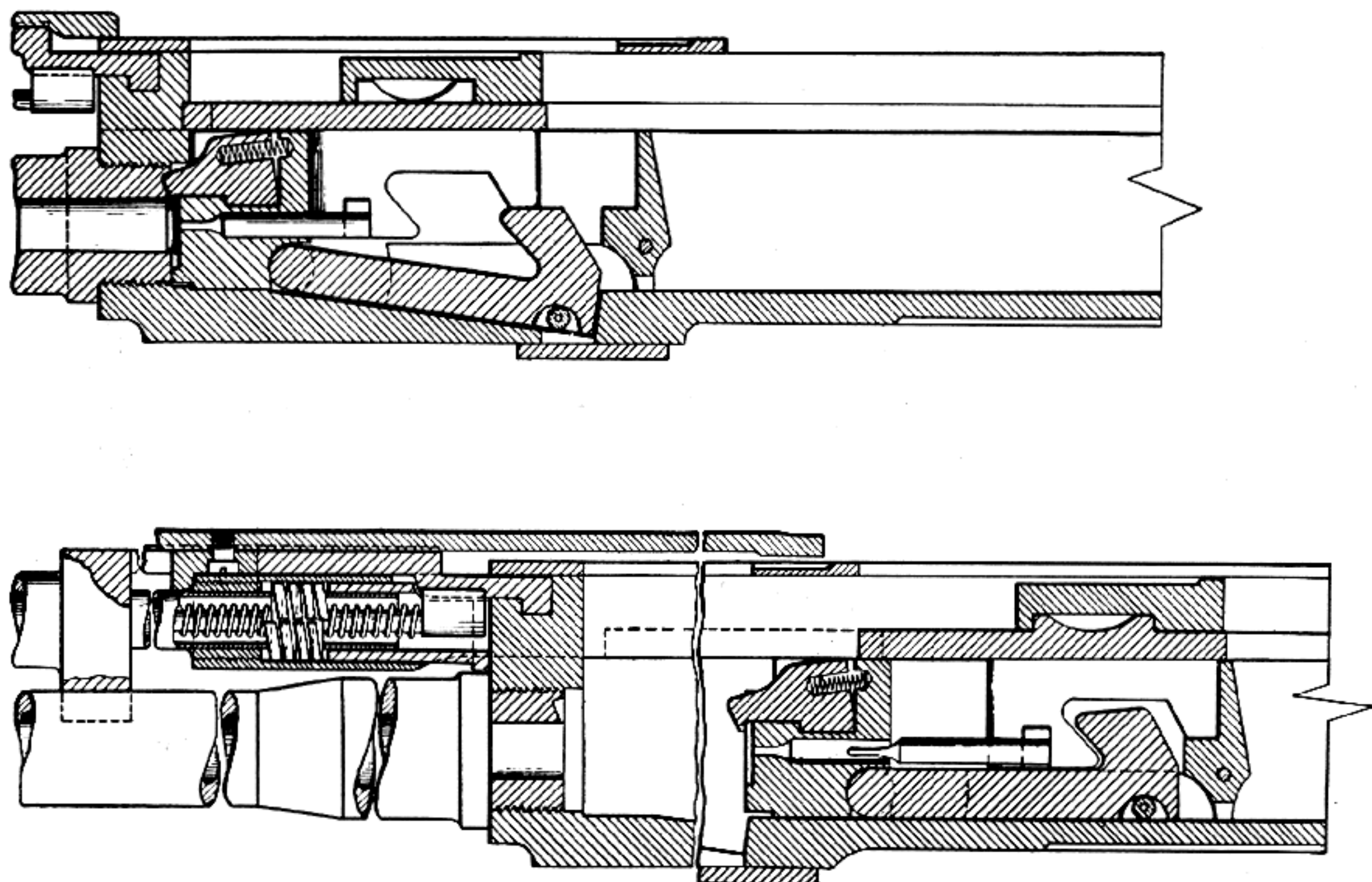
Its system of locking was covered in a patent application by Carl Swebilius, one of the most prolific machine-gun inventors the United States has even known and rated by many as second only to John M. Browning. As early as 15 March 1919, Swebilius applied for a patent on a firing mechanism for an automatic gun. The principal parts included a gas-operated piston that actuated a bolt and extension. The lock was the swinging type that was cammed down into position by the continued advancement of the slide or bolt extension. After the lock had been forced down behind the locking step, the slide, to which the firing pin was attached, insured that the weapon had to be securely locked before the pin could advance and strike the primer. When the gas piston was driven back by gas pressure, an ear on the slide (or extension) would lift the lock up out of its recess into the bolt body where it would then recoil as a part of this piece.

The Italian designer, Alfredo Scotti, can also be credited with several basic principles that were incorporated in the original Birkigt gun. In 1928 a series of machine guns and automatic cannon designed by Scotti began to make their appearance on the Continent. This inventor, who maintained his offices in Brescia, Italy, always depended upon companies with manufacturing facilities to make and promote the sale of his own weapons. His activities were by no means confined to his native land. To handle the distribution of his products outside Italy, he established the Scotti-Zürich Co., a firm located in Zürich, Switzerland. The main components for his guns were made by the nearby Oerlikon Co.

In November 1932 Oerlikon purchased outright the Scotti-Zürich concern, including patent rights for every nation except Italy, utilization of which was reserved for the Isotta-Fraschini company of Milan. The only variations in any Scotti-designed gun were in caliber and means of mounting. He invariably used a system originated by him of combining gas unlocking with blow back.

An outline of Scotti's method of operation, as described by the inventor, is given here in order that one may compare it with the functioning of the weapon later offered by Marc Birkigt.





The Method of Locking Patented by Carl Swebilius.

"The firing pin is housed inside the bolt body and is attached to slides that upon removal of the obstruction of the locking piece are forced forward by both inertia and driving spring pressure. The firing pin is directed into the primer which detonates the propellant charge. When the projectile passes the port in the barrel, sufficient gas is 'bled' into a cylinder that houses the gas piston. This closely metered gas gives the piston a slow thrust movement backward at just the right instant to permit the contiguous slides to move rearward. They unlock the bolt while a high residual pressure remains in the bore. The angle on the locking face is so abrupt as to require very little effort to unlock. In fact, the gas pressure acting on the face of the bolt would cause the piece to be freed if the lock was not covered by the slides. When the latter have been retracted with the attached firing pin, the whole mechanism starts to the rear with the operational force now coming from the remaining gas pressure or 'blow back,' the empty lubricated car-

tridge case being held to the bolt face by the extractor until struck by the ejector."

Scotti used a rotating bolt head for the purpose of locking, while the weapon devised by Marc Birkigt, used the pivoting or swinging type of lock, which was cammed down by slides, the energy being derived from the combination of inertia and driving spring compression. The firing pin, being attached to the slides or bolt extension, could only go forward to fire the cartridge after the weapon was securely locked, as already described in the Swebilius patent.

Since these patents not only were in existence but were well known years in advance of the Hispano-Suiza design, it is hard to see, when the major features of Swebilius and Scotti are combined, what is left in Birkigt's weapon that can be classified as original.

Upon hearing of the successful manufacture of this automatic cannon with its unusually high rate of fire, the French Air Ministry notified the



May 23, 1939.

M. BIRKIGT

AUTOMATIC FIREARM

Filed April 16, 1938

2,159,127

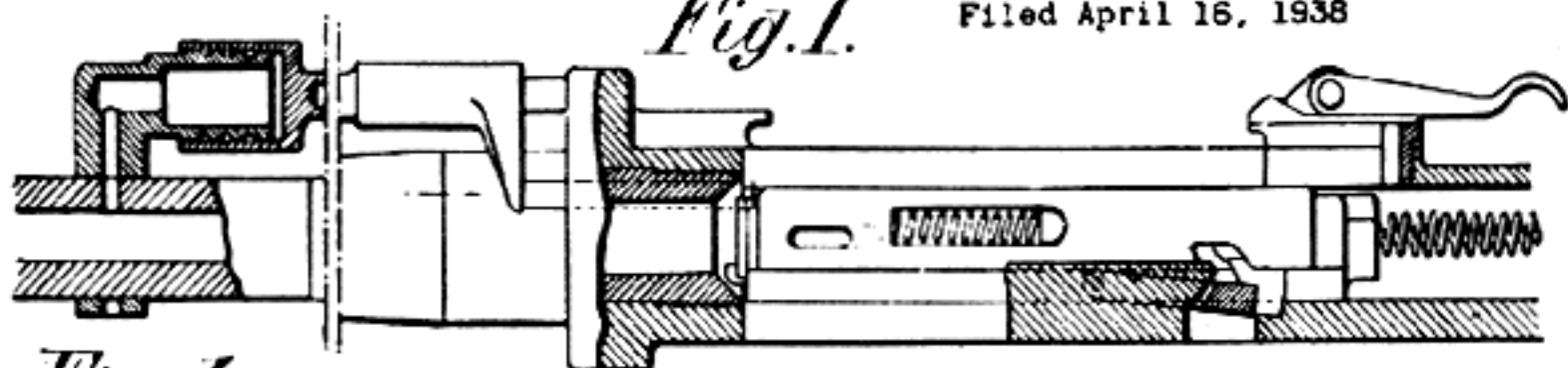


Fig. 1.

Fig. 4.



Fig. 3.

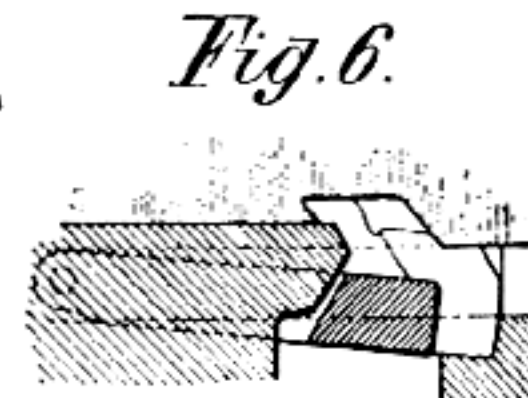
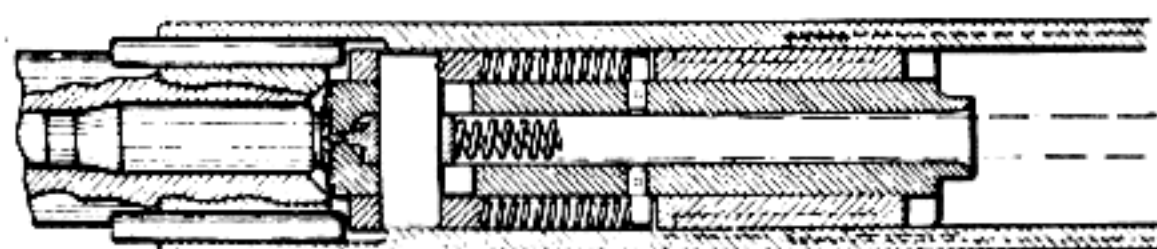


Fig. 6.

Fig. 5.

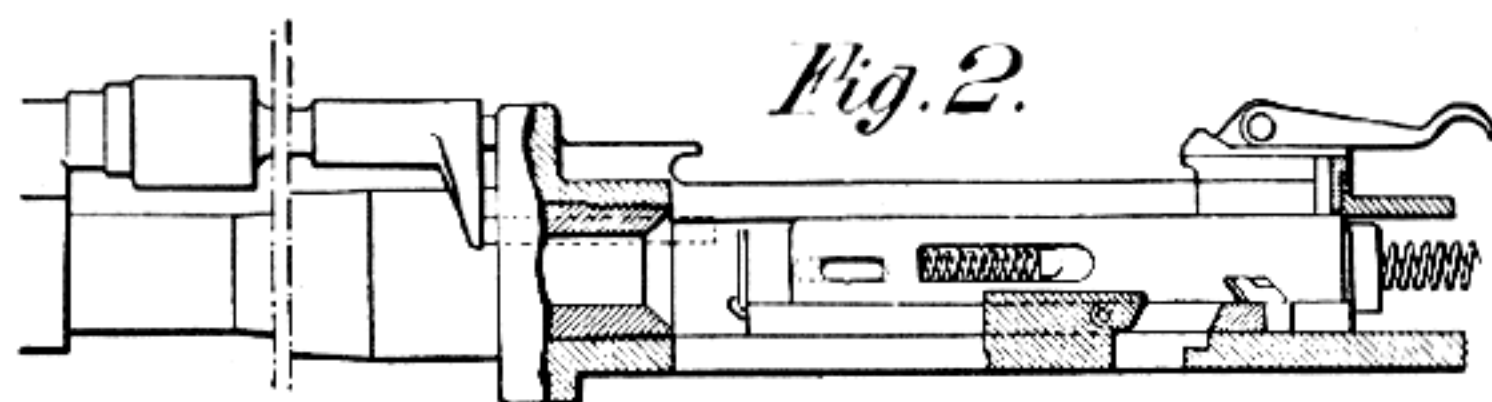
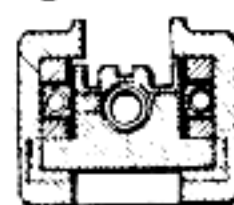


Fig. 2.

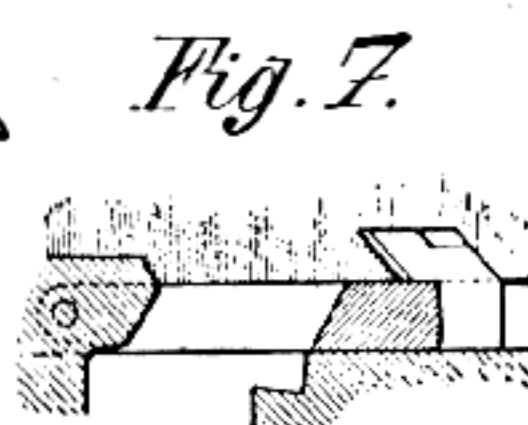


Fig. 7.

Inventor:  
*Marc Birkigt*  
*Barley & Carson Attorneys*

The Method of Locking Patented by Marc Birkigt.

Hispano company that no other country could be offered the weapon without its approval. Three countries, England, Russia, and Czechoslovakia, learning of experimental results through their military attachés, began to make overtures to the Hispano-Suiza company to purchase the cannon for testing purposes.

A rumor that a 23-mm version was sold to Russia without the consent of the Air Ministry placed the whole project practically under secret status. It was charged and denied on the floor of the Chamber of Deputies that the Russian sale had taken place. The Czechoslovakian Commission was unable to obtain official Government sanction to buy the gun and not until the fall of 1936 were British representatives permitted to see it in action.

The men given this privilege were Group Capt. C. H. Keith, R. A. F., and Christopher Bilney, Chief of the Operational Requirements Branch, who were invited by Hispano-Suiza to witness the function firing of a Birkigt auto-

matic 20-mm aircraft cannon. This weapon had been designed for engine installation, since the company was the original promoter of this system of mounting. A firing range had been improvised in an ancient fort at Bouviers, where the new cannon was mounted alongside an Oerlikon. The latter was fired first with creditable results. Then the Birkigt gun was fired and its amazingly high rate, estimated at 700 rounds a minute greatly impressed the British officers. Upon request the parts were disassembled before them, and attention was called to the small number of operational components, and their simple but rugged construction.

The main feature was then pointed out that the gun worked from both gas and blow-back. With this system the breech was completely locked as long as the projectile was in the bore. It not only insured safety but allowed the use of a light bolt. As a result an additional 200 rounds a minute rate over the Oerlikon was reached.



## Cycle of Operation

To fire the 20-mm Hispano-Suiza (Birkigt) automatic gun, the operator must first see that each cartridge case has been liberally lubricated before being placed into the magazine, after which the loaded feed is snapped into position on top of the receiver. Spring pressure positions the first round resting on top of the bolt, which is in battery.

The charging assembly is then pulled completely to the rear or until the sear is securely engaged in its recess under the bolt body. Upon release, the charging unit goes home under its own spring tension. The passing of the bolt rib under the feed mouth allows the incoming cartridge to drop a fraction of an inch for final positioning.

The gun is now in the cocked bolt position and release of the sear allows the driving spring to force the bolt and its components forward. As the front face of the bolt passes under the rear of the feed mouth, it engages the rim of the cartridge, forcing it down into the extractor claws, and continues to push it towards the chamber. Continued travel completes the seating of the cartridge and the forward motion of the bolt is finally stopped by contact with the barrel and receiver. At the instant of impact the breechblock lock is cammed downward into locked position against its locking key, held securely by the continued travel of the slides.

The latter, which are connected through the bolt body by means of a key that carries the firing pin, are now driven on by the combined action of the breechblock-slide springs and the inertia of the entire assembly, causing the firing pin to strike the primer. The powder charge in the cartridge is thereby ignited. The bolt is positively locked at the instant of firing and remains that way until the projectile has passed the port in the barrel, at which point gas is bled into the cylinder that houses the actuating piston.

As soon as the gas piston moves to the rear, its yoke contacts two push rods that in turn engage the slides through the receiver body. The movement of the slides retracts the firing pin for a stroke of three-fourths inch. It also permits the breech lock to rise and unlock after the projectile has cleared the bore, while a high residual

pressure still is present to drive the bolt rearward.

The lubricated cartridge case is now floating in the chamber and when the breech lock is suddenly raised, the remaining chamber pressure is brought to bear on the face of the bolt. The latter starts to the rear with the extractor acting merely as a guide and support under the empty cartridge case. When the bolt face passes beneath the feed mouth, the ejector prongs strike the rim of the empty case pivoting it downwards through the ejection slot in the bottom of the receiver and the spring tension in the feed positions another round for chambering. The bolt continues to travel rearward, compressing the driving spring. At the end of the recoil stroke, it strikes the rear buffer. The latter returns the bolt in counterrecoil to repeat the cycle of operation if the sear remains depressed.

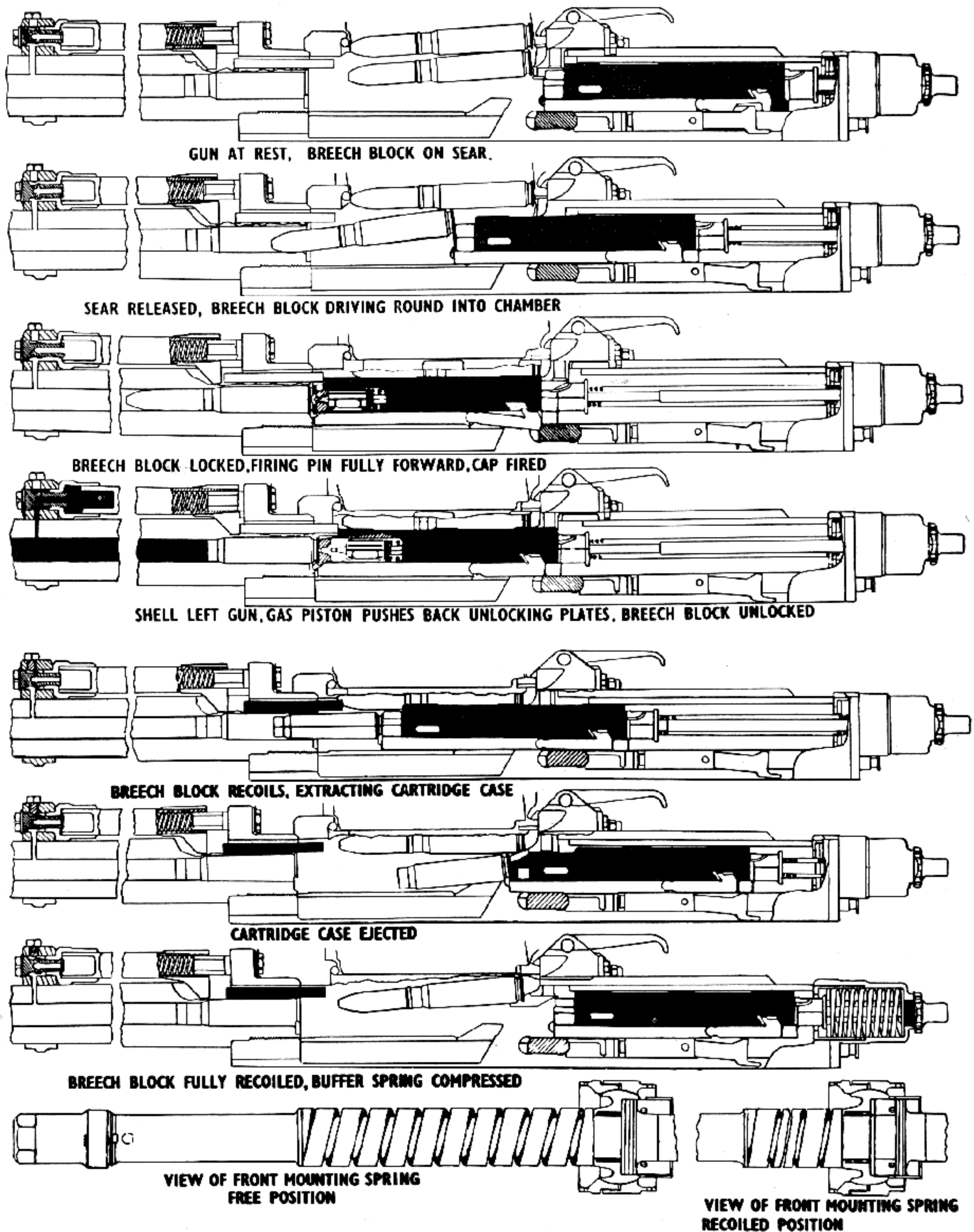
## British Adoption of the Gun

The British Commission, after informing its government of the gun's performance, sought permission from the French Air Ministry to purchase enough of the weapons to allow tests that would prove their worth. The French sanctioned the sale of six cannon to the British on the condition that their own air needs be met first.

The order for the six cannon was placed at once and its urgency was pointed out to Hispano-Suiza. Since the British were not interested in the cannon as an engine-mounted weapon, aircraft manufacturers had to have at least the physical dimensions in order to make a suitable wing or fuselage mounting. After some delay six wooden mock-ups were flown over to the British followed by a barrel and bolt assembly. This allowed proof firing of the barrel and experiments with ammunition of English manufacture.

The delay in actually delivering even one of the six guns on order caused the British authorities to notify the Hispano-Suiza officials that, unless the agreement was promptly met, the whole deal would have to be canceled. In reply the firm stated its intention of delivering the guns promised. The first such weapon was received in January 1937 and underwent tests at the Aeroplane and Armament Experimental Es-





Section Views of the Hispano-Suiza Action.



establishment at Martlesham Heath. Three more weapons awaited acceptance tests in March of the same year. In addition, the factory proposed the establishment of a Hispano-Suiza plant in England if given a token order for 400 cannon.

As the latter was exactly what the commission had ultimately hoped to accomplish, a contract was signed immediately. The French concern employed Dennis Kendall, an Englishman, as the managing director. This connection with Kendall, who had a successful background as production engineer with the Citroën motor car firm of France, was very fortunate for both Hispano-Suiza and the British Empire. His selection of a site near Grantham and the buying and arranging of necessary machinery and power tools in a short space of time were feats of no small proportions. The plant was constructed and by late December 1938 on land that had been leased only 6 months earlier, the first English-made Hispano-Suiza automatic cannon Type 404 was ready to be fired. In addition to the factory, a fine testing range had also been completed at the same time.

On 19 January 1939 an official ceremony was held with many important people present, among them the King, the Queen, and the Duke and Duchess of Gloucester. After the usual ceremony that accompanies an affair of such a nature, an inspection of the plant and its facilities was made. At its conclusion, the King personally fired a burst from the first cannon, the prototype of thousands that were to follow.

This newly formed company was given the harmless sounding name of British Manufacture & Research Co. The initials were at once picked up to nickname the gun the British "Mark," under which title it operated from that time on.

Very few official acts of the British showed their desperate need for an adequate aircraft cannon as much as did their dealings with the Hispano-Suiza Co. After witnessing just one firing demonstration in France and proofing a single barrel in England, they committed themselves so far as to contract almost without reservation with the Birkigt firm.

After production got under way at Grantham, the British Navy became interested in the 404 as a possible shipboard fast-firing cannon for anti-aircraft use. The Royal Navy had already con-

ducted tests on everything ranging from .303 caliber to two-pounders. The .303 had been dropped because of lack of range and destructive effect. The two-pounder was ruled out because of the necessity for skilled maintenance and the difficulty in hitting fast targets with a single-barrel model, while a multibarrel version was considered entirely too heavy for practical use.

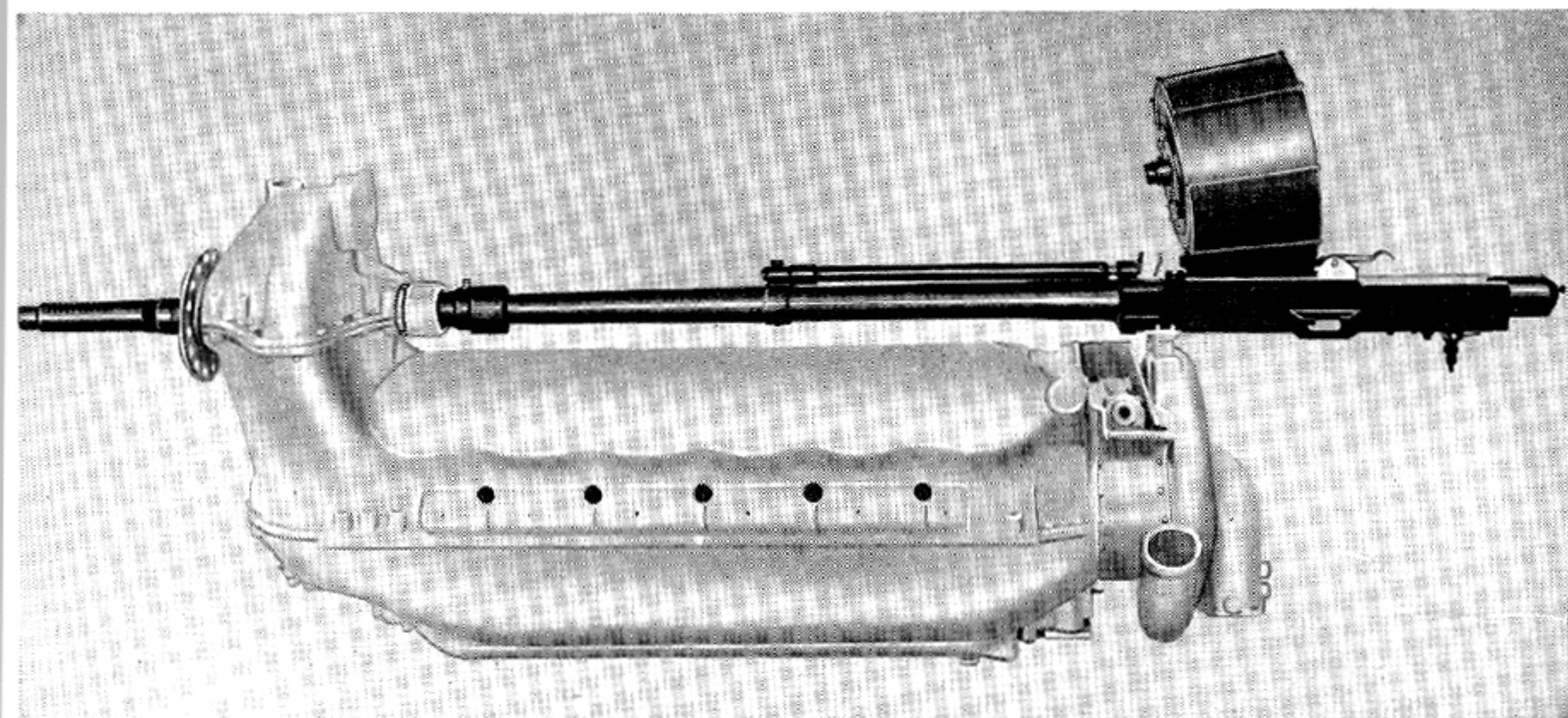
Twenty millimeters was eventually chosen as best for the purpose, it being the largest dimension suitable for shoulder control and the smallest to offer a worthwhile high-explosive projectile. It offered also possibilities for an exceptionally high rate of fire. The new Hispano-Suiza cannon was tested alongside the Oerlikon and the results were most disappointing as far as the Hispano-Suiza was concerned. The navy reported that, while its use in aircraft might prove satisfactory, it could in no way compare with the Oerlikon for shipboard service.

The English-produced gun was called the Hispano-Suiza Type 404, the model made in France being designated the Hispano-Suiza Birkigt Type 404. The Royal Air Force worked with the Procurement Board to iron out many malfunctions and manufacturing difficulties that naturally arose in putting into production an inadequately tested weapon. The British viewpoint was that war was imminent and the desperate need for armament at the moment made necessary the most rapid development work possible under the circumstances.

One of the first needs was a suitable wing mounting since the weapon in its present state could only be installed in the V block of an engine. The French firm, Société d'Applications des Machines Motrices, developed a recoil cradle that was used first in the Spitfires and Hurricanes. This mounting was always referred to as the S.A.M.M. cradle, from the initials of the firm that manufactured it.

It is a matter of record that, when World War II commenced, the British had a modest number of locally made guns, the reliability of which under simulated combat conditions had not been impressive. In fact, the Hispano weapon was actually developed during the critical days of the Battle of Britain. The report of the first Spitfire pilot to engage the enemy with the can-





Hispano-Suiza "Birkigt" 20-mm Automatic Aircraft Cannon, Type 404. Mounted on a Hispano-Suiza 12-Cylinder Engine to Fire through the Propeller Hub.

non stated that "upon opening fire against the enemy one gun jammed on the first round, and the recoil of the one remaining wing gun threw the axis of the airplane off line so that the enemy escaped before effective fire could be delivered. The second gun jammed after 30 rounds."

After this rather disheartening start the British, taking advantage of every failure, kept making changes wherever possible by close study and rechecking of design to improve performance. And in less than a year's time they had an aircraft cannon which was never phenomenal in its performance but did have an acceptable degree of reliability.

One of the worst features of the original gun was its feed system. It was an exceptionally large 60-shot drum arrangement that not only carried too small an ammunition supply but was limited in its possibilities of mounting by its cumbersome and bulky design. Well before the contract with the British had been approved by the French Air Ministry, the latter government's air force, also observing faults in the drum arrangement, began work at the manufacturing arsenal at Chatellerault on a feed that would employ a metal disintegrating belt. This design was still under way when the critical British need for it, plus the possibility of German occupation of France before its completion, re-

sulted in the French making all drawings and working models available to the British.

The feed, as received by the English ordnance engineers, needed many improvements before it could be expected to work and they were soon forthcoming. With the smaller profile of the new feed, British planes appeared with Hispano-Suiza cannon mounted in groups of four where heretofore it had been possible to fix no more than two. And while the French did not furnish the Royal Air Force with a workable feeder and much necessary improvement and redesign had to be done, they must be given full credit for the basic idea that was found in the Chatellerault feed upon which all successful systems of a similar nature have been constructed.

The French Air Force, upon delivery of the first Birkigt Type 404 guns of the original 20 that were ordered, mounted them in a single-seater Dewoitine fighter equipped with a Hispano-Suiza motor. The cannon were engine-mounted and fired through the propeller hub. The standard 60-shot drum was also used, since the new Chatellerault feeder had not reached a state of reliability. And while other types of French planes were equipped with the cannon as fast as production allowed, they saw little use because of the German occupation of the country.



## American Negotiations for the Cannon

In 1936 the United States Navy, after coming to the conclusion that a heavier aircraft machine gun than the caliber .50 would be needed to protect the fleet adequately from heavy bomber attack, turned its attention to the procurement of a larger automatic weapon with a caliber of approximately 20 mms, since that bore represented practically the smallest dimension of a projectile with enough bursting charge to inflict appreciable damage and still be large enough to permit fuzing. The Navy instructed its overseas attachés to check all tests being conducted in Europe and to notify the Bureau of Ordnance as to what weapons not only merited consideration but were readily available.

Reports indicate that four different weapons falling into this classification were considered worthy and the purchase of four each was authorized for testing purposes. The weapons in question were the Danish Madsen, the German Rheinmetall-Borsig, and the two Swiss models, Solothurn and Oerlikon. It was also specified that catalogs showing the construction, maintenance, and cycle of operation of each gun be transmitted with each weapon, together with ammunition price lists. With each gun there was to be a minimum of 400 rounds of each type of ammunition per gun, so that after their arrival demonstrations and tests could begin at the various Navy proving grounds. Actually, because of costs and other considerations, tests were carried out only on four 23-mm Madsen guns.

The development of the Birkigt gun was followed closely by both United States Navy and Army attachés in France. On 27 February 1937 the War Department authorized its attaché to "ascertain prices and dates of delivery of one and four Hispano-Suiza aircraft cannon Birkigt design, French manufacture, for both 20 and 23 mm, complete with fixed and flexible mounts, sights and accessories, and 500 rounds of explosive shell." The Department was informed that the 23-mm gun was in experimental status, that only the 20-mm gun could be considered far enough along to warrant interest and that authority to purchase it would be requested of the French Government.

At the same time information was desired on

the progress toward the 25-mm Hotchkiss aircraft cannon. If thought ready for trial, a request for purchase would be initiated. However, the French Bureau de Cessions de Materiel a l'Etranger, on 9 March 1937, informed the American representative that the Hotchkiss gun was still in secret status. Permission was granted to purchase Hispano-Suiza guns and the following message was sent back to Washington:

"Birkigt 23-mm examined . . . but not fully developed. No gun this caliber has left Hispano-Suiza factory. British have purchased nine cannon of similar type except for caliber which was 20-mm Birkigt design for motor mount only. \$3,500 quoted for gun, crank-case mount, magazine and tools. Same unit price for four guns, ammunition with inert projectile, \$2 each, explosive projectiles \$4 each. 45 days Paris delivery."

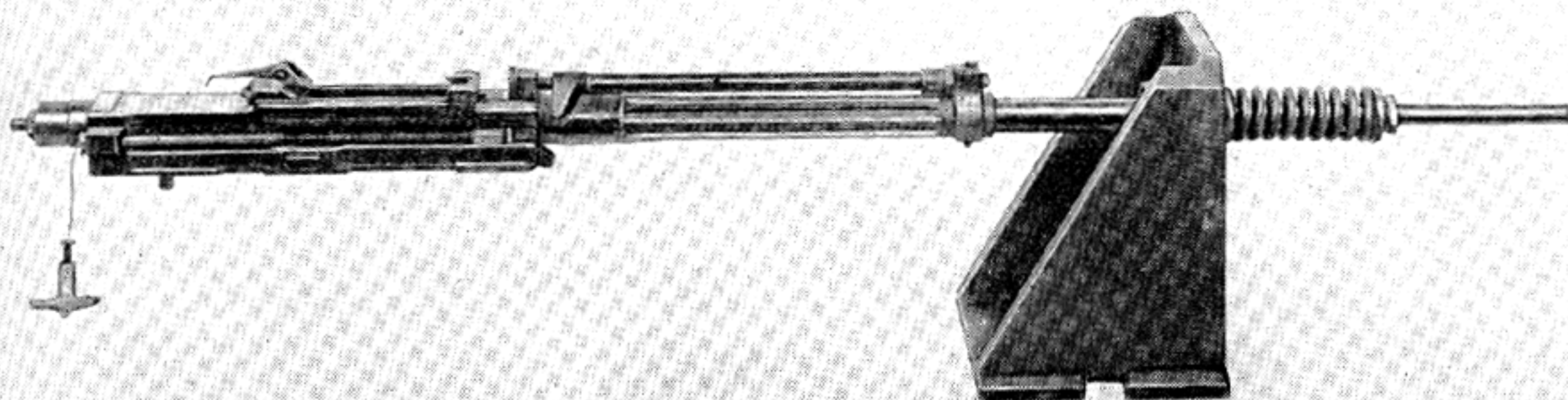
On 11 March 1937 the Army's technical expert in Europe sent a description of the complete breakdown of the Hispano-Suiza Birkigt Type 404 automatic gun, together with the manufacturer's specifications translated from French to English. The comments made by this authority are of unusual interest today, particularly the following quotation:

"The gun has been characterized by the undersigned as gas operated and locked breech. Sufficient gas is tapped off from the barrel to unlock the breech. Thereafter blow back comes into operation. It is interesting to note that this is the principle advocated by Alfredo Scotti, an Italian inventor of automatic weapons. Particular attention is invited to the use of lubricated cartridges which is said to be necessary for the functioning of the gun."

The writer also declared that he had seen a 23-mm gun differing from the 20-mm only in bore dimensions. When Prince Poniatowski was questioned whether this model had been sold to the Russians, he stated that "no 23-mm Hispano-Suiza gun has left the factory to this time." In addition to the 23-mm aircraft gun, a second and similar version was observed. It had a shorter barrel and employed a somewhat different system of mounting.

The American Ordnance Department, after considering the unusual interest that the British had shown in the gun from the very first and





Hispano-Suiza 20/60 Automatic Aircraft Cannon. Experimental Model Manufactured by the British M.A.R. Company.

the fact that they were doing more to develop the weapon than were the French, ordered its representatives abroad to watch very keenly production and refinement activities on the weapon. Since events were taking shape that might make the two countries allies at any moment, any information requested by our attachés was freely passed on.

On 27 July 1937 a procurement authority was sent to the Hispano-Suiza officials, signed by the Assistant Secretary of War, carrying an allotment of \$8,000 for the purchase of one gun, 1,250 rounds of ammunition with inert projectiles, 600 with tracer elements and 150 with high explosive, together with a tool kit, a magazine and engine mount. Immediate delivery, if possible, was requested, but in any event the date must be no later than 11 November 1937.

This limit for fabrication and assembly was accepted by the French firm but it was not until 15 December of the same year that the material was presented for inspection. The delay was due in part to French nationalization of the Hispano factory under the laws passed in 1936. Although the factory was taken over by the government, the company maintained an office across the street which remained in private hands. After a visual check it was agreed to give the gun a 50-round function test before sending it to America. This took place on 22 December 1936, 10 rounds first being fired for accuracy, then 20 in short bursts, and over 20 in one continuous burst. The results were considered satisfactory and the manufacturer was asked to ship in accordance with instructions.

The Hispano-Suiza Co., upon beginning the

manufacture of Birkigt automatic cannon, started numbering them above 1,000, so as not to confuse them with its Oerlikon serial numbers. The cannon sent to this country had a series number of 1027; in other words, it was the twenty-seventh gun made by the company. The number also indicated delivery of the 20 guns which the French had demanded before any outside order was to be filled and of the original British order for six.

On 17 February 1938, aboard the U. S. S. *President Roosevelt*, the gun and its ammunition (except for 1,000 rounds with inert projectile) left Le Havre, France, arriving in New York on the twenty-sixth of the month. The remainder of the ammunition was sent on 1 March on the U. S. S. *Independence*, reaching port on the fourteenth. The whole shipment was sent to Aberdeen Proving Grounds, Md., for its first official American test.

Although the sample gun reached the United States in February 1938, Hispano-Suiza officials did not file for an American patent until 16 April of that year. When this was done, it showed alleged improvements over the first patent granted in Belgium 16 September 1935. One of the principal changes was the addition of ears to the breech lock that, when engaged with their mating notches in the slide, lifted the lock out of its recess. The original breech lock had no ears, the angle being such that it would unlock automatically as soon as the slide uncovered it.

The British made available to the United States at this time the results of a test showing the failure of an attempt to fire the weapon without lubricating the ammunition. They called at-



tention to the Hispano-Suiza manual, which stated that the first step in preparing the gun for action was to grease each cartridge before placement in the magazine. As this would present endless difficulties for aircraft use, the United States was requested to seek a solution to this problem. The British Air Ministry was prepared to exchange reports on it or any other similar subject.

On 9 March 1938 the Chief of the Bureau of Ordnance, U. S. Navy, addressed a memorandum to the Army's Chief of Ordnance, stating that the Navy would be willing to allot funds for experimental and development work on aircraft cannon, provided that the weapon decided upon met certain requirements. It was considered highly important that aircraft cannon, when adopted for Naval use, be manufactured in this country either from designs originating here or acquired from abroad. Based on reports from tests conducted in Europe of both the Hispano-Suiza and Oerlikon guns, either would be acceptable to the Navy if these requirements were met.

On 21 June 1938 the first official test of the Hispano-Suiza cannon, serial number 1027, began at the Army's proving ground at Aberdeen, Md., and continued until 5 August. The object was to observe the functioning of the weapon and ammunition. The report noted that lubrication of the ammunition was not necessary since the cases were provided with a coating of heavy wax. During the trials, which were little more than demonstrations before high ranking officials, only 81 rounds were expended in the whole period.

In the testing of this gun, 2,511 rounds of ammunition were fired from 21 June 1938 to 9 April 1940. In his report, the range officer ventured the opinion that the Hispano-Suiza cannon under test "was reliable in functioning, safe for use, and as an aircraft weapon merited serious consideration." A later report had the following remarks: "Endurance appears satisfactory but further firing is necessary to establish this. Lubrication of the cartridges is necessary. The extractor spring is not adequate to withstand continued firing. The lock may crack from continued firing." It was recommended that a more severe trial be run to prove these doubtful features.

The Navy followed the trials at Aberdeen very closely. A report from the Armament Section of the Bureau of Aeronautics to its Engineering Division on 15 March 1939, was made in order to bring that unit up to date on past cannon procurement and to prepare it for what to expect in the future. It is quoted at length, as it graphically describes the state of affairs at this time.

"... Although considerable preliminary investigation and discussion had occurred, it was not until about September 1935 that this bureau first acquired an aircraft cannon, which was a 20-mm Oerlikon, Type 9, gun to be used with Hispano-Suiza 12 YCRC engine. The engine and gun were tested by the Navy and, subsequently, turned over to the Army. The gun is still in Army custody but the engine has been returned to the Naval Aircraft Factory.

"The next procurement involved purchase of three 20-mm Oerlikon guns, one flexible Type L, and two wing guns Type FF. The flexible gun is now in custody of the Glenn L. Martin Co.; one wing gun is in custody of the Army and the other wing gun is at the Naval Air Station, Anacostia.

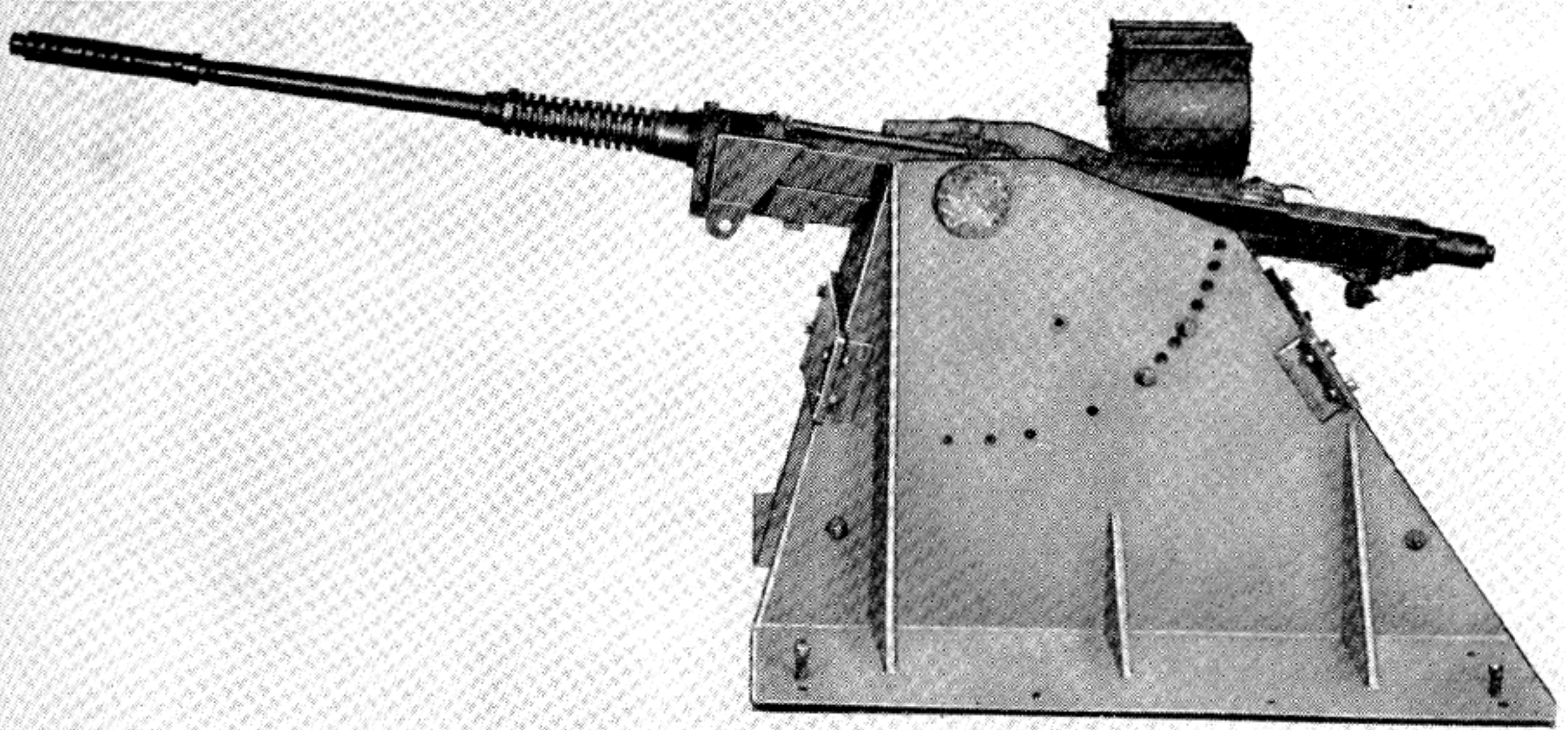
"In November 1936 the Army Development Program Sub-Committee met at Wright Field for the purpose of formulating a policy with regard to aircraft cannon development and procurement. While a Bureau of Aeronautics representative attended this conference, this bureau was not committed to the conclusions reached by the sub-committee. . . .

"In February 1937 a Joint Bureau of Aeronautics and Bureau of Ordnance Board met for the purpose of formulating a recommended armament program for naval aircraft. . . . For such uses as might be prescribed, guns of 20-23-mm were considered most satisfactory for Naval use.

"Pursuant to the foregoing this bureau recommended, 11 June 1937, procurement of seven aircraft cannon: three 20-mm Oerlikon, two 23-mm Madsen and two 20-mm Rheinmetall-Borsig. Because of cost and other considerations, the Bureau of Ordnance did not procure the above guns but, instead, purchased four 23-mm Madsens which have been delivered and are now at the Proving Ground awaiting test.

"In accordance with recommendation of the





Hispano-Suiza 30-mm Automatic Aircraft Cannon. This is an Experimental Model Manufactured in France.

Aeronautical Board that cognizance of the development of aircraft cannon be not assigned to either service to the exclusion of the other (recommendation approved by the Secretaries of War and Navy) and the stated willingness of the War Department to undertake any work in connection with aircraft cannon desired by the Navy, the Bureau of Ordnance transmitted, on 9 March 1938, to the Ordnance Department the characteristics considered necessary in a gun for Naval use. Information was requested as to whether any guns under development by the Ordnance Department met the above characteristics and, if not, whether the Ordnance Department would be willing to initiate such development during the fiscal year 1939.

"On 13 April 1938, the Bureau of Ordnance informed the Ordnance Department that it was interested in the Army automatic guns T1 (.9") and T2 and T3 (.9") guns and that it was proposed to make available to the Chief of the Ordnance Department about 1 July 1938 \$40,000 for the purpose of accelerating the development of the above listed guns.

"On 20 July 1938, this bureau requested, after conferences and understandings reached by representatives of the two bureaus, that the Bureau of Ordnance procure 20 23-mm Madsen guns and ammunition for installation in Model F2A-1

airplanes. The Bureau of Ordnance stated, in a letter dated 15 October 1938 that, as a matter of policy, it did not wish to equip any Navy planes with cannon of foreign manufacture. Accordingly, procurement of additional Madsen guns was not contemplated. At this time, however, the Ordnance Department was again requested to make available whatever information might be available concerning the Army T2-T3 guns then under development.

"Based upon disappointing developments to date, as well as further investigation and conversations with representatives of the Air Corps and Ordnance Department, this bureau and the Bureau of Ordnance have concluded that it is extremely doubtful that we are likely to be supplied with aircraft cannon of Army design or procurement within a reasonable number of years. Army Ordnance representatives are inclined to the same belief and, accordingly, no provision whatever is being made for installation of guns other than those now available, such as the 37-mm gun.

"Since it is not only desirable but essential that this bureau proceed at once with service tests of aircraft cannons firing explosive projectiles, representatives of this bureau and of the Bureau of Ordnance have concluded that the only possible manner in which such guns may



be acquired is by purchase of manufacturing rights by an American firm of a suitable foreign gun. The gun which appears to offer the most promise in this respect is the Hispano-Suiza (Birkigt) gun and accordingly negotiations to this end have been under way for some time with the Bendix Corp. Based upon possible procurement by the Navy and, possibly, Army, the Bendix Corp. has stated a willingness to proceed with negotiations toward acquirement of manufacturing rights, with possible delivery of these guns within one year.

"While the foregoing does not indicate a very satisfactory past, the future appears reasonably bright, since it now appears that we shall acquire the best known aircraft cannon within a period of approximately one year. In anticipation of future acquirement, this bureau is making provision for possible future installation of cannon in all applicable types, such as VF, VSB and VPB."

The Bendix Aviation Corp. was the only adequately equipped American factory that showed any interest in negotiating for a license to manufacture the Hispano-Suiza weapon. Through Army channels, the Bureau of Ordnance placed an order with Bendix for the manufacture of 20 guns. A memorandum from a very prominent Navy official perhaps stated the Navy's attitude about the whole business of cannon procurement when he said: "We have waited so long with so little results that I recommend strongly any cannon at any price in order to get some tangible results. I note with regret that even at this late date (3 June 1939) the proposal is to merely purchase a limited quantity for service test."

Bendix had made numerous attempts to procure American production rights even before the sample gun was delivered and as a result of the earlier inquiry, Hispano quoted a figure to take under consideration. The price stipulated was to be \$80,000 for manufacturing rights plus a royalty of \$400 a gun, provided a minimum of a hundred guns a year were produced. By this time Bendix felt justified in taking on a contract of such proportions and communicated its willingness to enter into the agreement.

Hispano, however, changed the terms to \$500,000 plus 10 percent royalty per gun, besides a 5

percent royalty on all ammunition produced. Again Bendix attempted to take steps to close the deal for the manufacturing privileges and before it could be consummated, the price was again increased to \$2,000,000.

This exorbitant demand forced Bendix to drop all further effort to obtain license, especially for an indeterminate number of experimental guns. It later turned out that the actual number to be given on the initial order was to be 33, of which 20 were to go to the Navy and 13 to the Army.

### Production of Hispano-Suiza Cannon by the United States

After months of negotiating through the State Department and military attachés, a contract was finally signed on 14 December 1939 and its terms officially approved by the Secretary of War on the eighteenth of December. The agreement was between the United States Government and the Suisse-Brevets-Aero-Mecaniques of Geneva, Switzerland, representing the Société Francaise Hispano-Suiza. The contract called for 33 Hispano (Birkigt) Type 404 Aircraft Guns and the Ordnance Department agreed to pay \$115,170, or \$3,490 per gun, plus \$141,830 for 59,500 cartridges, which was at a rate of \$2.38 each. In addition, the contract permitted the Ordnance Department to purchase all manufacturing rights within a year for \$425,000, plus a royalty of \$100 for each gun made.

At the time the contract was signed with the French company, our military attachés informed the Government that there were then four distinct models of the gun, as follows: The Types 404 caliber 20-mm, barrel length 1,600 mm, for motor mounting only; the 405 caliber 20-mm, barrel length 1,000 mm, designed to be mounted in turrets; the 406 caliber 23-mm, barrel length 1,150 mm, for turret installations; and the 407 caliber 23-mm, barrel length 1,600 mm, for engine mounting.

The Type 404 was considered the best for the purpose intended and interest in the other types was slight. Although the date of delivery for the first ten of the 33 guns ordered was scheduled for 28 February 1940, they were shipped ahead of time, arriving at Aberdeen Proving



Ground, Md., on 20 February, followed closely by the remainder which reached Aberdeen with 9,200 rounds of ammunition on 11 April.

Tests were started immediately and certain weaknesses were noted. Information was requested both from the French plant and the English firing ranges in order to remedy the various malfunctions.

The first six guns to be proof fired at Aberdeen were turned over to the Navy for testing at the Proving Ground at Dahlgren, Va. The rest, as soon as enough rounds were fired to prove any degree of reliability, were sent to various manufacturers of Navy aircraft for installation in experimental airplanes then under design.

On 11 April 1940 the Navy, through its Bureau of Ordnance, offered to stand half the cost with the Army in obtaining the Hispano-Suiza manufacturing license. On 12 April 1940 Gen. H. H. Arnold, Chief of the Army Air Forces, wrote to the Chief of Ordnance, U. S. Army, suggesting that immediate steps be taken to purchase production rights to the Hispano-Suiza gun on as large a scale as needed, and that an immediate order of 400 more guns from the French company be placed even before taking up the option. He also pointed out the desirability of standardizing the weapon as soon as possible. Quick action followed this suggestion and on 29 April 1940 the Chief of Ordnance recommended the immediate official adoption of the 20-mm Hispano-Suiza cannon.

Since receipt of manufacturing drawings of the gun from France would be delayed until the option had been officially taken up, Watervliet Arsenal, at Watervliet, N. Y., was ordered to prepare a set of drawings from a cannon sent there for study from the Army Proving Ground. As such blueprints were not considered suitable for contractors unfamiliar with the procedure necessary for mass production, all prospective bidders were informed that mechanical drawings would not be made available to them until they sent competent representatives to Watervliet. There they would study not only the gun's mechanism but likewise the accepted methods used for its manufacture. This was done to prevent or at least deter unqualified companies from bidding on the contract.

As a starter it was estimated that Air Force needs would be 456 for the fiscal year of 1941, while the Navy would require 100; therefore, 600 guns were planned for production to insure a surplus. However, when bids were sent out to a selected few firms on 10 July 1940, the requirements had been raised to 1,202 guns. Only three companies bid on producing the weapon. The Mergenthaler Linotype Co. was high with a price of \$2,875.28 for each gun produced; the National Pneumatic Co. was next with \$2,485.69; and the Bendix Aviation Corporation, Eclipse Division, was low with \$1,120.00 per gun.

Maj. Gen. C. M. Wesson, Chief of Army Ordnance, requested and received authority to reject all other bids and negotiate a contract with the Bendix Aviation Corp. for the amount of their offer. Bendix had a great advantage in bidding as its earlier and unsuccessful attempts to negotiate a license with the parent firm gave it insight not only on what would be necessary to meet the requirements of manufacture but also what the cost per unit would be.

This favorable position, brought about by earlier negotiations, made it possible for the firm to offer a reasonable bid from the start. On 23 September 1940 the contract was approved. It not only provided for the manufacture of immediate requirements but also permitted the Army to order up to a total of 5,000 at the stipulated price. This act, where a major power officially adopted a weapon of foreign origin and ordered its manufacture before obtaining a license from its owners, was perhaps without parallel in ordnance history.

Even after French drawings were available, those based on the one gun at Watervliet saved so much time over converting the French metric measurements to English units, that it was decided to start manufacture as originally planned, using the Watervliet prints. One of the original features that was overlooked in this procedure was the use of a braided wire driving spring.

The contract was signed on 6 November 1940 between the United States Government and the Brevets-Aero-Mecaniques S. A., of Geneva, Switzerland, whereby the United States would pay \$425,000 for the drawings and engineering data and \$35 for each gun, plus \$40 royalties. "In other words, for each receiver made which



by agreement of both parties would constitute a gun (all other components not counting), the United States agreed to pay the sum of \$75 to represent royalty or manufacturing know-how."

The Eclipse Machine Division of Bendix Aviation Corp. started tooling for production and of 1,202 on order 500 were for the Navy. All of this lot were the Type M1, as the American-made weapon was initially called, with delivery scheduled for May 1941.

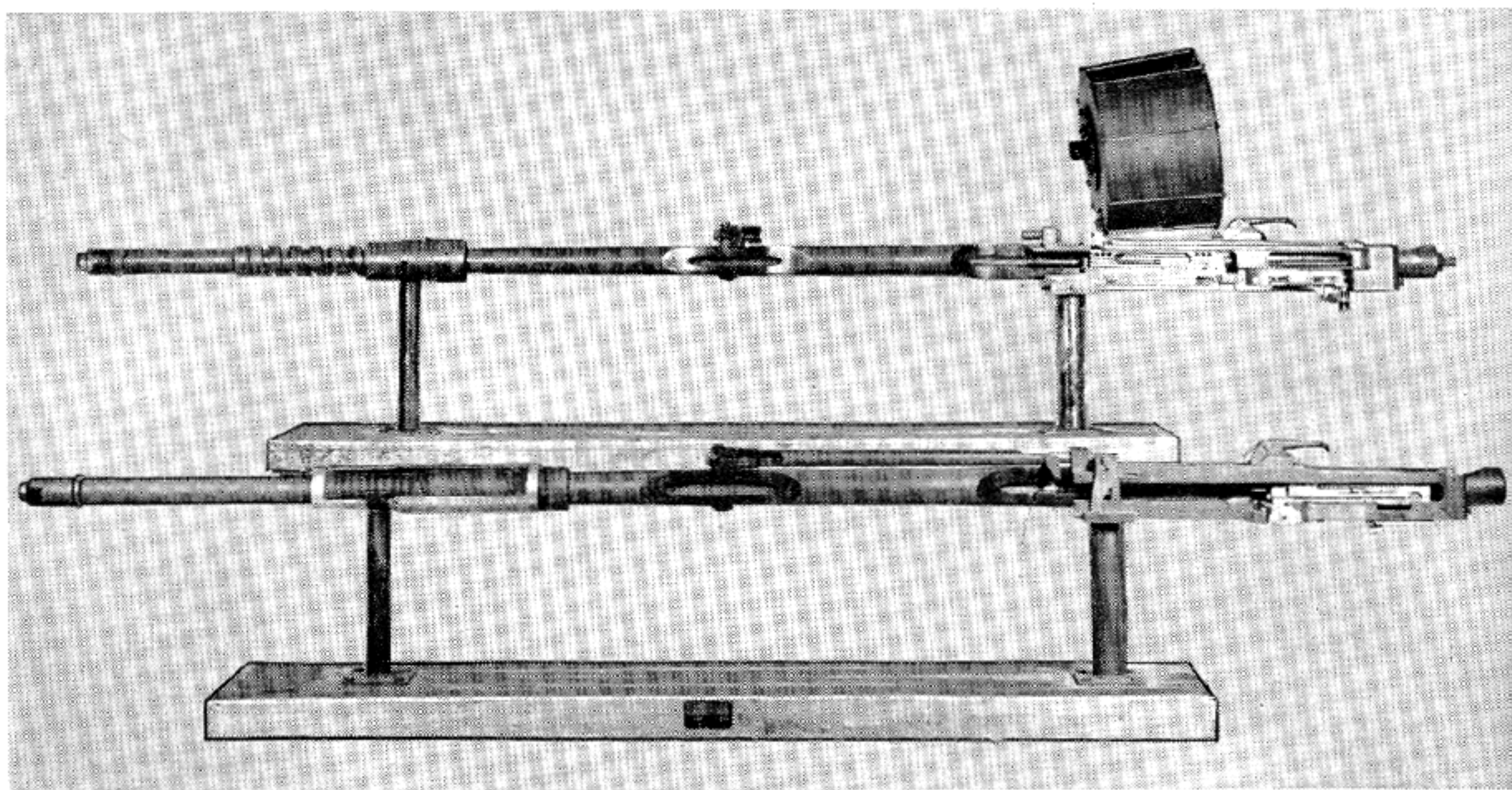
Before the first cannon came off the assembly line, Army Ordnance ordered all procurement following the original contract be given the designation of M2. Subsequently this model was identified officially as "Gun, Automatic, 20-mm, AN-M2 (Aircraft)." The latter type would have a heavier receiver with slightly greater external dimensions. The M2 would weigh 112 pounds, as compared with 105 pounds for the M1, and the point of balance would be 1.07 inches further forward. The weight difference was in the heavier constructed receiver. The reason for this receiver was that the gun was originally designed for engine mounting which did not require as much support as wing installations.

Another small difference was in the method of attaching the buffer system to the receiver body.

Bendix began shipping guns late in 1941 and later contracts placed with the company necessitated a monthly production rate of 1,300 guns, which was attained in December 1942. Manufacture continued at this rate until August 1943, when a reduction in the Army Supply Program caused a cut to 1,000 guns per month. In this month, Bendix requested its release as a facility by the end of the year so that an Air Forces item might be manufactured in its Elmira plant. The last 20-mm guns were completed at this plant in December 1943, a total of 22,642 having been manufactured.

The average unit price of the first guns manufactured at Bendix was \$1,010 each, while the final price charged was \$458 for the basic 20-mm gun with all components.

Since a new model had been authorized before the 500 guns ordered by the Navy were delivered, the Bureau of Aeronautics asked the War Department to supply only the M2, disregarding the original order. The result was that the Navy had delivered to it only 14 M1 guns. Six of them had been sent earlier to the Brewster Aeronautical Corp., Long Island City, for installation purposes in the F2A-3 airplanes. These represented the only M1 guns actually installed in Navy planes. The other eight remained in



Hispano-Suiza 20-mm Automatic Aircraft Cannon. Top: U.S. M2. Bottom: U.S. M1.



storage in custody of the Inspector of Naval Aircraft at Long Island City, N. Y., until they were turned in as not being acceptable for installation.

The increasing Army Supply Program during 1940 and early 1941 resulted in an over-all requirement of 44,747 20-mm guns. This staggering number made it obvious that other facilities than the Bendix subsidiary commence production. On 17 April 1941 a contract was awarded to the Oldsmobile Division, General Motors Corp., Lansing, Mich., for 9,000 guns. Oldsmobile delivered its first gun during November (the serial number of the weapon was 24,490) and by 1 January 1942 the company had produced a total of 1,056 cannon.

As additional demands were placed on the Army Supply Program, both orders and production increased until 4,000 guns a month were being delivered. This rate was held constant from November 1942 to September 1943 when, in order to keep a well-organized plant in operation as the demand slackened, Oldsmobile's quota was placed at 1,000 a month from that date to February 1944. Production then ceased entirely after Oldsmobile had turned out a total of 77,010 AN-M2 20-mm automatic cannon. When this firm first contracted to make the gun, the price was \$910 each and this amount was gradually reduced until the last ones manufactured were delivered at \$510 for each complete unit.

The International Harvester Co. of St. Paul, Minn., the next largest producer of the gun, was awarded a contract for an identical number of guns at the same time. However, its first gun was produced in January 1942 and it did not attain a capacity of 1,500 guns a month until May 1942. Upon receipt of additional contracts, an average monthly rate of 1,300 guns was held until September 1943 when the Army cut back on orders due to an excessive supply. Thereafter 1000 a month were manufactured until all work ended in December 1943. In all, this company delivered 24,526 cannon. The first were contracted for at \$840 each and this figure was steadily lowered until the last ones were delivered for \$465 each.

When the Army decided in 1944 to keep one of the major companies as a pilot-line operator, International Harvester was considered. How-

ever, it was not chosen because Oldsmobile had been tooled to manufacture at a high rate if the demand suddenly warranted it.

The other company awarded a manufacturing contract was International Business Machines Corp. of Poughkeepsie, N. Y. Only one agreement was entered into with this concern, which was in November 1941 for a total of 10,500 guns. The first complete unit came off the assembly line in March 1942 and an average of 1,000 a month was being turned out by May. This figure was held consistently until the contract ended in February 1943. By November 1942, it was found that production requirements for 20-mm aircraft cannon could be maintained by the three larger companies and it was considered advisable that one facility be dropped. Since IBM was the last in the field to enter and had been producing at a lower rate, it was considered logical to eliminate it first. After the 10,500 guns were satisfactorily completed, however, the action was delayed until the company had been given other war material work to compensate for the loss of the cannon order.

When the first complete IBM gun was turned over to Army inspectors, the price was \$905 for the basic gun. This cost was reduced as efficiency increased until the last 3,000 were sold to the Government at \$565 each.

### Modifications and Attempts at Standardization

By the time production really began with all companies, the United States Navy was the only branch of the service actually placing Hispano-Suiza cannon in planes in great numbers and demanding that aircraft designs of the future include 20-mm in lieu of lighter machine gun armament. Unfortunately, the gun, which was being delivered in prodigious numbers, was not proving itself totally reliable in America.

On the other hand, promising reports were coming in daily from the British, who had used practically the same procedure as our Army ordnance engineers in getting the gun into production status. The original Birkigt Type 404 gun was used as the model for the Mark I. This was followed shortly by the Mark II. Drawings and a sample of this improved cannon arrived in the



United States for purposes of study and test in January 1942. The British strongly suggested that American ordnance officials confer with their representatives in order to accomplish an early standardization. It was further desired that all 20-mm aircraft cannon of this design procured for British use be of the Mark II type, the principal differences between the Mark II and the American M1 being pointed out as follows:

"1. The magazine carrier of the Mark II gun had a different latch; the ejector was provided with a buffer, and changes had been made in the magazine holding boss.

"2. A heavier rear buffer was provided in the Mark II gun and the back plate was dovetailed into the receiver instead of being fitted with a simple groove as in the M1 gun. Inertia blocks were used in the breechblock slides of the Mark II gun.

"3. The sear of the Mark II gun had been modified.

"4. Triple wire driving spring and extractor springs were used in the Mark II gun instead of simple single-strand coil springs which were used in the M1 gun.

"5. Minor changes had been made in the muzzle brake of the Mark II gun.

"6. The receiver of the Mark II gun was substantially different from the one used in the M1 gun; much heavier guide rails were used and the receiver itself was larger, heavier, and designed in accordance with British manufacturing methods.

"7. The chamber of the Mark II gun was 2 mm shallower than the chamber of the M1 gun."

Practically all the changes suggested were of a minor nature and slight modifications or alterations would permit complete standardization. The main difference in the two types of gun was in the chamber dimensions. Since both were designed to use the same cartridge, it was quite obvious that one size would best handle the round. The British were very insistent that their measurements were better, pointing out, in particular, that their chamber was slightly more than one-sixteenth inch shorter than the American one. In their opinion, such a length would solve the problem of faint strikes, since the weapon was inertia fired and depended upon the

shoulder of the chamber to offer resistance and position the cartridge.

Tests were conducted at Aberdeen, Eglin Field, Wright Field, and Kenvil Proving Grounds to determine the relative merits of the British suggestions. The Army Ordnance engineers were not convinced by these tests that the British chamber was superior to the American design. However, it was agreed on 4 April 1942 that additional trials be initiated for the purpose of reaching a satisfactory compromise for both governments.

The only official action finally taken by the American representatives and approved by the Ordnance Committee was:

"(1) That the manufacture of the American 20-automatic gun M1 and AN-M2 be continued in the United States without modification to the chamber.

"(2) That no chamber with the small cone moved one-sixteenth inch to the rear (as was done in the British chamber) be considered for manufacture in the United States.

"(3) That the request made by British representatives that 20-mm automatic guns produced in the United States for British use be made with British chambers not be considered until after the 20-mm automatic guns M1 and M2 have been subjected to a thorough test in Great Britain."

After further comparative tests in late April 1942, it was again definitely decided by the Ordnance Department that all American-made 20-mm automatic guns continue to be made with the chambers longer by one-sixteenth inch than the British regardless of the employment of the same ammunition. This decision was final as far as American production was concerned, but in no way did it change the British representative's view on the longer chamber's performance.

Oddly enough, the question was again raised, not by the English or our many proving grounds, but by manufacturers of 20-mm ammunition. In testing their cartridges for reliability of action, they encountered a series of malfunctions known as light-struck primers that were all out of proportion for such a weapon. These were not isolated cases, the reports coming in from practically every maker of 20-mm ammunition that was engaged in function firing his products.



Since the munitions companies pointed out that the faint strikes were due to lack of impact on the primer resulting from error in the gun, and not as a result of defective materials or workmanship, it was decided to conduct another test on an extensive scale at Aberdeen. Ninety of the 20-mm guns, M1 and AN-M2, selected from every facility producing them, were expended in this test with all types of ammunition, both from accepted and rejected lots.

A complete record was made of every malfunction during the entire test and the probable causes of the trouble. The engineers in charge of the project in the early stages of this test recommended that two modifications should be made to overcome the serious malfunctions:

"(1) Shorten the chamber one-sixteenth inch, thus modifying it to approximately the British chamber.

"(2) Replace the extractor spring with a solid plug, thus positioning the rounds by means of the extractor. This change would include such modifications to the extractor, the bolt, and the ejector, as were deemed necessary."

The test began in June 1942 and continued until the last of January 1943. The final recommendations from Aberdeen Proving Ground were presented at a meeting attended by representatives of the Ammunition Branch, Industrial Division, Artillery Branch, Technical Division, and Field Service. All present accepted as official four much-needed modifications that were to be made on all 20-mm M1 and AN-M2 cannon: (1) The chambers were to be shortened one millimeter or approximately one thirty-second inch; (2) the extractor spring would be of the cantilever type; (3) the standard firing pin was to have one sixteenth inch removed from the back of the key slot to give it "float"; and (4) the breechblock slide springs would be strengthened.

This sanctioned change found the Army with 40,000,000 rounds of ammunition already stocked. While 56,410 guns had been manufactured to date, it would be easy to make external changes such as with the firing pin and extractor spring. Barrel chamber shortening, however, was a problem that generally cost as much in time and money as to make the whole barrel, to say nothing of the number of guns immobilized

while the modification process was being performed.

Action was taken immediately by the Industrial Division to put the alterations into effect. There still remained certain differences between the British Mark II and the AN-M2. As the British Ministry of Aircraft Production had long advocated having both guns manufactured identically, the Army Ordnance Department ordered a comprehensive test in England as soon as the modified weapons came off the assembly line.

At the suggestion of Capt. E. R. S. Adams of the British Air Mission, two guns each from International Harvester, Oldsmobile, and Bendix were shipped to England for the purpose of competitive aerial tests with the Mark II. Representatives of the Army Ordnance Department were present to observe the 2,000-round tests which were held during July and August 1943.

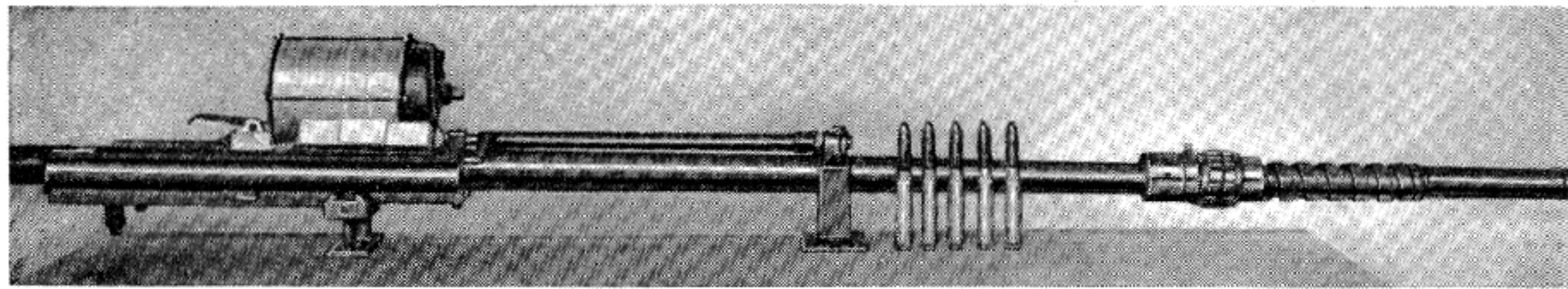
Two British Mark II's were mounted in the left wing of a Hurricane fighter with two AN-M2's made by Oldsmobile and International Harvester in the right wing. Combat flying, dives, G-loading, straight-away, etc., were simulated. One stoppage was attributed to the Oldsmobile gun. The International Harvester weapon had no stoppages but a cracked breechblock was noticed at the completion of the trial. Each Mark II had one sear failure and one of them had a cracked breech lock after 1,400 rounds. The Bendix guns were fired on the ground in competition with the British-made guns and made a creditable showing.

In reporting the findings of the test, Mr. Hansen, of the British Ministry of Aircraft Production, declared: "American guns are as good as British guns and are acceptable for service use."

### Mount, Feed, and Other Modifications

From the arrival of the first Hispano-Suiza cannon in this country, the problem of mounting was present, as the weapon was originally designed to fire only through the propeller hub. This was considered satisfactory at the time; later, the British and our Ordnance Department obtained a method of cradle mounting from the French. The authorities, however, soon realized that dependence upon this one system of mounting would greatly restrict the gun's usefulness.





Hispano-Suiza Automatic Aircraft Cannon AN-M2 with Feed Mechanism, 20-mm AN-M1. Developed from the French Chatellerault Feeder.

Later in 1940 the Edgewater Steel Co., Oakmont, Pa., agreed to develop a type of ring-spring mounting in an effort to reduce the unusually high recoil forces always present with automatic cannon. Tests were first conducted on the prototypes, the T6 and T6M1, from January to March 1941 and they were found too heavy. On 20 April 1942, the T6E1 was successfully tested and officially adopted by the Navy. It was given the designation, "Adapter, Gun, 20-mm, M1." Later it was named "Adapter, Gun, 20-mm, M6" when a rear mounting extension was used. A total of 70,011 M1's and M6's were manufactured by the Edgewater Steel Co.

In May 1942 after the Edgewater adapter had proved superior, a limited number of guns was produced with the M7 adapter, which, despite its higher number, was merely a refinement of the original French mount. Only guns produced for the British were equipped with this adapter, and Oldsmobile, after making 9,697, began replacing it with the Edgewater adapter.

The first Hispano-Suiza Type 404 gun received in this country carried a large 60-cartridge drum feed. Ammunition was placed in the feed by hand after first greasing each round. The spring on the drum had a preload of approximately 14 torque pounds to insure positioning the last round, each cartridge being placed with the full tension thrust absorbed by slowly winding the spring.

This type of feed was accepted as a standard component of the gun until 1941. In England, other methods of getting ammunition to the gun were being experimented with that should soon make the use of this cumbersome feed system unnecessary. But until this became a reality, our use of the drum continued and it was given the nomenclature, "Magazine, 60-round, 20-mm, M1."

The feed, for some unknown reason, was manufactured as late as 1944 with little or no change. At this time it was improved and the designation changed to "Magazine, 60-round, 20-mm, M1A1." Its characteristics were: weight, empty, 22 pounds; diameter, 12 inches; length, 8 inches; and maximum height, when mounted on gun, 18¾ inches. The last feature practically ruled it out for wing installation, because of its excessive overall height and small ammunition content. For this reason the records show only a very limited amount were procured for use by the British. And the Army Air Force was considering a single experimental plane mounting only one gun firing through the nose that could have employed this antiquated feed. Yet a total of 29,235 magazines of this type were procured, 6,200 from the Borg-Warner Corp. and 23,035 from the Seng Co., both of Chicago.

While the drum feed was being steadily produced, the devisement of a means of feeding the gun was being studied that would allow better profile while delivering a greater supply of cartridges. The most successful method heretofore used on other guns was the disintegrating metal link belt and investigation of its possibilities was authorized in May 1941. During subsequent experimentation many different systems of feeding were tried. Only three gave promise of warranting further effort: (1) the disintegrating belt and feed system devised by Watervliet Arsenal; (2) a similar method of feeding developed by Curtiss-Wright Aircraft Corp. under an Air Force contract; and (3) the Chatellerault feed mechanism initiated by the French and later turned over to the British, who made considerable improvements in it.

Tests were conducted at Aberdeen of all three mechanisms and it was reported that the Chatellerault, then designated the T1E1 (the latest type



that had been received from England), gave far more satisfactory performance than the other two. It was also stated that the Chatellerault was light in weight, very compact in construction, and capable of pulling a large belt of ammunition successfully. The latest model tested was declared a definite improvement over the earlier T1, as the original Chatellerault feed was marked.

The most serious difficulty found with the basic design of this system was that, to delink the cartridge, a cam was used on the nose of the projectile to push the round out of the belt. This principle made it necessary for all cartridges to have the same physical dimensions, which placed a very serious limitation on the feed, Armor-piercing shells were, by their very nature, constructed different from high-explosive and ball ammunition.

In spite of these shortcomings development proceeded. In order to have an adequate feed system at the earliest possible moment, the experimental "Mechanism, Feed, 20-mm, T1E1" was standardized and officially named "Mechanism, Feed, 20-mm, AN-M1."

The Chatellerault, as it was more commonly called when standardized, included a spring band, shaft, and sprocket assembly that acted as a clutch to allow slipping. This prevented overwinding and acted also as a safeguard against breakage in case of a seizure of the ammunition belt.

In the feed tested at Aberdeen the clutch band was fixed by welding which, if successful, eliminated not only many problems of manufacture, but gave extra strength to the vital part. The test indicated that it was feasible and Aberdeen recommended that all clutch mechanisms already manufactured be attached by welding.

While the Chatellerault feed did divorce the gun from the clumsy drum-type arrangement, it was not considered completely ideal. The Bureau of Ordnance in February 1943 gave the designation of "Mechanism, Feed, 20-mm, M1E1" to an experimental feed mechanism. It was the same basically as the M1, but had a considerably heavier spring that required 210 pounds of torque pressure to wind it and one additional sprocket. It was thought by the Navy that the original model did not produce the

necessary belt pull. This modified feed was tested successfully at Aberdeen and standardized on 12 June 1943 as "Mechanism, Feed, 20-mm, AN-M1A1."

The Navy then requested that it be furnished only this improved version; however, the Air Corps having expressed a preference for the M1, procurement of both types of feed continued until August 1944. This double problem of supply was then settled by the agreement of the Air Corps to use the AN-M1A1 only.

A total of 119,216 feed mechanisms carrying the designation, AN-M1 or AN-M1A1, were produced in all. The Chicago Flexible Shaft Co. and the Harley Machine Division, both of Chicago, the E. W. Carpenter Co., Bridgeport, Conn., and the National Pneumatic Co. of Rahway, N. J., produced this item. Initial contracts were signed with the first three companies in December 1941, while the last company began manufacture in August 1943.

As the feeding of ammunition to a gun from left to right, and vice versa, could be accomplished only by changing to another feed designed to work in the direction desired, it was necessary to make both right- and left-hand feeds. The following tabulation shows the number of left- and right-hand feeds made and whether they were the original or welded clutch models of the M1 or the improved AN-M1A1:

|                                      | Left hand | Right hand |
|--------------------------------------|-----------|------------|
| AN-M1 (Original design) . . . . .    | 19,785    | 14,782     |
| AN-M1 (with welded clutch) . . . . . | 53,690    | 10,613     |
| AN-M1A1 . . . . .                    | 6,825     | 13,521     |
| Total . . . . .                      | 80,300    | 38,916     |

The muzzle brake and the barrel-return spring were considered integral parts of each 20-mm M1 and AN-M2 after standardization. The muzzle brake consisted of two ferrules, a washer and a tubular body that had 36 ports and a like number of baffles. These slots were cut on a 45-degree angle to the axis of the bore and sloped backwards where they caught a good amount of the muzzle blast, thereby absorbing a considerable amount of the recoil forces. It fastened to the



front end of the barrel and was locked into place. This arrangement was quite satisfactory as long as the 60-shot magazine was being used. With the advent of the Chatellerault feed a minimum recoil of seven-eighths inch was found necessary in order to operate the feed, as the system utilized the force and distance of the recoil stroke to wind the operating spring.

Since the muzzle brake could obviously not be used on all guns in the future, it was given the nomenclature, "Brake, Muzzle, M1" and furnished only on special order for guns having the M7 adapter for the 60-shot drum magazine. As there was no call during the war for such a magazine, needless to say, the use of the muzzle brake was indeed limited.

As soon as the Navy saw possibilities of mounting the M1 and AN-M2 in the wings of a plane, a development contract was immediately placed with Bendix Products Division, South Bend, Ind., for the origination of a system of hydraulic charging by remote control from the cockpits. A prototype was completed and satisfactorily tested at several aviation ordnance proving grounds. As a result, the Navy Department requested the Army to procure a sufficient quantity of such chargers to equip all intended Navy installations.

To comply with this sudden demand for the accessory, an order was placed with Bendix without specifying a certain number. The company was simply to make as many as possible in the shortest time. In all Bendix manufactured 46,748 of this type of charger. During the early stages of procurement all were sent to the Navy separate from the gun but later it was decided to equip each new weapon with the charger. The Navy received all the hydraulic chargers made by Bendix during the war, as the Air Corps had a method all its own of retracting the firing assembly by means of manual operation from the cockpit for the few 20-mm cannon it used. And the British used a pneumatic system of reloading that was manufactured in England.

When the United States received its first Hispano-Suiza cannon in 1938, the trigger actuating mechanism was considered part of the firing assembly. It was operated by the Bowden Cable Control System, with which the pilot released the sear manually by means of a flexible shaft operating through a hollow tube. During all the

stages of manufacture of the M1 this type of device was used and was included in all drawings of the firing mechanism. The blueprints pertaining to this part of the gun refer to it as the "Platex Sear Cover Assembly."

The Army Air Force was the first of the services to become interested in tripping the sear by use of an electrical unit known as a solenoid. At its suggestion the Magnavox Co. of Fort Wayne, Ind., in May 1941 contracted to experiment with and develop an electric trigger actuator. The results of these efforts was known as the "Solenoid, G17" and it was so successful that both the Army and Navy specified that all future guns for their use be equipped with the device.

However, the British still clung to their original method of manual firing and continued to order their guns with the original Bendix cable. In order to avoid misunderstanding in ordering of the right parts, the manual release was given the designation "Mechanism, Sear release, M1" and was treated thereafter as a separate component of the guns and not an integral part.

Later when the system of "types" was adopted in order that a gun and certain special parts be included merely by ordering a certain code designation, it was decided that all guns for American use would be furnished with the G17 solenoid and all British ones with the original sear cover and manual trip. When the electric trigger actuator had been established as an official ordnance item, it was assigned the nomenclature "Trigger, Electric, AN-M1."

## Types of Hispano-Suiza Cannon

From the very first there was a continuous effort to produce improved mountings, feed systems, and trigger actuating devices. The latter two were done by authority of the Air Force. In order that someone stand responsible for the procurement of these essential components, the Ordnance Committee, which alone had the authority to do so, took action so that all future orders should be placed in such a manner as to prevent the ordering of 20-mm accessories unusable on the installation intended.

In order to simplify the requisitioning of 20-mm cannon, every combination of gun and components used by the Army, Navy, and British



was assigned an identifying type designation. After much discussion and arbitration it was determined that seven different types would be required to fill every known need. These groups are given below to clarify the purpose of this much needed act:

#### TYPE A—AIR CORPS

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, AN-M1  
Electric Trigger, AN-M1  
Manual Charger, M2

#### TYPE B—AIR CORPS

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, M6  
Electric Trigger, AN-M1  
Manual Charger, M2

#### TYPE C—AIR CORPS

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, M7  
Electric Trigger, AN-M1  
Manual Charger, M2

#### TYPE D—AIR CORPS

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, M7  
Electric Trigger, AN-M1  
Manual Charger, M2  
Muzzle Brake, M1

#### TYPE E—NAVY

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, AN-M1  
Electric Trigger, AN-M1  
Hydraulic Charger, M2

#### TYPE F—BRITISH

20-mm Gun, AN-M2, with the following components:

20-mm Adapter, M7  
Sear Mechanism, M1

#### TYPE G—BRITISH

20-mm Gun, M1, with the following components:

20-mm Adapter, M7  
Sear Mechanism, M1

In February 1944 production of all 20-mm M1 and AN-M2 cannon ceased. Although no use was ever found for the M1 guns, since there were almost no serious attempts at engine mountings, it was as late as 16 October of that year before the gun was declared obsolete. Total production of the 20-mm AN-M1 and M2 weapons was as follows:

|                         |                        |
|-------------------------|------------------------|
| Navy .....              | 21,228                 |
| Air Force .....         | 13,272                 |
| International Aid ..... | 44,478                 |
| Storage:                |                        |
| Serviceable .....       | 19,042                 |
| Unserviceable ...       | 35,955 (long chambers) |
| Total storage .....     | 54,997                 |
| Lost or expended ..     | 688                    |
| Total .....             | 134,663                |

#### T26 and Other Modified Hispano-Suiza Cannon

Since the protection of her carriers from heavy bombers called for a fast-firing automatic cannon, the United States Navy logically took the initiative in the development of the Hispano-Suiza. As early as December 1942 the Navy's Bureau of Ordnance requested that the Army, which had the responsibility of production, study the possibility of shortening the barrel and making other refinements.

On 18 January 1943 Aberdeen Proving Ground began a series of tests to show the effect on muzzle flash, velocity, dispersion, rate of fire, reliability of action, and trunnion loads. Five AN-M2 guns with barrels shortened 6, 12, 15, 18, and 20 inches, respectively, were given severe function tests to determine which was the most effective.

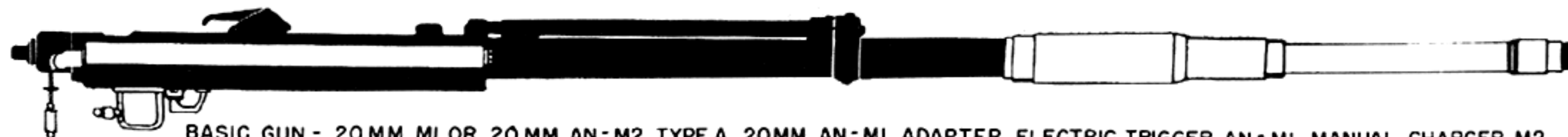
In July 1943 the Ordnance Committee decided that, in the event the tests at Aberdeen did prove successful and a substantial amount could be removed from the barrel length without interfering with the gun's performance, certain



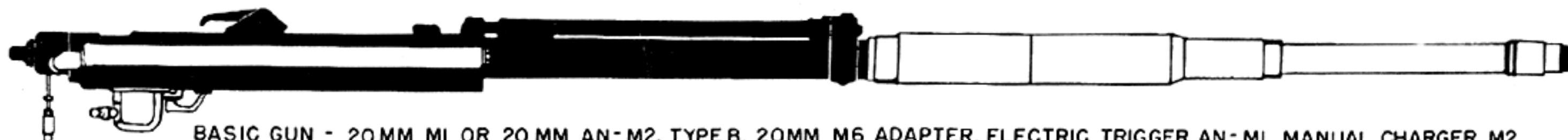
## 20 MM GUN TYPE DESIGNATION CHART



BASIC GUN - 20 MM MI OR 20 MM AN - M2



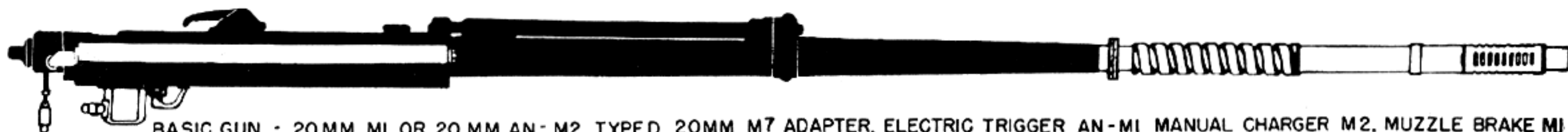
BASIC GUN - 20 MM MI OR 20 MM AN - M2, TYPE A, 20MM AN - MI ADAPTER, ELECTRIC TRIGGER AN - MI, MANUAL CHARGER M2



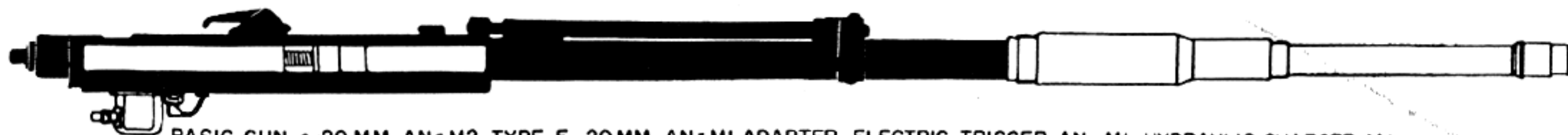
BASIC GUN - 20 MM MI OR 20 MM AN - M2, TYPE B, 20MM M6 ADAPTER, ELECTRIC TRIGGER AN - MI, MANUAL CHARGER M2



BASIC GUN - 20 MM MI OR 20 MM AN - M2, TYPE C, 20MM M7 ADAPTER, ELECTRIC TRIGGER AN - MI, MANUAL CHARGER M2



BASIC GUN - 20 MM MI OR 20 MM AN - M2, TYPE D, 20MM M7 ADAPTER, ELECTRIC TRIGGER AN - MI, MANUAL CHARGER M2, MUZZLE BRAKE MI



BASIC GUN - 20 MM AN - M2, TYPE E, 20MM AN - MI ADAPTER, ELECTRIC TRIGGER AN - MI, HYDRAULIC CHARGER M1



BASIC GUN - 20MM MI, TYPE F, 20MM M7 ADAPTER, SEAR MECHANISM MI  
 BASIC GUN - 20MM AN - M2, TYPE G, 20MM M7 ADAPTER, SEAR MECHANISM MI



other specifications should also be incorporated in the redesign of this weapon. There were definite disadvantages in the use of the AN-M2 gun mounted in aircraft, mainly because of its profile and weight. With the feed in place, the silhouette was very bulky, and often the weapon had to be installed in planes at various angles, sometimes even sideways. This not only handicapped the problem of mounting but wasted space and made the correct placement of feed chutes most complicated.

While the Chatellerault feed was a distinct advantage over the original 60-shot drum, it was not considered the ultimate in feeding and it was quite apparent that if the over-all height could be lowered and the weight of the entire assembly reduced, it would indeed be a progressive step forward.

With these points in mind, the Ordnance Committee took action on 22 February 1943 to authorize the development of a 20-mm gun with characteristics which, if met, would make the weapon practically the equivalent of a greatly refined Hispano-Suiza cannon. The specifications, as given by the committee, are as follows:

"1. The gun to be developed should be capable of using existing ammunition for the 20-mm Gun, M2.

"2. Feed should be of the disintegrating link belt type, without involving a separated transfer as in the case of a magazine throat.

"3. Must be capable of taking different lengths of projectiles.

"4. Rate of fire to be 575-650 rounds a minute.

"5. The gun should be of the self-locking semi-blowback type.

"6. The round in the gun must be controlled at all times.

"7. Feed must be left or right hand without the addition of extra parts.

"8. Belt pull should be at least 75 pounds or the limit permitted.

"9. If possible, the M3 Link (used in the M1 Feed) should be used."

The tests requested by the Navy at Aberdeen, to determine how much the barrel length of the 20-mm AN-M2 could be shortened, showed that 15 inches could be removed with no appreciable muzzle flash and with a velocity drop of only 80

feet per second. At the same time reports from Great Britain showed that the British likewise were refining the aircraft cannon based on the Birkigt or Hispano-Suiza principle. They had successfully removed 25 pounds in weight from the original design and had shortened the barrel by 12 inches. The weapon used for these experiments was the Mark II and the work had progressed so successfully that it had already been given a designation "20-mm Automatic Gun, Mark V."

Oldsmobile Division of General Motors had been given authority by the Ordnance Department to carry on research and development in this country on the contemplated improvement of the gun. By July 1943 Oldsmobile completed the refinement of an AN-M2 following the British pattern with a weight reduction of 27 pounds and a barrel 12 inches shorter in length than the original specifications. The rest of the mechanism was unchanged.

The Ordnance Committee acted to procure a number of these modified guns so that Navy flyers could also test them. It likewise recommended that the weapons be still further modified and stated that they should have these characteristics:

"1. Reduction in weight of approximately 25 pounds.

"2. Decrease in barrel length, 15 inches.

"3. Capable of using the standard M1 Adapter.

"4. Muzzle velocity to be reduced not more than 80 f/s.

"5. Have a cyclic rate of approximately 750 shots per minute.

"6. Capable of firing with the bolt closed and locked.

"7. Capable of using a nonadjustable ring spring adapter."

The lightweight version built to conform to the above specifications was to be given, upon completion, the designation "20-mm Automatic Gun, T26." The immediate modification of 14 standard AN-M2 guns was authorized on 7 October 1943.

Army Ordnance combined this project with a development problem given it in July 1943 when the Commanding General, Army Air Force, urgently requested that work be started on a 20-mm



aircraft cannon with the ability to fire from a closed and locked bolt. A limitation was placed on the time required to fire the gun of no more than one-hundredth of a second between sear release and the instant the projectile clears the muzzle.

Ordnance Department personnel believed that this could be done and added it to the intended improvements then being undertaken. A number of commercial firms were contacted and Watervliet Arsenal was also asked to investigate the problem and offer a solution.

Oldsmobile Division of General Motors was to undertake the devisement of a system of mechanically firing the weapon from a locked and closed bolt. The result was to be given the test designation "20-mm Automatic Gun, T27." The United Shoe Machinery Co. was asked to undertake a similar project, the nomenclature given to it being "20-mm Automatic Gun, T25."

Watervliet Arsenal, in being assigned the task of firing from a locked bolt, was given two means of accomplishing it: By percussion, the gun to be known as "20-mm Automatic Gun, T-28"; and by electric ignition, using electric primed ammunition, to be known as "20-mm Automatic Gun, T29."

This work was undertaken so that the possibilities of firing the AN-M2 from the front seared position could be proved. If accomplished, it permitted the synchronization of the weapon not only for firing through the propeller arc but for turret use as well, since employment of a synchronized fire interrupter could maintain position control throughout firing with no possible danger to the ship structure.

On 7 October 1943, 20 AN-M2 guns were authorized for issue to the above mentioned facilities for modification. On the same date the Navy Bureau of Ordnance requested that six 20-mm T26 guns be furnished it for test purposes. On 12 October the Air Force made a similar demand for 30 guns. Both activities also asked for wooden mock ups to send to airplane manufacturers in order that design changes in mounting could be accomplished.

By December 1943 prototypes of both the T28 and T29 had been produced and were tested at Aberdeen Proving Ground. Each weapon was

constructed for firing with the bolt in the locked battery position, one employing percussion ignition and the other electric.

A pilot model, having features of both the T28 and the T29, also made its appearance at this time. It was successfully fired, using bolts from the T28 and T29 alternately. In view of the advantages resulting from this combination, it was considered highly desirable to concentrate on developing it. The Ordnance Committee ordered the cessation of the separate T28 and T29 programs and gave the new weapon the official nomenclature, "Gun, Automatic, 20-mm, T31."

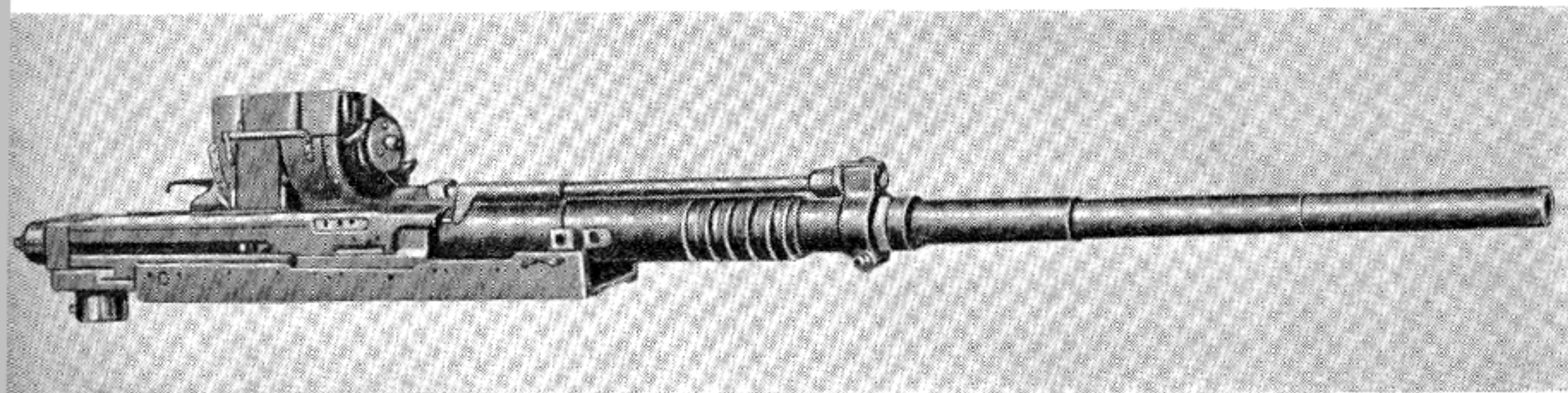
In January 1944 the Navy asked that 25 of the T31 version be sent to it as soon as possible for the purpose of testing. The Army Air Force likewise requisitioned 51 with the option of an additional order if it proved satisfactory.

The speed with which the whole matter moved is shown by a letter from the Bureau of Ordnance to the Office of the Chief of Ordnance on 12 February 1944 in which a requirement for 23,326 guns of the T31 specifications was to be delivered to the Navy in 1944. The Army asked for a thousand a short while later.

These demands were made before the specified modifications could have possibly been given the endurance firing so necessary for establishing reliability. The tremendous Navy order, with all future aircraft design committed to a weapon that had not been proved, certainly showed great faith in the mechanism.

The International Harvester Co. plant at St. Paul, Minn., having filled its contract and production having stopped on the AN-M2 in December 1943, was given an order in January 1944 to begin making the T31 for which there was already a terrific demand. This company notified the Industrial Branch of the War Department that the T31 could be easily produced by modification of AN-M2 guns. This took care of two things: First, only modification of an existing weapon would be necessary; second, there were in storage thousands of 20-mm AN-M2 guns that did not meet the requirements of the latest drawing revisions. While these guns were being brought up to date, they could at the same time be converted to meet the specifications set forth for the T31. Many of them were





Hispano-Suiza 20-mm Automatic Aircraft Cannon, Model T31.

returned to the St. Paul plant and on 10 July 1944 the first 20-mm T31 appeared. Between that date and 20 September a total of 2,455 guns had been modified, and a scheduled rate of 1,250 guns per month was set as necessary to fill the demand. By May 1945 a total of 12,083 weapons had been converted from AN-M2 to the lighter weight T31, at which time all alteration ceased. The modification of the M2 to the later designation was done at a price of \$625 per gun.

The Oldsmobile Division of General Motors was the other main contractor for the T31 guns. On 16 February 1944 an initial order for 50 weapons was placed with it, followed by a Navy requisition for over 12,000 guns. Large quantities of AN-M2 guns, which had not been modified to meet the latest revisions, were returned to Oldsmobile from storage to be changed into T31 mechanisms.

The first such weapons were produced by this firm in August 1944 and, as of 30 September 1944, 621 guns had been shipped. A rate of 1,400 guns per month was attained by October 1944 and this schedule continued until May 1945, at which time a total of 20,163 weapons had been converted. The final unit price of the Oldsmobile T31 was \$412.

The combined number of T31 mechanisms from International Harvester and Oldsmobile was 32,346. Eighty additional ones were procured by Research and Development Service, making a total production of 32,426 cannon.

Meanwhile experimentation continued on the feed mechanism for the 20-mm cannon, because of the limitations of the M1, or Chatterault, mechanism. Development of the feed mechanism, T4, which had been carried on at Curtiss-

Wright Field, was transferred to Oldsmobile, under the designation "Mechanism, Feed, 20-mm, T14." A preliminary test of this version was made on 10 June 1943, which gave evidence that it was the most promising of any feeder built to that date. It proved capable of lifting 105 rounds and its outside dimensions were much more compact than those of the M1.

The T14 used a new link named "20-mm Metallic Belt Link, T23." This link had no tendency to be cammed off the cartridge during handling and increased the flexibility of the ammunition belt.

In July 1943 a test of the mechanism was made at Aberdeen, during which over 5,000 rounds were fired. Maximum lifting capacity was found to be 110 to 120 rounds, and, after minor modifications, was found to function properly in all positions. Endurance qualities were also quite satisfactory.

The Air Force and the Bureau of Ordnance urged that development of the T14 feed be expedited. An initial order of 30 feed mechanisms and 55,000 belt links was authorized on 7 October 1943. Additional procurement was later requisitioned and on 6 April 1944 a requirement of 550 T14 mechanisms, to be supplied by July of that year, was approved by the Subcommittee on Aircraft Armament.

On 12 February 1944 the Chief of the Bureau of Ordnance established a requirement for approximately 30,000 feed mechanisms, T14, enough to provide one for each 20-mm light-weight gun needed by the Navy, together with necessary spares. Standardization of the mechanism was approved on 11 May 1944 as the "Mechanism, Feed, 20-mm, M2."



## Performance of Hispano-Suiza Cannon During World War II

It soon became apparent that the Navy would be the largest user of the 20-mm cannon; in fact, records show that this branch of the service mounted over 90 percent of the cannon actually placed in American aircraft. The first 20-mm Hispano-Suiza automatic gun in a mock up by the Navy was installed at the Bureau of Aeronautics test facility, then known as the Aircraft Armament Unit, Norfolk, Va., on 11 March 1942.

There was nothing slow about the Bureau of Aeronautics on armament decisions, for the gun was officially accepted for aircraft use the next day. The installation was in the wing of an SB-2C which had been shipped separately by the Curtiss-Wright Aeronautical Corporation, Columbus, Ohio, in order to proof fire the new cannon.

The Aircraft Armament Unit continued to test the weapon in its mock-up mounting and it was as late as August 1943 before the guns were actually placed in the planes at the factory, SB-1C, serial number 200, being the first to be so armed. It was quickly followed by plane number 50, SB-2C.

This aircraft, the scout bomber type, proved to be one of the most widely used during the war and the resulting damage inflicted upon the enemy by Naval pilots was tremendous. However, the records reveal such destruction was done by dive bombing rather than by the use of the 20-mm cannon. The SB-2C first reached the combat area on 11 November 1943 and its first action took place in March 1944.

As an innovation in Navy ordnance, factory representatives accompanied the new cannon to the front. These expert technicians sent back voluminous reports that explained that the malfunctions that did occur were due to one of three things: failure of the feeder, bad ammunition, and improper maintenance. Their zeal in clearing the gun itself in every instance casts doubt on the validity of the reports.

Available records show that the AN-M2 was installed in 5,800 Naval planes requiring the total mounting of 11,600 guns. The SB-2C and

SB-W aircraft were the principal planes carrying this weapon into combat, along with a very limited number of F4U-1Cs. Statistics on enemy aircraft shot down in World War II credit the AN-M2 in SB-2C aircraft with destroying few enemy aircraft. The F4U-1C planes brought down an even smaller number. However, it must be remembered that the primary mission of the SB-2C was not to shoot down aircraft.

The United States Navy has always permitted the introduction of evidence even when contrary to what it would like it to be. There existed two distinct schools of thought on the reliability of the gun. One was that the 20-mm Hispano-Suiza automatic cannon could not be considered satisfactory as an aircraft weapon as long as it was necessary for the ordnanceman to coat the cartridge case with a heavy lubricant or wax. The other was that this was unimportant as long as it bettered the performance of the weapon. But everyone even remotely connected with weapon development agreed on one thing, namely, that 20 millimeters was the minimum caliber for aerial warfare.

During war all that can be done is to install and make function as reliably as possible that which is issued. With the mounting of the 20-mm cannon in Navy planes a series of malfunctions began that could not be properly corrected at the time because manufacture was at the peak of production. The slightest change would practically mean retooling. The most serious problem was the oversize chamber. There still remained considerable variance in dimensions between the chambers of the British and American cannon, even after the latter chamber was made one thirty-second inch shorter.

Due to an outmoded agreement of long standing, everything above caliber .60 in the Army is considered artillery and the manufacture of the Hispano-Suiza cannon therefore came under this classification. In other words the production of this high-speed machine gun was done under artillery manufacturing tolerances. The resulting poor mating of parts, coupled with the inherent fault of all gas-operated weapons whereby the breech locking key in the receiver is immovable and the position of the gas port in the barrel is permanently fixed, made it impos-



sible to adjust the relationship between barrel and breech lock to establish head space. Thus the most vital measurement in any automatic weapon was governed by chance in this instance.

An unfortunate discovery was that chamber errors in the gun could be corrected for the moment by covering the ammunition case with a heavy lubricant. If the chamber was oversize, it served as a fluid fit to make up the deficiency and, if unsafe head space existed that would result in case rupture if ammunition was fired dry, then the lubricant allowed the cartridge case to slip back at the start of pressure build up, to take up the slack between the breech lock and the breech lock key. Had this method of "quick fix" not been possible, the Navy would have long ago recognized the seriousness of the situation. In fact, this inexcusable method of correction was in use so long that it was becoming accepted as a satisfactory solution of a necessary nuisance.

This state of affairs continued until the war's end, at which time all complaints and suggested improvements were carefully evaluated by the Chief of the Bureau of Ordnance, and a letter outlining past faults and suggesting improvements was dispatched on 26 December 1945 from that authority to the Army's Chief of Ordnance under the subject, "Reactivation of Certain 20-mm Automatic Gun Development Projects and 20-mm Ammunition Development Projects—Request for." The following paragraphs are quoted from the letter:

"There is a firm requirement on the part of the Navy Department for use of 20-mm automatic guns in practically all Navy combat aircraft currently in design and currently designated combat operational aircraft . . .

"The 20-mm automatic guns M2 and M3 in their present stage of development have certain objections and defects which make continued development of this type weapon highly desirable. The following features are considered objectionable and are believed capable of improvement:

"(a) The profile of the gun is too bulky for proper installation in VF type wings.

"(b) The cyclic rate of the gun is too low.

"(c) The belt pull is too low.

"(d) It is believed that the over-all weight of the gun and its associated equipments can be materially reduced.

"(e) The accumulated tolerances in the manufacture of the weapon are too great to give uniformly efficient operation in these guns.

". . . Other objectionable features which are believed capable of rectification are listed below:

"(a) The need to oil the ammunition prior to loading for use in this weapon is undesirable. Self-lubricated ammunition, or the elimination of the need for lubrication, is strongly desired.

"(b) The ballistics of the projectile can stand much improvement. It is believed that ballistics similar to that of the Caliber .60 projectile can be closely approximated.

"(c) It is believed that an electrically primed round can be developed for the gun which will give more efficient performance.

"(d) The ammunition should be manufactured to fit the chamber of the gun in which it will be fired and not to fit two of these weapons—namely, the American and British 20-mm automatic guns.

"From the above, it can be seen that the Navy's need for improvement in the gun and ammunition is immediate and will be continuing until the Army's long range development program of an optimum gun for aircraft materializes. It is understood that the optimum gun will require from 15 to 25 years for development to be completed. Continued improvement in the present cannon will certainly contribute materially in experience gained to the development work leading toward the optimum gun. . . .

"Inasmuch as the Chief of Ordnance is definitely interested in this development program, this Bureau wishes to indicate its active interest in and requests that the following program be undertaken:

"(a) Improve the present 20-mm Automatic Gun M3 for immediate needs.

"(b) Continue development projects of such guns as the 20-mm T32 and T33 to arrive at a reliable lightweight, high performance gun within the next four to six years.

"(c) Improve the ammunition for these



guns in order to achieve a family of matched projectiles of relatively high performance.

"(d) Through the experience gained in this development program obtain information, data and experience which, combined with current gun research for an optimum gun, might materially aid in the development of an optimum gun for aircraft within the next ten to fifteen years.

"To support such a program, this Bureau will initiate projects complementary to those undertaken by the Ordnance Department (ASF) to provide competent and experienced personnel and afford Navy Ordnance facilities to assist in the program. In addition, this Bureau will furnish funds to support a proportional part of

this development program as established by the estimates of the Chief of Ordnance."

This letter resulted in the cooperation of the Army, with Navy engineering personnel, familiar with the conditions that needed remedying, in solving the various problems. Today, barely five years after the war, every point brought out by the Navy's Chief of the Bureau of Ordnance has been answered. Nothing was basically wrong with the weapon. Its wartime performance, good or bad, was the result of having been bought in desperation, put into mass production without first having been adequately proved, and then modified regularly to meet a future commitment before the previous model had been made to function reliably.



## FURRER AUTOMATIC AIRCRAFT CANNON

The Swiss Air Force in 1933 introduced an aircraft cannon designed by its well known inventor, Col. Adolf Furrer. This officer originated a system that employed short recoil for operational energy and a clever method of timing the weapon to fire slightly out of battery while securely locked. This last feature permitted high rates of fire and gave a definite buffing action on the counterrecoil stroke.

The first Furrer aircraft cannon was 20-mm, air cooled, belt fed and short-recoil operated, with a quick-change barrel having an attached bolt assembly. All Furrer mechanisms are highly characteristic of the Swiss genius for precision-made instruments, being composed of a multiplicity of intricate components that perform reliably but do not lend themselves to mass production.

The aircraft models, regardless of caliber, had the following details in common: (1) Feeds interchangeably from left to right and vice versa; (2) possibility of mounting for either fixed or flexible; (3) a built-in rounds counter to give the gunner an instant check on ammunition supply; (4) feed pawl disengagement for bringing the bolt home on an empty chamber to prevent cook-off; (5) a non-disintegrating metal belt that did not separate when the cartridge was pushed out; (6) muzzle booster and front barrel bearing; (7) considerably larger barrels than usually employed with the same mechanism in ground work; and (8) single grips in place of the conventional two-grip (or spade) arrangements.

The first models made for the Swiss Air Force were designed for firing through the hollow propeller hub in a Hispano-Suiza engine at the rate of 400 shots a minute. It is of unusual interest to note that the official armament of the Swiss service was all designed by Furrer and government produced. The small arms manufacturing arsenals near Berne were committed to produce

every automatic weapon used by all branches of the Swiss service, despite the fact that two of the leading commercial types of automatic cannon (Hispano-Suiza and Oerlikon) were also manufactured within the borders of Switzerland. This shows, if nothing else, that this government had unlimited faith in the Furrer action and exploited its possibilities to the fullest.

After the engine-mounted 20-mm gun came a 34-mm version with an identical action that was looked upon with great favor because of the larger explosive charge in the projectile. The muzzle velocity of 3,445 feet per second coupled with a cyclic rate of 350 rounds per minute made it a very formidable aircraft and antiaircraft weapon. The cartridge case used in both guns was of the type known as rimmed and was fed into the weapon by a metallic open-type link. The 34 mm was not only adapted to wing mounting but to turret installations, the synchronization of the weapon making it one of the few automatic cannon that lent itself easily to turret mounting.

The cycle of operation of all Furrer aircraft cannon is the same, regardless of caliber. After the belt, or magazine, is put into place, bringing the cartridge in position to be picked up by the bolt face, the action is completely retracted. When released, the compressed driving spring gives the firing mechanism a thrust forward. As the bolt face comes abreast of the rear of the feeding system, a loaded round is shoved forward into the chamber. On the last fraction of an inch of forward travel the toggle joint is forced into line and locks, cocking the piece. The weapon is now loaded, ready to fire.

The scar is rotatable in the breech-bolt frame, and upon being actuated, pivots, releasing the firing pin to fly forward under tension of its spring and strike the primer of the cartridge. This in turn fires the charge. For the first fraction of an inch of recoil the barrel is rigidly

connected with the barrel extension and bolt. During this time it slides under action of recoil in the guides cut in the stationary receiver. The breech-bolt frame contains the bolt which is also moving rearward and is connected by a link with the front end of a pivoted member, also in the form of a link.

The latter is rotatably mounted in the breech-bolt frame on a pivot. The rear end is connected by means of a pin with one of the supporting links, the other end of which attaches to the barrel extension. The bolt only becomes unlocked from the barrel after the barrel and breech bolt have reached a point where a projection in the stationary receiver breaks the straight-line action of the pivoting links. This allows the bolt to open slowly to produce initial extraction. To complete the function, it carries back the fully loosened cartridge held to its face by the extractor.

The first breaking action of the links withdraws the firing pin slightly within the bolt face.

The continued recoil movement not only holds the firing pin in this position but carries the cartridge to a point where its base collides with an ejector built into the receiver. Here the empty cartridge case is pivoted and ejected through a slot opposite the one through which it was fed. With the barrel extension being unlocked from the bolt, the barrel remains in a retracted position. The bolt having completed its full recoil stroke starts counter movement and the bolt face, when in position, picks up the incoming round out of the feedway ready for chambering.

At this time the projection on the firing pin catches the sear mounted in the barrel extension. In the final act of locking, the bolt compresses the firing-pin spring. When the bolt and barrel are locked, the continued thrust of the driving spring then shoves the retracted barrel assembly into battery. If the trigger remains depressed, the sear releases again, firing the chambered cartridge.



## AMERICAN ARMAMENT AUTOMATIC AIRCRAFT CANNON

When the mania for "shell gun" mounting in planes was at its peak on the Continent and the revival of interest in air-borne cannon made the military authorities of all countries review what armament their own air forces had available, the American Armament Co., of New York City, announced in 1933 the development of a 37-mm automatic cannon designed primarily for aviation armament.

The director of the company, Mr. I. J. Miranda, and its chief engineer, Mr. B. P. Joyce, who claimed to have designed the weapon, not only made many trips abroad to interest major powers seeking just such an automatic arm but also made many claims for their weapons that were seized upon by writers for various aviation magazines and ordnance publications. Mr. W. S. Shackleton, of London, who was the firm's foreign representative, also published numerous articles on the virtues of this 37-mm automatic aircraft cannon.

The air-cooled, clip-fed weapon used long recoil for operation, and its rate of full automatic fire was 60 shots a minute, with a ridiculously low muzzle velocity of 1,200 feet a second. This is not surprising when the mechanism is examined closely and compared with others already in existence. For, notwithstanding the manufacturing claim that the mechanism was new in principle and was designed "just for aircraft," it goes back to World War I, being nothing more or less than a conversion for air use of the Puteaux cannon developed both in the United States and abroad.

The first country to become interested in the gun was Poland. It was not impressed by the low muzzle velocity and contracted with the American Armament Co. on the condition that the speed of the projectile be substantially increased. The Polish Government posted a bond

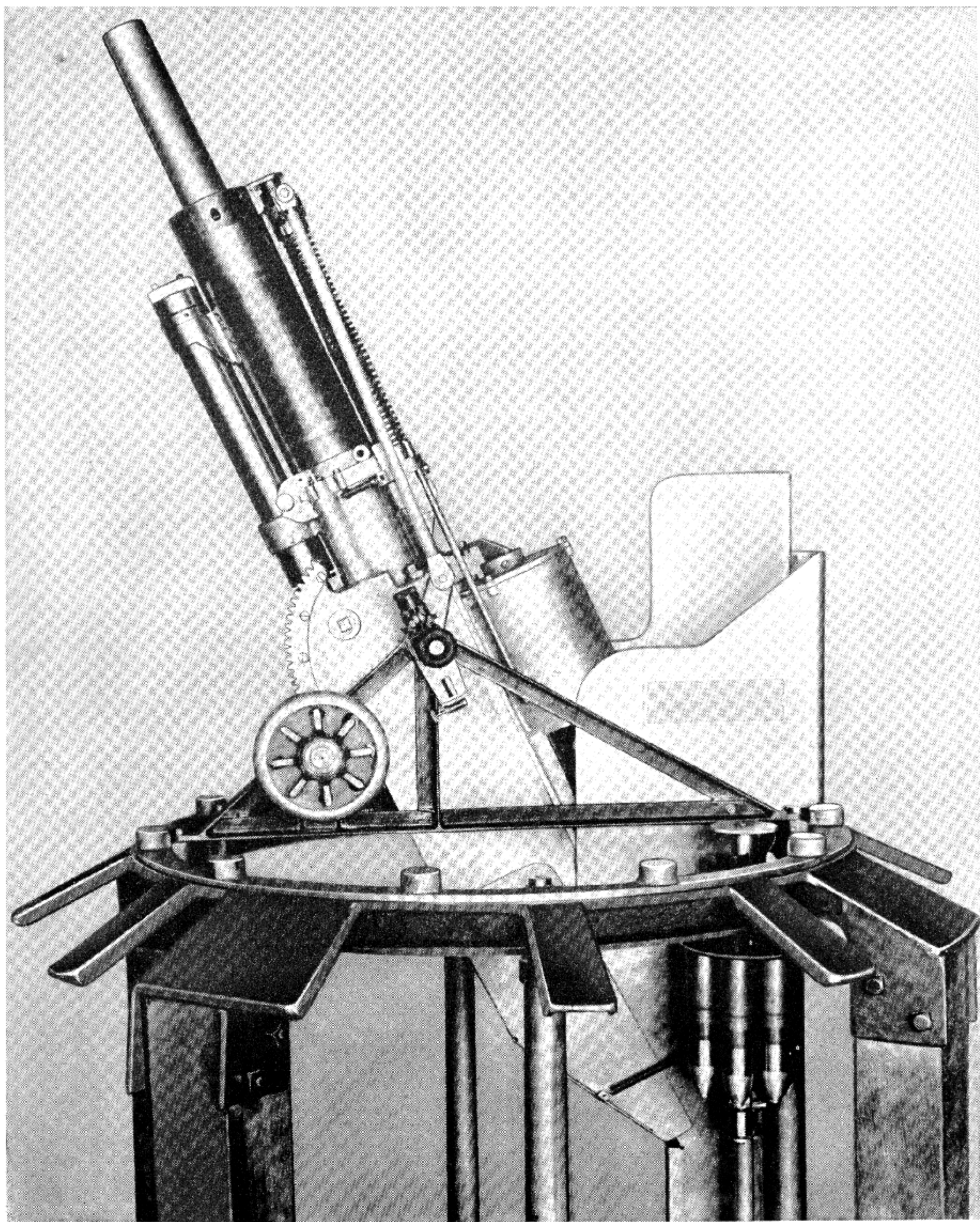
with a neutral agent equal to the cost of manufacture and demonstration of the weapon. This would be turned over to the company if the tests were successful. The agreement stipulated that muzzle velocity and ballistics would be improved. At the trials in Poland in competition with the antiquated C. O. W. gun, then made by the Vickers Co., the English-made weapon consistently outshot the American product. It was also demonstrated that the muzzle velocity had not been increased one particle and the Poles ordered return of the bond. The next venture was with Italy with results that were comparable with the earlier failure.

About the only real accomplishment of the weapon was to mislead the American public into thinking this country had an automatic aircraft cannon that was superior to that of any other country in the world. Practically every aviation magazine or ordnance publication contained artists' conceptions of huge aircraft armed with the gun, firing both from fixed positions in the wings and in power-driven turrets. In reality, little or no improvement over the Puteaux, of which it was a close copy, can be found.

The limited number that were manufactured were made in two models, *M* and *F*. The *M* represented a weapon adapted for turret or movable use. The *F* was for fuselage or fixed installations.

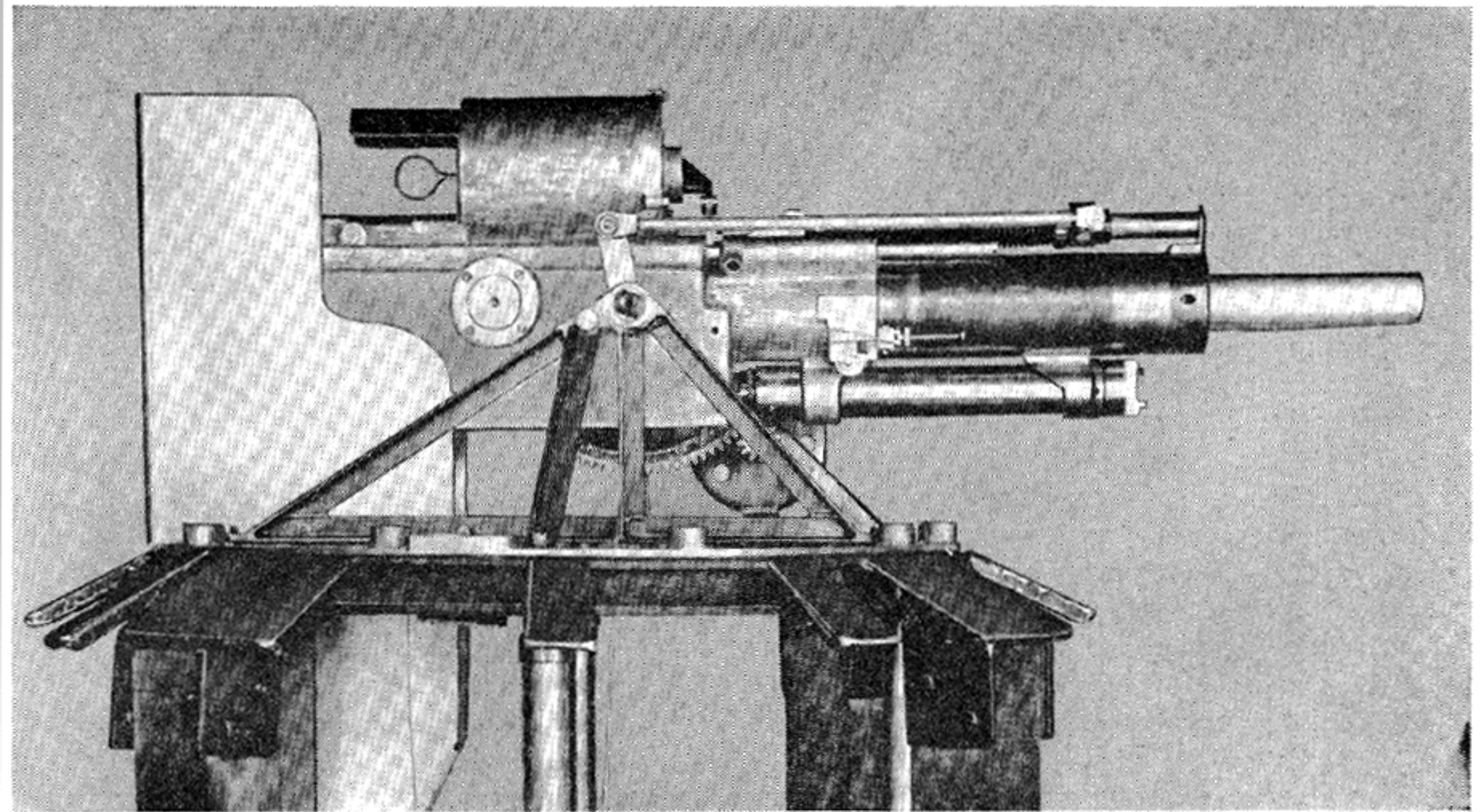
To fire the American Armament cannon, the chambering of the first round requires the efforts of two men. It is a very clumsy operation since the breech must be opened by a special tool which moves the pinion on the breech operating shaft. After the cartridge is chambered, it is fired by percussion, a striker hitting the firing pin a smart blow. The barrel and its extension then recoil together a distance greater than the over-all length of the loaded round. At this





American Armament 37-mm Automatic Aircraft Cannon (Flexible).





American Armament 37-mm Automatic Aircraft Cannon.

time the breech is unlocked by the camming down of the lock. The barrel and breech lock start toward battery while the extractor attached to the carrier remains seared to the rear.

When the barrel assembly is a half inch from the battery position, the sear holding the carrier is released and this assembly starts home. The feed system, which holds a clip of five cartridges, consists of a recoil-operated cage which rotates to feed the rounds through an opening in the loading tray. The carrier picks up the positioned cartridge and the extractor snaps over the rim as it chambers. The final movement forward of the carrier cams up the breech lock and the weapon is ready to repeat the cycle.

After much paper promotion and exaggerated factory claims this gun disappeared from existence shortly before World War II, but not before it had caused a great deal of interest both here and abroad. It was hardly possible to find any prominent aviation magazine of the day that did not show a sketch of an American plane with this weapon in both fixed and flexible mounting.

The company manual sent to prospective customers on the care, use, and handling of the

American Armament automatic cannon devoted many pages to the potentialities of its devastating fire. Particular attention was called to the ease of its operation, said to require the services of just one man. A direct quote from the booklet permits the reader to determine whether the company was really serious in describing this allegedly simple feat or whether the gunner was some form of contortionist seeking another hazardous occupation for a livelihood.

"The gunner is seated facing one side of the gun and with his eye at the sight at all times. With his left hand he operates the elevating hand wheel whilst with his right hand he traverses the piece by means of a traversing hand wheel. He fires the gun with his left foot while his right foot works the breech pedal that is used to lock the gun in traverse, releasing the right hand to feed clips of ammunition to the magazine."

Regardless of the performance of the gun, any gunner who could accomplish so many things simultaneously would have made a fortune in public exhibitions.



## LAHTI AIRCRAFT CANNON

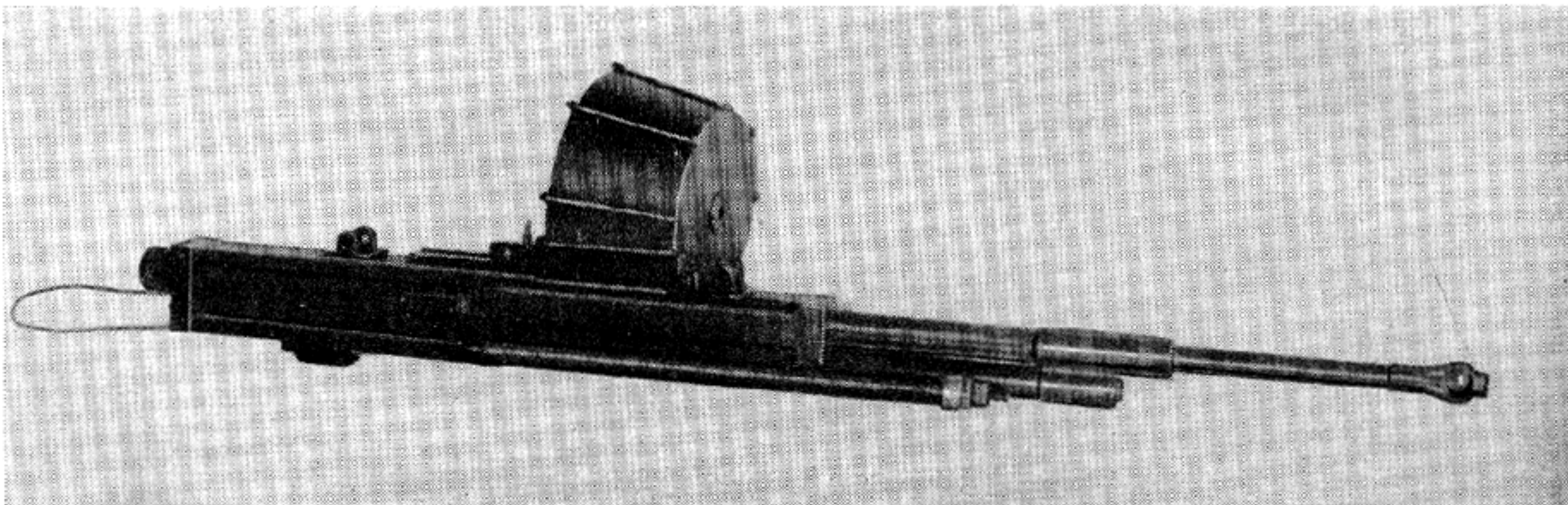
Finland's highly respected small arms designer, Aimo Johannes Lahti, in 1933 produced at the state manufacturing arsenal at Jyväskylä his first prototype 20-mm automatic aircraft cannon, soon destined for use by the Finnish Air Force. The 84-pound weapon was gas operated, both front and rear seared, and magazine fed (60-shot drum). Charging was done by means of compressed air and the rate of fire was 550 shots per minute, with a muzzle velocity of 2,750 feet per second.

As part of a peculiar mounting system, the brackets were located on top of the receiver immediately fore and aft of the drum magazine. A muzzle brake was always used on the weapon to dampen out a portion of the recoil forces. Half of the barrel starting at the breech end was fluted, giving not only rigidity but offering more cooling surface. An electric solenoid mounted on the left rear of the receiver triggered the firing mechanism when remote control was needed. The air charger was not an integral part of the weapon but fastened to the right side of the receiver. A latch operated by thumb pressure locked or released the magazine at will. An unusually heavy nested spring buffer at the rear of the receiver deflected the operating parts back into counterrecoil.

The Lahti 20-mm automatic cannon had a very clean profile and, with the exception of the abnormally large drum feed, was easily adaptable to aircraft mounting. The inventor was permitted by the Finnish Government in 1935 to demonstrate this weapon before British ordnance officers. It did not give a satisfactory performance, having, in the opinion of the British, too many stoppages from broken parts resulting from the experimental nature of the weapon. The most prevalent malfunction was failure to extract. This could have been caused by the use of too much gas to operate the mechanism. Hasty unlocking thus resulted while too high a residual pressure remained in the bore.

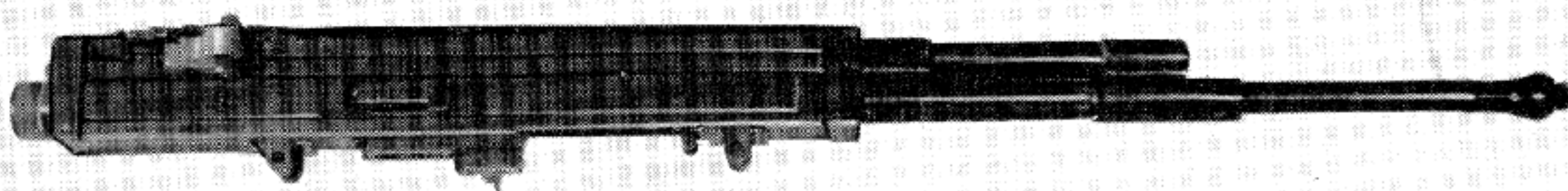
Much work was done to correct the malfunctions that turned up in the English trials and eventually the weapon was considered satisfactory and adopted by the Finnish Air Force. It saw much action in the Russo-Finnish War. At its conclusion the Russians became greatly interested in this weapon and its influence is most certainly shown in some of their later developments.

To fire the Lahti 20-mm automatic gun in an aircraft installation, the loaded drum is placed on top of the receiver and latched into position with the bolt forward. The air charger is then



Lahti 20-mm Automatic Aircraft Cannon, Model L27, with Drum Feed.





Lahti 20-mm Automatic Aircraft Cannon, Model L27.

actuated. The bolt and piston assembly are then thrust rearward until the sear rises and engages its recess in the bottom of the gas piston. By actuating the electric solenoid, the sear disengages the piston and bolt assembly which is driven forward by the energy of the compressed driving spring. The feed rib on top of the bolt shoves the first round out of the lips of the magazine and chambers it. While the barrel assembly is still three-fourths inch out of battery, the bolt seats behind the cartridge and the extractor claw snaps over its rim. At the same time the bolt-locking piece is cammed up into its locking notch in the barrel extension and this act releases the device that has been holding the barrel and extension to the rear.

The locked barrel, the extension, and the bolt start final movement forward. At a point one-sixteenth inch from full battery position, a pivoting pin in the bolt-body tip that has been in the path of the retracted firing pin contacts a ramp in the receiver and is levered up out of the way. The firing pin is now released to fly forward, striking the primer. The timing is such that recoil forces of the exploding powder charge are set up before the fast-traveling locked mass strikes the solid receiver, thus utilizing these forces to buff the forward action.

The recoiling parts are locked securely together for a distance of a half inch; as the projectile passes the port in the barrel, a portion of the gas is released into the cylinder housing the piston to give the member a sudden thrust rearward. The movement is done in such a manner as to allow the bolt to creep a few thousandths of an inch rearward before total unlocking. This permits the extractor to break the gas seal and fully loosen the cartridge before the instant of complete release, at which time energy is transferred from the fast recoiling barrel to the bolt by means of an accelerator. The latter, upon pivoting, speeds the bolt to the rear with the extractor holding the empty cartridge case. When its rim strikes the solid ejector, it is knocked out of the slot in the bottom of the gun.

The first recoil movement starts to jack the firing pin to the rear and continues to do so until the sear in the left side of the bolt drops in front of the circular projection over the body of the pin. The barrel and its extension at the moment of bolt release are held in a retracted position by the holding latch. When the bolt has reached full recoil, compression of the driving spring starts the assembly forward to repeat the cycle.

## BREDA 20-MM AUTOMATIC CANNON

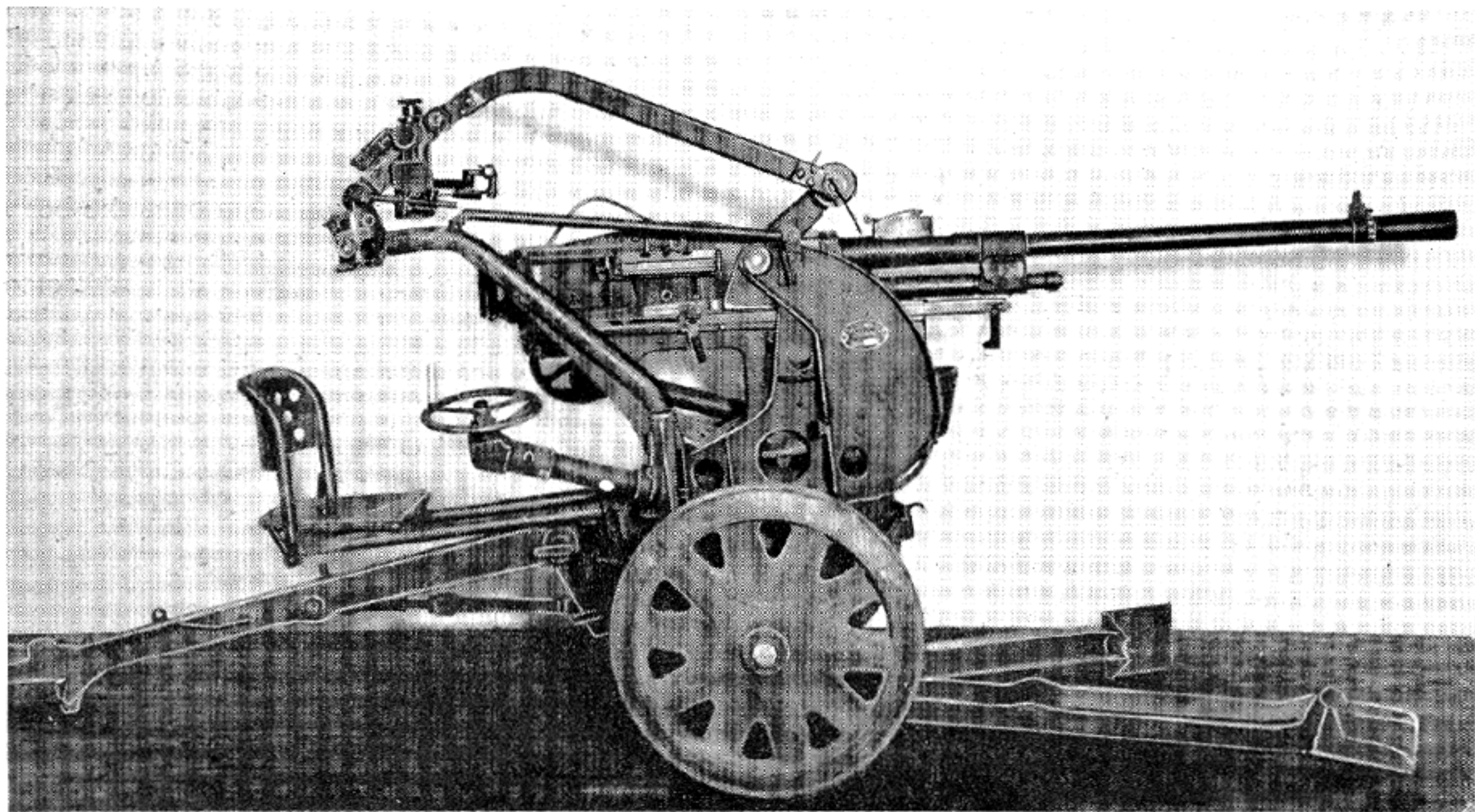
An early experience with aircraft cannon that ended in complete failure caused the Italian Air Force to delay the development of large-bore aviation weapons until it was altogether too late. And had the Breda 20-mm automatic gun not been designed originally for ground work against armored vehicles and later refined for aircraft use, there would have been no Breda aircraft cannon. In 1934 the Italian Army introduced this weapon as an antitank gun and mounted it on a carriage similar to that of a field piece.

This 20-mm, gas-operated, air-cooled Breda is clip fed with each tray holding 12 cartridges. Continuous fire can be accomplished by keeping one clip in contact with another. The cannon may be fired either single shot or full automatic, as desired. The empty cartridge case is not ejected, but is carried back into its original position in the feed clip by the extractor. This

method of handling the brass unnecessarily complicates the feeder mechanism. The bolt assembly, which actuates the feed, has to perform its work during the very short time it takes for the bolt to clear the rear of the feeder, strike the buffer, and return to position.

To reduce shock and keep the action from being erratic, the mechanism is so designed that the ammunition is not indexed through positive linkage. The bolt assembly on recoil cocks a set of springs and they in turn move the clip through the gun. Also the stroke of the recoiling assembly extends beyond the feed. This long bolt stroke accounts for the weapon's low rate of fire.

The breech lock is of the rising block type and it is impossible to fire out of battery, since the bolt must be securely locked before the firing pin is alined with the primer.



Breda 20-mm Antitank Automatic Cannon.



The gas bracket, which locates the gas housing beneath the barrel, is an integral part of the latter. This assembly includes an adjusting screw to control the pressure bled from the barrel that operates the mechanism. On its breech end the barrel has interrupted threads that enable the gunner to make a quick change. It is also recessed for the extractor and barrel-locking detent.

The receiver consists of a front face, two sides and a bottom plate rigidly joined. The forward part is threaded for the barrel and has in its upper part a seat for the locking detent. Inside and toward the front of the receiver there are slideways for the bolt; slots at the back permit attachment of the back plate; and on the top part of the inside is milled the locking recess. Forward and near the top on each side are the necessary openings permitting the clip to be fed into and carried out of the receiver.

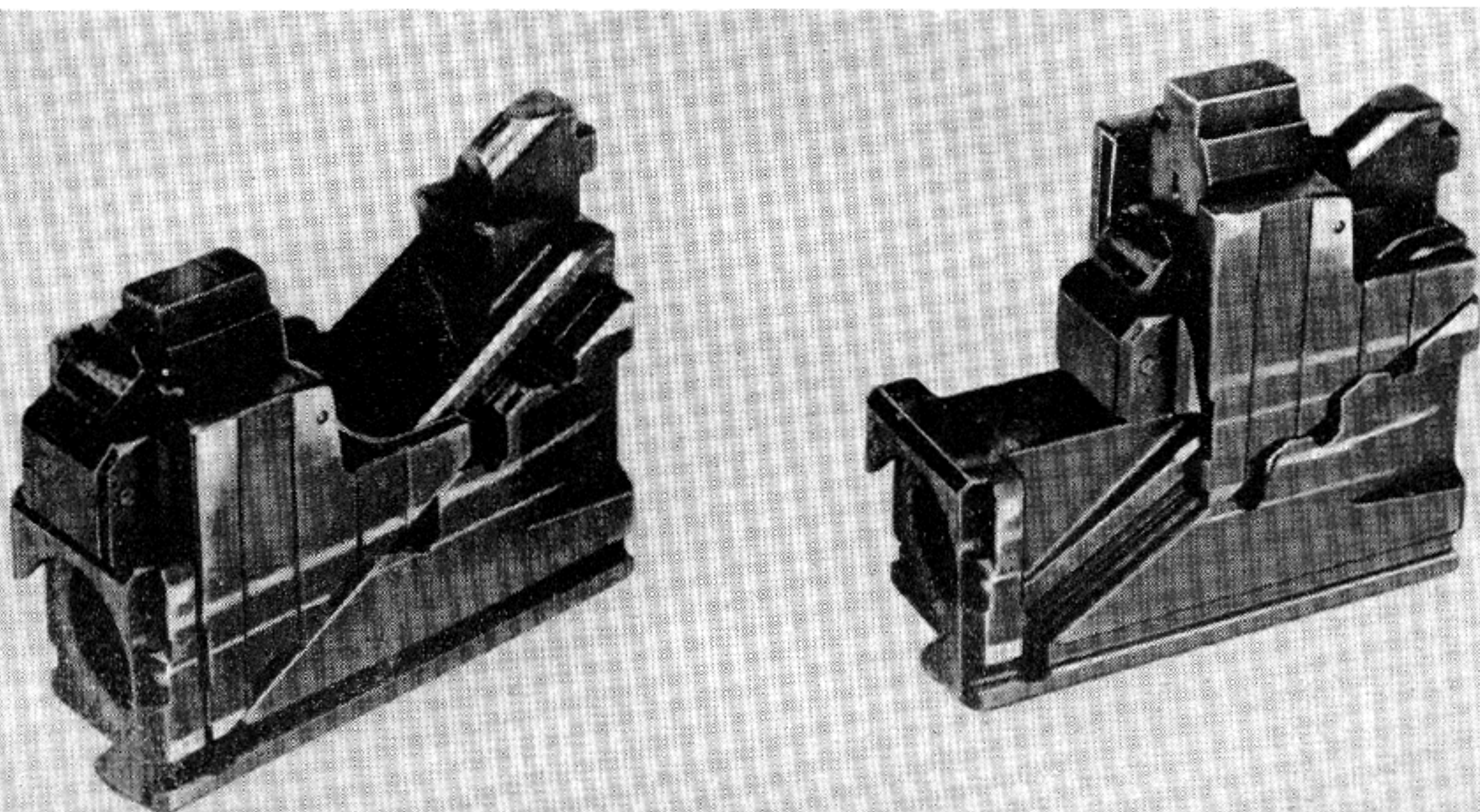
The operating parts include the gas piston, the driving spring and the two-piece bolt and bolt extension assembly. The gas piston is a hollow tube that houses the driving spring. When assembled in the weapon it is fastened to the bolt extension and may be considered part of this piece.

The lower part of the bolt extension is rectangular in shape and bored out to permit the driving spring to pass through it and into the gas piston. A wedge-shaped lug extends from the upper rear part of the bolt extension, and on each side is machined an inclined plane upon which rides the bolt carrying the firing pin. The bolt straddles the horizontal surface of the bolt extension and the action of the angular surfaces cams the bolt up and down to lock and unlock the weapon. Grooves in the lower part of the piece mate with the guide rails in the receiver permitting the assembly to reciprocate in the act of firing.

The upper rear part of the bolt extension has a protrusion that acts as the firing-pin striker after the bolt is securely locked. The forward part of the bolt, which carries the firing pin, has vertical grooves in which the extractor slides.

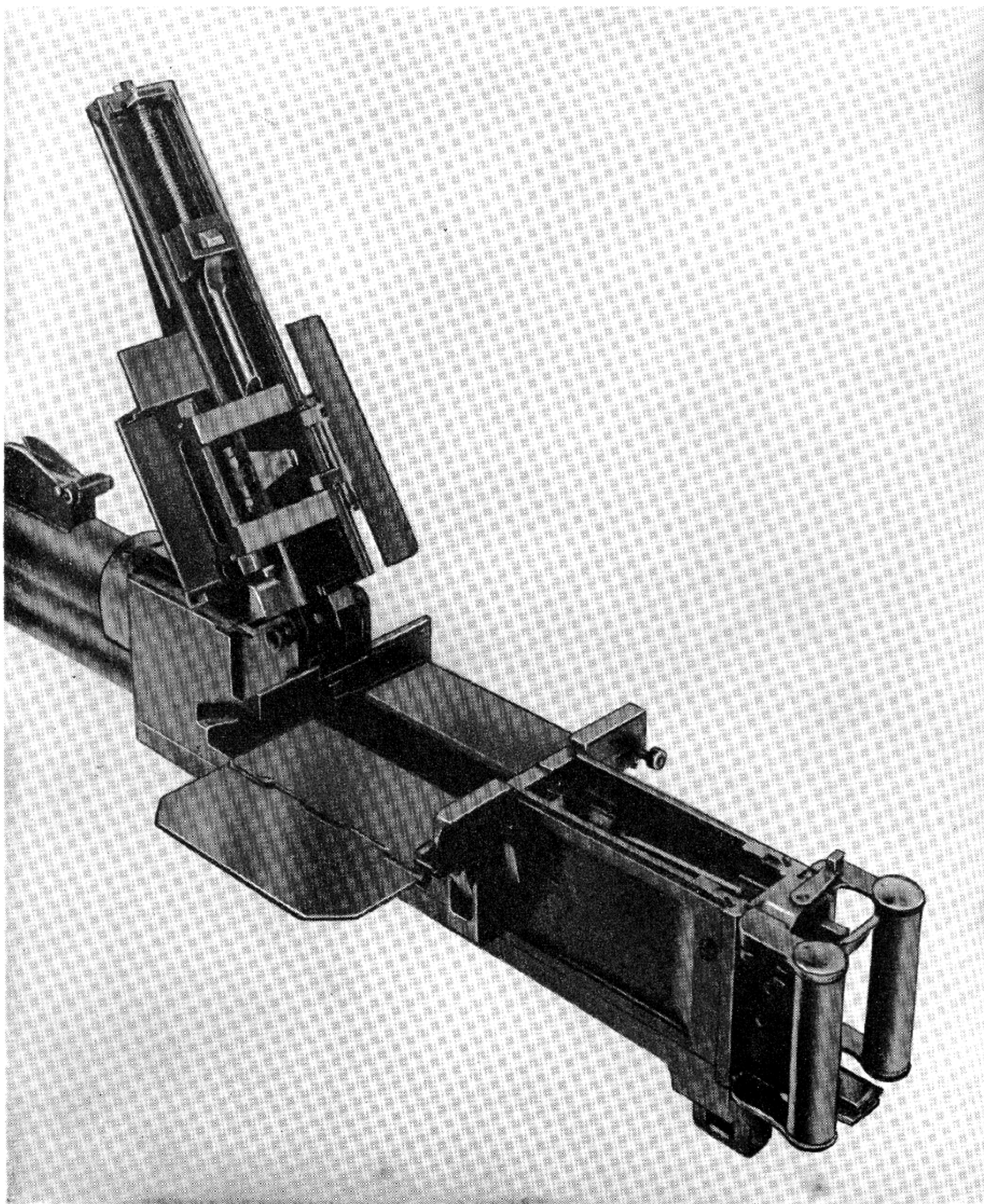
The loaded clip is indexed when the feed cam is engaged by the lug on the bolt extension. As the cam is stroked to the rear by the firing mechanism's recoil, it compresses the feed pawl springs. On reaching full recoil, the spring-driven feed pawls are released and move a round into position for loading.

Incorporated in the design of this weapon is



Bolt Assembly of the Breda 20-mm Automatic Cannon. Left: Bolt in Traveling Position. Right: Bolt Locked in Battery Position.





Breda 20-mm Automatic Aircraft Cannon with Cover Group Open, Exposing Feed Mechanism.



a unique safety feature by which a spring-loaded latch falls into a slot whenever the corresponding recess in the feed clip fails to contain an expended cartridge. Consequently, if an empty case is not withdrawn from the chamber by the extractor and positioned into its former place in the clip, the feed will remain stationary without indexing the next round at the end of the recoil stroke. This will jam the mechanism but will prevent a loaded high-explosive projectile from striking the base of an unextracted cartridge left in the chamber.

To fire the Breda 20-mm automatic aircraft cannon, a loaded clip holding 12 cartridges is placed into position on the left-hand side of the receiver and the mechanism is retracted by pulling rearward on a lever located on the lower right side of the receiver. This charging device contacts a lug on the bottom of the bolt extension. As the bolt assembly is moved to the rear against the compression of the driving spring, two lugs one on each side of the extractor strike the inclined surface of the cams in the receiver, causing the extractor to be depressed against spring pressure. Further movement to the rear makes the feed clip move over one space, thereby indexing the first round.

At the completion of the rearward movement the sear engages the bolt extension at a point just below and forward of the hammer and holds the bolt assembly in the retracted position. The weapon is now loaded and cocked. When the trigger is depressed, the firing assembly is released and flies forward by the action of the driving spring.

The top front portion of the bolt starts to shove a round out of the feed clip, while the extractor rises and positions itself around the rim of the cartridge. Continued travel forward chambers the round, with the front face of the bolt striking the breech end of the barrel. The bolt

extension continues forward causing the bolt to rise vertically until its rear portion slips into the locking recess in the receiver. The firing pin has now been moved into position and the upper lug on the bolt extension strikes it a smart blow, driving it into the primer.

The barrel, bolt, and receiver are securely locked at the instant of firing. As the projectile passes through the bore and the port is uncovered, gas is bled into the gas cylinder exerting an impinging action against the piston. This causes the bolt extension to start in recoil and at the same time cams the bolt down and out of the locked position.

The extractor now withdraws the empty cartridge case from the chamber, and releases it after it has been carried back into the space it originally occupied in the feed clip. The release is caused as the lugs on the extractor strike their cams, thus lowering the piece out of engagement with the round. As the recoil movement continues, the top part of the bolt extension strikes the feed cam and indexes the clip through a complete cycle, so that the next round is positioned for stripping.

At the end of the recoil stroke the shock of the bolt is absorbed by the buffer spring, and counterrecoil movement begins. The cycle of operation is repeated if the trigger remains depressed.

The Italian Air Force was practically in World War II before it realized that it lacked adequate armament against heavy bombers. This 20-mm Breda gun was hastily refined and modifications made for aircraft mounting. The weapon was manufactured by the Società Italiana Ernesto Breda of Brescia, Italy, a locomotive works which had turned to armament production in the first European war and continued to turn out weapons in the years that followed.



# MAUSER AUTOMATIC CANNON

## MG-151

When Hitler seized control of the German nation, the military authorities immediately began open Government financing of weapon development and production. The Waffenfabrik Mauser A. G., which had barely existed since World War I, was among the first so expanded. The firm had remained in business through the manufacture of infantry rifles and semiautomatic small arms, which were considered second to none. In 1934 the Government recruited experienced weapons engineers and financed the expansion of the plant.

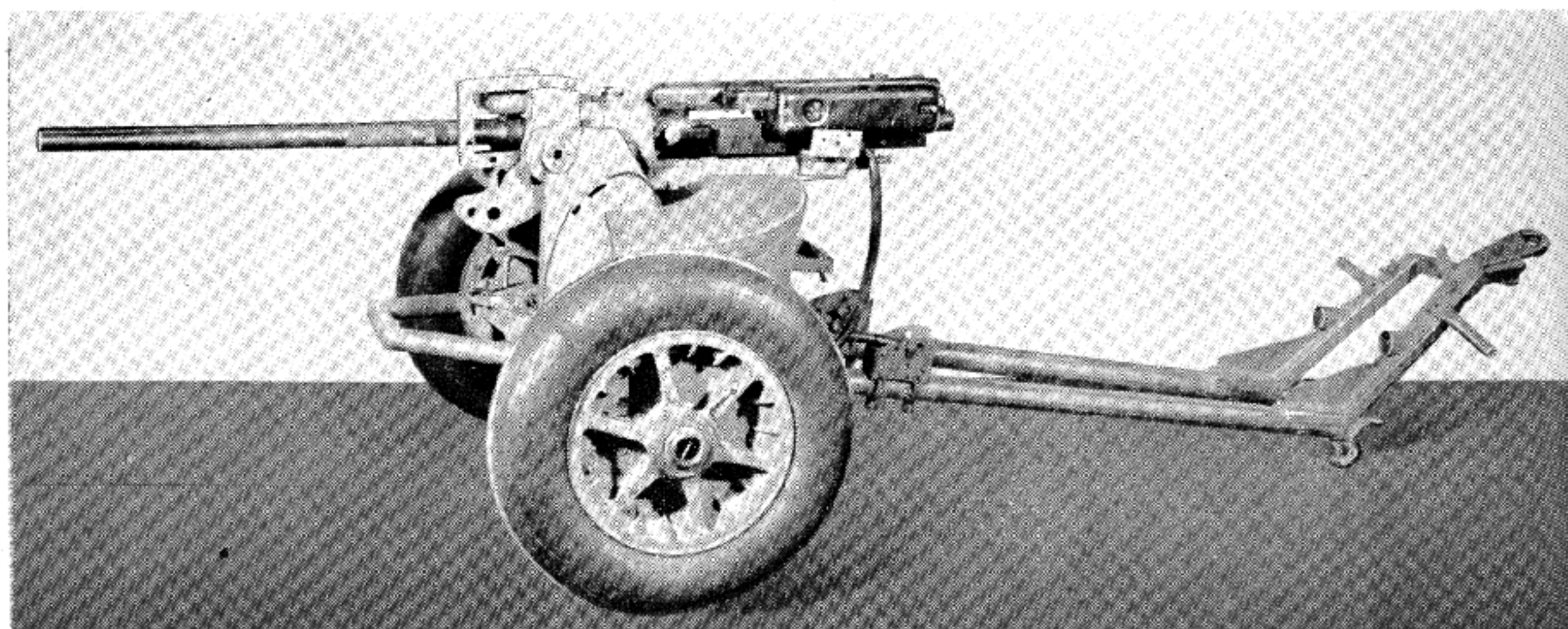
The Mauser Co.'s initial venture into the field of automatic weapons for aircraft was in 1935. It was given the assignment of developing an automatic gun to use a 15-mm high-velocity cartridge to fill the needs for an intermediate weapon for the German Air Force and to compete with the 13-mm development of Rheinmetall. The action chosen was very similar to an infantry light machine gun that it was also in the act of developing.

High-velocity ammunition had reached a stage

where tests showed the speed of the bullet to be slightly in excess of 3,300 feet per second and an electric primer had proved reliable. This eliminated synchronization difficulties. This work had been accomplished by the D. W. M. plant which likewise had been placed under contract by the German Government. The new aircraft gun used a short recoil, with a rotating bolt head for locking. It was air cooled, belt fed, with a metal disintegrating push-out type link, and the rate of fire was 650 to 700 shots a minute.

While first tests showed reliability of action to a satisfactory degree, the high-velocity bullet practically destroyed the rifling in the barrel in a comparatively short burst. Since the projectile was too small to fuze for a high explosive charge, and as the slight increase of bullet speed was not considered worth the difference, the German ordnance department ordered that the work on this caliber weapon be stopped at once and that every effort be made to use the same mechanism with a 20-mm bore, which put it in the automatic cannon class.

The German system of nomenclature at this time placed everything at 20 millimeters and



Mauser 20-mm Automatic Aircraft Cannon, Model 151, Mounted for Antitank Duty.



above in the cannon classification, while all below were designated rifle caliber. This method of identification called for the letters MG or MK to be placed on rifle caliber guns and cannon, respectively, followed by the closest numeral to the bore diameters in millimeters, plus the model number. Thus the Mauser Co. designated its original gun the "MG-151" (the "MG" for *Maschinen Gewehr*, or machine gun, the "15" for the bore diameter in millimeters, and the "1" representing the first model.) This is explained in order to clarify events that followed shortly. For when the gun was changed to 20-mm, putting it in the MK, or *Maschinen Kanon* (cannon), classification, the original designation was kept, showing that the weapon was first constructed in a rifle caliber, although now definitely a cannon. The official nomenclature, as ordered by the German ordnance department, was "MG-151 15/20." However, it did not take long for the 15 to be dropped and this weapon is universally known as the MG-151 20-mm aircraft cannon.

The men responsible for the design and development of both versions were Dr. Kurt Fleck, Mr. Otto Helmutt von Lossnitzer, and Dr. Doerge. Dr. Fleck was responsible for production while the other two members busied themselves with the design. All were joint directors of the Mauser firm.

One of the Germans' main objections to the rifle-caliber gun was the weight of projectiles fired a minute. The 15-mm gun firing at 700 rounds a minute placed 93 pounds in flight while the 20-mm, with its higher rate of fire (750 rounds per minute), discharged 190 pounds of metal in the same time. This, coupled with the low destructive power of the solid-ball versus the high-explosive projectile, prevented the smaller caliber from being seriously considered as an aircraft weapon.

The MG-151 20-mm had several good features, the most outstanding of them being: The incorporation of the accelerator as an integral part of the bolt; a quick-change barrel that required only a quarter turn; electric ignition; a driving spring in the cover group, which when raised left the bolt free to be lifted out; push-out type link with snap at the rear to prevent misalignment after belting by engaging the can-

nelure of the round; complete housing of the barrel-return spring; an electric charger that actuated the bolt by energizing its motor; a roller-type sear that insured an easy release by requiring only a minimum amount of energy to free the mechanism but at the same time providing a positive searing action; and a feed system actuated by a lug on top of the bolt, that rotates a feed cam which in turn moves the belted rounds into place. In its final design the weapon weighed 93½ pounds and had a muzzle velocity of 2,590 feet per second.

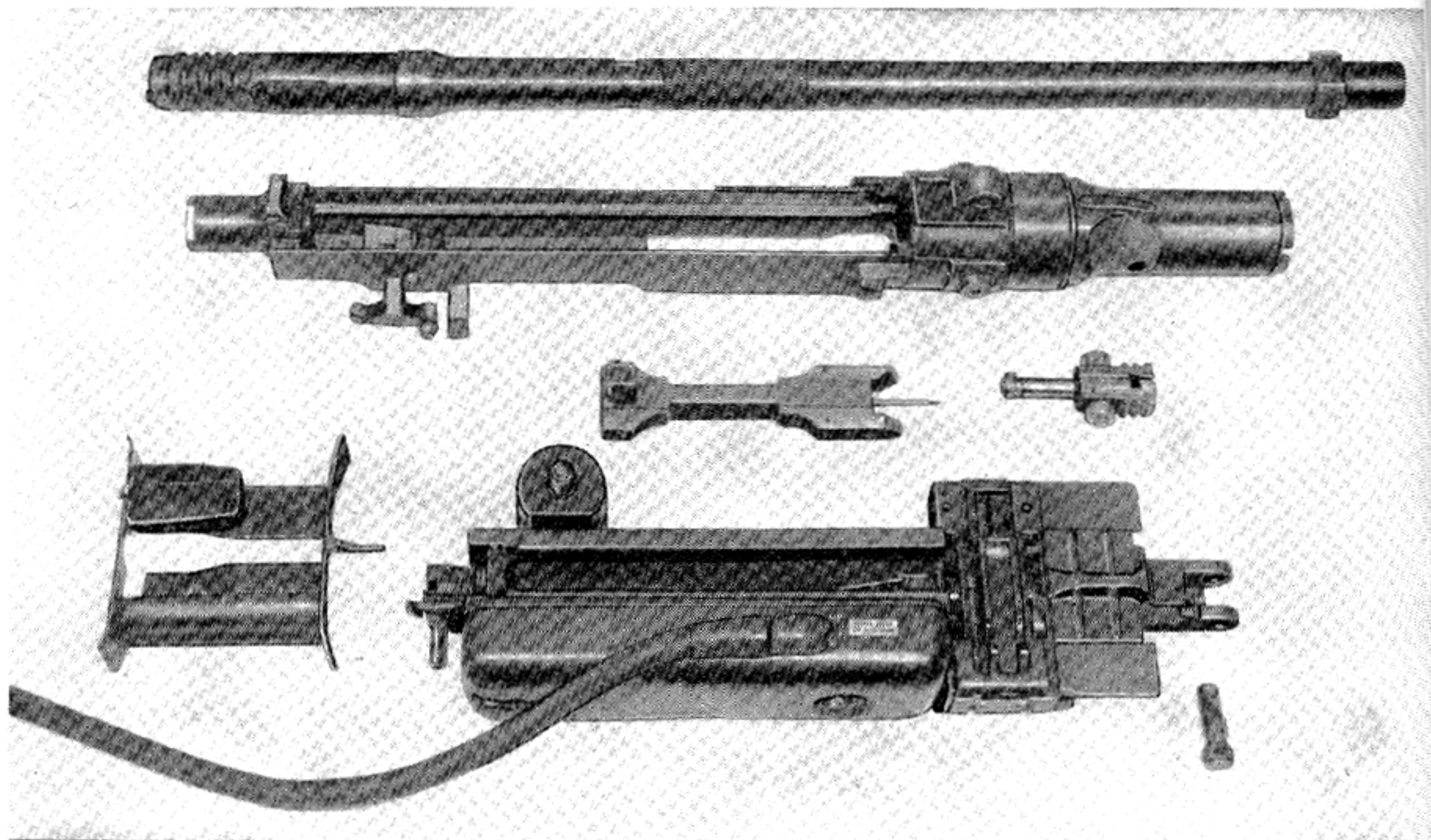
To fire the MG-151 15/20, the operator first makes certain the bolt is all the way forward, then the belt is placed in the feedway and pushed across until the second cartridge is well inside the receiver. By closing the charger's electric circuit, the bolt is retracted until it engages its rear sear at which time the device returns home under its own spring tension. The rearward movement rotates the feed tube to position a round for loading and the bolt is in the cocked position ready for firing.

When the solenoid that pulls the roller sear downward is engaged, the bolt assembly is started forward by the force of the driving spring in the cover group. The top of the bolt head strikes the base of the cartridge and moves it forward out of its link. As the round is guided downward towards the axis of the bore, the extractor claw engages the rim of the cartridge just as it is chambered.

Locking commences at the instant the bolt-head rollers come in contact with the cams of the sleeve on the rear of the barrel. The locking lugs on the bolt head then turn in a clockwise direction and engage their mating flanges on the sleeve. This movement is aided by the cams on the front of the bolt body acting from the rear against the rollers.

At this moment the bolt carrier is in its foremost position and the weapon securely locked. The firing pin is energized by an electric circuit that is closed by this final movement to detonate the electric primer and explode the powder charge in the cartridge. With the bolt and barrel rigidly locked together while the projectile is in the bore, these parts recoil together five-eighths inch. The bolt-head rollers then engage the surfaces of the unlocking cam, as continued





Component Parts of the Mauser 20-mm. Automatic Aircraft Cannon, Model 151.

movement causes the lugs to turn counterclockwise unlocking the piece.

As the bolt head turns with a sudden movement, the rearward portion of the bolt carrier is accelerated by the action of the bolt-head rollers pushing against the cams on the bolt carrier. The barrel continues to travel a half inch until it is stopped by its recoil spring and the snubbing action of the buffer rings. The last action of the rotating bolt head before full unlocking is to extract initially or loosen the round. As the freed bolt starts recoil movement, the extractor pulls the empty case from the chamber and holds it to the bolt face. Near the end of this rearward movement the ejector slides through its slot in the bolt head causing this part to strike the rim of the empty case, knocking the spent cartridge out of the ejection slot in the bottom of the receiver.

Throughout bolt recoil the belt-feed rack and belt-feed pawls draw the linked rounds into the feedway. The belt-holding pawls hinge upward to clear the incoming round. As the bolt approaches its rearmost travel, the pawls snap down against the first cartridge link holding by

spring action the round down in the feedway slot where it can be picked up and chambered by the bolt when it assumes counterrecoiling movement. A strong single-spring buffer stops the bolt's recoil stroke and speeds it back towards battery if the rear sear remains depressed.

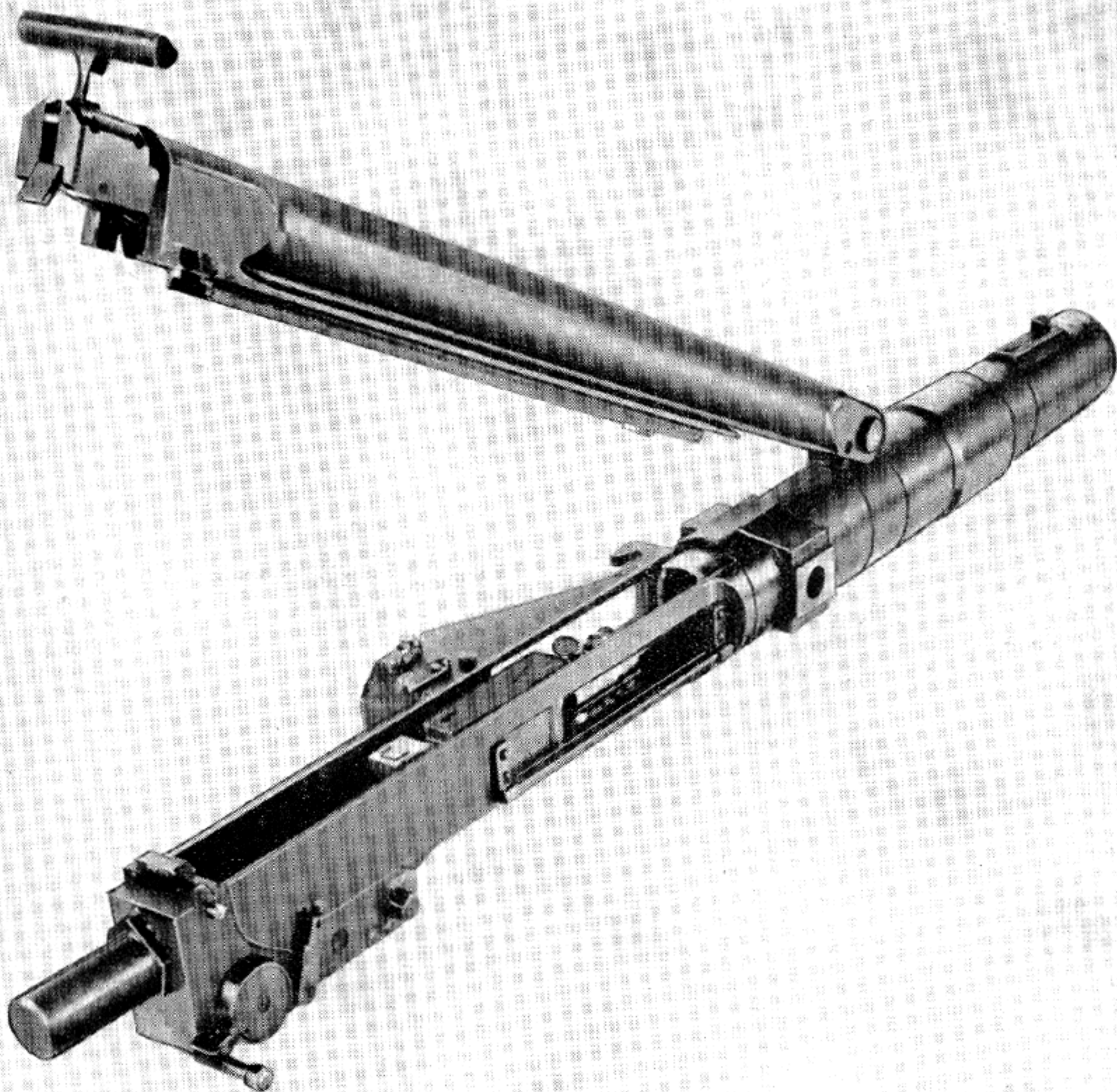
A good indicator as to its general use is that the Mauser Co. alone made 29,500 of these weapons in 20-mm caliber from 1940 to 1943.

### Flak 38

The Germans have long been famous for using a reliable firing mechanism in every conceivable manner in which it could be applied and the MG-151 was certainly no exception. It made practically a simultaneous appearance as an anti-aircraft automatic gun and was given the designation of Flak 38. This cannon was designed by Mauser engineers, Linder and Froebel, and although similar in appearance and identical in operating principles, it is a distinct weapon and not to be confused with the MG-151 20.

The Flak 38 has a 20-mm bore, it feeds through the left side with a 20-shot spring-





Mauser 20-mm Automatic Antiaircraft Cannon, Model Flak 38, with Cover Group Raised.

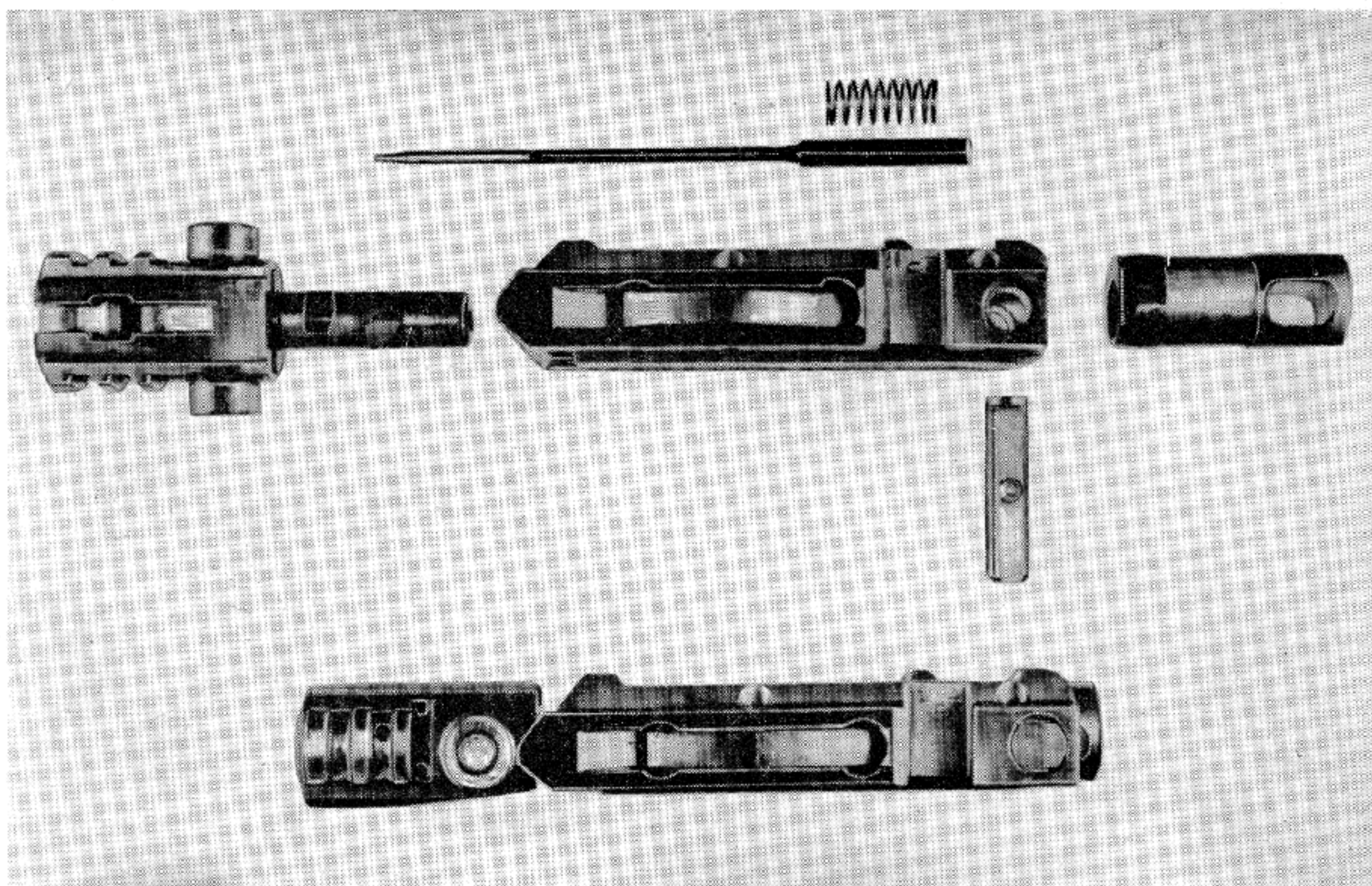
loaded curved magazine, and the spent brass is ejected through an opening in the right side of the receiver. The gun is percussion fired and a selector lever on the side allowed single-shot fire if desired. The weapon weighs 123 pounds, has a muzzle velocity of 2,720 feet per second and a rate of fire of 420 rounds per minute. Incorporated in this design is a Belleville washer-type rear buffer.

The Flak 38 was popular from its introduction and eventually superseded the standard 20-mm antiaircraft weapon that had previously been in use. The Mauser factories made 20,900

of this model in the years between 1939 and 1945. Captured documents have revealed that Japan was also furnished manufacturing drawings and all necessary specifications for making both the aircraft and antiaircraft models.

In 1943 the British turned over to the United States a MG-151 20-mm aircraft gun that had been shot down in the battle of Britain and immediately work began in this country in an attempt to devise a weapon using an identical system of operation but in a caliber that was thought to be more desirable than 20 millimeters. American authorities decided on a bore of





Bolt Assembly of the Mauser 20-mm Automatic Antiaircraft Cannon, Model Flak 38.

60/100 inch, the same as the German weapon that proved unsatisfactory. After seven years and an outlay of money that would be most interest-

ing from a statistical standpoint of negative results, it is in exactly the same status as when originated.



## AUTOMATIC AIRCRAFT CANNON, CALIBER .90 SERIES

During the thirties when the European powers became unusually interested in development of automatic cannon for plane armament, the Ordnance Department, United States Army, also started work at its manufacturing arsenal on several different weapons of this type. Because of the peculiar caliber chosen, they were called by the personnel who worked on them the 9/10ths, or caliber .90, guns. The bore diameter of this series was in reality .900 of an inch.

The first design, known as the T1, was a cumbersome affair. It used a flat drum feed that held 50 rounds, weighed 205 pounds with loaded feeder in place, employed the long-recoil system of operation and was air cooled. Surplus recoil forces were absorbed by a conventional spring-oil-type hydraulic system. The rate of fire ranged up to 150 shots a minute and could be adjusted by a valve in the buffer that controlled oil flow through the counterrecoil bypass.

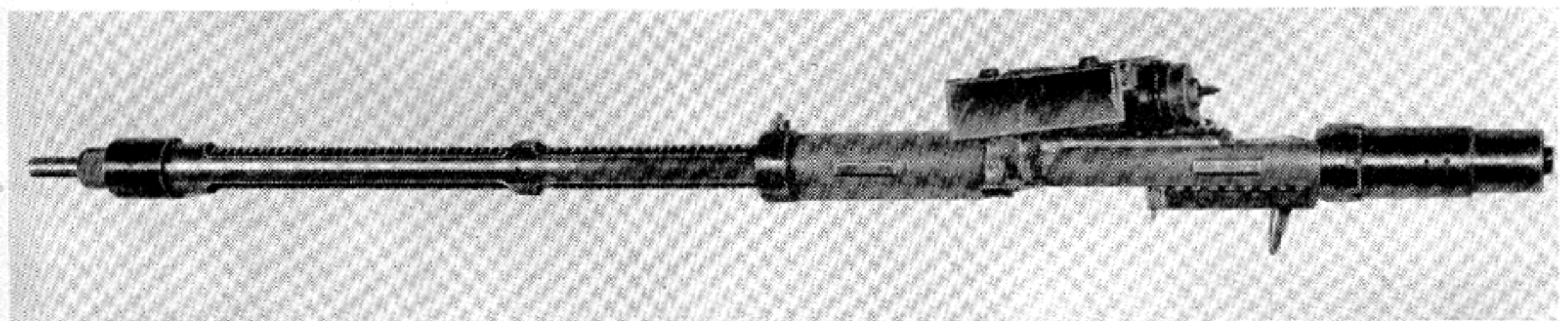
The very awkward feed system, low rate of fire and numerous other features that were far behind those of already existing weapons caused the project to be dropped. The cannon, however, was made and tested with rather disappointing results.

To fire the T1, the 80-pound magazine is positioned on top of the receiver and the operating parts pulled to the rear by means of a hydraulic charging device. When allowed to go forward,

the drum rotates and positions a live round for chambering, while the bolt is held to the rear. Energizing the electric solenoid sends the bolt forward to shove the round toward the chamber until the bolt's locking lugs come opposite their recesses. This act cams in a dog that has been holding the barrel a half inch from battery. As the entire assembly goes forward, the bolt rotates, locking behind the chambered round.

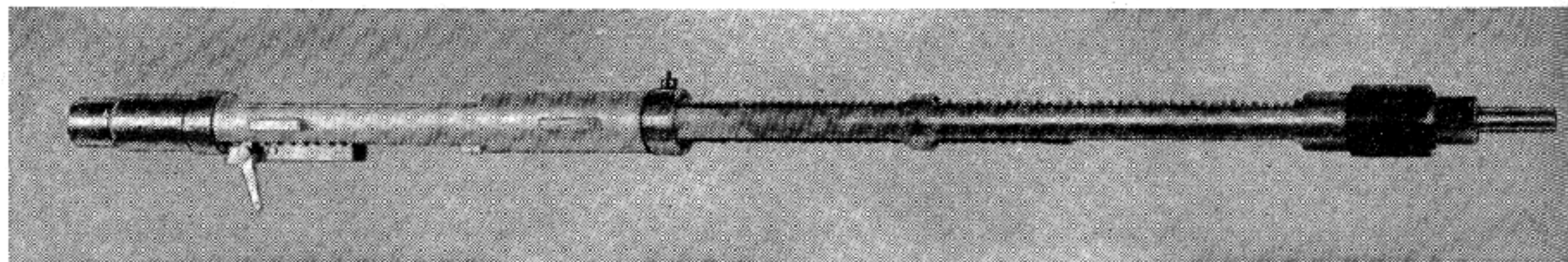
The final act of locking releases the spring-loaded firing pin and cams the extractor claws over the rim of the cartridge. The pressure generated by the exploding powder charge drives the barrel, bolt, and barrel extension rearward all locked together for a distance greater than the over-all length of a loaded round. A spring-actuated device then rises and holds the bolt while the barrel goes forward pulling the chamber away from the empty cartridge case. The latter falls from gravity through the bottom of the receiver as soon as it is clear of the chamber. If the solenoid remains energized, the returning barrel will trip the sear holding the bolt to the rear and repeat the cycle of operation.

Not only was this notoriously slow long-recoil system of operation used but an additional delay was built into this weapon in the partial retraction of the barrel. The result was a cannon with such a low rate of fire that it was out of the question for aviation use. About the only



Cal. .90 Automatic Aircraft Cannon, Model T2, with Feed Mechanism.





Cal. .90 Automatic Aircraft Cannon, Model T2.

thing to be said in its favor was that it fired a very efficient fuzed projectile at a velocity of 2,850 feet per second.

The T2 air-cooled, magazine-fed model that soon followed used straight blow back for operation and had a bore diameter of .900. The blow-back force was the only energy used in performing the various functions of retracting the firing pin, shoving the bolt to the rear, extracting and ejecting the empty cartridge case and compressing the driving spring for counter-recoil. Cartridges were originally fed to the gun by a drum magazine holding 48 rounds.

As each cartridge is stripped from the feed by the bolt in its forward movement, the succeeding round is positioned by means of a clip and spring contained in the mouth of the feed. The magazine is held in position on top of the receiver by means of a spring-loaded bracket. For mounting in aircraft four trunnions are attached 90° apart at the forward end of the receiver. The weight of the gun without feeder is 240½ pounds with an over-all length of 97 inches. The weapon is rear seared and the firing pin is actuated by forces of inertia.

The magazine functions in an unusual manner and can be set to feed from 2 to 48 rounds. This is accomplished by means of a large gear at the rear of the magazine bracket, geared with the inner revolving unit of the magazine at a ratio of 1 to 4. Each hole in the larger gear represents one round in the magazine. By means of the plunger, which protrudes through and can be rotated about the axis of the gear, selective bursts can be fired. Allowing for the round in position, the setting of the plunger would be one hole less than the selected burst. The plunger, when set, will rotate with the gear until it contacts and depresses the push rod located in the left side of the bracket.

The push rod when depressed has a twofold

function. One is to stop the inside of the magazine from rotating; the other is to release the sear. The first is accomplished by the enlarged diameter of the push rod head coming to rest on the bracket; the second is brought about by depressing the flexible lug on the sear which permits it to return to its normal position. This last function renders the gun safe, as it cannot be fired until the magazine has been reset.

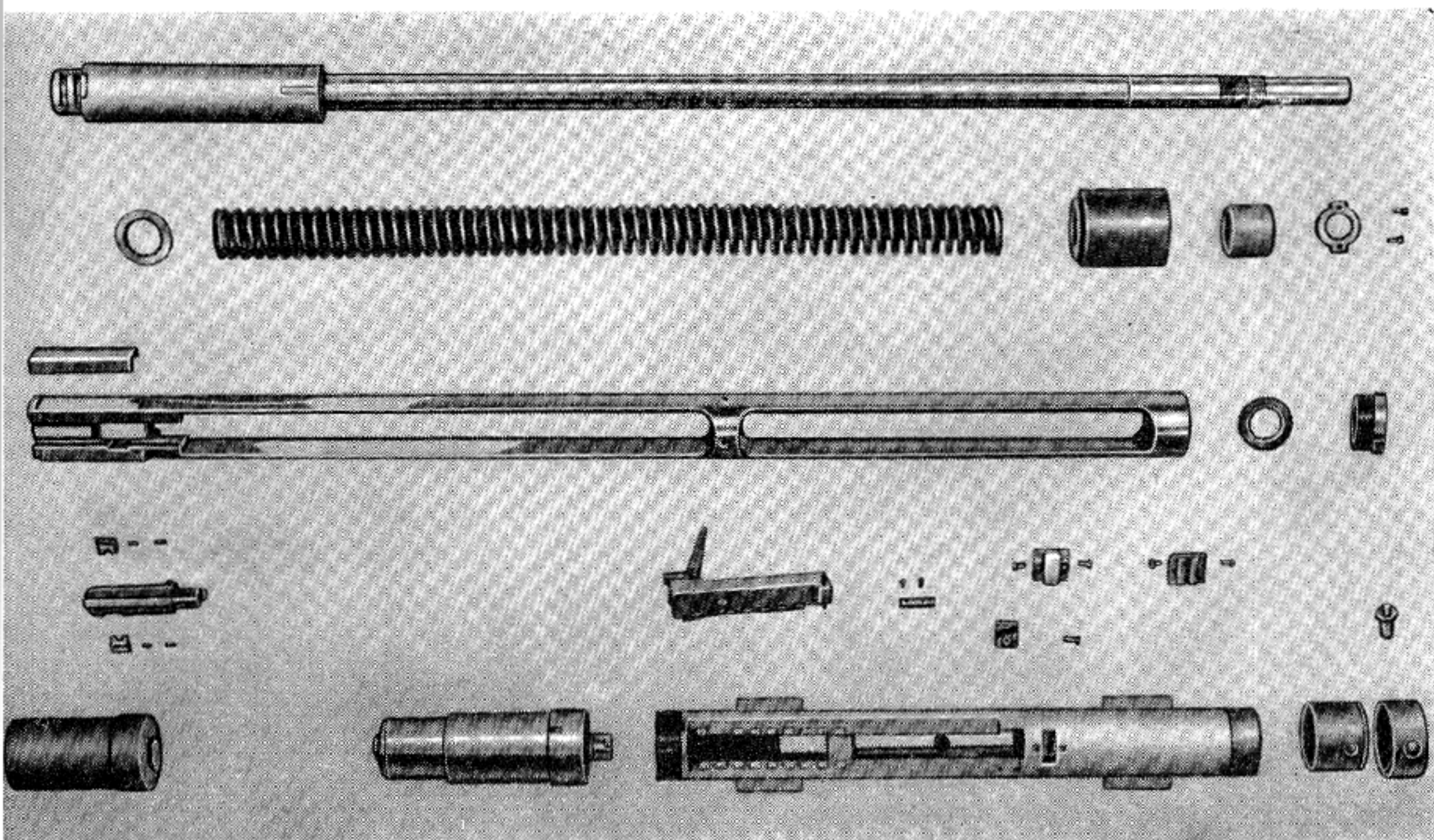
The weapon used straight blow back for operational power and the ammunition had to be waxed before being used. This feature has always been one of the most objectionable associated with such a system. The low rate of fire (400–450), likewise inherent with blow-back operation, made it undesirable for aircraft use.

A flat type of feeder that operated from the recoil of the weapon was later developed to replace the drum feed, but it too proved unsatisfactory.

The T2 caliber .90 automatic aircraft gun resembled the Oerlikon from which it was closely copied. But as in most instances where an attempt is made to duplicate a weapon in principle but not identically, the finished product assumed proportions that were all out of reason for its intended use. This devisement was no exception, as it weighed 240 pounds without feed. This exorbitant weight resulted from use of a heavy bolt and spring to serve as a locking factor instead of inertia as did other weapons of this particular design.

The blow-back force is opposed by the weight of the recoiling parts amounting to 47 pounds, plus the force required to compress the large driving spring. An assembly of gears inclosed in a housing filled with heavy grease acts as a front buffer. The function of this buffer is to absorb the shock of the fast-moving heavy parts in the last phase of counterrecoil movement. The rear buffer is hydraulic in type. A piston





Components of the Cal. .90 Automatic Aircraft Cannon, Model T2.

rod protrudes from the front end, and, when filled with oil, the buffer requires a void only large enough to allow for piston-rod displacement.

The helical driving spring is mounted forward of the receiver over the barrel and inside the bolt sleeve. The hand-charging device consists of a screw with a loop on one end, a serrated nut and a ratchet wrench. The loop on the end of the screw fits the top of the trunnion while the body of the screw lies in the yoke attached to the bolt sleeve. The face of the nut and yoke are brought together by means of the ratchet wrench, which fits the serrated nut. By this crude method the bolt and assembly are jacked to the rear-seared position.

To fire the T2 caliber .90 automatic aircraft cannon, the loaded feeder is set into position and adjusted for the desired number of rounds to be fired. The bolt is then charged back until it is held in the cocked position by the rear sear. When the trigger is pulled, the sear is rotated releasing the bolt to move forward under tension of the advancing driving spring. The bolt

face contacts the head of the first round in the feed mouth, strips it from the magazine and starts to chamber it. When the bolt reaches a point .003 inch out of battery the lug on the firing pin contacts its release cam which causes it to rotate driving the firing pin forward. The inertia-type firing-pin assembly advances rapidly and explodes the propellant.

The pressure from the explosion starts to drive the heavy bolt to the rear and compress the large return spring. The waxed cartridge case slips back with the recoiling parts held by the extractor claw. The bolt passes under a fixed device that strikes the base of the cartridge and knocks it down through the ejection slot in the receiver. The bolt then contacts the hydraulic buffer which dampens out the shock of the heavy recoiling mass, as the operating parts start into counterrecoil movement to fire the next cartridge already positioned by the feed spring.

Later another such weapon, officially designated the T3, was made. It was so close in working principles and in performance to the T2 that it does not warrant further mention.



# BOFORS AUTOMATIC AIRCRAFT CANNON

The name Bofors first appeared in the Swedish public records in November 1646 when an individual named Paul Horsman was granted permission to erect a forge and hammer mill in the mining district of Bofors in central Sweden. It was typical of the many such mills that were later to bring fame to the Swedish steel industry.

There was nothing outstanding about this particular establishment until the middle of the nineteenth century when world events enlarged its sphere of activity. As early as 1870 it was rated the largest manufacturer of rolled bar stock in Sweden and in 1873 the mill was converted into a joint stock company, AB. Bofors-Gullspång. During the late seventies Bofors succeeded in producing a new kind of steel that was considered highly suitable for the manufacture of cannon. This made it a serious competitor of the mighty Krupp works of Germany. In 1883 it built its own workshop for the manufacture of war material and its first order was in 1888 from Switzerland for 28 cannon with a 12-cm bore.

In 1894 outright ownership of the company was acquired by the famous explosives inventor, Alfred Nobel, who immediately stressed the importance of specialization and erected the company's first research laboratory at Björkborn. The manufacture of gunpowder was started and later armor plate was added to the items produced.

In spite of keen foreign competition Bofors prospered and after 1900 began the manufacture of ammunition and fuzes. The company made money but had no need for added factories until World War I when huge orders made its existing facilities inadequate and necessitated considerable enlargement of the plant. After the defeat of Germany, the dismemberment of the Krupp plant by the victorious Allies not only removed a big competitor but also allowed Bofors to

make under license many Krupp guns that could not be produced in Germany.

Events leading up to the second world conflict greatly stimulated the armaments industry during the 1930's and many countries placed large orders with Bofors. Its machinery was thoroughly modernized and production leaned towards heavy automatic weapons development. However, aircraft armament was not overlooked and several experimental models were produced and tested at its modern range. Bofors was the only plant in the world that manufactured and proofed weapons, powder, cartridges, and fuzes on the same company property.

In 1938 the firm announced that it had for sale a 20-mm automatic aircraft cannon. This weapon operated by short recoil, was air cooled and belt fed, using a metal disintegrating push-out type link and was very streamlined in design compared with other known 20-mm guns of this date. A muzzle booster was used to speed up the action to 700 shots per minute. A hinged cover permitted the instant inspection of components for visual check or replacement of broken parts.

An air charger located directly on top of the cover group contacted the bolt by means of a ringed member that protruded through a slot in the center of the receiver that permitted manual operation. A large buffer using Belleville washers was used to absorb shock and give a faster return to the recoiling parts. The barrel was quickly detachable and was housed in a slotted barrel jacket. Mounting was done both on the center line of the receiver and on a T-slot sort of arrangement beneath the trunnion could also be employed whenever this type of installation was needed.

The feed could be made to function from right to left and vice versa merely by the repositioning of parts. Releasing the sear could be accomplished by air and manually, the former



being used when the weapon was mounted for remote control firing.

The links were of thin spring steel and covered half of the cartridge case from base to shoulder of the cartridge. A portion of the link snapped into the cannellure of the round making it impossible for it to get out of calibration once it was belted.

Later the development and great success of a large-caliber automatic gun for antiaircraft use led to this mechanism being refined for aerial use. The bore diameter of 57-mm, however, was thought to be necessary for the specific purpose the weapon was designed for, namely antitank work in close ground support by heavily armored planes especially adapted for this purpose.

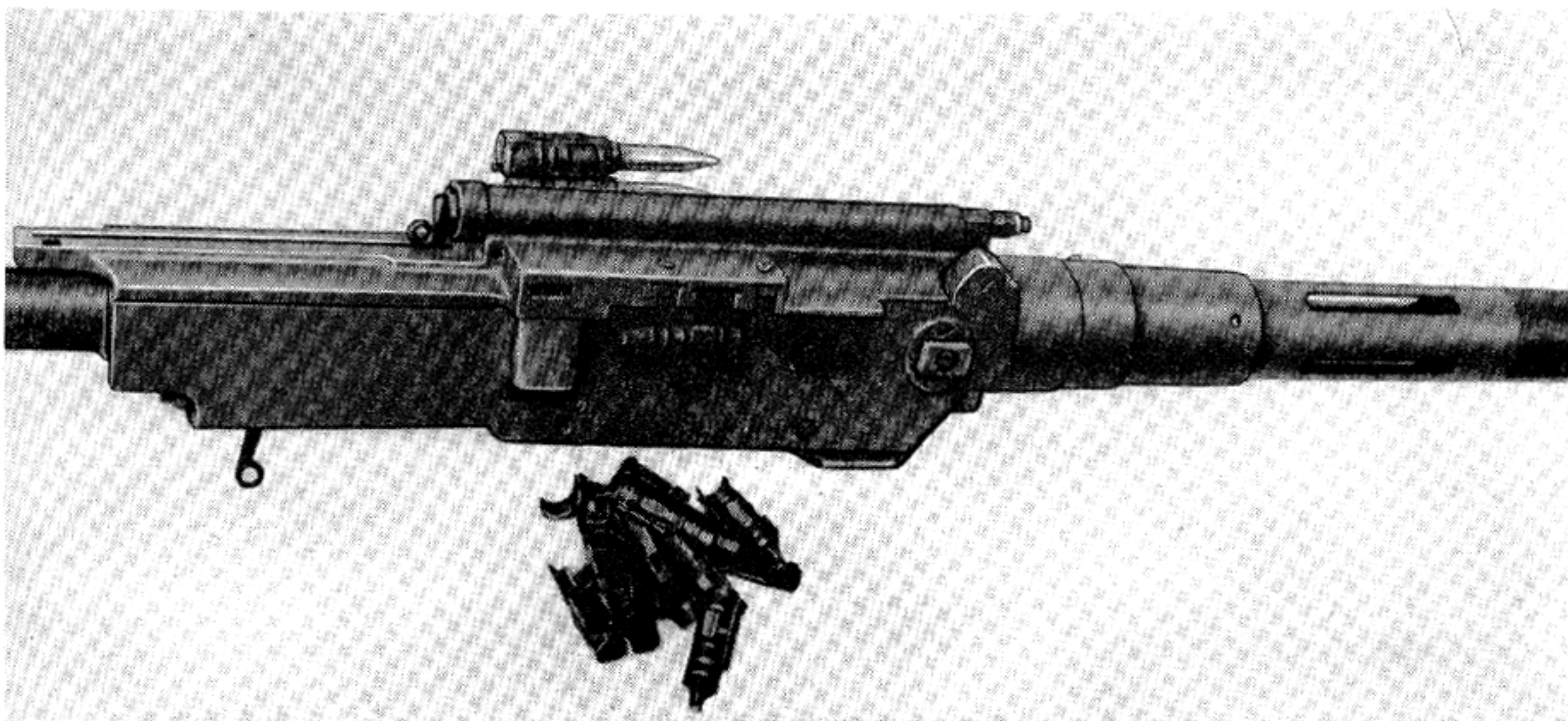
The operation and basic features are identical with the Bofors antiaircraft gun, with the exception of the heavier components for withstanding the greater shock of the larger round. The Bofors 57-mm automatic aircraft cannon is operated by short-recoil, non-reciprocating bolt action. It is air cooled, drum fed by a 25-round magazine, and its rate of fire is 100 rounds a minute. A very efficient recoil system is employed to cushion the shock from this unusually large-bore automatic cannon. The recoil assembly consists of a spring and a cylinder. The spring provides in counterrecoil the force necessary to return the gun mechanism to the battery position,

cock the rammer, and feed a new round. The recoil cylinder controls the length of recoil and the velocity of counterrecoil. As the piston rod is drawn to the rear in the recoil cylinder, liquid is forced from the front of the piston through the eight holes in the piston head. Through these ports the liquid passes to the rear. This effective and controlled flow sets up a fluid resistance that adequately retards recoil.

In full automatic fire, only six operations are necessary for a complete cycle. A live round is fed into the loading tray. The rammer is cocked. The round is rammed into the chamber, the breech closed, the round fired, and the empty case ejected.

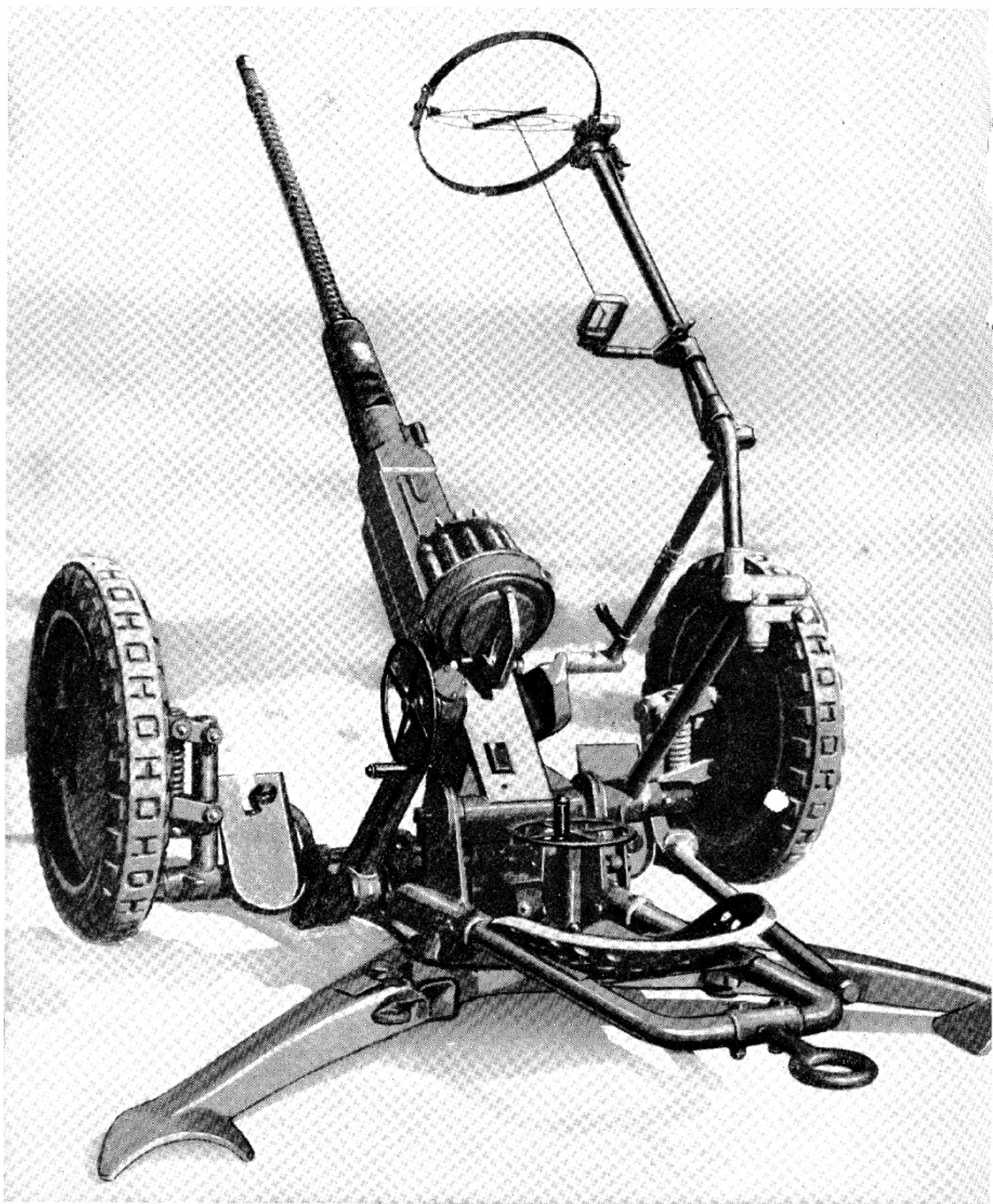
The large drum feeder indexed each round by spring pressure. While quite simple in operation and efficient, this feed made mounting in aircraft difficult and relegated the weapon to fuselage installations only. The manufacturers of the gun pointed out that this was no hardship since it was for a specific purpose that required a minimum number of rounds to accomplish its mission.

To fire the Bofors 57-mm aircraft model in flight, assuming the weapon is properly serviced before taking off, the operator has only to throw the selector switch from *Safe* to *Fire* and press the firing button. By means of a solenoid a cam forces the sear inward and releasing the inner



Bofors 20-mm Automatic Aircraft Cannon.





Bolors 20-mm Automatic Cannon, Model L/70, on a Field Carriage.



cocking lever and the firing pin, which strikes the primer and explodes the cartridge's propellant charge.

During recoil the cams on the side act on the outer crank to rotate the crankshaft and the inner cranks. The latter's first movement retracts the firing pin and unlocks the breechblock after  $\frac{7}{8}$  inches of travel. At this time the projectile has safely cleared the bore and continued rotations of the inner cranks lower the breechblock into contact with the toes of the extractors accelerating them in their housing. The empty cartridge case is thrown violently through the opening in the top of the breechblock and clear of the working mechanism of the gun, until it hits a deflector.

During the remainder of recoil the rammer and feed pawls of the loader are raised above the incoming round, being held in position by the stop pawl. This action is brought about by movement of the roller on the feed rod by means of the guides on the sides of the tray.

In the counterrecoil that begins after full compression of the driving spring, the breechlocking spring acts to move the breechblock to the closed position but this motion is stopped

as the breech is latched open by the hooks on the extractor. Consequently, the outer crank is carried clear of the side cam. As the tray moves forward, the pawls on the top surface rotate the star-wheel in the feeder forcing a loaded round on the tray up to the point where the rammer shoe is latched to the rear by the tray catch lever. When an inch from battery position, the cam on the bottom of the tray trips the rocker arm. This in turn fires the tray catch lever, releasing the rammer to start the round into the chamber. At the end of this stroke the ramming levers are spread by the slots in the tray and the live round, released at a high rate of speed, is literally knocked into the chamber.

At the completion of this action the breechblock-closing spring is free to raise the breechblock to the closed position as the extractors are unhooked from the block by the rim of the cartridge in the act of chambering.

While the block rises, pressure on the left inner cam is removed from the cocking lever and firing of the round is accomplished. As the breech is closed, its action on the cam controlling the sear is automatic as long as the selector switch is set for this type of fire.



# JAPANESE AUTOMATIC AIRCRAFT CANNON

The status of Japanese large-caliber automatic-weapon development all during World War II is best described as chaos compounded by confusion, with a slight bit of bewilderment thrown in for good measure. No originality was shown and only a desperate attempt to meet critical conditions by combining a few good features of other weapons was attempted. A scaled-up version of a well-known rifle-caliber machine gun was generally the finished product.

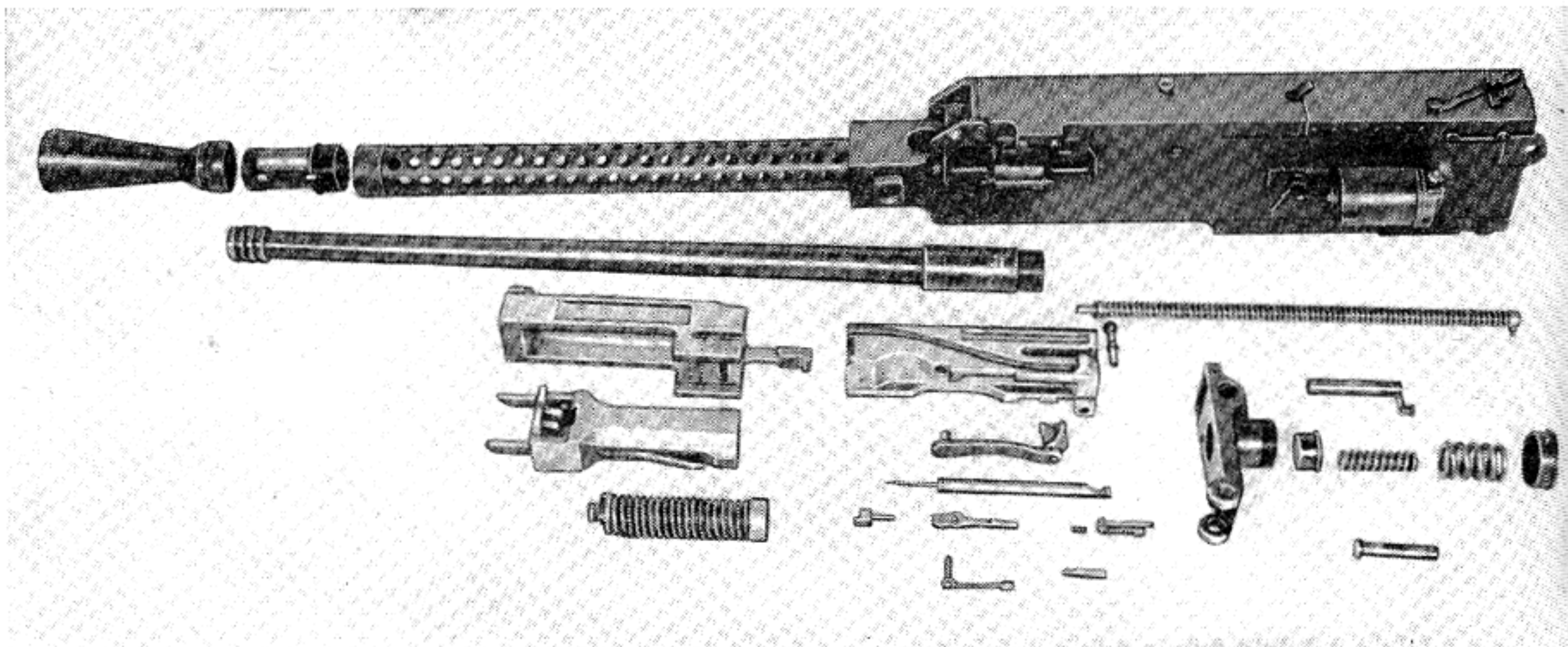
The best way to approach a Japanese aircraft cannon is first to identify it and then compare it with its counterpart among weapons that had been made for years in other countries, such as Hotchkiss, Hispano-Suiza, Oerlikon, Browning, or Vickers. The similarity in operating principles will usually be very apparent.

The most outstanding example of such borrowing is the 20-mm automatic gun given the designation HO-5B. It was simply the successful caliber .50 Browning machine gun made in 20-mm bore by copying an American weapon captured in the early stages of the war. According to official documents found after the Jap

surrender, this condition was the result of Japanese confidence in their 7.7-mm rifle caliber machine guns and 20-mm Oerlikon-type cannon. It later became apparent that a quick victory was not possible and that there was a pressing need for larger bore automatic weapons and for higher rates of fire and greater velocity. Consequently, they copied and put into production whatever was most readily available.

After their successful conquest of the Philippines, the Japs captured thousands of our Browning machine guns and upon this reliable mechanism they based practically all wartime cannon development. It was first made in 13 millimeters and then raised progressively to whatever bore was demanded. These were all designated HO with the Type and bore diameter following, such as HO-103-13-mm, HO-5 20-mm, HO-153 Type 1, 30-mm, and HO-204-37-mm. Of these the HO-5 was the most successful. During the latter days of the war it was the air force's first-line 20-mm aircraft cannon.

While the Japanese simply copied our Browning gun in detail and showed no originality,



20-mm Automatic Aircraft Cannon, Model HO5.



they did deserve great credit for furnishing an answer to one question that was asked all through World War II. If the Browning caliber .50 machine gun was the best of its kind in the world, then why did not American engineers scale it up to the 20-mm arm we needed so desperately at the time? While we advanced theories as to why it could not be done, the Japs not only did it but succeeded remarkably well. It had a rate of fire of 960 rounds a minute and weighed only 84 pounds. Even with the use of inferior metals the components had a life expectancy of 3,000 rounds.

Later a 57-mm cannon, copied after the Hispano-Suiza Type 404, was attempted and was in an experimental stage at the close of the war. It was known as the HO-401.

Discussion of Japanese aircraft cannon with any degree of clarity is impossible since they were not produced with any object other than to copy and improvise various mechanisms in as large a caliber as metal limitations would permit.

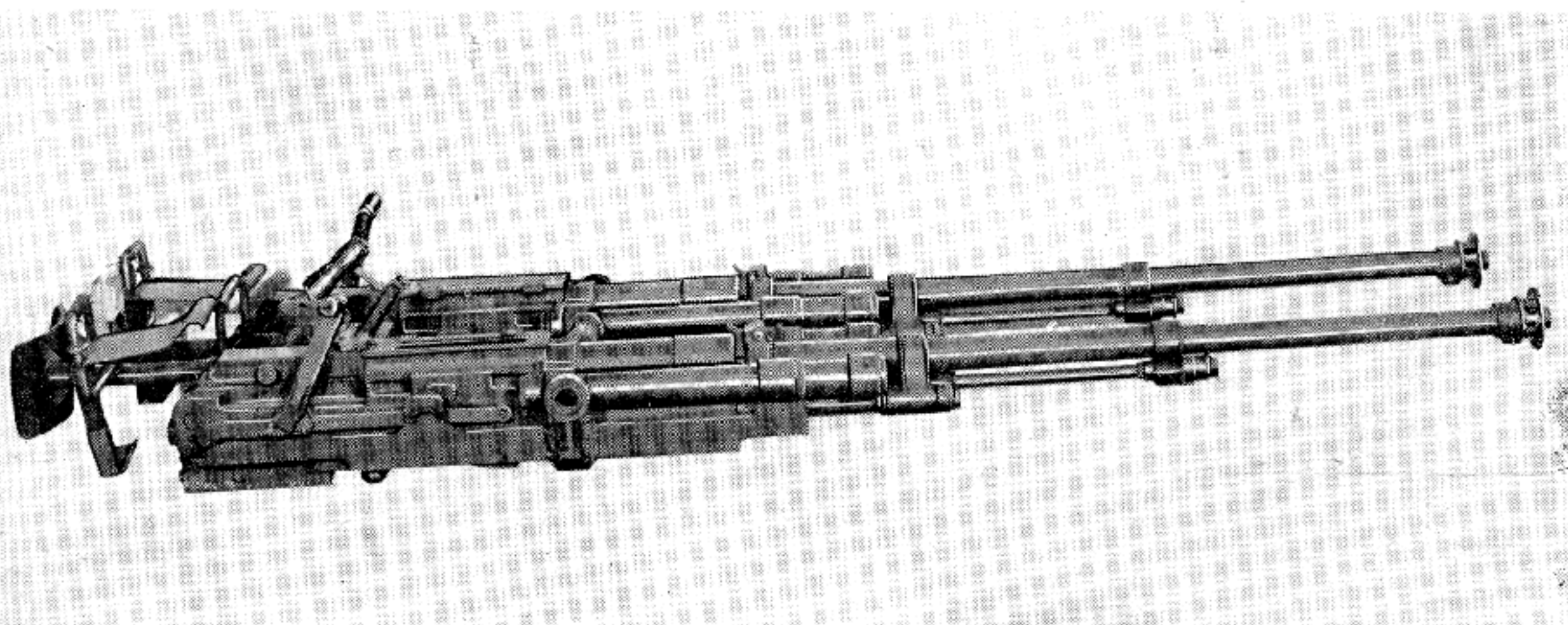
One of the best examples of Japanese developments was the Model 98 20-mm automatic cannon. This was as close as their designers came to originality in weapon planning, but was still only a combination of features that have been in standard use for years.

This weapon was so constructed as to be adapted to both aircraft and antitank mounting, and was successfully tested in 1938 at the government arms plant. The mechanism was relatively simple and rugged in construction. It

operated by gas and blow-back and was magazine fed, air cooled and rear seared. It was relatively light for this caliber, weighing 152 pounds with loaded magazine attached. The official rate of fire was given as 180 aimed shots per minute and 450 maximum during full automatic. The bolt was securely locked during the act of firing with gas being used only to unlock the piece. Blow back furnished the necessary energy to complete the cycle.

The barrel is quickly fastened or detached. It is positioned by a set screw in the top of the receiver acting as a key in a slot on the barrel. After the interrupted thread bushing is rotated a sixth of a turn, a spring lock snaps in the rim of the bushing securing the whole assembly. The bolt, gas piston yoke, driving spring, rear buffer, magazine interlock, safety lock, and ejector are all housed in the receiver. The opening in the receiver into which the magazine fits has a spring-loaded door that snaps shut whenever the magazine is removed and the gun is not in use. This prevents dust or any other foreign matter from getting into the working parts.

The gas-piston yoke rides in the slideway in the sides of the receiver. The locking key that backs up the breech lock is also set in this member. The yoke is the carrier for the bolt assembly, having two tubes that go to the cylinder and act as pistons. The driving springs are housed in these tubes. The angled surface of the yoke's rear end acts to cam the back of the bolt upward into locked position while the rearward thrust



20-mm Automatic Cannon, Model 98, Dual Antitank Mount.



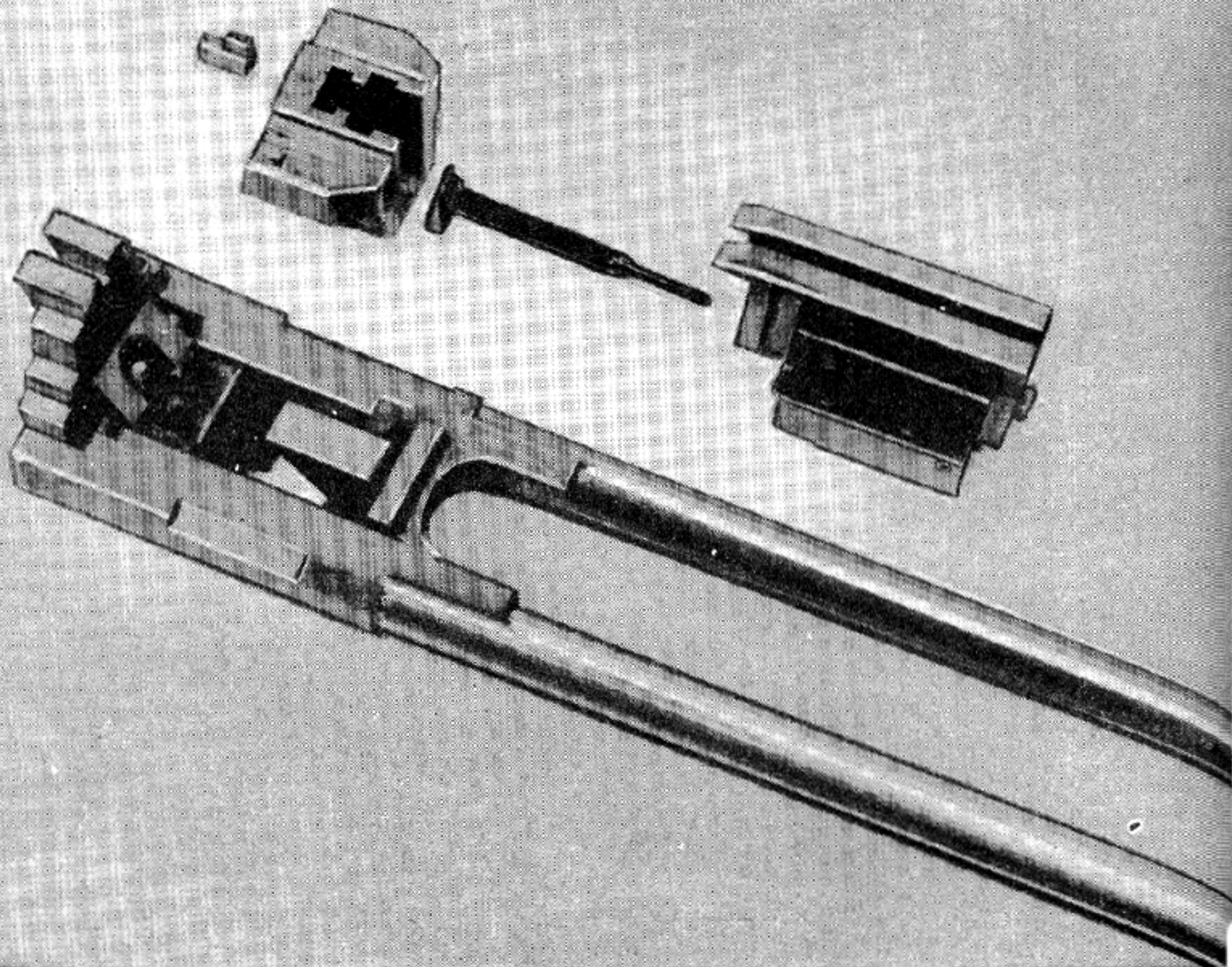
by gas pressure on the piston cams the bolt down to unlock. The ejector rides through a slot in the top rear portion of the yoke, the surface below the ejector groove serving as a cushion for the striker.

The breech lock has two T slots. The rear one engages the firing pin camming it rearward for unlocking, while the forward one forces a vertical movement for locking. The firing pin, which is housed by the bolt, is slotted at the top so that the ejector can make contact with the base of the empty case. Also attached to the bolt is the spring-loaded claw-type extractor.

When the weapon is mounted for aircraft, a drum feed is employed and the rate of fire increased by raising the size of the gas orifice. When used as an antitank gun a vertical metal-box-type magazine holding 20 staggered rounds is fitted into a slot in the top of the receiver and held in place by a shoulder at the forward end and a spring catch at the rear.

To fire the 20-mm Model 98 automatic cannon, the gunner first places a loaded drum or magazine into place with the bolt forward. He then grasps the charging handle located on the lower right side of the receiver and pulls all the way to the rear. This draws the bolt assembly and gas-piston yoke rearward until the spring loaded sear hook in the receiver snaps into its recess in the gas piston assembly holding the entire mechanism in the cocked position. The trigger, actuated by a firing handle, transmits its movement to the sear by means of a linkage and releases the gas-piston yoke and bolt assembly to go forward by compression of the driving springs.

The charging handle also moves ahead with the firing of the first round and remains that way throughout automatic fire. The rib on top of the bolt, in passing under the magazine, strips the first round from the feed and starts it towards the chamber. During the final act of chambering



Bolt and Bolt Extension Assembly of the 20-mm Automatic Cannon, Model 98.



the spring-pivoted extractor snaps over the rim and into the cannellure of the cartridge case. As the bolt is seated all the way forward, the gas piston yoke is free to continue on, the bolt and its locking piece being interlocked in such a manner as to permit the latter to rise vertically. The angled surface of this piece and the corresponding cam on the gas piston yoke force it upwards in front of its locking key, thereby holding the bolt securely behind the chambered round.

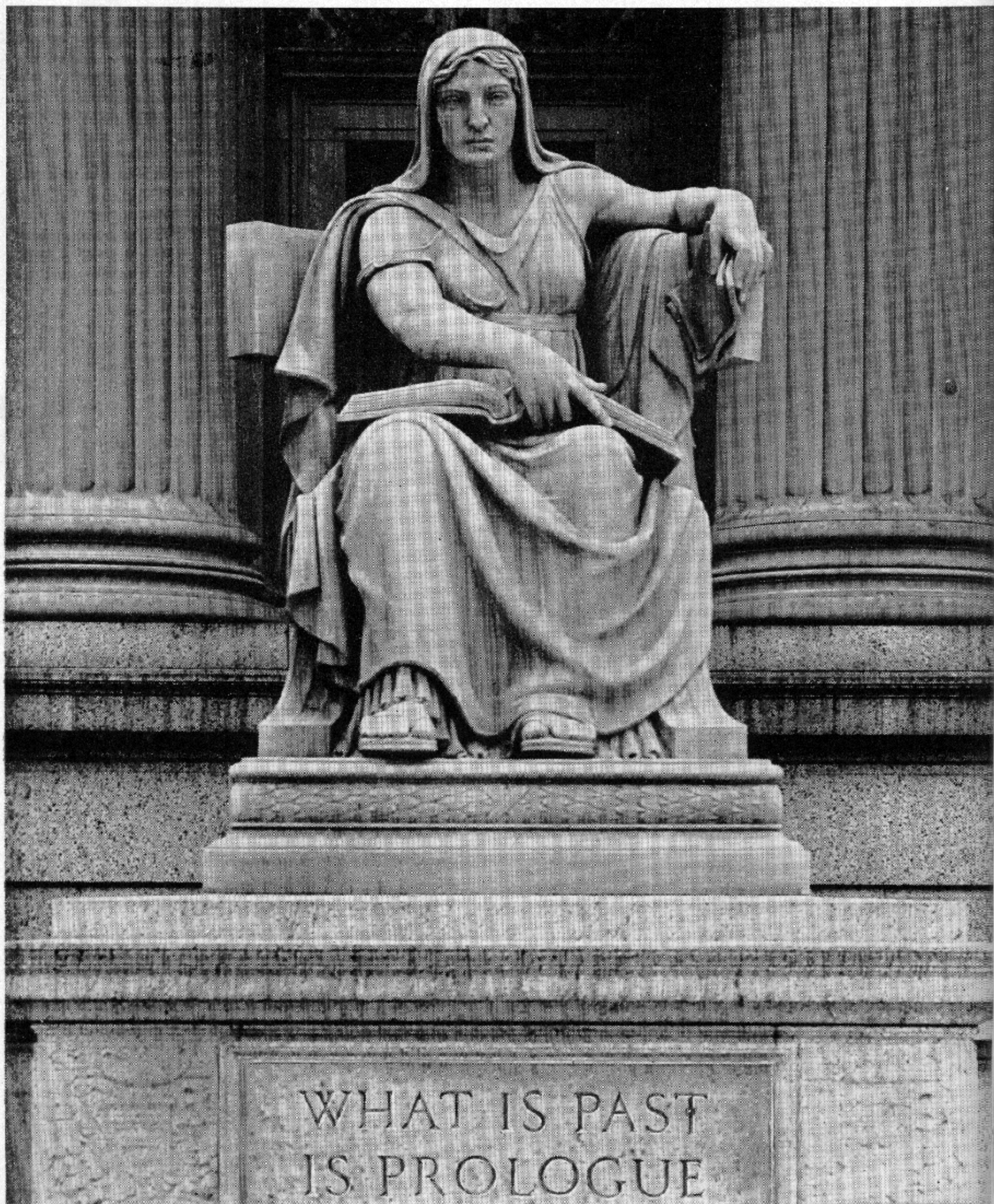
The piston yoke travels forward a few thousandths of an inch when its rear vertical projection strikes the firing pin, driving it into the primer which in turn detonates the powder charge. While the projectile is in the bore, the entire action is rigidly locked but a portion of the gas is metered into the gas cylinder through the barrel port after the passage of the projectile.

This forces the yoke to the rear, camming the breech lock down, and the entire unit starts to recoil with the extractor carrying the empty car-

tridge case. The first movement rearward cams the firing pin back into the bolt body. As the movement continues, the ejector fixed to the inside top of the receiver rides through the grooved upper part of the bolt, striking the rim of the empty case, pivoting it down through the ejection slot in the bottom of the receiver. Full recoil stroke is accomplished when the bolt assembly and the gas piston yoke strike the rear buffer. This heavy spring-loaded device absorbs all surplus energy not taken up by compression of the driving spring. The operating parts enter into counterrecoil movement to repeat the cycle of operation provided the firing handle remains depressed.

The Japanese used the weapon as a ground gun, but during the latter days of World War II in their desperate attempt to stop the devastating American bombing raids, they modified and adapted the cannon to aircraft use. It was usually mounted as a free gun but there are records showing experimental installations in power-driven turrets.





Statue at the Entrance to National Archives Building, Washington, D. C.



# CONCLUSION

It was indeed an eventful day when man stepped from the path of his upward climb for the purpose of starting war. While his travel along the road to progress has been notable, he has found occasion to pause more times than civilization would care to admit, in order to seize, save, or sanctify those things of his neighbor which he deemed worthy of the effort.

The improvements in methods of transportation, communication, medicine, and divers other things are of such vast proportions that they seem magical in comparison with their predecessors. The years since the advent of gunpowder have seen the replacement of the oxcart by the jet plane, the town crier by television, and snake oil by penicillin but there have been no such phenomena with respect to progress in projectile delivery.

In armament man has yet to achieve the mental capacity to replace the earliest of his discoveries, the missile weapon, first brought about by the hasty throwing of a rock. True, throughout the years, countless thousands of hours have been expended, along with sums of money, too fabulous to estimate, in an effort to break away from this mode of lethal delivery. However, the result has been only a refinement—evolutionary, but in no sense revolutionary.



# APPENDIX A

## Patents on Machine Guns and Relating Mechanisms Upon which the World's Automatic Weapons Have Been Based

The following patents granted by the United States Patent Office to American and foreign inventors cover the most important machine-gun and firing mechanisms from which have evolved the automatic weapons we know today.

The patents are listed under the inventors and the firms or individuals to whom they may have been assigned. The title, patent number, and date of patent are given for each, together with names of joint inventors and assignees, where applicable. Entries under assignees are marked with an asterisk (\*) and are cross-referenced to the names of the inventors.

### ACCELERATING FIRE ARMS CO.—NEW YORK, N.Y. (\*)

Gun, Accelerating 200,740 26 Feb 1878 (Lyman)

### ACCLES, JAMES G.—MIDDLESEX, ENGLAND

Machine gun 426,356 22 Apr 1890

Feeder for machine gun 290,622 18 Dec 1883 (Assigned to Gatling Gun Co.)

### ADAMSON, KEITH F.—FORT BRAGG, N.C.

Automatic gun 1,648,469 8 Nov 1927 (Adamson & Stambaugh)

### ADST, FRANK W.—ST. PAUL, MINN.

Machine gun 1,313,038 12 Aug 1919

### AGNELLI, GIOVANNI—TURIN, ITALY

Firearm, Automatic 1,187,957 20 June 1916

### AKTIEBOLAGET J. C. LJUNGMAN—MAIMO, SWEDEN (\*)

Disconnecter means in self-charging firearms 2,390,061 4 Dec 1945 (Eklund)

### AKTIEBOLAGET AUTOMATGEVAR—STOCKHOLM, SWEDEN (\*)

Firearm, Automatic 680,488 13 Aug 1901 (Kjellman & Andersson)

Firearm, Automatic 690,739 7 Jan 1902 (Kjellman & Andersson)

### AKTIEBOLAGET STOCKHOLMS VAPENFABRIK—STOCKHOLM, SWEDEN (\*)

Firearm, Recoil-operated 765,491 19 Jan 1904 (Kjellman)

Firearm, Automatic 738,140 1 Sep 1903 (Friberg)

Firearm, Automatic 814,547 6 Mar 1906 (Kjellman)

Firearm, Automatic 1,040,692 8 Oct 1912 (Kjellman)

### ALDRICH, WALES—CLEVELAND, OHIO

Firearm, firing pin & extractor (breech loading) 38,455 12 May 1863

### ALESSI, FEDERICO—NEW YORK, N.Y.

Gun, Machine 672,690 23 Apr 1901

Gun, Machine 683,240 24 Sep 1901

### ALEXANDER, ALBERT M.—HAVRE DE GRACE, MD.

Automatic firearm feed mechanism 2,436,370 24 Feb 1948

### ALIEN PROPERTY CUSTODIAN (\*)

Automatic or repeating firearm 2,325,484 27 Jul 1943 (Kiraly & Koucher)

Firing mechanism for automatic firearm 2,356,615 22 Aug 1944 (Revelli)

Automatic shoulder firearm adapted for use in a carriage 2,376,726 22 May 1945 (Rossmanith)

### ALLENDER, HENRY—DETROIT, MICH.

Gun, Machine 323,997 11 Aug 1885

Gun, Machine 372,191 25 Oct 1887

### AMERICAN & BRITISH MFG. CO. (\*)

Automatic gun 851,196 23 Apr 1907 (Bevans & Bartholmes)

### AMERICAN MACHINE & ORDNANCE CO. (\*)

Automatic gun 851,196 23 Apr 1907 (Bevans & Bartholmes)

### AMERICAN PAPER GOODS CO.—KENSINGTON, CONN. (\*)

Cartridge, Belt 1,341,111 25 May 1920 (Cooley)

### ANDERSON, EDWARD WILLIAM—WITTON, ENGLAND

Gun, Automatic 671,062 2 Apr 1901

### ANDERSON, LOUIS A.—DAYTON, OHIO

Bolt mechanism 2,503,575 11 Apr 1950 (Anderson & Pearson) (Assigned to General Motors Corp.)

### ANDERSSON, GUSTAV L.—STOCKHOLM, SWEDEN

Firearm, Automatic 680,488 13 Aug 1901 (Kjellman & Andersson) (Assigned to Aktiebolaget Automatgevar)

Firearm, Automatic 690,739 7 Jan 1902 (Kjellman & Andersson) (Assigned to same)

### ANDREWS, JOEL W.—NORRISTOWN, PA.

Gun & bayonet batteries, Improvement in 33,731 19 Nov 1861

### ANDRUS, GEORGE P.—ABERDEEN, WASH.

Bombing gun for aircraft 1,636,451 19 Jul 1927



## ANSLEY H. FOX CO.—PHILADELPHIA, PA.

Gas-operated machine gun 1,293,396 4 Feb 1919 (Fox)  
 Gas-operated automatic machine gun 1,294,892 18 Feb 1919 (Fox & Rice)  
 Gun, Machine 1,388,856 30 Aug 1921 (Fox)

## ARCHBOLD, ISRAEL N.—RIDGE FARM, ILL.

Gun, Machine 476,590 7 Jun 1892

## ARMAMENTI MILITARI S. A.—TURIN, ITALY (\*)

Automatic firearm 1,759,277 20 May 1930 (Revelli)

## ARMIT, ROBERT H.—LONDON, ENGLAND

Gun, Machine 446,807 17 Feb 1891 (Assigned to T. McCulloch)

## ARMSTRONG, WHITWORTH &amp; CO. LTD.—NEWCASTLE-ON-TYNE, ENGLAND

Gun, Automatic 702,240 10 Jun 1902 (Noble)

## ARTER, JOHN J. B.—BIRMINGHAM, ENGLAND

Machine gun, Anti-aircraft & other 1,334,983 30 Mar 1920

## AUTO-ORDNANCE CORP.—NEW YORK, N.Y. (\*)

Automatic gun 1,396,949 15 Nov 1921 (Eickhoff)  
 Automatic gun 1,425,810 15 Aug 1922 (Thompson)  
 Automatic gun 2,053,489 8 Sep 1936 (Norman)

## AUTOMATGEVAR, AKTIEBOLAGET—See AKTIEBOLAGET AUTOMATGEVAR.

## AUTOMATIC ARMS CO.—CLEVELAND, O. &amp; BUFFALO, N.Y. (\*)

Gun, Gas-operated 1,003,632 1 Sep 1911 (McClean)  
 Gun, Gas-operated machine 1,005,263 10 Oct 1911 (McClean)  
 Automatic machine gun 1,042,135 22 Oct 1912 (McClean)  
 Breech-loading & discharge-actuated firearm 1,042,363 22 Oct 1912 (McClean)  
 Gas regulator & trap for gas-operated firearm 1,195,693 22 Aug 1916 (Lewis)

## AUTOYRE CO.—OAKVILLE, CONN. (\*)

Cartridge belt link 2,423,346 1 Jul 1947 (Ryan)  
 Cartridge feeding mechanism 2,501,143 21 Mar 1950 (Sanford)  
 Feeding mechanism for automatic guns 2,502,891 4 Apr 1950 (Sanford)

## BAILEY, FORTUNE L.—INDIANAPOLIS, IND.

Gun, Machine 206,852 13 Aug 1878 (Assigned to Bailey Gun Co.)  
 Guns, Improvement in machine 173,752 22 Feb 1876  
 Improvements in machine guns 173,751 22 Feb 1876

## BAILEY GUN CO.—INDIANAPOLIS, IND. (\*)

Gun, Machine 206,852 13 Aug 1878 (Bailey)

## BAILEY, OLIVER J.—FLORENCE, MASS.

Silencer for firearms 1,207,264 5 Dec 1916

## BALL, ALBERT—WORCESTER, MASS.

Firearms, Self-loading 38,935 23 Jun 1863

## BANGERTER, FRIEDRICH—NEW YORK, N.Y.

Automatic rapid-fire machine gun 1,424,751 8 Aug 1922

## BARDELLI, ARTURO—MILAN, ITALY

Firearm, Automatic 1,355,378 12 Oct 1920  
 Firearm, Automatic 1,425,627 15 Aug 1922

## BARNES, CHARLES EMERSON—LOWELL, MASS.

Cannon, Improved automatic 15,315 8 Jul 1856 (Assigned to self and M. W. Oliver)

## BARNES, CHARLES H.—ILION, N.Y.

Firearm, Automatic 1,089,621 10 Mar 1914

## BARRETT, J. B.—WYTHE COUNTY, VA. (\*)

Improvements in repeating cannon 110,233 20 Dec 1870 (Hedrick)

## BARROS, JOSE DE—IMPERIAL, CALIF. (\*)

Rapid-fire gun 1,285,765 26 Nov 1918 (Martin)

## BARRY, MACK CARLTON—ATLANTA, GA.

Rapid-fire gun 1,233,165 10 Jul 1917

## BARTHOLMESS, CHARLES W.—ILION, N.Y.

Automatic gun 851,196 23 Apr 1907 (Bevans & Bartholmess)

## BATCHELDER, FRANK R.—WORCESTER, MASS.

Machine gun belt 1,243,686 23 Oct 1917 (Assigned to Universal Patents Co.)

## BAUMWART, GABRIEL W.—GARDEN CITY, N.Y.

Automatic locking ammunition container 2,506,409 2 May 1950 (Assigned to Republic Aviation Corp.)

## BAXTER, JOHN—KNOXVILLE, TENN. (\*)

Gun, Machine 296,365 23 Jul 1878 (Taylor)  
 Guns, Improvement in machine 174,872 14 Mar 1876 (Taylor)  
 Guns, Improvement in machine 174,873 14 Mar 1876 (Taylor)  
 Guns, Improvement in machine 177,030 2 May 1876 (Taylor)

## BECK, MICHAEL—MINNEAPOLIS, MINN.

Gun, Automatic magazine 645,932 27 Mar 1900 (Beck & Ferrant)

## BECKER, REINHOLD—KREFELD, GERMANY

Automatic firearm 1,144,285 22 June 1915

## BEEBE, FRANK N.—COLUMBUS, OHIO

Extractor, Spring 230,224 20 Jul 1880

## BEECHER, EBENEZER B.—NEW HAVEN, CONN. (\*)

Gun, Machine 430,206 17 Jun 1890 (Garland)  
 Gun, Machine 479,799 2 Aug 1892 (Garland)  
 Automatic mechanism for machine guns 636,974 14 Nov 1899 (Garland)  
 Gun, Automatic machine 643,118 13 Feb 1900 (Garland)

## BELL, DAVITT S.—PITTSBURGH, PA.

Automatic gun 2,370,835 6 Mar 1945 (Bell & Wilkander)  
 (Assigned to Edgewater Steel Co.)  
 Automatic gun 2,395,211 19 Feb 1946 (Bell & Wilkander)  
 (Assigned to same firm)



**BENDIX AVIATION CORP.—SOUTH BEND, IND. (\*)**

Gun-feed mechanism 2,379,185 26 Jun 1945 (Reek)  
 Automatic gun charger 2,410,767 5 Nov 1946 (Wisman & Rolin)  
 Gun-charging mechanism 2,413,104 24 Dec 1946 (Goepf-rich)

**BENEDICTIS, CAMILLO D.—PHILADELPHIA, PA. (\*)**

Gas-operated firearm 630,136 1 Aug 1899 (Travaglini)

**BENET, LAURENCE V.—PARIS, FRANCE**

Gun, Automatic machine 564,043 14 Jul 1896 (Benét & Mercié) (Assigned to Hotchkiss Ordnance Co., Ltd.)  
 Gun, Gas-operated 588,380 17 Aug 1897 (Benét & Mercié) (Assigned to same)  
 Gun, Gas-operated 606,115 21 Jun 1898  
 Gun, Semi-automatic 649,393 8 May 1900 (Benét & Mercié)  
 Gun, Automatic 696,306 25 Mar 1902 (Benét & Mercié)  
 Gun, Gas-operated 861,939 30 Jun 1907 (Benét & Mercié)  
 Feed apparatus for automatic guns 958,078 17 May 1910  
 Rifle, Automatic shoulder 1,125,937 26 Jan 1915 (Benét & Mercié)  
 Gun, Semi-automatic 852,253 30 Apr 1907 (Benét & Mercié)  
 Firing sear, Automatic 854,253 21 May 1907 (Benét & Mercié)

**BENNETT, THOMAS G.—NEW HAVEN, CONN.**

Automatic firearm 695,784 18 Mar 1902 (Bennett & Mason) (Assigned to Winchester Repeating Arms Co.)

**BERGMANN, THEODOR EMIL—ROTENFELS, GERMANY**

Automatic firearm 2,072,197 2 Mar 1937

**BERGMANN, THEODOR—SUHL, GERMANY (\*)**

Firearm, Recoil-operated 547,451 8 Oct 1895 (Schmeisser)  
 Machine pistol 1,450,834 3 Apr 1923 (Schmeisser)

**BERTHIER, ANDRE VIRGILE PAUL MARIE—PARIS, FRANCE**

Gun, Automatic 918,646 20 Apr 1909  
 Firearms, Cooling device for 1,017,373 13 Feb 1912  
 Gun, Gas-operated 1,082,916 30 Dec 1913  
 Gun, Machine 1,144,994 6 Jul 1915

**BERTRAN, EDWARD M.—JACKSON HEIGHTS, N.Y.**

Gun, Ammunition magazine 2,364,510 5 Dec 1933 (Ber-tran & Lesnick) (Assigned to Brewster Aeronautical Corp.)

**BEVANS, W. H.—BRIDGEPORT, CONN.**

Gun, Automatic 851,196 23 Apr 1907 (Bevans & Bar-tholmes) (Assigned to American & British Manuf. Co. & American Machine & Ordnance Co.)  
 Electric & percussion firing mechanism 855,427 28 May 1907

**BICKART, M.L.—ATLANTA, GA.**

Gun, Machine 664,952 1 Jan 1901 (2/3 assigned to Black-burn & Spilman)

**BILLINGHURST, WILLIAM—ROCHESTER, N.Y.**

Improvement in platoon batteries 36,448 16 Sep 1862 (Billinghurst & Requa)

**BIRKIGT, LOUIS—BOIS-COLOMBES, FRANCE**

Tripping device 1,993,645 5 Mar 1935  
 Mechanism for the tripping or release of movable organs 2,040,197 12 May 1936

**BIRKIGT, MARC—BOIS-COLOMBES, FRANCE**

Combined gun and engine for aerial machines 1,319,510 21 Oct 1919  
 Magazine for the automatic feeding of objects 2,011,889 20 Aug 1935  
 Aircraft provided with a gun 2,014,876 17 Sep 1935  
 Aircraft engine and gun assembly 2,020,872 12 Nov 1935  
 Aircraft engine and gun assembly 2,053,691 8 Sep 1936  
 Machine provided with an automatic firearm 2,075,086 30 Mar 1937  
 Airplane provided with an automatic firearm 2,075,087 30 Mar 1937  
 Automatic firearm 2,159,126 23 May 1939  
 Automatic firearm 2,159,127 23 May 1939  
 Detent mechanism 2,179,914 14 Nov 1939  
 Automatic firearm 2,199,871 7 May 1940  
 Automatic firearm 2,199,872 7 May 1940  
 Firearm of the recoiling type 2,291,867 4 Aug 1942

**BIRMINGHAM SMALL ARMS CO., LTD.—BIRMINGHAM, ENGLAND (\*)**

Firearm, Automatic 1,637,234 26 Jul 1927 (Norman)  
 Firearm, Automatic 1,637,235 26 Jul 1927 (Norman)

**BJORGUM, NILS—ASKER, NORWAY**

Automatic firearm 1,007,911 7 Nov 1911

**BLACKER, L. V. S.—LONDON, ENGLAND**

Machine gun & small arm 1,856,022 26 Apr 1932

**BLACKBURN, B. M.—ATLANTA, GA. (\*)**

Machine gun 664,952 1 Jan 1901 (Jeter)

**BLICKENSERFER, GEORGE C.—STAMFORD, CONN.**

Attachment for automatic guns 1,290,828 7 Jan 1919

**BOEGER, JOSEPH—DRESDEN, KANS.**

Machine gun 800,062 19 Sep 1905

**BOCHNAK, ANDREW—BOBTOWN, PA.**

Machine gun 2,024,125 10 Dec 1935

**BOGDONOV, ANTON—ALTOONA, PA. (\*)**

Antiaircraft machine gun 1,443,249 23 Jan 1923 (Dupcza)

**BOMINGHAUS, FRANZ—ESSEN-ON-THE-RUHR, GERMANY**

Recoil gun 923,051 25 May 1909 (Lambur & Boming-haus) (Assigned to Fried. Krupp A. G.)

**BONHAM, JOHN L.—HELLEN, PA.**

Improvement in revolving ordnance 36,555 30 Sep 1862

**BORCHARDT, HUGO—CHARLOTTENBURG, GERMANY**

Trigger mechanism for automatic firearms 987,543 21 Mar 1911  
 Cartridge-ejecting device for firearms 1,009,464 21 Nov 1911  
 Breech-mechanism lock for automatic firearms 1,071,023 26 Aug 1913  
 Automatic firearms with toggle joint 1,160,831 16 Nov 1915



- Breech mechanism for automatic firearms 1,184,065 23 May 1916  
Hold-back device 1,196,759 5 Sep 1916
- BOTTS, ROBERT E.—BLUE EARTH, MINN.**  
Buffer spring assembly for automatic firearms 2,504,958 25 Apr 1950 (Botts & Young)
- BOURDELLES, E. A. L.—ST. DENIS, FRANCE**  
Automatic firearm 1,382,058 21 Jun 1921 (Assigned to Société Anonyme des Etablissements Delaunay)  
Machine gun 1,402,564 3 Jan 1922 (Assigned to same firm)
- BOURNE, ROLAND B.—WEST HARTFORD, CONN.**  
Gun silencer 2,375,617 8 May 1945 (Assigned to Maxim Silencer Co.)
- BOUSSEL, ANDRE—COURBEVOIE, FRANCE**  
Automatic firearm 2,108,026 8 Feb 1938 (Sutter & Bous-  
sel) (Assigned to Société Anonyme des Anciens Et.  
Hotchkiss & Cie.)
- BOWMAN, MARK H.—PINKSTAFF, ILL.**  
Machine gun 662,761 27 Nov 1900 (Hughes & Bowman)
- BRADY, FREEMAN, JR.—WASHINGTON, PA.**  
Gun, Magazine 34,126 14 Jan 1862 (Brady & Noble)
- BRAND, CHRISTOPHER C.—NORWICH, CONN.**  
Revolving firearm 38,279 28 Apr 1863
- BRAUNING, KARL A.—HERSTAL, BELGIUM**  
Automatic firearm with fixed barrel and breech action 1,020,596 19 Mar 1912  
Firing mechanism for automatic firearms 1,073,588 23 Sep 1913  
Firearm, Automatic 1,350,543 24 Aug 1920  
Automatic firearm 1,411,473 4 Apr 1922
- BREDA—See SOCIETA ITALIANA ERNESTO BREDA**
- BREHM, EDUARD—JERSEY CITY, N.J.**  
Improvement in revolving cannons 110,194 20 Dec 1870
- BRETT, JAMES—MATTEAWAN, N.Y.**  
Gun batteries, Many barrels 42,552 3 May 1864
- BREVETS AERO-MECHANQUES S. A.—GENEVA, SWITZERLAND (\*)**  
Gas piston operated firearm 2,494,889 17 Jan 1950 (Maillard)  
Ammunition charging device for automatic arms 2,503,116 4 Apr 1950 (Maillard)  
Pivoted breech bolt lock 2,522,628 19 Sept 1950 (Mail-  
lard)
- BREWSTER AERONAUTICAL CORP.—NEW YORK, N.Y. (\*)**  
Gun, Ammunition magazine 2,364,510 5 Dec 1944 (Ber-  
tran & Lesnick)
- BRISTOL, MORTIMER L.—WEST HARTFORD, CONN.**  
Gun, Automatic 862,384 6 Aug 1907 (Assigned to Colt's  
Patent Firearms Mfg. Co.)
- BRISTOL AEROPLANE CO., LTD.—BRISTOL, ENGLAND (\*)**  
Ammunition feed mechanism for machine guns 2,521,346 5 Sep 1950 (d'Assis-Fonseca)
- BRODERICK, CLEMENT M.—HARTFORD, CONN.**  
Machine gun 504,517 5 Feb 1893 (Broderick & Vankiers-  
bilck) (Assigned to Gatling Gun Co.)  
Feed for machine guns 504,516 5 Sep 1893 (Broderick &  
Vankiersbilck) (Assigned as above)
- BRONDBY, FRIDTJOF N.—OSLO, NORWAY**  
Gas-operated firearm, Automatic 2,223,671 3 Dec 1940
- BROTHERSTON, ALEXANDER M.—MONCTON, NEW BRUNSWICK**  
Machine gun 1,216,938 20 Feb 1917 (1/2 assigned to  
Holmes)  
Apparatus for cooling gun barrels 1,216,939 20 Feb 1917
- BROWN, AARON A.—RAWLINS, WYO. (\*)**  
Automatic gun 718,062 8 Jan 1903 (Weed)
- BROWN, CHARLES W.—INDIANOLA, IOWA**  
Machine gun 1,401,667 27 Dec 1921
- BROWN, JOHN F.—CASA GRANDE, ARIZ. (\*)**  
Automatic rifle 1,398,452 29 Nov 1921 (Wagon)
- BROWN, JOHN L.—MOMENCE, ILL.**  
Gun silencer & scavenger 2,208,093 16 Jul 1940
- BROWN, M. W.—TRENTON, N.J.**  
Automatic rifle 966,995 9 Aug 1910
- BROWN, RICHARD J. W.—LONDON, ENGLAND**  
Breech mechanism for automatic recoil-operated guns 1,021,130 26 Mar 1912
- BROWNING CO., J. M. & M. S.—OGDEN, UTAH (\*)**  
Gas-operated automatic firearm 2,093,706 21 Sep 1937  
(Marriner Browning)  
Automatic firearm 2,039,705 21 Sep 1937 (Marriner  
Browning)  
Automatic firearm 2,039,704 21 Sep 1937 (Marriner  
Browning)  
Firing mechanism for automatic firearms 2,116,140 3 May  
1938 (Marriner Browning)  
Firing mechanism for automatic firearms 2,116,139 3 May  
1938 (Marriner Browning)  
Firing mechanism for automatic firearms 2,093,707 21 Sep  
1937 (Marriner Browning)  
Gas-operated automatic firearm 2,116,141 3 May 1938  
(Marriner Browning)  
Firing mechanism for repeating firearms 2,385,057 18 Sep  
1945 (Val A. Browning)
- BROWNING, JOHN M.—OGDEN, UTAH**  
Machine gun 471,783 29 Mar 1892 (John & Matthew  
Browning)  
Machine gun 471,784 29 Mar 1892 (John & Matthew  
Browning)  
Gun, Gas-operated breech-loaded 502,549 1 Aug 1893  
Gas-operated machine gun 544,657 20 Aug 1895  
Gas-operated machine gun 544,658 20 Aug 1895



Gas-operated machine gun 544,659 20 Aug 1895  
 Gun, Gas-operated breech-loaded 544,660 20 Aug 1895  
 (John & Matthew Browning)  
 Gun, Gas-operated 544,661 20 Aug 1895  
 Gas-operated firearm 621,747 21 Mar 1899  
 Recoil-operated firearm 659,507 9 Oct 1900  
 Recoil-operated firearm 659,786 16 Oct 1900  
 Gun, Automatic 678,937 23 Jul 1901  
 Automatic firearm 689,283 17 Dec 1901  
 Recoil-operated firearm 701,288 3 Jun 1902  
 Automatic firearm 708,794 9 Sep 1902  
 Automatic firearm 747,585 22 Dec 1903  
 Automatic firearm 853,438 14 May 1907  
 Recoil-operated firearm 984,263 14 Feb 1911  
 Automatic machine gun 1,293,021 4 Feb 1919  
 Automatic machine rifle 1,293,022 4 Feb 1919  
 Automatic firearm 1,511,262 14 Oct 1924  
 Automatic firearm 1,525,065 3 Feb 1925  
 Automatic firearm 1,525,066 3 Feb 1925  
 Cartridge-feeding device for firearms 1,525,067 3 Feb 1925  
 Recoil buffer for automatic guns 1,548,708 4 Aug 1925  
 Automatic firearm 1,618,510 22 Feb 1927  
 Automatic firearm 1,628,226 10 May 1927  
 Cartridge feeding mechanism for automatic firearm  
 1,629,652 24 May 1927

## BROWNING, MARRINER A.—OGDEN, UTAH

Gas-operated automatic firearm 2,093,706 21 Sep 1937  
 (Assigned to Browning Co.)  
 Automatic firearm 2,093,705 21 Sep 1937 (Assigned to  
 same)  
 Automatic firearm 2,093,704 21 Sep 1937 (Assigned to  
 same)  
 Firing mechanism for automatic firearm 2,116,140 3 May  
 1938 (Assigned to same)  
 Firing mechanism for automatic firearm 2,093,707 21 Sep  
 1937 (Assigned to same)  
 Gas-operated automatic firearm 2,116,141 3 May 1938  
 (Assigned to same)

## BROWNING, MATTHEW S.—OGDEN, UTAH

Machine gun 471,783 29 Mar 1892 (John M. & Matthew  
 Browning)  
 Machine gun 471,784 29 Mar 1892 (John M. & Matthew  
 Browning)  
 Gas-operated breech-loading gun 544,660 20 Aug 1895  
 (John & Matthew Browning)

## BROWNING, JONATHAN E.—OGDEN, UTAH

Gas-operated firearm 2,211,405 13 Aug 1940 (Assigned  
 to Western Cartridge Co.)  
 Gas-operated automatic firearm 2,252,754 19 Aug 1941  
 (Assigned to same)

## BROWNING, VAL A.—OGDEN, UTAH

Firing mechanism for repeating firearms 2,385,057 18 Sep  
 1945 (Assigned to Browning Co.)

## BRUCE, LUCIEN F.—SPRINGFIELD, MASS.

Cartridge charger for machine gun feeders 341,371 4 May  
 1886 (Assigned to Gatling Gun Co.)

Cartridge feeder for machine gun 343,532 8 Jun 1886  
 (Assigned to same)

Cartridge feeder for machine guns 351,960 2 Nov 1886

## BUCK, EDWARD R.—WINDSOR, VT. (\*)

Automatic magazine firearm 900,965 13 Oct 1908 (C. W.  
 Louis)

## BUCKHAM, GEORGE THOMAS—LONDON, ENGLAND

Gun, Automatic or other machine 687,130 19 Nov 1901  
 (Dawson & Buckham) (Assigned to Vickers Sons &  
 Maxim, Ltd.)  
 Automatic gun 909,849 12 Jan 1909 (Dawson & Buck-  
 ham) (Assigned to same)  
 Automatic gun 920,832 4 May 1909 (Dawson & Buck-  
 ham) (Assigned to same)  
 Automatic gun 942,167 7 Dec 1909 (Dawson & Buck-  
 ham) (Assigned to same)  
 Cartridge-feed mechanism for Maxim guns 951,999 15  
 Mar 1910 (Assigned to same)  
 Automatic gun 926,052 22 Jun 1909 (Dawson & Buck-  
 ham) (Assigned to same)  
 Cartridge-feed mechanism for automatic guns 1,091,640  
 31 Mar 1914 (Assigned to same)  
 Automatic gun 1,077,680 4 Nov 1913 (Assigned to same)  
 Automatic gun 1,262,196 9 Apr 1918 (Assigned to same)  
 Automatic gun 1,262,181 9 Apr 1918 (Dawson & Buck-  
 ham) (Assigned to same)  
 Machine gun 1,312,106 5 Aug 1919 (Dawson & Buckham)  
 (Assigned to same)  
 Machine gun 1,314,734 2 Sep 1919 (Dawson & Buckham)  
 (Assigned to same)  
 Machine gun 1,327,086 6 Jan 1920 (Dawson & Buckham)  
 (Assigned to same)  
 Machine gun 1,453,974 1 May 1923 (Dawson, Buckham  
 & Haskell) (Assigned to same)  
 Automatic gun 1,468,262 18 Sep 1923 (Dawson, Buckham  
 & Larson) (Assigned to same)  
 Machine gun 1,456,625 29 May 1923 (Dawson & Buck-  
 ham) (Assigned to same)  
 Articulated link for the cartridge belts for machine guns  
 1,550,787 25 Aug 1925 (Dawson, Buckham & Larsson)  
 Automatic gun 1,553,992 15 Sep 1925 (Dawson, Buck-  
 ham & Larsson)

## BULL, WILLIAM R.—SPRINGFIELD, MASS.

Method of and apparatus for cooling gun barrels 1,631,190  
 7 Jun 1927  
 Machine gun 2,108,817 22 Feb 1938 (Hoppert, Bull &  
 Simpson)

## BULLARD, HERBERT A.—SAN FRANCISCO, CALIF.

Centrifugal gun 1,311,492 29 July 1919 (Assigned to In-  
 tercontinental Co.)

## BURCESS, ANDREW—BUFFALO, N.Y.

Automatic firearm magazine 557,359 31 Mar 1896  
 Gas-operated firearm 589,120 31 Aug 1897  
 Recoil-operated magazine gun 520,753 29 May 1894  
 Automatic gun 636,196 31 Oct 1899 (Assigned to Win-  
 chester Repeating Arms Co.)  
 Automatic firearm 663,954 18 Dec 1900



Automatic firearm 663,955 18 Dec 1900  
 Automatic firearm 663,956 18 Dec 1900  
 Automatic gun 666,081 15 Jan 1901  
 Automatic gun 687,448 26 Nov 1901  
 Automatic gun 693,105 11 Feb 1902  
 Automatic gun 693,106 11 Feb 1902  
 Automatic gun 715,971 16 Dec 1902  
 Automatic gun 821,922 29 May 1906  
 Automatic gun 822,851 5 June 1906  
 Recoil-operated firearm 591,525 12 Oct 1897  
 Recoil-operated firearm 520,752 29 May 1894 (Assigned to Burgess Gun Co.)

**BURGESS GUN CO.—NEW YORK, N.Y. (\*)**  
 Recoil-operated firearm 520,752 29 May 1894 (Burgess)

**BURGESS, WILLIAM STARLING—BROOKLINE, MASS.**  
 Recoil-operated gun 591,155 5 Oct 1897

**BURK, PAUL W.—WASHINGTON, D.C.**  
 Machine gun 2,453,830 16 Nov 1948 (Chadwick & Burk)

**BURNEY, CHARLES D.—BAYNARDS PARK, ENGLAND**  
 Magazine loaded recoilless gun 2,503,578 11 Apr 1950

**BURTON, BETHEL—LONDON, ENGLAND**  
 Automatic machine gun 390,114 25 Sep 1888

**BURTON, FRANK F.—SHORT BEACH, CONN.**  
 Gun with recoiling barrel 941,006 23 Nov 1909 (Assigned to Winchester Repeating Arms Co.)  
 Cartridge-ejecting mechanism for firearms 2,101,236 7 Dec 1937 (Assigned to same)

**BUSKIRK, THOMAS B.—PAOLI, IND. (\*)**  
 Machine gun 547,717 8 Oct 1895 (Dougherty)  
 Self-acting breech-loading gun 529,521 20 Nov 1894 (Dougherty)

**BYE, MARTIN—WORCESTER, MASS.**  
 Recoil-operated firearm 812,015 6 Feb 1906 (Assigned to Harrington and Richardson Arms Co.)

**CAMPBELL, THOMAS J.—LINCOLN, NEBR.**  
 Improvement in automatic revolving ordnance 35,504 10 Jun 1862

**CANET, JEAN B. G. A.—LE CREUSOT, FRANCE**  
 Recoil apparatus for guns 713,691 18 Nov 1902 (Schneider & Canet)

**CANTLEY, JOSEPH C.—BEVERLY, MASS.**  
 Automatic firearm 2,409,251 15 Oct 1946 (Assigned to United Shoe Machinery Corp.)

**CAPALDO, FRANCESCO—NAPLES, ITALY**  
 Machine gun 1,371,351 15 Mar 1921 (Casseta & Capaldo)

**CAPELL, WILLIAM H.—HAMPTON, VA.**  
 Aircraft machine gun installation 1,907,342 2 May 1933

**CAPALUPO, VINCENZO—E. BOSTON, MASS.**  
 Automatic firearm 1,639,425 16 Aug 1927

**CARL, JOHN HOWARD—GILROY, CALIF.**  
 Automatic firearm 1,118,330 24 Nov 1914  
 Automatic firearm 1,118,331 24 Nov 1914

**CARPENTER, JOHN H.—PICABO, IDAHO (\*)**  
 Recoil-operated firearm 1,078,224 11 Nov 1913 (Taylor)

**CARR, HOWARD—SAN FRANCISCO, CALIF.**  
 Recoil-operated firearm 574,189 29 Dec 1896 (Assigned to San Francisco Arms Co.)  
 Recoil-operated firearm 584,153 8 Jun 1897 (Assigned to same)

**CARRILLO, LEOPIDO A.—BIG WELLS, TEX.**  
 Machine gun 2,004,925 18 Jun 1935

**CARVEN, HARRY—PITTSFIELD, ILL.**  
 Gun silencer 984,750 21 Feb 1911

**CASSETTA, VINCENZO—NAPLES, ITALY**  
 Machine gun 1,371,351 15 Mar 1921 (Casseta & Capaldo)

**CASTELLI, VITTORIO—BRESCIA, ITALY**  
 Cartridge-feed device for automatic firearms 1,611,289 21 Dec 1926 (Soncini & Castelli)  
 Automatic firearm with recoiling barrel 1,613,205 4 Jan 1927 (Soncini & Castelli)

**CATLIN, ROBERT M.—TUSCARORA, NEV.**  
 Recoil-operated firearm 574,350 29 Dec 1896 (Assigned to San Francisco Arms Co.)  
 Recoil-operated magazine gun 454,993 30 Jun 1891

**CAYLOR, HENRY M.—NOBLESVILLE, IND. (\*)**  
 Machine gun 458,268 25 Aug 1891 (Cook)

**CECERO, RALPH S.—WATERBURY, CONN.**  
 Machine gun, Automatic 1,595,993 17 Aug 1926

**CEBILLO, NICASIO—HOUSTON, TEX.**  
 Recoil-operated firearm 1,453,439 1 May 1923 (Assigned to Reed, C. E.)

**CENTRIFUGAL GUN CORP.—MATTAPAN, MASS. (\*)**  
 Centrifugal gun 1,420,660 27 Jun 1922 (Lombard)

**ČESKOSLOVENSKÁ ZBRŮJOVKA AKČIOVÁ-SPOLČNOST V. BRNE—BRUNN, CZECHOSLOVAKIA (\*)**  
 Gas-pressure regulating device for firearms 1,802,816 28 Apr 1931 (Holek, E.)  
 Automatic firearm 1,906,800 2 May 1933 (Marek)  
 Automatic firearm 2,115,526 26 Apr 1938 (Holek, V.)  
 Automatic firearm 2,223,004 26 Nov 1940 (Holek, V.)  
 Automatic firearm in particular machine guns 2,093,169 14 Sep 1937 (Holek, V.)  
 Self-loading firearm 1,960,913 29 May 1934 (Marek)  
 Automatic firearm 2,146,185 7 Feb 1939 (Holek, V.)  
 Automatic firearm 2,267,501 23 Dec 1941 (Holek, V.)  
 Automatic gun 1,926,816 12 Sep 1933 (Podrabsky)

**CHADWICK, GEORGE A.—WASHINGTON, D.C.**  
 Machine gun 2,453,830 16 Nov 1948 (Chadwick & Burk)

**CHAFFEE, REUBEN S.—SPRINGFIELD, ILL.**  
 Feed mechanism for breech-loading firearms 314,515 24 Mar 1885



## CHALLENGER, GEORGE H.—WESTMINSTER, ENGLAND

Bullet deflector for the propellers of aeroplane and similar aircraft provided with guns 1,298,886 1 Apr 1919 (Assigned to Vickers, Ltd.)

Automatic gun 1,298,887 1 Apr 1919 (Challenger & Savage) (Assigned to same)

## CHANDLER, EDWARD F.—BROOKLYN, N.Y.

Self-propelled projectile 2,391,865 1 Jan 1946

## CHAPMAN, THOMAS O.—GLENDALE, CALIF.

Firing mechanism for rifles 2,441,029 4 May 1948 (Nyvall & Chapman)

## CHEVALLIER, ARNOLD LOUIS—LONDON, ENGLAND

Automatic firearm 1,454,039 8 May 1923

## CHILDRESS, GEORGE F.—WILLS POINT, TEX.

Gun muffler 953,943 5 Apr 1910

## CHRISTOPHE, LOUIS—BRUSSELS, BELGIUM

Machine gun 121,277 28 Nov 1871 (Montigny)

## CLADWELL, THOMAS F.—RICHMOND, AUSTRALIA

Quick-firing machine gun 1,090,124 10 Mar 1914

## CLARK, ALFRED L.—DUBUQUE, IOWA

Machine gun 1,169,237 25 Jan 1916

## CLARK, WILLIAM R.—SEATTLE, WASH.

Gas-operated gun 1,308,016 24 June 1919 (Assigned 1/2 to Martin, William.)

## CLARUS, BRUNO—LUTTICH, BELGIUM

Recoil-operated firearm 898,038 8 Sep 1909

## CLAUSIUS, CLAUS H. R.—HAMBURG, GERMANY

Firearm, Recoil-operated 593,835 16 Nov 1897

## CLEMENT, CHARLES P.—LIEGE, BELGIUM

Automatic firearm 976,122 15 Nov 1910

## COBB, LYMAN H.—FITCHBURG, MASS.

Automatic firearm 499,259 23 May 1911 (Assigned to Johnson, M. E.)

## COLE, CHARLES SCHNEIDER—SANDY HOOK, CONN.

Automatic firearm 1,843,916 9 Feb 1932

## COLEMAN, BENJAMIN F.—PRENTISS, MASS.

Multibarrel machine gun 2,404,277 16 Jul 1946

## COLLEONI, GIUSEPPE—NEW YORK, N.Y.

Automatic gun 960,825 7 Jun 1910

## COLONEY, MYRON—NEW HAVEN, CONN.

Machine gun 225,462 16 Mar 1880 (Assigned to J. H. McLean)

Machine gun 225,466 16 Mar 1880 (Assigned to J. H. McLean)

Machine gun 231,653 31 Aug 1880 (Assigned to J. H. McLean)

Machine gun 282,549 7 Aug 1893 (Assigned to J. H. McLean)

Magazine gun 231,652 31 Aug 1880 (Assigned to J. H. McLean)

## COLT'S PATENT FIRE ARMS MFG. CO.—HARTFORD, CONN. (\*)

Gas-operated machine gun 550,262 26 Nov 1895 (Ehbets)

Gas-operated magazine gun 570,388 27 Oct 1896 (Ehbets)

Automatic gun 862,384 6 Aug 1907 (Bristol)

Automatic machine gun 1,499,846 1 Jul 1924 (Tansley)

Magazine-feed mechanism for machine guns 1,719,126 2 Jul 1929 (Pfeiffer & Moore)

Barrel mounting for firearms 1,738,500 3 Dec 1929 (Moore)

Gas-operated automatic firearm 1,738,501 3 Dec 1929 (Moore)

Trigger mechanism for machine gun 1,738,502 3 Dec 1929 (Pfeiffer & Moore)

Speed regulator for machine guns 1,741,432 31 Dec 1929 (Pfeiffer)

Speed regulator for machine guns 1,741,534 31 Dec 1929 (Pfeiffer)

Reversible feed mechanism for machine guns 1,803,351 5 May 1931 (Pfeiffer & Moore)

Automatic firearm 1,803,349 5 May 1931 (Pfeiffer)

Firing mechanism for machine guns 1,966,592 17 Jul 1934 (Moore)

Automatic firearm 2,050,538 11 Aug 1936 (Moore)

Firing mechanism for machine guns 2,050,539 11 Aug 1936 (Moore and Tansley)

Machine gun and attachment therefor 2,061,313 17 Nov 1936 (Moore)

Machine gun 2,110,165 8 Mar 1938 (Moore)

Machine gun 2,140,809 20 Dec 1938 (Moore)

Automatic firearm 2,169,083 8 Aug 1939 (Swartz)

Firing mechanism for automatic firearms 2,335,688 30 Nov 1943 (Moore)

Automatic firearm and combined accessories 2,359,263 26 Sep 1944 (Webb)

Automatic firearm 2,375,452 8 May 1945 (Webb)

Improvement in operating machine gun 120,588 7 Nov 1871 (Kinne)

Bolt mechanism for machine guns 2,529,391 7 Nov 1950 (Hedges)

## COMPAGNIA COMMERCIALE CAPRONI—MILAN, ITALY (\*)

Gun barrel 2,238,670 15 Apr 1941 (Traversi & Pagna)

## CONDIT, WILLIAM D.—DES MOINES, IOWA (\*)

Gas-operated machine gun 784,966 14 Mar 1905 (Smith)

Recoil-operated firearm 804,984 21 Nov 1905 (Scarle)

Gas-operated automatic firearm 814,242 6 Mar 1906 (Smith)

## CONLON, THOMAS A.—SILVER SPRING, MD.

Automatic gun 2,213,953 10 Sep 1940

## CONLY, ART B. (\*)

Automatic firearm 747,073 15 Dec 1903 (Huntley)

## CONLY, J. GRIFFIN (\*)

Automatic firearm 747,073 15 Dec 1903 (Huntley)

## CONNOR, MARCUS W.—LOUISVILLE, MISS.\*

Machine gun 282,787 7 Aug 1883 (Shields)



## COOK, THOMAS R.—NOBLESVILLE, IND.

Machine gun 458,268 25 Aug 1891 (Assigned 1/3 to Caylor)

Machine gun 560,842 26 May 1896 (Assigned 1/2 to Over)

## COOKE, CHARLES JOHN—HONG KONG, CHINA

Non-recoil gun for aeroplanes 1,375,381 29 May 1921

Non-recoiling gun for aeroplanes 1,380,358 7 Jun 1921

## COOLEY, HENRY B.—KENSINGTON, CONN.

Cartridge belt for machine guns 1,341,111 25 May 1920  
(Assigned to American Paper Goods Co.)

## CORNWELL, WILLIAM D.—LOUISVILLE, MISS. (\*)

Machine gun 282,787 7 Aug 1883 (Shields)

## COULOMBE, JOSEPH C.—NORTHFIELD, VT.

Noiseless gun 1,140,578 25 May 1915

## COUPLAND, RICHARD C.—DAYTON, OHIO

Counting or registering apparatus for machine guns  
1,653,698 27 Dec 1927

Operating mechanism for machine guns 1,799,284 7 Apr 1931

Bolt-operating mechanism for machine guns 1,845,242 16 Feb 1932

Operating mechanism for machine guns 1,897,099 14 Feb 1933 (Woody & Coupland)

Means for cooling gun barrels 2,112,144 22 Mar 1938

## COVENTRY ORDNANCE WORKS, LTD.—COVENTRY, ENGLAND (\*)

Feed mechanism for automatic guns 1,298,091 25 Mar 1919 (Redpath & Hellberg)

Automatic gun 1,315,329 9 Sep 1919 (Redpath)

## COX, CHARLES F.—SING SING, N.Y. (\*)

Improvements in firearms 31,933 2 Apr 1861 (McCord)

## CRANMER, T. J.—VALLICITA, CALIF.

Self-loading battery gun 74,994 3 Mar 1868

## CRAWFORD, SAMUEL—SHULLSBURG, WIS. (\*)

Machine gun 14,215 5 Feb 1856 (Terrel)

## CREON, WARNANT JULIEN—HOICNEE-CHIERATTE, BELGIUM

Automatic rifle 908,631 5 Jan 1909

## CROCKETT, HARRY L.—NEW HAVEN, CONN.

Gas-operated self-loading firearm 2,370,233 27 Feb 1945  
(Assigned to Western Cartridge Co.)

Gas-operated self-loading firearm 2,394,986 19 Feb 1946  
(Assigned to Olin Industries, Inc.)

## CZAVRA, IGNATI—ROCHESTER, N.Y.

Automatic gun 1,321,419 11 Nov 1919

## CZEGKA, VICTOR H.—WASHINGTON, D.C.

Centrifugal gun 1,404,378 24 Jan 1922

## DAAM, GERRIT VAN—BUFFALO, N.Y.

Gun heater 2,403,415 2 Jul 1946

## DANSK REKYL-RIFFEL SYNDIKAT—COPENHAGEN, DENMARK (\*)

Automatic firearm 701,815 3 June 1902 (Rasmussen)

## DANUVIA IPARI ES' KERESKEDELMI R. T.—BUDAPEST, HUNGARY (\*)

Gas-operated firearm 2,186,582 9 Jan 1940 (Gebauer)

## DARCHE, PAUL—PARIS, FRANCE

Firearm, Recoil-operated 519,151 1 May 1891

## DARLINGTON, THOMAS—NEW YORK, N.Y. (\*)

Automatic gun 954,797 12 Apr 1910 (Hammond)

Automatic gun 954,798 12 Apr 1910 (Hammond)

## DARNE, PIERRE—ST. ETIENNE, FRANCE

Automatic firearm or machine gun 1,323,025 25 Nov 1919  
(R. & P. Darne)

## DARNE, REGIS—ST. ETIENNE, FRANCE

Automatic firearm or machine gun 1,323,025 25 Nov 1919  
(R. & P. Darne)

Device of regulating the rate of fire in automatic firearms  
1,532,305 7 Apr 1925

Automatic firearm 1,730,269 10 Oct 1929

Automatic firearm 2,124,911 26 Jul 1938

## D'ASSIS-FONSECA, EVELYN C. M.—BRISTOL, ENGLAND

Ammunition feed mechanism for machine guns 2,521,346  
5 Sep 1950 (Assigned to Bristol Aeroplane Co., Ltd.)

## DAVIS, CLELAND—WASHINGTON, D.C.

Aeroplane gun 1,108,714 25 Aug 1914 (Assigned to Ordnance Development Co.)

Apparatus for firing projectiles from aeroplanes 1,108,715  
25 Aug 1914 (Assigned as above)

Apparatus for firing projectiles from aeroplanes 1,108,716  
25 Aug 1914

Fixed ammunition for use in aircraft 1,108,717 25 Aug 1914 (Assigned as above)

Gun, Non-recoil 1,395,630 1 Nov 1921

Armament for aircraft 1,446,000 20 Feb 1923

## DAVIS, LOUIS, JR.—GALVESTON, TEX.

Machine gun 1,869,738 2 Aug 1932 (Assigned to Halett, Dalbert & Stuckey)

## DAWSON, ARTHUR T.—WESTMINSTER, ENGLAND

Automatic gun 1,262,181 9 Apr 1918 (Dawson & Buckham)  
(Assigned to Vickers, Ltd.)

Machine gun 1,312,106 5 Aug 1919 (Dawson & Buckham)  
(Assigned as above)

Machine gun 1,314,734 2 Sep 1919 (Dawson & Buckham)  
(Assigned as above)

Machine gun 1,327,068 6 Jan 1920 (Dawson & Buckham)  
(Assigned as above)

Machine gun 1,453,974 1 May 1923 (Dawson, Buckham & Haskell)  
(Assigned as above)

Machine gun 1,456,625 29 May 1923 (Dawson & Buckham)  
(Assigned as above)

Automatic gun 1,468,262 18 Sep 1923 (Dawson, Buckham & Larsson)  
(Assigned as above)

Links for the cartridge belts for machine guns 1,550,787  
25 Aug 1925 (Dawson, Buckham & Larsson) (Assigned as above)

Automatic gun 1,553,992 15 Sep 1925 (Dawson, Buckham & Larsson)



## DE BRAME, J. A.—NEW YORK, N.Y.

Improvement in breech-loading ordnance 34,025 24 Dec 1861 (Assigned to J. Gurney)  
Improvement in revolving ordnance 34,024 24 Dec 1861

## DEGAILLE, PIERRE ALBIN—PARIS, FRANCE

Automatic firearm 1,059,680 22 Apr 1913 (Menteyne & Degaille)  
Automatic firearm 981,210 10 Jan 1911 (Menteyne & Degaille)  
Cartridge belt 1,150,435 17 Aug 1915 (Laird, Menteyne & Degaille)

## DEHM, EDWARD—FRUITA, COLO.

Magazine repeating firearm 841,670 22 Jan 1907

## DEKNIGHT, VICTOR P.—WASHINGTON, D.C.

Automatic rapid-fire gun 698,107 22 Apr 1902 (Assigned to Victor P. DeKnight Gun Co.)  
Automatic rapid-fire gun 709,880 30 Sep 1902 (Assigned to same)  
Rapid-fire automatic gun 709,881 30 Sep 1902 (Assigned to same)  
Rapid-fire automatic gun 709,883 30 Sep 1902 (Assigned to same)

## DELAUNAY CO. See SOCIETE ANONYME DES ETABLISSEMENTS DELAUNAY

## DERSCHAU, ALBERT VON—EMDEN, GERMANY

Electrically controlled lock for firearms 439,055 21 Oct 1890

## DEUTSCHE WAFFEN UND MUNITIONSFABRIKEN—BERLIN, GERMANY (\*)

Trigger mechanism for machine guns 905,071 24 Nov 1908 (Heinemann)  
Automatic gun 1,045,549 26 Nov 1912 (Heinemann)  
Machine gun 1,087,371 17 Feb 1914 (Heinemann)  
Automatic gun 1,114,463 20 Oct 1914 (Gebauer)  
Automatic gun 1,114,611 20 Oct 1914 (Heinemann)  
Machine gun 1,123,530 5 Jan 1915 (Heinemann, Karl)  
Machine gun 1,128,310 16 Feb 1915 (Heinemann)  
Machine gun 1,150,364 17 Aug 1915 (Heinemann, Karl)  
Machine gun 1,155,061 28 Sep 1915 (Heinemann)  
Machine gun 1,167,498 11 Jan 1916 (Heinemann)  
Automatic firearm 1,725,272 20 Aug 1929 (Heinemann)

## DEVRIES, PETER J.—SHELDON, IOWA

Gun muffler 1,143,814 22 June 1915

## DESTREE, JOSEPH—BRUSSELS, BELGIUM

Automatic firearm 1,735,160 12 Nov 1929  
Automatic firearm 1,713,955 21 May 1929  
Automatic firearm with gas extraction 1,846,993 23 Feb 1932

## DIBOVSKY, VICTOR V.—LONDON, ENGLAND

Machine gun 1,298,911 1 April 1919  
Buffing device for machine guns 1,298,912 1 Apr 1919  
Machine gun 1,362,479 14 Dec 1920 (Assigned to Type Release Co., Inc.)

## DICKE, ALLEN A.—MONTCLAIR, N.J.

Automatic firearm 2,297,693 6 Oct 1942

## DICKINSON, CHARLES S.—CLEVELAND, OHIO

Improvement in centrifugal guns 24,997 9 Aug 1859

## DICKINSON, JACOB M.—CHICAGO, ILL.

Automatic firearm 1,835,286 8 Dec 1931

## DIEHM, LUCIUS N.—WEST HARTFORD, CONN.

Automatic firearm 1,226,478 15 May 1917 (Assigned 2/3 to Stone)

## DIESTELKAMP, FREDERICK A.—BLAND, MO.

Automatic magazine firearm 1,126,726 2 Feb 1915

## DINSMORE, ROBERT—WESTON, W.VA.

Magazine gun with pneumatically operated magazines 444,666 13 Jan 1891 (Assigned to Greenstein)

## DOBREMYSL, JOSEF—LONDON, ENGLAND

Automatic firearm 2,367,488 16 Jan 1945  
Automatic gun 2,365,498 19 Dec 1944

## DODGE, JOSIAH—DUMMERSTON, VT.

Improved mode of charging cannons 15,357 15 July 1856  
Improved mode of discharging cannons 17,920 4 Aug 1857

## DODGE, WILLIAM W., JR.—ASHEVILLE, N.C.

Machine gun 1,551,809 1 Sep 1925

## DOLLEY, LEON H.—SHERMAN MILLS, ME.

Recoil-operated firearm 1,067,721 15 July 1913

## DOOLITTLE, JAMES B.—SEYMOUR, CONN.

Magazine firearm 35,996 29 July 1862

## DOUGHERTY, ALBERT G.—CHAMBERSBURG, IND.

Machine gun 547,717 9 Oct 1895 (Assigned 2/3 to Buskirk & Foote)  
Self-acting breech loading gun 529,521 20 Nov 1891 (Assigned 2/3 to Buskirk)

## DOUGLAS, WILLIAM M.—GALVESTON, TEX.

Automatic gun or rifle 1,025,132 7 May 1912

## DOUGLAS, WILLIAM—CORY, PA.

Improvement in battery guns 43,903 23 Aug 1864

## DOVELL, HARPER H.—BALTIMORE, MD.

Machine gun 1,294,636 18 Feb 1919

## DRIGGS, LOUIS LABODIE—NEW YORK, N.Y.

Rapid-fire gun 613,195 25 Oct 1898 (Driggs & Tasker)  
(Assigned to Driggs-Seabury Gun & Ammunition Co.)  
Automatic gun 698,472 29 Apr 1902 (Assigned to same)

## DRIGGS ORDNANCE CO., INC.—NEW YORK, N.Y. (\*)

Gas-operated gun 1,291,690 14 Jan 1919 (Smith)

## DRIGGS-SEABURY GUN &amp; AMMUNITION CO.—NEW YORK, N.Y. (\*)

Rapid-fire gun 613,195 25 Oct 1898 (Driggs & Tasker)  
Automatic gun 698,472 29 April 1902 (Driggs)

## DRIGGS-SEABURY ORDNANCE CORP.—SHARON, PA. (\*)

Automatic gun 781,503 31 Jan 1905 (Driggs)



**DRIGGS, WILLIAM HALE—WASHINGTON, D.C.**

Automatic gun 781,503 31 Jan 1905 (Assigned to Driggs-Seabury Ordnance Corp.)

**DUFFEK, JOSEF—STEYR, AUSTRIA**

Gun lock for automatic firearm 1,387,369 9 Aug 1921  
(Assigned to Oesterreichische Waffenfabrikgesellschaft, Steyr, Austria)

**DUNLOP RUBBER CO. LTD.—LONDON, ENGLAND (\*)**

Firing device for automatic guns 2,135,688 8 Nov 1938  
(Wright & Trevaskis)

Solenoid 2,403,315 2 July 1946 (Trevaskis)

Firing mechanism for automatic gun 2,397,387 26 Mar 1946 (Trevaskis)

**DUNWOODY AUTOMATIC GUN & PROJECTILE CO. (\*)**

Automatic gun 1,227,897 29 May 1917 (H. H. C. Dunwoody)

**DUNWOODY, HENRY H. C.—WASHINGTON, D.C.**

Automatic gun 1,227,897 29 May 1917 (Assigned to Dunwoody Automatic Gun & Projectile Co.)

**DUPCZA, PETER A.—LYNDORA, PA.**

Machine gun 990,642 25 April 1911

Antiaircraft machine gun 1,443,249 23 Jan 1923 (Assigned 1/2 to Bogdonov)

**EATON, GILBERT C.—CLEVELAND, OHIO (\*)**

Centrifugal gun 37,159 16 Dec 1862 (Turner)

**EBELING, FRED—LINN, KANS.**

Machine gun 531,168 18 July 1894

**EDGEWATER STEEL CORP.—OAKMONT, PA. (\*)**

Automatic gun 2,370,835 6 Mar 1945 (Bell & Wilkander)

Automatic gun 2,395,211 19 Feb 1946 (Bell & Wilkander)

**EDWARDS, DANIEL G.—HOPKINSVILLE, KY.**

Fire control means for aircraft machine guns 1,466,951 4 Sep 1923 (Assigned to Stone)

**EGLIN, HANS—GENEVA, SWITZERLAND**

Automatic inertia-locked firearm with automatic hammer 2,512,014 20 Jun 1950 (Assigned to Oerlikon Co.)

**EBBETS, CARL J.—HARTFORD, CONN.**

Gas-operated machine gun 550,262 26 Nov 1895 (Assigned to Colt's Patent Firearms Mfg. Co.)

Gas-operated magazine gun 570,388 27 Oct 1896 (Assigned to Colt's Patent Firearms Mfg. Co.)

**EICKHOFF, THEODORE H.—CLEVELAND, OHIO**

Automatic gun 1,396,949 15 Nov 1921 (Assigned to Auto-Ordnance Corp.)

**EIANE, HALVOR O.—WASHINGTON ISLAND, WIS.**

Automatic gun 2,149,512 7 Mar 1939

**ERLUND, HANS E.—MALMO, SWEDEN**

Disconnecter means in self-charging firearms 2,390,061 4 Dec 1945 (Assigned to Aktiebolaget J. C. Ljungman)

**EKSERGIAN, CAROLUS L.—DETROIT, MICH.**

Rocket projectile (Spin S.) 2,405,415 6 Aug 1946

Recoilless gun mechanism 2,405,414 6 Aug 1946

**ELLOTT, CARLETON R.—DAYTON, OHIO**

Gun cocking device 2,386,801 16 Oct 1945 (Johnson & Elliott)

**ELLIOTT, DANIEL S.—MIDDLE RIVER, MD.**

Machine gun feed 2,428,414 7 Oct 1947 (Assigned to Glenn L. Martin Co.)

**END, G.—SCHIAFFHAUSEN, SWITZERLAND**

Automatic firearm 2,031,305 18 Feb 1936 (End & Gactzi)  
(Assigned to Schweizerische-Industrie Gesellschaft)

Automatic firearm 2,130,383 20 Sep 1938 (Assigned to Schweizerische-Industrie Gesellschaft)

Automatic firearm 2,052,287 25 Aug 1936 (Assigned to Schweizerische-Industrie Gesellschaft)

**ENGEL, GEORG—DUSSELDORF, GERMANY**

Automatic firearm 2,133,661 18 Oct 1938 (Engel & Winter)  
(Assigned to Rheinmetall-Borsig)

**ERIKSEN, JOHAN—CHRISTIANA, NORWAY**

Machine gun 1,497,096 10 June 1924

**ERNESTI, WALTER—BERLIN, GERMANY**

Gun which fires with forward movement of the gun 2,218,877 22 Oct 1940 (Ernesti & Herlach)  
(Assigned to Rheinmetall-Borsig Aktiengesellschaft)

**EYLER, LAWRENCE J.—DAYTON, OHIO**

Cocking handle for aerial guns 1,528,950 10 May 1925  
(Russell & Eyler)

**FAIRCHILD AVIATION CORP.—NEW YORK, N.Y. (\*)**

Gun synchronizer 1,848,720 8 Mar 1932 (Horton)

**FARQUHAR, MOUBRAY GORE—ABOYNE, SCOTLAND**

Automatic rifle 867,960 15 Oct 1907 (Farquhar & Hill)

Automatic firearm 920,301 4 May 1909 (Farquhar & Hill)

Automatic firearm 1,019,620 5 Mar 1912 (Farquhar & Hill)

Cartridge magazine for rifles and machine guns 1,337,893  
20 Apr 1920 (Farquhar & Hill)

Automatic firearm 1,350,961 24 Aug 1920 (Farquhar & Hill)

Automatic firearm 1,353,736 21 Sep 1920 (Farquhar & Hill)

**FARRINGTON, DE WITT CLINTON—LOWELL, MASS.**

Machine gun 165,318 6 July 1875

Barrel-shifting mechanism for machine guns 198,366 18 Dec 1877

Cartridge feeder for machine guns 198,368 18 Dec 1877

Machine gun 241,130 10 May 1881

Improvement in machine guns 179,450 4 July 1876

Improvement in traverse mechanism for machine guns 198,367 18 Dec 1877

Improvement in locks for machine guns 185,510 19 Dec 1876

**FARWELL GUN CO.—NEW YORK, N.Y. (\*)**

Machine gun 154,596 1 Sep 1874 (Farwell)

**FARWELL, WILLARD B.—NEW YORK, N.Y.**

Machine gun 137,428 1 Apr 1873

Machine gun 154,596 1 Sep 1874 (Assigned to Farwell Gun Co.)

Machine gun 169,686 9 Nov 1875



- FERRANT, EMIL—MINNEAPOLIS, MINN.**  
Automatic magazine gun 645,932 27 Mar 1900 (Beck & Ferrant)
- FIELDS, WILLIAM—WILMINGTON, DEL.**  
Gun, Battery 113,996 25 Apr 1871
- FISHER, GEORGE O.—BROOKLYN, N.Y.**  
Automatic gun 1,475,761 27 Nov 1923
- FITTIPALDI, RAFAEL—BUENOS AIRES, ARGENTINA**  
Automatic repeating firearms 1,099,245 9 June 1914
- FLETCHER, WALLACE R.—DAYTON, OHIO**  
Blast tube for machine guns 1,557,820 20 Oct 1925  
Electrical synchronizer and trigger motor for automatic machine guns 1,530,700 24 Mar 1925 (Russell & Fletcher)
- FLÖRICKE, ALBERT E.—NEW YORK, N.Y.**  
Machine gun 1,401,768 27 Dec 1921
- FOKKER, ANTHONY H. G.—AMSTERDAM, NETHERLANDS**  
Breech lock for machine guns 1,426,851 22 Aug 1922
- FOOTE, OSCAR—WASHINGTON, D.C. (\*)**  
Machine gun 547,717 8 Oct 1895 (Dougherty)
- FOSBERY, GEORGE VINCENT—LONDON, ENGLAND**  
Recoil-operated firearm 584,631 15 June 1897
- FOSKETT, WILLIAM A.—HARTFORD, CONN. (\*)**  
Machine gun 430,206 17 June 1890 (Garland)  
Machine gun 479,499 2 Aug 1892 (Garland)
- FOWLER, ELBERT—BALTIMORE, MD.**  
Machine gun 1,451,443 10 Apr 1923
- FOX, ANSLEY H.—PHILADELPHIA, PA.**  
Gas-operated machine gun 1,293,396 4 Feb 1919 (Assigned to Ansley Fox Co.)  
Gas-operated automatic machine gun 1,294,892 18 Feb 1919 (Fox & Rice) (Assigned to Ansley Fox Co.)  
Machine gun 1,388,856 21 Aug 1930 (Assigned to Ansley Fox Co.)
- FRANCIS, LOUIS—MIAMI, FLA.**  
Multi-charge gun 2,360,217 10 Oct 1944
- FRANK, HOLMES A.—MILLARTON, NEW BRUNSWICK, CANADA (\*)**  
Machine gun 1,216,938 20 Feb 1917 (Brotherston)  
Method of and apparatus for cooling gun barrels 1,216,939 20 Feb 1917 (Brotherston)
- FRANKE, BERNHARD—NEW YORK, N.Y.**  
Improvement in revolving ordnance 35,998 29 July 1862
- FRANKS, BENJAMIN R.—SCOTTSDORO, ALA.**  
Extractor for revolving firearms 239,238 22 Mar 1881
- FREEMAN, CHARLES—LOS ANGELES, CALIF.**  
Automatic firearm 802,033 17 Oct 1905  
Automatic firearm 870,719 12 Nov 1907
- FRIBERG, H.—STOCKHOLM, SWEDEN**  
Automatic firearm 738,140 1 Sep 1903 (Assigned to Aktiebolaget Stockholms-Vapenfabrik)
- FRIED. KRUPP AKTIENGESELLSCHAFT—ESSEN ON THE RUHR, GERMANY (\*)**  
Recoil gun 809,821 9 Jan 1906 (Lauber)  
Barrel-recoil gun with wedge breech lock 842,547 29 Jan 1907 (Hermsdorf)  
Barrel-recoil gun 911,818 9 Feb 1909 (Hermsdorf)  
Recoil gun 911,849 9 Feb 1909 (Theile)  
Recoil gun 923,051 25 May 1909 (Lauber and Bominghaus)  
Composite gun barrel assembled by rotary motion of its component parts 1,400,780 20 Dec 1921 (Vollmer)
- FRISSELL, FRANK H.—MIDDLETOWN, CONN.**  
Belt-like cartridge carrier for machine guns 1,168,876 18 Jan 1916 (Assigned to Russell Mfg. Co.)  
Machine-gun belt 1,247,811 27 Nov 1917  
Machine-gun feed belt 1,258,553 5 Mar 1918 (Assigned to Russell Mfg. Co.)
- FITZPATRICK, KIRBY—OKLAHOMA CITY, OKLA.**  
Automatic gun 1,161,384 23 Nov 1915
- FROMMER, RUDOLF VON—BUDAPEST, AUSTRIA-HUNGARY**  
Firearm for hand and automatic loading 952,896 22 Mar 1910  
Automatic firearm 959,002 24 May 1910  
Automatic firearm 960,880 7 June 1910  
Automatic firearm 988,996 11 Apr 1911  
Automatic firearm 992,184 16 May 1911  
Automatic firearm 1,038,555 17 Sep 1912  
Firing mechanism for automatic firearms 1,159,004 2 Nov 1915  
Automatic firearm 1,516,835 25 Nov 1924  
Automatic firearm 1,521,676 6 Jan 1925  
Automatic firearm 1,579,742 6 Apr 1926  
Automatic firearm 1,680,186 7 Aug 1928  
Automatic firearm 1,758,486 13 May 1930  
Automatic firearm 1,809,741 9 June 1931  
Barrel spring for automatic firearm 1,877,839 20 Sep 1932  
Automatic firearm with removable barrel 1,991,302 12 Feb 1935
- FROST, JOSEPH W.—NEW YORK, N.Y.**  
Electric firearm 319,898 9 June 1885
- FURRER, ADOLF—BERNE, SWITZERLAND**  
Automatic firearm 1,518,498 9 Dec 1924 (Assigned to Schweizerische Industrie Gesellschaft)
- GABBETT-FAIRFAX, HUGH WILLIAM—LONDON, ENGLAND**  
Automatic firearm 684,055 8 Oct 1901  
Recoil-operated firearm 600,066 1 Mar 1898 (Assigned to the Mars Automatic Firearms Syndicate, Ltd.)  
Automatic or semi-automatic firearm 1,338,649 27 Apr 1920  
Automatic firearm 1,344,499 22 June 1920  
Firearm or machine gun 1,348,702 3 Aug 1920  
Automatic firearm 1,357,857 2 Nov 1920
- GAETZI, JAKOB—SCHAFFHAUSEN, SWITZERLAND**  
Automatic firearm 2,031,305 18 Feb 1936 (End & Gaetzi) (Assigned to Schweizerische Industrie Gesellschaft)



GAIDOS, ALONZO F.—REDWOOD, CALIF.

Fire control selector for automatic firearms 2,512,638 27 Jun 1950

GANNOC MFG. CO.—W.VA. (\*)

Centrifugal gun 1,309,129 8 July 1919 (Gannoc, T. A.)

GANNOC, THOMAS A.—WARREN, PA.

Centrifugal gun 1,309,129 8 July 1919 (Assigned to Gannoc Mfg. Co.)

GARAND, JOHN C.—SOMERSET, MD.

Automatic gun 1,603,684 19 Oct 1926

GARAND, JOHN C.—NEW YORK, N.Y. (\*)

Machine gun 1,472,126 30 Oct 1923 (Kewish)

GARDNER, WILLIAM—HARTFORD, CONN. & CLEVELAND, OHIO

Machine gun 245,710 16 Aug 1881

Machine gun 216,266 10 Jan 1879

Improvement in machine guns 174,130 29 Feb 1876

GARLAND, EDWARD E.—BELLEVILLE, N.J.

Automatic firearm 2,189,202 6 Feb 1940

GARLAND, FRANK M.—NEW HAVEN, CONN.

Machine gun 430,206 17 June 1890 (Assigned 2/3 to Beecher, Foskett, Newton & Sherman)

Machine gun 513,995 6 Feb 1894

Machine gun 479,799 2 Aug 1892 (Assigned 2/3 to Beecher, Foskett, Newton & Sherman)

Machine gun 457,276 17 May 1892

Automatic machine gun 623,003 11 Apr 1899

Automatic operating mechanism for machine guns 636,974 14 Nov 1899 (2/3 to Beecher)

Automatic machine gun 636,977 14 Nov 1899

Automatic machine gun 643,118 13 Feb 1900 (2/3 Assigned to Beecher)

Automatic machine gun mechanism 643,119 13 Feb 1900

Automatic machine gun 669,236 5 Mar 1901

GASS, GEORGE WILLIAM—BOLTON, ENGLAND

Machine gun 729,858 2 June 1903

GAST, CARL—BARMEN, GERMANY

Double-barrel machine gun with recoiling barrels 1,477,115 11 Dec 1923

GASTAV GENSCHOW & CO.—BERLIN, GERMANY (\*)

Automatic firearm 2,182,907 12 Dec 1939 (Vollmer)

GATES, WILLIAM H.—NORWICH, CONN.

Automatic firearm 962,137 21 June 1910

GATLING GUN CO.—HARTFORD, CONN. (\*)

Feeder for machine guns 290,622 18 Dec 1883 (Accles)

Cartridge-charger for machine gun feeders 341,371 4 May 1886 (Bruce)

Cartridge feeder for machine guns 343,532 8 June 1886 (Bruce)

Cartridge feeder for machine guns 351,960 2 Nov 1886 (Bruce)

Machine gun 504,517 5 Feb 1893 (Broderick & Vankeirsbilck)

Feed for machine guns 504,516 5 Sep 1893 (Broderick & Vankeirsbilck)

GATLING, RICHARD J.—HARTFORD, CONN. AND INDIANAPOLIS, IND.

Traversing gun mechanism for machine guns 145,563 16 Dec 1873

Machine gun 502,185 25 Dec 1893

Feed for machine gun 499,534 13 June 1893

Improvement in revolving-battery guns 125,563 9 Apr 1872

Revolving-battery gun 36,836 4 Nov 1862

Improvement in revolving-battery guns 112,138 28 Feb 1871

Improvement in battery guns 47,631 9 May 1865

GAVITT, JAMES K. G.—PHILADELPHIA, PA.

Electric firearm 332,071 8 Dec 1885

GEBAUER, FERENC—BUDAPEST, HUNGARY

Gas-operated firearm 2,186,582 9 June 1940 (Assigned to Danuvia Ipari es' Kereskedelmi R. T.)

GEBAUER, PAUL—BERLIN, GERMANY

Automatic gun 1,114,463 20 Oct 1914 (Assigned to Deutsche Waffen und Munitionsfabriken)

GENERAL AIRCRAFT EQUIPMENT, INC.—SOUTH NORWALK, CONN. (\*)

Gun actuator 2,341,641 15 Feb 1944 (Mejean, J. G.)

GENERAL ELECTRIC CO.—NEW YORK, N.Y. (\*)

Gun charger 2,389,943 27 Nov 1945 (Wall)

GENERAL MOTORS CORP.—DAYTON, O. AND DETROIT, MICH. (\*)

Cartridge feed mechanism 2,418,428 1 Apr 1947 (Rundquist)

Bolt mechanism 2,503,575 11 Apr 1950 (Anderson & Pearson)

Feed mechanism for machine guns 2,519,947 22 Aug 1950 (Watt)

GENERAL ORDNANCE CO.—GORTON, CONN. (\*)

Non-recoil gun 1,394,490 18 Oct 1921 (Giles)

GERNER, JOSEPH H.—LOWVILLE, N.Y.

Rapid-fire battery gun 1,283,728 5 Nov 1918

GESELLSCHAFT ZUR VERWARTUNG VON FEUERWAFFEN-PATENTEN

MBH—COLOGNE, GERMANY (\*)

Machine gun 1,032,413 16 July 1912 (Knotgen)

Automatic machine gun 1,005,759 11 Mar 1913 (Knotgen)

Automatic firearm 1,114,150 20 Oct 1914 (Knotgen)

GILES, JULIAN A.—DERBY, CONN.

Non-recoil gun 1,394,490 18 Oct 1921 (Assigned to the General Ordnance Co.)

GLENN L. MARTIN CO.—BALTIMORE, MD. (\*)

Machine gun feed 2,428,414 7 Oct 1947 (Elliott)

GOEBEL, B.—LIEGE, BELGIUM

Semi-automatic firearm with cylindrical breech 909,398 12 Jan 1909

- GOEPFRICH, GEORGE A.—SOUTH BEND, IND.  
 Gun charging mechanism 2,413,104 24 Dec 1946 (Assigned to Bendix Aviation Corp.)  
 Gun charger 2,408,624 1 Oct 1946
- GORTON, WALTER T.—SPRINGFIELD, MASS.  
 Buffer mechanism for machine guns 1,561,713 17 Nov 1925  
 Machine gun 1,625,993 26 Apr 1927  
 Machine gun 1,625,994 26 Apr 1927  
 Machine gun 1,498,542 24 June 1924  
 Combined barrel support and flash hider for guns 1,538,243 19 May 1925  
 Automatic firearm 2,352,193 27 June 1944
- GRANT, HARRY C., JR.—NEW YORK, N.Y.  
 Gun charger 2,409,623 22 Oct 1946 (Assigned to Specialties Development Corp.)
- GRAY, WILLIS R.—OAKTON, VA.  
 Silencer for firearms 1,066,898 8 July 1913
- GREEN, SAMUEL G.—GRAY, GA.  
 Electrically controlled mechanism for firearms 1,352,891 14 Sep 1920  
 Attachment for preventing the feeding of ball cartridges to a gun 1,354,825 5 Oct 1920  
 Attachment for gas-operated guns 1,445,583 13 Feb 1923 (Assigned to United States Ord. Co.)  
 Machine gun unit 1,689,482 30 Oct 1928  
 Water jacket for machine guns 1,963,086 19 Jun 1931  
 Gun barrel and barrel mounting 1,980,399 13 Nov 1934  
 Packed joint for guns 2,026,528 7 Jan 1936  
 Trigger mechanism for machine guns 2,069,244 2 Feb 1937  
 Cartridge feeding mechanism for automatic guns 2,073,632 16 Mar 1937  
 Muzzle attachment for guns 2,101,063 7 Dec 1937  
 Stabilizer for guns 2,101,848 14 Dec 1937  
 Muzzle attachment for guns 2,101,849 14 Dec 1937  
 Muzzle attachment for guns 2,101,850 14 Dec 1937  
 Machine gun jacket mounting 2,101,851 14 Dec 1937  
 Bolt operating mechanism for machine guns 2,104,033 4 Jan 1938  
 Back plate latch for machine guns 2,108,060 15 Feb 1938  
 Trigger for machine guns 2,119,536 7 Jun 1938  
 Gland adjusting mechanism 2,121,030 21 Jun 1938  
 Recoil check and barrel accelerator for a machine gun 2,128,243 30 Aug 1938  
 Muzzle attachment for guns 2,128,936 6 Sep 1938  
 Muzzle attachment for guns 2,150,161 14 Mar 1939  
 Machine gun structure 2,186,969 16 Jan 1940  
 Back plate and driving spring for machine guns 2,321,592 15 Jun 1943 (Green & Hopkins)  
 Gun barrel mounting 2,326,139 10 Aug 1943  
 Back plate latch mechanism for machine guns 2,335,854 7 Dec 1943  
 Flash hider 2,339,777 25 Jan 1944  
 Barrel mounting 2,345,596 4 Apr 1944  
 Stabilizer for guns 2,351,037 13 Jun 1944  
 Recoil check and barrel accelerator for automatic weapons 2,362,996 21 Nov 1944  
 Speed regulator for automatic guns 2,382,411 14 Aug 1945  
 Gun feed mechanism 2,405,207 6 Aug 1946
- GREENSTEIN, ADOLPH—WESTON, W.VA. (\*)  
 Magazine gun with pneumatically operated magazine 444,666 13 Jan 1891 (Dinsmore)
- GREER, JOHN WILLIAM—AUSTIN, TEX.  
 Machine gun 431,515 1 July 1890
- GREGG, CLARENCE—PITT BRIDGE, TEX.  
 Machine gun 1,277,307 2 Aug 1918
- GRIFFITHS, WILLIAM—LONDON, ENGLAND  
 Recoil-operated gun 512,437 9 Jan 1894 (Woodgate & Griffiths)
- GRILL, CALVIN E.—SAN FRANCISCO, CALIF.  
 Automatic gun 1,617,683 15 Feb 1927
- GURNEY, J.—NEW YORK, N.Y. (\*)  
 Improvement in breech-loading ordnance 34,025 24 Dec 1861 (De Brame)  
 Improvement in revolving ordnance 34,024 24 Dec 1861 (De Brame)
- GUSTAVO, VINCON—TURIN, ITALY  
 Automatic firearm 1,484,163 19 Feb 1924
- HAGEN, RUDOLF A.—MASON CITY, IOWA  
 Machine gun 1,653,171 20 Dec 1927
- HALETT, DELBERT—GALVESTON, TEX. (\*)  
 Machine gun 1,869,738 2 Aug 1932 (Davis)
- HALL, EUGENE ADELBERT—WEST BAY CITY, MICH.  
 Recoil-operated firearm 830,226 4 Sep 1906
- HALL AUTOMATIC FIRE ARMS SYND., LTD.—LONDON, ENGLAND (\*)  
 Recoil-operated firearms 755,482 22 Mar 1904 (Hallé)  
 Automatic firearm 753,700 1 Mar 1904 (Hallé)
- HALL, CLIFFORD R. S. J.—HAMPTON WICK, ENGLAND  
 Recoil-operated firearm 755,482 22 Mar 1904 (Assigned to the Hallé Automatic Firearms Syndicate, Ltd.)  
 Automatic firearms 753,700 1 Mar 1904 (Assigned to Hallé Automatic Firearms Syn., Ltd.)  
 Automatic firearms 1,010,899 5 Dec 1911
- HAMILTON, L. M.—PARIS, FRANCE  
 Means for cooling machine guns 1,527,585 24 Feb 1925 (Hamilton, Joly & Pullock)
- HAMMOND, GRANT—HARTFORD, CONN.  
 Automatic gun 954,797 12 Apr 1910 (Assigned 1/2 to Darlington)  
 Automatic gun 954,798 12 Apr 1910 (Assigned to Darlington)  
 Automatic gun 954,799 12 Apr 1910
- HANSEN, OLE—CHOATE, MICH. (\*)  
 Gas-operated firearm 532,380 8 Jan 1895 (Johnson)
- HANSEN, SERN L.—NORTHFIELD, OHIO  
 Rapid-fire gun 2,374,816 1 May 1945
- HARDY, MOSES F.—SEWARD, N.Y.  
 Improvement in revolving ordnance 36,148 12 Aug 1862



- HARE, D. O.—CHARLESTOWN, ILL. (\*)**  
Improvement in repeating ordnance 12,295 23 Jan 1855 (Hoffman)
- HARPER, ANGELO C.—WASHINGTON, D.C.**  
Machine gun 1,369,426 22 Feb 1921
- HARRING, HARRY K.—WASHINGTON, D.C.**  
Machine gun 1,698,228 8 Jan 1929 (Assigned 2/3 to Morgan R. Mills)
- HARRINGTON & RICHARDSON ARMS COMPANY—WORCESTER, MASS. (\*)**  
Recoil operated firearm 812,015 6 Feb 1906 (Bye)  
Safety device for firearms 2,495,383 24 Jan 1950 (Mulno)
- HARVEY, EARLE M.—SPRINGFIELD, MASS.**  
Automatic firearm 2,397,963 9 Apr 1946
- HASKELL, GEORGE D.—CONCORD, MASS.**  
Machine gun 1,379,339 24 May 1921 (Assigned to United States Ordnance Co.)  
Machine gun 1,453,974 1 May 1923 (Dawson, Buckham & Haskell) (Assigned to Vickers, Ltd.)
- HATCHER, JAMES L.—WINCHESTER, VA.**  
Gun 1,744,162 2 Jan 1930  
Apparatus for rifling gun barrels 1,789,308 20 Jan 1931  
Belt-feed mechanism for machine guns 1,808,847 9 June 1931  
Bolt-operating mechanism for machine guns 1,858,498 17 May 1932
- HAUFF, ALBERT—BERLIN, GERMANY**  
Recoil-operated firearm 545,496 3 Sep 1895
- HAUBROE, WERNER CHRISTIAN LASSEN—COPENHAGEN, DENMARK**  
Machine gun with exchangeable barrels 1,588,887 15 June 1926
- HAYN, GEORG—ESSEN-ON-THE-RUHR, GERMANY**  
Recoil gun barrel 913,403 23 Feb 1909
- HAZELTON, GEORGE—LONDON, ENGLAND**  
Machine gun 1,339,390 11 May 1920  
Machine gun 1,447,246 6 Mar 1923 (Assigned to Vickers Ltd.)  
Machine gun 1,479,138 1 Jan 1924 (Assigned to Vickers Ltd.)
- HEDGES, ELLSWORTH C.—WEST HARTFORD, CONN.**  
Bolt mechanism for machine guns 2,529,391 7 Nov 1950 (Assigned to Colt's Manufacturing Co.)
- HEDRICK, FLOYD C.—KENTLAND, IND.**  
Automatic firearm 1,249,622 11 Dec 1917
- HEDRICK, JAMES H.—WYTHE COUNTY, VA.**  
Improvement in repeating cannons 110,233 20 Dec 1870 (Assigned to Barrett)
- HEINEMANN, KARL—BERLIN, GERMANY**  
Trigger mechanism for machine guns 905,071 24 Nov 1908 (Assigned to Deutsche Waffen und Munitionsfabriken)
- Automatic gun 1,045,549 26 Nov 1912 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,087,371 17 Feb 1914 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Automatic gun 1,114,611 20 Oct 1914 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,123,530 5 Jan 1915 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,128,310 16 Feb 1915 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,150,364 17 Aug 1915 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,155,061 28 Sep 1915 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Machine gun 1,167,498 11 Jan 1916 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Automatic firearm 1,725,272 20 Aug 1929 (Assigned to Deutsche Waffen und Munitionsfabriken)  
Automatic firearm 1,825,904 6 Oct 1931 (Assigned to Deutsche Waffen und Munitionsfabriken)
- HEIZLER, EDWARD J.—WEST CLADWELL, N.J.**  
Gun charger 2,411,877 3 Dec 1946 (Assigned to Specialties Development Corp.)
- HELLBERG, HELDGE—COVENTRY, ENGLAND**  
Feed mechanism for automatic guns 1,298,091 25 Mar 1919 (Redpath & Hellberg) (Assigned to Coventry Ordnance Works)
- HANDLEY, JAMES A.—MIDDLETOWN, CONN.**  
Cartridge feed-belt for machine guns 2,422,898 24 June 1947 (Assigned to Russell Mfg. Co.)
- HENCKEL, AAGE F. C.—HELLERUP, DENMARK**  
Cartridge feeder and cartridge feeder dog for automatic firearms 2,499,583 7 Mar 1950
- HENNEVELD, JACOBUS—LAANDAM, NETHERLANDS**  
Cartridge belt for machine guns 1,136,956 27 Apr 1915 (Henneveld & Lemei)
- HENNICK, DANIEL G.—MITCHELL, ONTARIO, CANADA**  
Automatic firearm 1,004,424 26 Sep 1911
- HENNING, HERMANN—BERLIN, GERMANY**  
Automatic gun 2,202,201 28 May 1940 (Assigned to Rheinmetall-Borsig Aktiengesellschaft)
- HEPBURN, LOUIS L.—NEW HAVEN, CONN.**  
Repeating firearm 882,561 24 Mar 1908 (Assigned to Marlin Fire Arms Co.)
- HEPPERT, ERWIN—ZÜRICH, SWITZERLAND**  
Automatic firearm 2,380,455 31 Jul 1945 (Lippert & Hepperle)  
Automatic firearm breech bolt locking mechanism 2,523,704 26 Sep 1950 (Lippert & Hepperle) (Assigned to Oerlikon Co.)  
Trigger mechanism for automatic firearms 2,524,258 3 Oct 1950 (Assigned to Oerlikon Co.)

- HERAPH, S. H.—ST. LOUIS, MO. (\*)**  
Improvement in repeating ordnance 29,437 31 July 1860 (Matthews)
- HERLACH, FRITZ—DUSSELDORF, GERMANY**  
Automatic firearm 1,709,399 16 Apr 1929 (Herlach & Rakula) (Assigned to Rheinische Metallwaren und Maschinenfabrik)  
Automatic firearm with two cartridge magazines 1,784,355 9 Dec 1930 (Herlach & Rakula) (Assigned to Rheinische Metallwaren und Maschinenfabrik)  
Automatic gun 2,067,322 12 Jan 1937 (Herlach & Rakula) (Assigned to Waffenfabrik Solothurn A.G.)  
Automatic firearm 1,746,471 11 Feb 1930 (Herlach & Rakula) (Assigned to Rheinische Metallwaren und Maschinenfabrik)  
Automatic firearm 2,015,908 1 Oct 1935 (Rakula & Herlach) (Assigned to Waffenfabrik Solothurn A.G.)
- HERLACH, HEINRICH—BERLIN, GERMANY**  
Gun that fires during forward movement of the gun 2,218,887 22 Oct 1940 (Ernesti & Herlach) (Assigned to Rheinmetall-Borsig Aktiengesellschaft)  
Automatic gun 2,230,328 4 Feb 1941 (Krum & Herlach) (Assigned to Rheinmetall-Borsig)
- HERMAN, HENRY—LOUISVILLE, MISS. (\*)**  
Machine gun 282,787 7 Aug 1883 (Shields)
- HERMSDORF, MAX—ESSEN-ON-THE-RUHR, GERMANY**  
Barrel-recoil gun with wedge breechblock 842,547 29 Jan 1907 (Assigned to Fried. Krupp Aktiengesellschaft)  
Barrel-recoil gun 911,818 9 Feb 1909 (Assigned to Fried. Krupp Aktiengesellschaft)
- HIGH STANDARD MFG. CORP.—NEW HAVEN, CONN. (\*)**  
Self-loading repeating firearm 2,342,824 29 Feb 1944 (Swebilius)  
Self-loading repeating firearm 2,365,307 19 Dec 1944 (Swebilius)  
Belt-holding pawls for machine guns 2,392,012 1 Jan 1946 (Swebilius)  
Extractor switch mechanism for machine guns 2,404,325 16 July 1946 (Swebilius)
- HIGSON, PERCY REUBEN—WESTMINSTER, ENGLAND**  
Gas-operated machine gun & Automatic small arm 1,811,693 23 June 1931 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Drum magazine for machine guns and automatic small arms 1,811,694 23 June 1931 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Machine gun and automatic small arms 1,846,035 9 Feb 1932 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Machine gun 2,013,312 3 Sep 1935 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Machine gun 2,048,395 21 July 1936 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Machine gun 2,037,244 14 Apr 1936 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)
- Machine gun & drum 2,113,793 12 Apr 1938 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Machine gun and automatic small arm 2,137,612 22 Nov 1938 (Larsson & Higson) (Assigned to Vickers Armstrong Ltd.)  
Automatic gun 2,347,559 25 Apr 1944 (Assigned to Vickers Armstrong Ltd.)  
Double-barreled automatic gun 2,509,734 30 May 1950 (Assigned to Vickers-Armstrong Ltd.)
- HILL, ARTHUR HENRY—BIRMINGHAM, ENGLAND**  
Automatic rifle 867,960 15 Oct 1907 (Farquhar & Hill)  
Automatic firearm 920,301 4 May 1909 (Farquhar & Hill)  
Automatic firearm 1,019,620 5 Mar 1912 (Farquhar & Hill)  
Cartridge magazine for rifles and machine guns 1,337,893 20 Apr 1920 (Farquhar & Hill)  
Automatic firearm 1,350,961 24 Aug 1920 (Farquhar & Hill)  
Automatic firearm 1,353,736 21 Sep 1920 (Farquhar & Hill)
- HODGES, LLOYD E.—GLENORA, CALIF.**  
Machine gun 1,399,119 6 Dec 1921
- HOFFMAN, SAMUEL—CHARLESTON, ILL.**  
Improvement in repeating cannons 12,295 23 Jan 1855 (Assigned to Hare, D. O.)
- HOLEK, EMANUEL—BRUNN, CZECHOSLOVAKIA**  
Gas-pressure regulator device for firearms 1,802,816 28 Apr 1931 (Assigned to Ceskoslovenska Zbrojovka Akciová Společnost V. Brne)
- HOLEK, VACLAV—BRUNN, CZECHOSLOVAKIA**  
Automatic firearm 2,146,185 7 Feb 1939 (Assigned to Ceskoslovenska Zbrojovka)  
Automatic firearm 2,223,004 26 Nov 1940 (Assigned to Ceskoslovenska Zbrojovka)  
Automatic firearm 2,267,501 23 Dec 1941 (Assigned to Ceskoslovenska Zbrojovka)  
Automatic firearm 2,093,169 14 Sep 1937 (Assigned to Ceskoslovenska Zbrojovka)  
Automatic firearm 2,115,526 26 Apr 1938 (Assigned to Ceskoslovenska Zbrojovka)
- HOLLINGSWORTH, J.—ZANESVILLE, OHIO (\*)**  
Firearm, Self-cocking revolving 39,825 8 Sep 1863 (Mershon)
- HOOHAM, GEORGE—BIRMINGHAM, ENGLAND**  
Automatic gun 621,085 14 Mar 1899
- HOPKINS, EDWARD W.—ENFIELD, CONN.**  
Back plate and driving spring for machine guns 2,321,592 15 Jun 1943 (Green & Hopkins)
- HOPPERT, FILSER D.—SPRINGFIELD, MASS.**  
Machine gun 2,108,817 22 Feb 1938 (Hoppert, Bull & Simpson)



**HORAN, TIMOTHY F.—NEW HAVEN, CONN.**

Automatic firearm 2,341,780 15 Feb 1944  
 Automatic firearm 2,357,047 29 Aug 1944 (Assigned to  
 Savage Arms Corp.)  
 Cartridge feeding mechanism for repeating firearms  
 2,422,301 17 June 1947

**HORNE, GEORGE A.—SYRACUSE, N.Y.**

Recoil-operated firearm 690,955 14 Jan 1902

**HORTON, WINTHROP S.—FARMINGDALE, N.Y.**

Gun synchronizer 1,848,720 8 Mar 1932 (Assigned to  
 Fairchild Aviation Corp.)

**HOTCHKISS, BENJAMIN B.—NEW YORK, N.Y.**

Machine gun 10,280 6 Feb 1883  
 Metallic cartridge 98,278 28 Dec 1869 (Leet, C. D.)  
 Breech-loading firearm 99,898 15 Feb 1870  
 Machine gun or battery gun 103,501 13 Aug 1872  
 Machine gun 211,737 28 Jan 1879  
 Machine gun 211,849 4 Feb 1879  
 Machine gun 253,924 21 Feb 1882

**HOTCHKISS ET CIE (FRANCE) See SOCIETE ANONYME DES ANCIENS  
ETABLISSEMENTS HOTCHKISS & CIE.****HOTCHKISS ORDNANCE CO. LTD.—LONDON, ENGLAND (\*)**

Automatic machine gun 563,043 14 July 1896 (Benét &  
 Mercié)  
 Gas-operated gun 588,380 17 Aug 1897 (Benét & Mercié)

**HOWIE, JAMES F.—SEATTLE, WASH.**

Centrifugal gun 1,235,897 7 Aug 1917

**HUDSON, ROBERT F.—RICHMOND, VA.**

Machine gun 1,386,872 9 Aug 1921  
 Machine gun 1,749,137 4 Mar 1930 (Assigned to Auto-  
 matic Guns Inc.)  
 Machine guns 1,786,207 23 Dec 1930 (Assigned to Auto-  
 matic Guns Inc.)  
 Automatic gun 2,112,660 29 Mar 1938

**HUGHES, CHARLES F.—VANCOUVER, BRITISH COLUMBIA, CANADA**

Automatic firearm 1,190,653 12 Apr 1916

**HUGHES, ROBERT H. S.—BALTIMORE, MD.**

Recoil control for firearms 2,184,595 26 Dec 1939 (As-  
 signed to Roberts, M.)

**HUGHES, WILLIAM O.—PINKSTAFF, ILL.**

Machine gun 662,761 27 Nov 1900 (Hughes & Bowman)

**HUMESTON, FREDERICK L.—HAMDEN, CONN.**

Gas-operated actuating mechanism for firearms 2,340,962  
 8 Feb 1944 (Assigned to Western Cartridge Co.)

**HUNTLEY, STEPHEN A.—SIOUX CITY, IOWA**

Automatic firearm 747,073 15 Dec 1903 (Assigned to  
 Spatz & Conly)

**IDE, CHARLES E.—REDLANDS, CALIF. (\*)**

Automatic firearms 1,028,884 11 June 1912 (Johnson)

**INTERCONTINENTAL CO.—CALIF. (\*)**

Centrifugal gun 1,311,465 29 July 1919 (Saliger)  
 Centrifugal gun 1,311,492 29 July 1919 (Bullard)

**INTERSTATE AIRCRAFT & ENGINEERING CORP.—CALIF. (\*)**

Remote control gun charger 2,397,507 2 Apr 1946  
 (Roberts)

**ITHOMITIS, APOSTOLOS C.—RAYMOND, WASH.**

Automatic firearm 1,442,951 23 Jan 1923

**JAESCHKE, ERNST—HAMBURG, GERMANY**

Lateral dispersion device for machine guns 1,413,936 25  
 Apr 1922 (Rauchfuss & Jaeschke)

**JAGGARD, WILLIAM R.—HYTHE, ENGLAND**

Air-cooled gun 2,337,840 28 Dec 1943 (Scott-Paine &  
 Jaggard)

**JANECEK, FRANTISEK—PRAGUE, CZECHOSLOVAKIA**

Machine gun 1,747,546 18 Feb 1930  
 Automatic firearm 2,270,683 20 Jan 1942

**JERVEY, THOMAS M.—WASHINGTON, D.C.**

Automatic gun 1,651,128 29 Nov 1927

**JETER, EDMOND W.—ATLANTA, GA.**

Machine gun 664,952 1 Jan 1901 (Assigned 2/3 to Black-  
 burn, Spilman & Bickart)

**JOHNSON, CHRIST—WAUSAU, WIS.**

Gas-operated firearm 532,380 8 Jan 1895 (Assigned 9/20  
 to Ole Hansen)

**JOHNSON, CLIFFORD E.—DAYTON, OHIO**

Gun cocking device 2,386,801 16 Oct 1945 (Johnson &  
 Elliott)

**JOHNSON, MARY E.—FITCHBURG, MASS. (\*)**

Automatic gun 499,259 23 May 1911 (Cobb)

**JOHNSON, MELVIN M., JR.—BROOKLINE, MASS.**

Automatic firearm 2,215,470 24 Sep 1940 (Assigned to  
 Johnson & Rice)  
 Automatic gun 2,383,487 28 Aug 1945 (Assigned to  
 Johnson & Rice)  
 Automatic firearm 2,409,569 15 Oct 1946 (Assigned to  
 Johnson & Rice)

**JOHNSON, QUINTON C.—GARDENA, CALIF.**

Gun blast seal 2,514,495 11 Jul 1950 (Assigned to North  
 American Aviation, Inc.)

**JOHNSON, THOMAS C.—NEW HAVEN, CONN.**

Automatic firearm 681,481 27 Aug 1901 (Assigned to  
 Winchester Repeating Arms Co.)  
 Automatic firearm 694,157 25 Feb 1902 (Assigned to  
 Winchester Repeating Arms Co.)  
 Recoil-operated firearm 768,665 30 Aug 1904 (Assigned  
 to Winchester Repeating Arms Co.)  
 Locking block for automatic guns 760,871 24 May 1904  
 (Assigned to Winchester Repeating Arms Co.)  
 Recoiling-barrel firearm 945,328 4 Jan 1910 (Assigned to  
 Winchester Repeating Arms Co.)  
 Recoiling-barrel gun 946,134 11 Jan 1910 (Assigned to  
 Winchester Repeating Arms Co.)

**JOHNSTON, JAMES S.—UTICA, N.Y.**

Machine gun 1,335,939 6 Apr 1920  
 Machine gun 1,328,230 13 Jan 1920

- Gas delay for firearms 1,387,889 16 Aug 1921  
 Cartridge magazine for machine guns 1,447,860 6 Mar 1923  
 Cocking mechanism for automatic machine guns 1,447,861 6 Mar 1923  
 Machine gun 1,485,460 4 Mar 1924
- JOHNSTON, MILLARD L.—UTICA, N.Y.  
 Cooler for firearms 1,296,193 4 Mar 1919  
 Actuator for machine guns 1,452,465 17 Apr 1923  
 Cartridge mechanism for machine guns 1,460,800 3 July 1923
- JOHNSON, IVAR—REDLANDS, CALIF.  
 Automatic firearm 1,028,884 11 June 1912 (Assigned 1/2 to Ide, Charles E.)
- JOLY, CHARLES LEVQUE—NEW YORK, N.Y.  
 Means for cooling machine guns 1,527,585 24 Feb 1925 (Hamilton, Joly & Pullock)
- JORGENSEN, BERNHARDT—MARBLEHEAD, MASS.  
 Gun loading mechanism 2,425,425 12 Aug 1947 (Assigned to United Shoe Machinery Corp.)
- JORGENSEN, ERIC—KONGSBERG, NORWAY  
 Straight pull breech bolt for firearms 502,727 8 Aug 1893 (Krag & Jorgensen)
- JOSLIN, WILLIAM—CLEVELAND, OHIO  
 Improvement in centrifugal guns 24,031 17 May 1859
- JUHASZ, ELEK B.—LEBANON, PA.  
 Automatic concealed firearm for self defense 1,726,228 27 Aug 1929
- JUSSELIN, LEON—MOREAUVILLE, LA.  
 Machine gun 861,467 30 July 1907
- KAUCH, ROBERT—DAYTON, OHIO  
 Machine gun synchronizer 1,592,500 13 July 1926 (Paulus & Kauch)
- KEHNE, KARL—BERLIN, GERMANY  
 Cocking device for automatic firearms having a sliding barrel and a bolted breech 2,056,577 6 Oct 1936  
 Gun having sliding and interchangeable barrels 2,345,127 28 Mar 1944
- KENNEY, CHARLES H.—NEW LONDON, CONN.  
 Silencer for firearms 1,017,003 13 Feb 1912
- KEWISH, JOHN T.—NEW YORK, N.Y.  
 Machine gun 1,472,126 30 Oct 1923 (Assigned 1/2 to Garand, John C.)  
 Automatic firearm 1,563,751 1 Dec 1925  
 Automatic firearm 1,587,003 1 June 1926  
 Automatic firearm 1,696,537 25 Dec 1928  
 Automatic firearm 1,993,887 12 Mar 1935
- KEY, MINTER P.—MEMPHIS, TENN.  
 Machine gun 241,671 17 May 1881
- KILGORE MFG. CO.—WESTERVILLE, OHIO (\*)  
 Machine gun 2,039,930 5 May 1936 (Rickenbacher)
- KIMBALL, WILLIAM W.—WASHINGTON, D.C.  
 Recoil-operated bolt gun 554,068 4 Feb 1896
- KING, WILLIS L.—APRONAUG, R.I.  
 Automatic firearm 515,526 27 Feb 1894 (Assigned to self & Potter, Louis K.)
- KINNE, GEORGE O.—HARTFORD, CONN.  
 Improvement in operating machine guns 120,588 7 Nov 1871 (Assigned to Colt's Patent Fire Arms Mfg. Co.)
- KINSMAN, FRANK E.—PLAINFIELD, N.J.  
 Electric firearm 317,545 12 May 1885
- KIRALY, PAUL VON—BUDAPEST, AUSTRIA-HUNGARY  
 Automatic breech-loading firearm 1,073,908 23 Sep 1913 (Kiraly & Lovasz)  
 Automatic or repeating firearm 2,325,484 27 July 1943 (Kiraly & Kucher) (Assigned to Alien Property Custodian)
- KJELLMAN, RUDOLF HENRIK—STOCKHOLM, SWEDEN  
 Automatic firearm 680,488 13 Aug 1901 (Kjellman & Andersson) (Assigned to Aktiebolaget Automatgevar)  
 Automatic firearm 690,739 7 Jan 1902 (Kjellman & Andersson) (Assigned to Aktiebolaget Automatgevar)  
 Recoil-operated firearm 765,491 19 July 1904 (Assigned to Aktiebolaget Stockholms Vapenfabrik)  
 Automatic firearm 814,547 6 Mar 1906 (Assigned to Aktiebolaget Stockholms Vapenfabrik)  
 Automatic firearm 1,040,692 8 Oct 1912 (Assigned to Aktiebolaget Stockholms Vapenfabrik)
- KLEIE, CURT—DUSSELDORF, GERMANY  
 Gun with long recoil 1,151,476 14 Aug 1915 (Assigned to Rheinische Metallwaren und Maschinenfabrik)
- KNORR-BREMSE A. G.—BERLIN, GERMANY (\*)  
 Gas-operating loading device 2,119,169 31 May 1938 (Lauf)
- KNÖTGEN, MATHIAS—COLOGNE, GERMANY  
 Automatic firearm with stationary barrel 993,175 23 May 1911  
 Machine gun 1,032,413 16 July 1912 (Assigned to Gesellschaft zur Verwaltung von Feuerwaffen Patenten m.b.H.)  
 Automatic machine gun 1,005,759 11 Mar 1913 (Assigned to Gesellschaft zur Verwaltung von Feuerwaffen Patenten)  
 Automatic firearm 1,114,150 20 Oct 1914 (Assigned to Gesellschaft zur Verwaltung von Feuerwaffen Patenten)
- KNOTTS, ADDISON BURGESS—RAMOS, LA.  
 Means for operating machine gun 1,179,635 18 Apr 1916  
 Means for operating machine gun 1,198,557 19 Sep 1916
- KNOUS, FRANKLIN H.—NEW HAVEN, CONN.  
 Automatic firearm 933,254 7 Sep 1909 (Assigned to Winchester Repeating Arms Co.)
- KNOWLES, WILLIAM H.—HARTFORD, CONN.  
 Recoil-operated automatic firearm 829,163 21 Aug 1906
- KOBER, FERDINAND—ALLENTOWN, PA.  
 Machine gun 771,019 27 Sep 1904



**KOCH, NORBERT—ESSEN-ON-THE-RUHR, GERMANY**

Barrel recoil gun 913,403 23 Feb 1909

**KOUCHER, JOZSEF—BUDAPEST, HUNGARY**Automatic or repeating firearm 2,325,484 27 July 1943  
(Alien Property Custodian)**KOUCKY, JOSEF—PRAGUE, CZECHOSLOVAKIA**

Automatic firearm 2,351,976 20 Jun 1944

Inertia member for retarding breechblock movement in automatic firearms 2,495,460 24 Jan 1950 (Assigned to Zbrojovka Brno Narodni Podnik)

Cartridge feeding means for automatic firearms 2,519,582 22 Aug 1950 (Assigned to Zbrojovka Brno Narodni Podnik)

**KOZURIK, OSKAR VON—VIENNA, AUSTRIA**

Machine gun 2,147,003 14 Feb 1939 (Assigned to Latscher-Latka &amp; Beck-Rzikowsky)

**KRAG, OLE HERMAN—KONGSBERG, NORWAY**Straight-pull breech bolt for firearms 502,727 8 Aug 1893  
(Kraig & Jorgensen)

Automatic repeating firearm 954,441 12 Apr 1910

**KRNKA, CHARLES—VIENNA, AUSTRIA-HUNGARY**

Automatic firearm 676,995 25 June 1901 (Roth &amp; Krnka)

Automatic firearm 683,072 24 Sep 1901 (Roth &amp; Krnka)

**KRNKA, KARL—PRAGUE, AUSTRIA-HUNGARY**

Revolving magazine firearm 459,874 22 Sep 1891

Straight-pull breech loading gun 441,673 2 Dec 1890  
(K. & S. Krnka) (Assigned to Krnka Repeating Rifle Co. Ltd.)

Recoil-operated firearm 634,913 17 Oct 1899 (Roth &amp; Krnka)

Automatic firearm 975,256 8 Nov 1910

Automatic firearm 1,018,914 27 Feb 1912

Automatic firearm 1,166,913 4 Jan 1916

**KRNKA REPEATING ARMS CO. LTD.—LONDON, ENGLAND (\*)**Straight-pull breech loading gun 441,673 2 Dec 1890  
(Silvester & Karl Krnka)**KRNKA, SILVESTER—PRAGUE, AUSTRIA-HUNGARY**Gun, straight-pull breech loading 441,673 2 Dec 1890  
(Silvester & Karl Krnka) (Assigned to Krnka Repeating Rifle Co. Ltd.)**KRUM, ALFRED—BERLIN, GERMANY**Automatic gun 2,230,328 4 Feb 1941 (Krum & Herlach)  
(Assigned to Rheinmetall-Borsig Aktiengesellschaft)**KRUPP, FRIED., A. G. See FRIED. KRUPP A. G.****KRZYZANOWSKI, THEODORE R.—PHILADELPHIA, PA.**

Antiaircraft gun 1,297,699 18 March 1919 (Assigned 1/10 to Gliwski, Frank and 1/2 to Pinder, S. S.)

**KÜNG, ALBERT—ZÜRICH, SWITZERLAND**

Automatic gun 1,556,225 6 Oct 1925 (Assigned to Werkzeug-Maschinenfabrik Oerlikon)

**LAHTI, AIMO JOHANNES—JYVASKYLA, FINLAND**

Automatic firearm 1,895,719 31 Jan 1933

Machine gun 1,987,939 15 Jan 1935

**LAIRD, CHARLES WILLIAM—LONDON, ENGLAND**

Cartridge belt 1,150,435 17 Aug 1915 (Laird, Menteyne and Degaille)

**LALOIX, RENE—BRUSSELS, BELGIUM**

Automatic rapid-fire gun 2,136,512 15 Nov 1938

Barrel fastening means 2,121,171 21 June 1938

Automatic repeating gun 2,017,283 15 Oct 1935

Machine gun 2,115,861 3 May 1938

Machine gun 2,141,537 27 Dec 1938

**LARSSON, CARL ALFRED—LONDON, ENGLAND**

Automatic gun 1,468,262 18 Sep 1923 (Dawson, Buckham &amp; Larsson) (Assigned to Vickers)

Automatic gun 1,553,992 15 Sep 1925 (Dawson, Buckham &amp; Larsson) (Assigned to Vickers)

Articulated link for the cartridge belts of machine guns 1,550,787 25 Aug 1925 (Dawson, Buckham &amp; Larsson) (Assigned to Vickers)

Gas-operated machine gun and automatic small arm 1,811,693 (Larsson &amp; Higson) (Vickers)

Drum magazine for machine guns and automatic small arms 1,811,694 23 June 1931 (Larsson &amp; Higson) (Assigned to Vickers Armstrong Ltd.)

Machine gun and automatic small arms 1,846,035 9 Feb 1932 (Larsson &amp; Higson) (Vickers)

Machine gun 2,013,312 3 Sep 1935 (Larsson &amp; Higson) (Assigned to Vickers)

Machine gun 2,048,395 21 July 1936 (Larsson &amp; Higson) (Assigned to Vickers)

Machine gun 2,037,244 14 April 1936 (Larsson &amp; Higson) (Assigned to Vickers)

Machine gun and magazine therefor 2,113,793 12 April 1938 (Larsson &amp; Higson) (Assigned to Vickers)

**LAUBER, OTTO—ESSEN-ON-THE-RUHR, GERMANY**

Recoil gun 809,821 9 Jan 1906 (Assigned to Fried. Krupp Aktiengesellschaft)

Recoil gun 923,051 25 May 1909 (Lauber &amp; Bominghaus) (Assigned to same)

**LAUF, HANS—BERLIN, GERMANY**

Gas-operating loading device 2,119,169 31 May 1938 (Assigned to Knorr-Bremse)

**LEE, JAMES P.—ILION, N.Y.**

Gun, straight-pull bolt 506,319 10 Oct 1893

Gun, straight-pull bolt 506,320 10 Oct 1893

Gun, straight-pull bolt 506,321 10 Oct 1893

**LEE, JAMES PARIS—HARTFORD, CONN. (\*)**

Gun, straight-pull bolt 506,339 10 Oct 1893 (Richards)

**LEET, C. D.—VIENNA, AUSTRIA**

Metallic cartridge 98,278 28 Dec 1869 (Hotchkiss)

**LEMEI, ALEXANDER—AMSTERDAM, NETHERLANDS**Cartridge belt for machine guns 1,136,956 27 Apr 1915  
(Henneveld & Lemei)

**LANG, CHARLES WELLINGTON—PHILADELPHIA, PA.**

Rapid-fire gun 1,329,979 3 Feb 1920  
 Rapid-fire gun 1,359,608 23 Nov 1920  
 Cartridge feed mechanism for breech-loading firearms  
 1,359,607 23 Nov 1920

**LEONARD, HARVEY REID—SAN FRANCISCO, CALIF.**

Machine gun 207,747 3 Sep 1878 (Assigned to Abraham  
 Rosenberg)

**LESNICK, ROBERT N.—BROOKLYN, N.Y.**

Gun ammunition magazine 2,364,510 5 Dec 1944 (Ber-  
 tran & Lesnick) (Assigned to Brewster Aeronautical  
 Corp.)

**LEVE, CHARLES—CANNES, FRANCE**

Automatic gun 1,738,439 3 Dec 1929

**LEWIS, ISAAC NEWTON—FORTRESS MONROE, VA.**

Air-cooled automatic firearm 1,004,666 3 Oct 1911  
 Automatic firearm 1,142,896 15 June 1915  
 Gas regulator and trap for automatic gas-operated firearms  
 1,195,693 22 Aug 1916 (Assigned to Automatic Arms  
 Co.)

**LEWIS, JOHN—RAWLINS, WYO. (\*)**

Automatic gun 718,062 8 Jan 1903 (Weed)

**LIEBENFELD, LOUIS—LOUISVILLE, MISS. (\*)**

Machine gun 282,787 7 Aug 1883 (Shields)

**LINDER, FRIEDRICH—DUSSELDORF, GERMANY**

Firearm with exchangeable barrel 2,014,184 10 Sep 1935  
 (Assigned to Rheinische Metallwaren und Maschinen-  
 fabrik)

**LINDSEY, BEN G.—JASPER, TEXAS (\*)**

Machine gun 1,959,737 22 May 1934 (Rigsby)

**LIPPERT, HANNS—ZÜRICH, SWITZERLAND**

Automatic firearm 2,380,455 31 Jul 1945 (Lippert &  
 Hepperle)  
 Automatic firearm breech bolt lock 2,512,027 20 Jun 1950  
 (Lippert and Muhlemann) (Assigned to Oerlikon Co.)  
 Automatic firearm breech bolt locking mechanism 2,523,704  
 26 Sep 1950 (Lippert & Hepperle) (Assigned to  
 Oerlikon Co.)

**LJUNGMAN, J. C. AKTIEBOLAGET. See AKTIEBOLAGET J. C. LJUNG-  
 MAN****LJUTIC, ALBERT V.—VERONA, CALIF.**

Gas-operated automatic rifle 2,456,290 14 Dec 1948

**LOCHHEAD, JOHN L.—SPRINGFIELD, MASS.**

Machine gun 2,205,426 2 Mar 1938  
 Reversible feed mechanism for machine guns 2,504,994 25  
 Apr 1950

**LOCAN, HUMPHREY THOMAS—LONDON, ENGLAND**

Machine gun and the like 1,318,214 7 Oct 1919

**LOMBARD, LEVI W.—MATTAPAN, MASS.**

Centrifugal gun 1,420,660 27 June 1922 (Assigned to  
 Centrifugal Gun Corp.)

**LOUIS, CHARLES W.—SPRINGFIELD, MASS.**

Firearm, Automatic magazine 900,865 13 Oct 1908 (As-  
 signed to Edward R. Buck)

**LOVASZ, JOSEF—BUDAPEST, AUSTRIA-HUNGARY**

Automatic breech-loading firearm 1,073,908 23 Sep 1913  
 (Király & Lovasz)

**LOVELACE, CHARLES D.—FORT WORTH, TEX.**

Recoil gun 922,173 18 May 1909

**LUCAS, OWEN DAVIS—LONDON, ENGLAND**

Machine gun and similar weapon 1,412,252 11 Apr 1922  
 (Martin & Lucas) (Assigned to M. L. Experimental Ltd.)  
 Means for controlling the rate of fire of automatic guns car-  
 ried by aircraft 1,486,909 18 Mar 1924 (Assigned to  
 Vickers Ltd.)

**LUCINANI, JACQUES—PARIS, FRANCE**

Multiple-barrel machine gun 1,319,882 28 Oct 1919 (As-  
 signed to Solms, W. J.)

**LUDORF, ERNST—BERNE, SWITZERLAND**

Machine gun 1,446,388 20 Feb 1923

**LUGER, GEORG—CHARLOTTENBURG, GERMANY**

Recoil-operated firearm 839,778 25 Dec 1906  
 Cartridge having multipart projectiles 926,431 29 June  
 1909  
 Recoil-operated firearm 851,538 23 Apr 1907

**LUTTON, GEORGE E.—KALISPFEL, MONT.**

Automatic rifle 1,886,113 1 Nov 1932

**LYMAN, A. S.—NEW YORK, N.Y.**

Gun, Accelerating 200,740 26 Feb 1878 (Assigned to  
 Accelerating Fire Arms Co.)

**LYTTON, EDWARD—LONDON, ENGLAND**

Firing mechanism for small arms 1,240,068 11 Sep 1917

**M. L. EXPERIMENTAL LTD.—LONDON, ENGLAND (\*)**

Machine gun and similar weapon 1,412,252 11 Apr 1922  
 (Martin & Lucas)

**MAHER, EDMUND—NEW YORK, N.Y.**

Improvement in repeating ordnance 33,813 26 Nov 1861  
 (McCord & Maher)  
 Improvement in repeating firearms 33,167 6 May 1862

**MAILLARD, BERNARD—GENEVA, SWITZERLAND**

Gas piston operated firearm 2,494,889 17 Jan 1950 (As-  
 signed to Brevets Acro-Mecaniques S. A.)  
 Ammunition charging device for automatic arms 2,503,116  
 4 Apr 1950 (Assigned to Brevets Acro-Mecaniques S. A.)  
 Pivoted breech bolt lock 2,522,628 19 Sep 1950 (Assigned  
 to Brevets Acro-Mecaniques S. A.)

**MANCINI, NICCOLO—FLORENCE, ITALY**

Detachable feed belt for automatic firearms 2,016,750 8  
 Oct 1935  
 Automatic firearm 2,016,646 8 Oct 1935

**MANGLE, ST. OMER—BOSTON, MASS.**

Automatic firearm 896,453 18 Aug 1909



**MANNLICHER, FERDINAND RITTER VON—VIENNA, AUSTRIA—HUNGARY**

Feed mechanism for magazine guns 518,821 24 Apr 1894  
 Automatic firearm 581,295 27 Apr 1897  
 Automatic firearm 581,296 27 Apr 1897  
 Automatic firearm 728,739 19 Mar 1903

**MAREK, ANTON—VIENNA, AUSTRIA**

Automatic firearm 1,906,800 2 May 1933 (Assigned to Ceskoslovenska Zbrojovka Akciová Společnost v. Brne)  
 Self-loading firearm 1,960,913 29 May 1934 (Assigned as above)

**MARGA, ULDARIQUE A.—BRUSSELS, BELGIUM**

Automatic firearm 1,456,811 29 May 1923

**MARINER, NORMAN E.—BEVERLY, MASS.**

Magazine for machine guns 2,489,428 29 Nov 1949 (Assigned to United Shoe Machinery Corp.)

**MARLIN FIRE ARMS CO.—NEW HAVEN, CONN. (\*)**

Repeating firearm 882,561 24 Mar 1908 (Hepburn)  
 Automatic firearm 1,402,459 3 Jan 1922 (Swebilius)  
 Automatic gun 1,450,653 3 Apr 1923 (Swebilius)  
 Automatic gun 1,441,890 13 Feb 1923 (Swebilius)  
 Automatic firearm 1,521,730 6 Jan 1925 (Swebilius)  
 Automatic gun 1,565,756 15 Dec 1925 (Rockwell)  
 Automatic firearm 1,550,759 25 Aug 1925 (Swebilius)  
 Automatic firearm 1,550,760 25 Aug 1925 (Swebilius)  
 Automatic gun 1,558,566 27 Oct 1925 (Rockwell)

**MARS AUTOMATIC FIRE ARMS SYND. LTD.—LONDON, ENGLAND (\*)**

Recoil-operated firearm 600,066 1 Mar 1898 (Gabbett-Fairfax)

**MARTIN, HELMUTH PAUL—LONDON, ENGLAND**

Machine gun and similar weapon 1,412,252 11 Apr 1922 (Martin & Lucas) (Assigned to M. L. Experimental Ltd.)

**MARTIN, JAMES—HIGHER DENHAM, ENGLAND**

Cartridge feeding mechanism for automatic cannon 2,522,457 12 Sep 1950

**MARTIN, JOHN—IMPERIAL, CALIF.**

Rapid-firing gun 1,285,765 26 Nov 1918 (Assigned 1/2 to Jose de Barros)

**MARTIN, JOSEPH—LOUISVILLE, KY.**

Machine by which the centrifugal force is controlled in throwing balls and other bodies 1,713 3 Aug 1840

**MARTIN, THOMAS—ST. ETIENNE, FRANCE**

Automatic firearm 935,672 5 Oct 1909

**MARTIN, WILLIAM—SEATTLE, WASH. (\*)**

Gas-operated gun 1,308,016 24 June 1919 (Clark)

**MARTINEAU, JOSEPH A. E.—BRITISH COLUMBIA, CANADA**

Rotary barrel gun 2,406,089 20 Aug 1946

**MARTINEZ-SILVA, LUIS—BOGOTA, COLUMBIA**

Automatic mechanism for firearms 1,233,096 10 July 1917

**MASCARUCCI, GIUSEPPE—TURIN, ITALY**

Automatic firearm with recoiling barrel and without movable breech 1,733,231 29 Oct 1929 (Assigned to Società Anonima Fabbrica Armi-Torino)  
 Device for reducing the rate of fire of automatic firearms 1,771,132 22 July 1930 (Assigned to Società Anonima Fabbrica Armi-Torino)

**MASON, WILLIAM—NEW HAVEN, CONN.**

Magazine for firearms 285,284 18 Sep 1883 (Assigned to Winchester Repeating Arms Co.)  
 Gas-operated gun 525,151 28 Aug 1894 (Assigned to Winchester Repeating Arms Co.)  
 Automatic firearm 695,784 18 Mar 1902 (Bennett & Mason) (Assigned to Winchester Repeating Arms Co.)  
 Gun, Tubular magazine automatic 874,856 24 Dec 1907 (Assigned to Winchester Repeating Arms Co.)  
 Gas-operated gun 877,657 28 Jan 1908 (Assigned to Winchester Repeating Arms Co.)  
 Gas-operated gun 885,166 21 Apr 1908 (Assigned to Winchester Repeating Arms Co.)  
 Automatic firearm 846,591 12 Mar 1907 (Assigned to Winchester Repeating Arms Co.)  
 Automatic firearm 854,707 21 May 1907 (Assigned to Winchester Repeating Arms Co.)

**MATTHEWS, J. A.—ST. LOUIS, MO.**

Improvement in repeating ordnance 29,437 31 July 1860 (Assigned to Heraph)

**MATHEWS, T.—LEWISBURGH, W.VA. (\*)**

Machine gun 130,098 30 July 1872 (Wood)

**MAUSER A. G. See WAFFENFABRIK MAUSER A. G.****MAUSER, PAUL—OBERNDORF, GERMANY**

Breech-loading firearm 78,603 2 June 1868 (Norris & Mauser)  
 Recoil-operated firearm 584,479 15 June 1897  
 Recoil-operated firearm 639,421 19 Dec 1899  
 Automatic gun 1,014,660 16 Jan 1912  
 Ejector device for automatic firearm 1,035,210 13 Aug 1912  
 Automatic firearm 1,091,857 31 Mar 1914  
 Device for automatic firearms for shooting with blanks 1,092,157 7 Apr 1914  
 Automatic firearm 1,107,815 18 Aug 1914  
 Automatic firearm 1,125,578 19 Jan 1915  
 Automatic firearm 1,130,312 2 Mar 1915  
 Automatic firearm 1,131,721 16 Mar 1915  
 Firing mechanism for automatic firearms 1,150,611 17 Aug 1915  
 Rotatable breech bolt for automatic firearms 1,180,784 25 Apr 1916 (Assigned to Waffenfabrik Mauser Aktiengesellschaft)  
 Rotatable lug bolt firearm 1,180,785 25 Apr 1916 (Assigned to Waffenfabrik Mauser Aktiengesellschaft)  
 Firearm 1,217,974 6 Mar 1917 (Assigned to Waffenfabrik Mauser Aktiengesellschaft)  
 Means for combining the barrel with the receiver in connection with firearms 1,234,783 31 July 1917 (Assigned to Waffenfabrik Mauser Aktiengesellschaft)

**MAUSER, WILHELM—WÜRTEMBERG, GERMANY**

Breech-loading firearm 78,603 2 June 1868 (Norris & Mauser)

**MAXIM, HIRAM PERCY—HARTFORD, CONN.**

Silencer for firearm 880,386 25 Feb 1908  
 Silencer for firearm 916,885 30 Mar 1909 (Assigned to Maxim Silent Firearms Co.)  
 Silent firearm 958,934 24 May 1910 (Assigned to Maxim Silent Firearms Co.)  
 Silent firearm 958,935 24 May 1910 (Assigned to Maxim Silent Firearms Co.)  
 Silencer or device 1,018,720 27 Feb 1912 (Assigned to Maxim Silent Firearms Co.)  
 Silencer for guns 1,482,805 5 Feb 1924

**MAXIM, HIRAM STEVENS—LONDON, ENGLAND**

Automatic machine gun 551,779 24 Dec 1895 (Maxim & Silverman)  
 Machine gun 317,161 5 May 1885 (Assigned to Vickers & Symon)  
 Machine gun 319,596 9 June 1885  
 Machine gun 321,513 7 July 1885  
 Machine gun 321,514 7 July 1885  
 Machine gun 367,825 9 Aug 1887  
 Automatic gun 430,210 17 June 1890  
 Machine gun 439,248 28 Oct 1890  
 Machine gun 395,791 8 Jan 1889  
 Automatic machine gun 430,211 17 June 1890  
 Automatic gun 593,228 9 Nov 1897 (Assigned to Maxim-Nordenfelt Guns and Ammunition Co. Ltd.)  
 Automatic gun 436,899 23 Sep 1890  
 Recoil-operated gun 579,401 23 Mar 1897  
 Automatic gas-operated gun 577,485 23 Feb 1897  
 Gas-operated gun 586,362 13 July 1897

**MAXIM MUNITION CORP.—NEW YORK, N.Y. (\*)**

Recoil-operated firearm 1,228,827 5 June 1917 (Saalfeld)

**MAXIM-NORDENFELT GUNS & AMMUNITION CO. LTD.—LONDON, ENGLAND (\*)**

Automatic gun 593,228 9 Nov 1897 (Maxim)  
 Gas-operated automatic gun 577,485 23 Feb 1897 (Maxim)  
 Gas-operated gun 596,362 13 July 1897 (Maxim)

**MAXIM SILENT FIREARMS CO.—NEW YORK, N.Y. (\*)**

Silent firearm 916,885 30 Mar 1909 (Maxim, H. P.)  
 Silent firearm 958,935 24 May 1910 (Maxim, H. P.)  
 Silent firearm 958,935 24 May 1910 (Maxim, H. P.)  
 Silencing device for firearms 1,018,720 27 Feb 1912 (Maxim, H. P.)  
 Gun silencer 2,375,617 8 May 1945 (Bourne)

**MAYALL, THOMAS J.—ROXBURY, MASS.**

Improvement in breech-loading ordnance 30,335 9 Oct 1860  
 Improvement in ordnance 30,742 27 Nov 1860  
 Improvement in ordnance 32,376 21 May 1861

**MCABOY, ISAAC E.—HUNTINGTON, W.VA.**

Automatic rapid-firing gun 566,214 18 Aug 1896

**MCAILLISTER, ALBERT H.—COTTON PLANT, MISS.**

Machine gun 201,810 26 Mar 1878  
 Machine gun 674,811 21 May 1901 (Assigned to McAllister Machine Gun Co.)

**MCAILLISTER MACHINE GUN CO.—MEMPHIS, TENN. (\*)**

Machine gun 674,811 21 May 1901 (McAllister)

**MCCARTY, ROBERT—NEW YORK, N.Y.**

Machine for throwing balls, shot etc. 1,049 31 Dec 1838

**MCCLEAN ARMS & ORDNANCE CO.—CLEVELAND, OHIO (\*)**

Gas-operated automatic firearm 816,591 3 Apr 1906 (McClean)  
 One-pounder machine gun 859,745 2 July 1907 (McClean)

**MCCLEAN, SAMUEL NEAL—CLEVELAND, OHIO**

Gas-actuated magazine gun 785,971 28 Mar 1905  
 Gas-operated gun 785,974 28 Mar 1905  
 One-pounder machine gun 858,745 2 July 1907 (Assigned to McClean Arms & Ord. Co.)  
 Gas-operated gun 1,003,632 19 Sep 1911 (Assigned to Automatic Arms Co.)  
 Gas-operated machine gun 1,005,263 10 Oct 1911 (Assigned to Automatic Arms Co.)  
 Automatic machine gun 1,042,135 22 Oct 1912 (Assigned to Automatic Arms Co.)  
 Breech-loading and discharge-actuated firearm 1,042,363 22 Oct 1912 (Assigned to Automatic Arms Co.)  
 Gas-operated firearm 783,453 28 Feb 1905  
 Gas-operated automatic firearm 816,591 3 Apr 1906 (Assigned to McClean Arms and Ordnance Co.)

**MCCLURE, ADOLPHUS C.—KEITHVILLE, LA.**

Automatic repeating firearm 1,075,431 14 Oct 1913

**MCCORD, WILLIAM—SING SING, N.Y.**

Improvements in firearms 31,933 2 Apr 1861 (McCord, Cox & Woodward)  
 Improvement in repeating ordnance 33,813 26 Nov 1861 (McCord & Maher)

**MCCRUDDEN, JOHN CHARLES R.—HURSTVILLE, NEW SOUTH WALES, AUSTRALIA**

Machine gun 1,406,404 14 Feb 1922  
 Machine gun 1,452,123 17 Apr 1923

**MCCULLOCH, THOMAS—LONDON, ENGLAND**

Machine gun 446,807 17 Feb 1891 (Armit)

**McLAIN, ROBERT M.—HUNTSVILLE, ALA.**

Machine gun 1,375,653 19 Apr 1921 (McLain & Quick)  
 (Assigned to the Quick-McLain Machine Gun Co.)

**MCLEAN, JAMES HENRY—ST. LOUIS, MO. (\*)**

Machine gun 225,462 16 Mar 1880 (Coloney)  
 Machine gun 225,466 16 Mar 1880 (Coloney)  
 Machine gun 231,653 31 Aug 1880 (Coloney)  
 Machine gun 282,549 7 Aug 1883 (Coloney)  
 Machine gun 231,652 31 Aug 1880 (Coloney)

**MCLEAN, JAMES HENRY—ST. LOUIS, MO.**

Machine gun 282,551 7 Aug 1883  
 Machine gun 282,553 7 Aug 1883



**McMANUS, LUIS M.—HOUSTON, TEX.**

Machine gun 1,273,078 16 July 1918 (Assigned to Warner, James H.)

**McNAIER, JOSEPH TREANOR—NEW YORK, N.Y.**

Centrifugal machine gun and method for feeding same 1,472,080 30 Oct 1923

**MEINERSMANN, WILLIAM—ELIZABETH, N.J.**

High velocity gun 1,326,763 30 Dec 1919

**MEJEAN, JACQUES G.—GENEVA, SWITZERLAND**

Gun actuator 2,341,641 15 Feb 1944 (Assigned to General Aircraft Equipment Co.)

**MEJIA, ENRIQUE A.—MEXICO CITY, MEXICO**

Improvement in many-barreled guns 62,281 19 Feb 1867

**MENDOZA, RAFAEL—MEXICO CITY, MEXICO**

Machine gun bolt mechanism 2,031,383 18 Feb 1936

**MENTEYNE, PAUL MARIE—PARIS, FRANCE**

Automatic firearm 1,059,680 22 Apr 1913 (Menteyne & Degaille)

Automatic firearm 981,210 10 Jan 1911 (Menteyne & Degaille)

Cartridge belt 1,150,435 17 Aug 1915 (Laird, Menteyne & Degaille)

**MERCIE, HENRI A.—PARIS, FRANCE**

Automatic machine gun 564,043 14 July 1896 (Benét & Mercié) (Assigned to Hotchkiss Ordnance Co. Ltd.)

Gas-operated gun 588,380 17 Aug 1897 (Benét & Mercié) (Assigned to Hotchkiss Ordnance Co. Ltd.)

Semi automatic gun 649,393 8 May 1900 (Benét & Mercié)

Automatic gun 696,306 25 Mar 1902 (Benét & Mercié)

Gas-operated gun 861,939 30 Jan 1907 (Benét & Mercié)

Semi-automatic gun 852,253 30 Apr 1907 (Benét & Mercié)

Firing gear 854,557 21 May 1907 (Benét & Mercié)

Automatic shoulder rifle 1,125,937 26 Jan 1915 (Benét & Mercié)

Automatic firearm 1,317,633 30 Sep 1919 (Squire & Mercié) (Assigned to Hotchkiss Ordnance Co. Ltd.)

**MERSHON, RALPH S.—PHILADELPHIA, PA.**

Self-cocking firearm 39,835 8 Sep 1863 (Hollingsworth)

**MERTENS, LUDWIG—LONDON, ENGLAND**

Non-recoiling firearm 891,778 23 June 1908

**METALLURGICA BRESCIANA GIA TEMPINI—BRESCIA, ITALY (\*)**

Automatic firearms actuated by compressed air 1,803,946 5 May 1931 (Revelli)

Device for loading firearms 1,812,363 30 June 1931 (Orlando)

**METHILIEN, NICOLAS E.—PARIS, FRANCE**

Multibarrel gun 1,535,619 28 Apr 1925 (Assigned to Schneider & Cie)

**MEYER, FRANCIS ED.—NEW YORK, N.Y. (\*)**

Machine gun 208,203 17 Sep 1878 (Schultze)

Machine gun 208,204 17 Sep 1878 (Schultze)

**MICHAL, CHARLES J.—HINSDALE, ILL.**

Machine gun 2,139,691 13 Dec 1938

Machine gun 2,223,380 3 Dec 1940

**MICHAUS, ALEXANDER, JR.—WASHINGTON, D.C.**

Automatic gun 1,136,695 20 Apr 1915

**MILG, ARMAND—HEIDELBERG, GERMANY**

Recoil-operated firearm 533,911 12 Feb 1895

**MILBURN, NATHAN L.—ST. LOUIS, MO.**

Improvement in revolving ordnance 57,751 4 Sep. 1866

**MILES, W. A.—SALISBURY, CONN.**

Machine gun 129,976 30 July 1872

**MILLER, JOHN A.—PADUCAH, KY.**

Improvement in breech-loading ordnance 46,257 7 Feb 1865

**MILLS, MORGAN R.—RICHMOND, VA. (\*)**

Machine gun 1,698,228 8 Jan 1929 (Harring)

**MILTIMORE, ALONZO E.—U.S. ARMY**

Improvement in battery guns 145,224 2 Dec 1873

Improvement in battery guns 181,093 15 Aug 1876

**MISKUNAS, ANTON—OGLESBY, ILL.**

Machine gun 1,441,517 9 Jan 1923

**MONFORT, EDGAR A.—NEW YORK, N.Y.**

Electric cartridge 365,842 5 July 1887 (Assigned to Universal Electric Arms & Ammo. Co.)

Electrical breech-loading firearm 365,843 5 July 1887 (Assigned to Universal Electric Arms & Ammo. Co.)

**MONGARDI, GIOVANNI—SOMERVILLE, MASS.**

Automatic firearm 1,296,204 4 Mar 1919

**MONNER, RAY J.—DENVER, COLO.**

Machine gun cooling means 2,416,768 4 Mar 1947 (Assigned to Sorensen)

**MONTIGNY, JOSEPH—BRUSSELS, BELGIUM**

Machine gun 121,277 28 Nov 1871 (Christophe)

**MOORE, FREDERICK T.—EAST HARTFORD, CONN.**

Magazine feed mechanism for machine guns 1,719,126 2 July 1929 (Pfeiffer & Moore) (Assigned to Colt's Patent Firearms Mfg. Co.)

Gas-operated automatic firearm 1,738,501 3 Dec 1929 (Pfeiffer & Moore) (Assigned to Colt's Co.)

Barrel mounting for firearms 1,738,500 3 Dec 1929 (Pfeiffer & Moore) (Assigned to Colt's Patent Firearms Mfg. Co.)

Trigger mechanism for machine guns 1,738,502 31 Dec 1929 (Pfeiffer & Moore) (Assigned to Colt's Patent Firearms Mfg. Co.)

Reversible feed mechanism for machine guns 1,803,351 5 May 1931 (Pfeiffer & Moore) (Assigned to Colt's Patent Firearms Mfg. Co.)

Firing mechanism for machine guns 1,966,592 17 July 1934 (Pfeiffer & Moore) (Assigned to Colt's)

Automatic firearm 2,050,538 11 Aug 1936 (Pfeiffer & Moore) (Assigned to Colt's)

Firing mechanism for machine guns 2,050,539 11 Aug 1936 (Tansley & Moore) (Assigned to Colt's)  
 Machine gun & attachment therefor 2,061,313 17 Nov 1936 (Assigned to Colt's)  
 Machine gun 2,110,165 8 Mar 1938 (Assigned to Colt's)  
 Machine gun 2,140,809 20 Dec 1938 (Assigned to Colt's)  
 Firing mechanism for automatic firearms 2,335,688 30 Nov 1943 (Assigned to Colt's)

MOORE, HERBERT P.—NORWALK, OHIO

Silencer for firearms 1,080,154 2 Dec 1913

MOORE, ROBERT A.—CHICAGO, ILL.

Silencer for firearms 956,717 3 May 1910 (Assigned to the Moore Silencer Co.)

Silencer for firearms 1,021,742 26 Mar 1912

Automatic firearm 1,376,456 3 May 1921

MOORE SILENCER CO.—NEW YORK, N.Y. (\*)

Silencer for firearms 956,717 3 May 1910 (Moore)

MORRIS, RICHARD—BLACKHEATH, ENGLAND

Machine gun 353,231 23 Nov 1886

MOTTIN, WILLIE F.—NOEL, MO.

Machine gun 1,290,842 7 Jan 1919

MOSES, H. O.—LYNN, MASS. (\*)

Machine gun 563,701 7 July 1896 (Wilder)

MÜHLEMANN, ERNST—ZÜRICH, SWITZERLAND

Bearing surface for breech bolts in automatic firearms 2,509,043 23 May 1950 (Assigned to Oerlikon Co.)

Automatic firearm breech bolt lock 2,512,027 20 Jun 1950 (Lippert & Mühlemann) (Assigned to Oerlikon Co.)

MÜLLER, BERNHARD—WINTERTHUR, SWITZERLAND

Automatic firearm 802,582 24 Oct 1905

MULNO, LESTER F.—WORCESTER, MASS.

Safety device for firearms 2,495,383 24 Jan 1950 (Assigned to Harrington & Richardson Arms Co.)

MURPHY, JOHN L.—SPRINGFIELD, MASS.

Machine gun 427,239 6 May 1890

MUSITELLI, ROBERTO—BRESCIA, ITALY

Automatic firearm 1,455,503 15 May 1923

NARDIN, CELESTIN F.—WOODHAVEN, N.Y.

Automatic firearm 1,067,054 8 July 1913

NATCHER, GABRIEL SIDNEY, OHIO

Improvement in many-barreled cannons 45,623 27 Dec 1864

NAUGLER, WALTER E.—BEVERLY, MASS.

Gun charging mechanism 2,411,934 3 Dec 1946 (Assigned to United Shoe Machinery Corp.)

Ammunition feeder 2,524,132 3 Oct 1950 (Naugler and Stacey) (Assigned to United Shoe Machinery Corp.)

NEAL, ERNEST C.—CHICAGO, ILL.

Automatic firearm 2,436,175 17 Feb 1948

NEILS, FRANK—DAVENPORT, IOWA

Machine gun 562,846 30 June 1896

NELSON, ADOLPH L.—INDIANAPOLIS, IND.

Control mechanism for machine guns (aircraft) 1,562,424 17 Nov 1925

NELSON, CHARLES A.—UTICA, N.Y.

Machine guns 1,256,923 19 Feb 1918 (Assigned to Savage Arms Corp.)

Gas-operated firearm 1,388,879 30 Aug 1921 (Assigned to Savage Arms Corp.)

NETTLES, ISAAC—DETROIT, MICH.

Gun with reciprocal breech and rotary feeder 2,483,837 4 Oct 1949

NEWTON, CLARK A.—NEW YORK, N.Y.

Automatic gun 1,307,594 24 June 1919

NEWTON, FREDERICK P.—NEW HAVEN, CONN. (\*)

Machine gun 430,206 17 June 1890 (Garland)

Machine gun 479,799 2 Aug 1892 (Garland)

NOBLE, ANDREW—NEWCASTLE, ENGLAND

Automatic gun 702,240 10 June 1902 (Assigned to Armstrong, Whitworth & Co., Ltd.)

NOBLE, JOHN C.—WASHINGTON, PA.

Improvement in magazine gun 34,126 14 Jan 1862 (Brady)

NORDENFELT, THORSTEN—LONDON, ENGLAND (\*)

Machine gun 218,190 5 Aug 1879 (Palmcrantz)

Machine gun 220,545 14 Oct 1879 (Palmcrantz)

NORDENFELT, THORSTEN—LONDON, ENGLAND

Machine gun 298,493 13 May 1884

Machine gun 303,879 19 Aug 1884

Machine gun 340,725 27 Apr 1886

NORMAN, GEORGE—BIRMINGHAM, ENGLAND

Automatic firearm 1,637,234 26 July 1927 (Assigned to Birmingham Small Arms Co. Ltd.)

Automatic firearm 1,637,235 26 July 1927 (Assigned to Birmingham Small Arms Co.)

Automatic firearm 2,053,489 8 Sep 1936 (Assigned to Auto-Ordnance Corp.)

NORRIS, SAMUEL—SPRINGFIELD, MASS.

Breech-loading firearm 78,603 2 June 1868 (W. & P. Mauser)

NORTH, THOMAS KEPPEL—WESTMINSTER, ENGLAND

Feed system 723,719 24 Mar 1903

NORTH AMERICAN AVIATION, INC.\*

Gun blast seal 2,514,495 11 Jul 1950 (Johnson)

NORTHOVER, HARRY ROBERT—WINNIPEG, MANITOBA, CANADA

Gas cylinder for machine guns 1,234,071 17 July 1917

Retracting assembly 1,207,612 5 Dec 1916

Flash absorber attachment for machine guns 1,242,843 9 Oct 1917

NYVALL, YNGVE J.—SAN PEDRO, CALIF.

Firing mechanism for rifles 2,441,029 4 May 1948 (Nyvall & Chapman)



OBREGON, ALEJANDRO—MEXICO CITY, MEXICO

Automatic loading firearm 2,115,041 26 Apr 1938

ODKOLEK, ADOLF—VIENNA, AUSTRIA-HUNGARY

Magazine firearm 422,327 25 Feb 1890

Quick-firing gun 486,938 29 Nov 1892

Recoil-operated machine gun 452,403 16 June 1891

Automatic firearm 799,884 19 Sep 1905

OERLIKON, *See* WERKZEUG-MACHINENFABRIK OERLIKON

OESTERREICHISCHE WAFFENFABRIKSGESELLSCHAFT—STEYR, AUSTRIA (\*)

Gun lock for automatic firearms 1,387,369 9 Aug 1921 (Duffek)

OLIN INDUSTRIES INC.—NEW HAVEN, CONN. (\*)

Piston means for gas-operated firearms 2,376,466 22 May 1945 (Williams)

Gas-operated self-loading firearm 2,394,986 19 Feb 1946 (Crockett)

Cartridge extracting mechanism for firearms 2,412,663 17 Dec 1946 (Williams)

OLIVER, M. W.—LOWELL, MASS. (\*)

Improved automatic cannon 15,315 8 July 1856 (Barnes)

OLIVER, STACY—HARTFORD, CONN.

Automatic rifle 1,383,966 5 July 1921

O'MALLEY, JOHN F.—MERIDEN, CONN.

Machine gun 1,307,316 17 June 1919

Machine gun 1,329,922 3 Feb 1920

Machine gun 1,366,210 18 Jan 1921

ONDERDONK, JOHN P.—PHILADELPHIA, PA.

Recoil mechanism for firearms 294,402 4 Mar 1884

ORDNANCE DEVELOPMENT CO.—GORTON, CONN. (\*)

Aeroplane gun 1,108,714 25 Aug 1914 (Davis)

Apparatus for firing projectiles from aeroplanes 1,108,715 25 Aug 1914 (Davis)

Apparatus for firing projectiles from aeroplanes 1,108,716 25 Aug 1914 (Davis)

Fixed ammunition for use in aircraft 1,108,717 25 Aug 1914 (Davis)

ORLANDO, LUIGI—MILAN, ITALY

Device for loading firearms 1,812,363 30 June 1931 (Assigned to Metallurgica-Bresciana Gia Tempini)

ORMAN, BENJAMIN—BELVEDERE, ENGLAND

Automatic firearm 1,128,180 9 Feb 1915

OVER, EWALD—INDIANAPOLIS, IND. (\*)

Machine gun 560,842 26 May 1896 (Cook)

PAGE, J. H. W.—BOSTON, MASS. (\*)

Improvement in repeating cannons 46,762 7 Mar 1865 (Tufts)

PALMCRAFT, HELGE—STOCKHOLM, SWEDEN

Machine gun 218,190 5 Aug 1879 (Assigned to Nordenfelt)

Machine gun 220,545 14 Oct. 1879 (Assigned to Nordenfelt)

PALMER, CHARLES H.—LAKEVILLE, CONN.

Repeating gun 37,052 2 Dec 1862

PALMER, CHARLES H.—NEW YORK, N.Y.

Machine gun 332,741 22 Dec 1885

PALMER, WILLIAM—NEW YORK, N.Y.

Improvement in revolving firearms 41,857 8 Mar 1864

PARKER, WILLIAM H.—MILLVILLE, N.J.

Chamber loader indicator for firearms 2,416,712 4 Mar 1947

PARKHURST, EDWARD G.—HARTFORD, CONN.

Machine gun 228,777 15 June 1880 (Assigned to self and Pratt & Whitney Co.)

Machine gun 231,607 24 Aug 1880 (Assigned 1/2 to Pratt & Whitney Co.)

PARSONS, JOHN H.—RIDLEY PARK, PA.

Centrifugal gun 1,408,137 28 Feb 1922 (Assigned to Runnell & Normoyle)

PATCHETT, GEORGE W.—CHIGWELL, ENGLAND

Fire controlling mechanism for automatic firearms 2,432,486 9 Dec 1947

Cartridge magazine for automatic firearms 2,510,831 6 June 1950

PATRICK, LIDO J.—SAN DIEGO, CALIF.

Machine gun 1,347,753 27 July 1920

PAULSON, SIVIL—RED WILLOW, ALBERTA, CANADA

Automatic firearm 950,576 1 Mar 1910

PAULUS, CHARLES LEIGH—DAYTON, OHIO

Automatic advance for synchronizing gun control 1,471,375 23 Oct 1923 (Russell & Paulus)

Charging device for machine guns 1,471,348 23 Oct 1923

Control for synchronized guns 1,504,712 12 Aug 1924 (Russell & Paulus)

Automatic cocking attachment for machine guns 1,504,714 12 Aug 1924 (Russell & Paulus)

Synchronized gun control 1,523,952 10 Mar 1925 (Russell & Paulus)

Feed box for cartridge belts for machine guns 1,541,282 9 June 1925 (Russell & Paulus)

Machine gun synchronizer 1,592,500 13 July 1926 (Paulus & Kauch)

Lock mechanism for machine gun 1,427,855 5 Sep 1922 (Russell & Paulus)

PAUMIER, EMILE LOUIS ALBERT—PARIS, FRANCE

Machine gun 1,444,849 13 Feb 1923

PEARSON, HAROLD C.—DAYTON, OHIO

Bolt mechanism 2,503,575 11 Apr 1950 (Anderson & Pearson) (Assigned to General Motors Corp.)

PECK, HELEN R.—WASHINGTON, D.C. (\*)

Attachment for machine guns 1,320,711 4 Nov 1917 (Rasmussen)

PEDERSEN, JOHN D.—JACKSON, WYO.

Auto-loading firearm 1,348,733 3 Aug 1920

- PEDERSON, SIVERT—MENOMONEE, WISC.**  
Machine gun 264,897 26 Sep 1882
- PEGNA, GIOVANNI—REGGIO EMILIA, ITALY**  
Gun barrel 2,238,670 15 Apr 1941 (Travers & Pegna)  
(Assigned to Compagnia Commerciale Caproni)
- PELO, CARL—TAVASTEHUS, FINLAND**  
Light machine gun 1,897,710 14 Feb 1933
- PERINO, GIUSEPPE—ROME, ITALY**  
Machine gun 682,230 10 Sep 1901
- PERMENTIER, PAUL R.—CASABLANCA, MOROCCO**  
Thermostatically controlled firearm cooling system  
2,428,359 7 Oct 1947
- PETERSEN, CHARLES—SAN FRANCISCO, CALIF.**  
Automatic gun 754,691 15 Mar 1904
- PFEIFFER, CHRISTIAN—HARTFORD, CONN.**  
Feed mechanism for machine guns 1,719,126 2 July 1929  
(Pfeiffer & Moore) (Assigned to Colt's Patent Firearms  
Mfg. Co.)  
Trigger mechanism for machine guns 1,738,502 31 Dec  
1929 (Pfeiffer & Moore) (Assigned to Colt's)  
Speed regulator for machine guns 1,741,534 31 Dec 1929  
(Pfeiffer & Moore) (Assigned to Colt's)  
Reversible feed mechanism for machine guns 1,803,351 5  
May 1931 (Moore & Pfeiffer) (Assigned to Colt's)  
Automatic firearm 1,803,349 5 May 1931 (Moore &  
Pfeiffer) (Assigned to Colt's)
- PHELAN, JOHN—PITTSBURGH, PA.**  
Machine gun 249,204 8 Nov 1881 (Assigned 1/2 to  
Richardson, Ralph J.)
- PHILLIPS, HARRY—BEVERLY, MASS.**  
Firing mechanism for guns 2,440,381 27 Apr 1948 (As-  
signed to United Shoe Machinery Corp.)
- PODRABSKY, ANTONIN—BRUNN, CZECHOSLOVAKIA**  
Automatic gun 1,926,816 12 Sep 1933 (Assigned to  
Ceskoslovenska Zbrojovka)
- POTTER, LOUIS K.—WARWICK, R.I. (\*)**  
Automatic firearm 515,526 27 Feb 1891 (King)
- POTTS, ALBERT—PHILADELPHIA, PA.**  
Centrifugal battery 17,339 19 May 1857
- PRATHER, ANDREW T.—RODEO, N.MEX.**  
Attaching means for gun silencers 1,171,242 8 Feb 1916
- PRATT & WHITNEY CO.—HARTFORD, CONN. (\*)**  
Machine gun 228,777 15 June 1880 (Parkhurst)  
Machine gun 231,607 24 Aug 1880 (Parkhurst)
- PRIDEAUX, WILLIAM DE COURCY—WEYMOUTH, ENGLAND**  
Construction of links for ammunition belts for machine  
guns 1,305,160 27 May 1919  
Ammunition belt for machine guns 1,315,742 9 Sep 1919  
Ammunition belt for machine guns 1,305,161 27 May 1919
- PRINKE, CARL H.—BALTIMORE, MD.**  
Automatic firearm 875,209 31 Dec 1907  
Automatic firearm 904,646 24 Nov 1908
- PRITCHETT, WILLIAM H.—CARTERSVILLE, GA.**  
Automatic machine gun 1,297,240 11 Mar 1919
- PULLOCK, GRANVILLE ALEXANDER—PARIS, FRANCE**  
Means for cooling machine guns 1,527,585 24 Feb 1925  
(Hamilton, Joly & Pullock)
- PUTNAM, BURLEIGH—PASADENA, CALIF.**  
Machine gun 1,334,052 16 Mar 1920 (Assigned to John  
T. Thompson)  
Machine gun 1,429,370 19 Sept 1922
- QUICK-McLAIN MACHINE GUN CO.—HUNTSVILLE, ALA. (\*)**  
Machine gun 1,375,653 19 Apr 1921 (McLain & Quick)
- QUICK, WILLIAM M.—HUNTSVILLE, ALA.**  
Machine gun 1,375,653 19 Apr 1921 (McLain & Quick)  
(Assigned to Quick-McLain Machine Gun Co.)
- QUISLING, R. H.—CHRISTIANIA, NORWAY**  
Portable gun for throwing grenades and the like 1,087,608  
17 Feb 1914
- RAINES, RICHARD—NEW YORK, N.Y.**  
Machine gun 965,538 26 July 1910
- RAKULA, THEODOR—DUSSELDORF, GERMANY**  
Automatic firearm 1,709,399 16 Apr 1929 (Herlach &  
Rakula) (Assigned to Rheinische Metallwaren und  
Machinenfabrik)  
Automatic firearm with two cartridge magazines 1,784,355  
9 Dec 1930 (Herlach & Rakula) (Assigned to Rheinische  
Metallwaren und Maschinenfabrik)  
Automatic firearm 2,015,908 1 Oct 1935 (Rakula &  
Solothurn H.) (Assigned to Waffenfabrik Solothurn  
A. G.)  
Automatic gun 2,067,322 12 Jan 1937 (Herlach &  
Rakula) (Assigned to Waffenfabrik Solothurn A. G.)
- RAMSAY, JAMES—LONDON, ENGLAND**  
Muzzle attachment for automatic guns 870,497 5 Nov  
1907 (Dawson & Ramsay) (Assigned to Vickers Sons &  
Maxim Ltd.)
- RASMUSSEN, JULIUS ALEXANDER NICOLAI—COPENHAGEN, DENMARK**  
Automatic firearm 701,815 3 June 1902 (Assigned to  
Dansk Rekyl-Riffel Syndicate)
- RASMUSSEN, ERNEST J.—U.S. ARMY**  
Attachments for machine guns 1,320,711 4 Nov 1919 (As-  
signed 1/2 to Peck, H. R.)
- RAUCHFUSS, KURT V.—CUXHAVEN, GERMANY**  
Lateral dispersion device for machine guns 1,413,936 25  
Apr 1922 (Rauchfuss & Jaeschke)
- RAY, EUGENE J.—BEVERLY, MASS.**  
Gun ammunition magazine 2,447,092 17 Aug 1948 (As-  
signed to United Shoe Machinery Corp.)
- RECHEL, ERNEST R.—HUNTINGDON VALLEY, PA.**  
Method for making incendiary bullets 2,425,005 5 Aug  
1947
- REDFIELD, EDWARD E.—GLENDALE, ORE.**  
Automatic firearm 984,489 14 Feb 1911



**REDPATH, ROBERT—COVENTRY, ENGLAND**

Feed mechanisms for automatic machine guns 1,289,091  
(Redpath & Hellberg) (Assigned to Coventry Ordnance Works Ltd.)  
Automatic gun 1,315,329 9 Sep 1919 (Assigned to Coventry Ordnance Works Ltd.)

**REED, C. E.—HOUSTON, TEX. (\*)**

Recoil-operated firearm 1,453,439 1 May 1923 (Cedillo)

**REEK, ROYAL J.—SOUTH BEND, IND.**

Gun feed mechanism 2,379,185 26 June 1945 (Assigned to Bendix Aviation Corp.)

**REIFGRABER, JOSEPH J.—ST. LOUIS, MO.**

Automatic firearm 729,413 26 May 1903  
Automatic firearm 834,753 30 Oct 1906  
Automatic firearm 929,491 27 July 1909  
Automatic firearm 1,418,021 30 May 1922

**REMINGTON ARMS CO. INC.—BRIDGEPORT, CONN. (\*)**

Gun barrel straightness testing apparatus 2,422,294 17 June 1947 (DuPont)

**RÉPUBLIQUE AVIATION CORPORATION (\*)**

Automatic locking ammunition container 2,506,409 2 May 1950 (Baumwart)

**REINHOLD, FRANK W.—BEVERLY, MASS.**

Ammunition feeder 2,494,728 17 Jan 1950 (Stacey & Reinhold) (Assigned to United Shoe Machinery Corp.)

**REQUA, J.—ROCHESTER, N.Y.**

Improvement in battery or platoon weapons 36,448 16 Sep 1862 (Billingshurst & Requa)

**REVELLI, BETHEL ABIL—ROME, ITALY**

Automatic gun 1,073,709 23 Sep 1913  
Automatic firearm 1,159,417 9 Nov 1915 (Assigned to Officine di Villar Perosa)  
Machine gun 1,286,884 3 Dec 1918 (Assigned to Officine di Villar Perosa)  
Automatic firearm 1,759,277 20 May 1930 (Assigned to Armamenti Militari S.A.)  
Automatic firearm actuated by compressed air 1,803,946 5 May 1931 (Assigned to Metallurgica Bresciana Gia Tempini)  
Automatic rifle 1,854,064 12 Apr 1932

**REVELLI, GINO—ROME, ITALY**

Firing mechanism for automatic arms 2,356,615 22 Aug 1944 (Assigned to Alien Property Custodian)

**REYNOLDS, JOHN A.—ELMIRA, N.Y.**

Improvement in firearms 13,292 17 July 1855  
Improved apparatus for cooling repeating firearms 13,294 17 July 1855  
Improvements in firearms 13,293 17 July 1855

**RHEINISCHE METALLWAREN UND MASCHINENFABRIK—DÜSSELDORF, GERMANY (\*)**

Gun with recoiling gun barrel 855,366 28 May 1907 (Voller)  
Breech mechanism for self-loading firearm 909,233 12 Jan 1909 (Schmeisser)

Automatic firearm 956,430 26 Apr 1910 (Schmeisser)  
Automatic firearm 956,431 26 Apr 1910 (Schmeisser)  
Breech operating mechanism for automatic firearms 1,002,764 5 Sep 1911 (Schmeisser)  
Automatic gun 1,033,625 23 July 1912 (Schmidt)  
Gun with long recoil 1,151,476 14 Aug 1915 (Klette)  
Automatic firearm 1,709,399 16 Apr 1929 (Herlach & Rakula)  
Automatic firearm 1,755,034 15 Apr 1930 (Stange)  
Automatic firearm with two cartridge magazines 1,784,351 9 Dec 1930 (Herlach & Rakula)  
Automatic firearm 1,801,179 14 Apr 1931 (Stange)  
Automatic firearm 1,846,156 23 Feb 1932 (Stange)  
Automatic firearm 1,825,904 6 Oct 1931 (Heinemann)  
Firearm with exchangeable barrel 2,014,184 10 Sep 1931 (Linder)  
Automatic gun 2,113,202 5 Apr 1938 (Stange)  
Automatic firing mechanism 887,713 12 May 1908 (Voller)

**RHEINMETALL-BORSIG A. G.—DÜSSELDORF, GERMANY (\*)**

Gun-loading device 2,151,288 21 Mar 1939 (Wagninger)  
Automatic firearm 2,133,661 18 Oct 1938 (Engel & Winter)  
Gun which fires during forward movement of the gun 2,218,877 22 Oct 1940 (Ernesti & Herlach)  
Automatic gun 2,202,201 28 May 1940 (Henning)  
Automatic gun 2,230,328 4 Feb 1941 (Krum & Herlach)

**RICE, EDWARD E.—BOSTON, MASS. (\*)**

Automatic firearm 2,215,470 24 Sep 1940 (Johnson)

**RICE, WALTER J.—PHILADELPHIA, PA.**

Gas-operated automatic machine gun 1,294,892 18 Feb 1919 (Fox & Rice) (Assigned to Ansley Fox Co.)

**RICE, WAYNE H.—WINDSOR, CONN.**

Self-loading firearm 38,604 19 May 1863

**RICHARDS, FRANCIS H.—HARTFORD, CONN.**

Gun, Straight-pull bolt 506,339 10 Oct 1893 (Assigned to James Paris Lee)

**RICHARDSON, RALPH J.—PITTSBURGH, PA. (\*)**

Machine gun 249,204 8 Nov 1881 (Phelan)

**RICHAY, DAVID M.—DEVON, CONN.**

Gun charger installation 2,431,079 18 Nov 1947 (Assigned to United Aircraft Corp.)

**RICHMOND, ROMULUS R.—CHARITON, IOWA**

Automatic machine gun 572,771 8 Dec 1896

**RICKENBACHER, ROBERT J.—COLUMBUS, OHIO**

Machine gun 2,039,930 5 May 1936 (Assigned to Kilgore Mfg. Co.)

**RIGSBY, VIRGIL—VEACH, TEX.**

Machine gun 1,959,737 22 May 1934 (Assigned 1/2 to Ben G. Lindsey)

**RIPLEY, EZRA—TROY, N.Y.**

Gun batteries, Improvements in repeating 33,544 22 Oct 1861

- ROBERTS, FRED T.—LOS ANGELES, CALIF.  
Remote-control gun charger 2,397,507 2 Apr 1946 (Assigned to Interstate Aircraft & Engineering Corp.)
- ROBERTS, MILTON—CHICAGO, ILL. (\*)  
Recoil control of firearms 2,184,595 26 Dec 1939 (Hughes)
- ROBINSON, CHARLES—CAMBRIDGEPORT, MASS. (\*)  
Improvements in centrifugal guns 21,109 3 Aug 1858 (Thayer, C. B.)
- ROCKWELL, HUGH M.—BRISTOL, CONN.  
Automatic gun 1,565,756 15 Dec 1925 (Assigned to Marlin Firearms Corp.)  
Automatic gun 1,558,566 27 Oct 1925 (Assigned to Marlin Firearms Corp.)
- ROEMER, WILLIAM C.—NEW HAVEN, CONN.  
Self-loading firearm 2,372,339 27 Mar 1945 (Assigned to Western Cartridge Co.)
- ROHN, WILLIAM C.—SOUTH BEND, IND.  
Automatic machine gun charger 2,410,767 5 Nov 1946 (Wiseman & Rohn) (Assigned to Bendix Aviation Corp.)
- ROSEBUSH, WALDO E.—SPOKANE, WASH.  
Composite automatic firearm 1,377,629 10 May 1921
- ROSENBERG, ABRAHAM—SAN FRANCISCO, CALIF. (\*)  
Machine gun 207,747 3 Sep 1878 (Leonard)
- ROSENGREN, OVAR E.—HAMDEN, CONN.  
Machine gun fire retarder 2,509,530 30 May 1950 (Rosengren & Sunderland)
- ROSIER, HENRY—LOWELL, MASS.  
Automatic firearm 1,520,671 23 Dec 1924
- ROSNER, KARL—PRAGUE, CZECHOSLOVAKIA  
Aircraft gun 1,510,109 30 Sep 1921
- ROSS, CHARLES H. A. F. L.—BALNAGOWAN CASTLE, SCOTLAND  
Recoil-operated firearm 643,983 20 Feb 1900  
Automatic firearm 958,545 17 May 1910  
Breech-closing mechanism for automatic firearm 954,543 12 Apr 1910
- ROSS, OSCAR A.—NEW YORK, N.Y.  
Synchronized machine gun for aeroplanes 1,454,137 8 May 1923  
Synchronized machine gun 1,782,148 18 Nov 1930
- ROSSMANN, WOLFGANG—SOLOTHURN, SWITZERLAND  
Automatic shoulder firearm 2,376,726 22 May 1945 (Assigned to Alien Property Custodian)  
Cocking mechanism for automatic firearms 2,202,232 May 28 1940 (Assigned to Rheinmetall-Borsig)
- ROTH, GEORGES—VIENNA, AUSTRIA-HUNGARY  
Automatic firearm 616,260 20 Dec 1898  
Recoil-operated firearm 616,261 20 Dec 1898  
Recoil-operated firearm 634,913 17 Oct 1899 (Krnka & Roth)  
Automatic firearm 676,995 25 June 1901 (Krnka & Roth)  
Automatic firearm 681,737 3 Sep 1901  
Automatic firearm 683,072 24 Sep 1901 (Krnka & Roth)
- RUGER, WILLIAM B.—GREENSBORO, N.C.  
Machine gun 2,388,291 6 Nov 1945
- RUNDQUIST, HENNING W.—EAST LANSING, MICH.  
Cartridge feeding mechanism 2,418,428 1 Apr 1947 (Assigned to General Motors Corp.)
- RUSSELL, HERBERT O.—LOS ANGELES, CALIF. & DETROIT, MICH.  
Lock mechanism for machine guns 1,427,855 5 Sep 1922 (Russell & Paulus)  
Automatic advance for synchronizing gun control 1,471,359 23 Oct 1923 (Russell & Paulus)  
Control for synchronized guns 1,504,712 12 Aug 1924 (Russell & Paulus)  
Machine gun & hopper feed box 1,504,714 12 Aug 1924 (Russell & Paulus)  
Automatic cocking attachment for machine guns 1,504,717 12 Aug 1924 (Russell & Paulus)  
Cocking handle for aerial guns 1,528,950 10 Mar 1925 (Russell & Eyler)  
Synchronized gun control 1,528,952 10 Mar 1925 (Russell & Paulus)  
Electrical synchronizer and trigger motor for automatic machine guns 1,530,700 24 Mar 1925 (Russell & Fletcher)  
Sear and sear release for machine guns 1,530,702 24 Mar 1925  
Feed box for cartridge belts of machine guns 1,541,282 9 June 1925 (Russell & Paulus)
- RUSSELL MFG. CO.—MIDDLETOWN, CONN. (\*)  
Beltlike cartridge carrier for machine guns 1,168,876 18 Jan 1916 (Frissell)  
Machine gun feed belt 1,253,553 5 Mar 1918 (Frissell)  
Cartridge feed belt for machine guns 2,422,898 24 June 1947 (Hendley)
- RYAN, LESTER R.—PLYMOUTH, CONN.  
Cartridge belt link 2,423,346 1 July 1947 (Assigned to Autoyre Co.)
- SAALFIELD, OLIVER BERRY—WEST HOBOKEN, N.J.  
Recoil-operated firearm 1,228,827 5 June 1917 (Assigned to Maxim Munitions Corp.)
- SAFAT (SOCIETA ANONIMA FABRICA ARMI-TORINO)—TURIN, ITALY (\*)  
Automatic firearm with recoiling barrel and without moveable breech 1,733,231 29 Oct 1929 (Mascarucci)  
Device for reducing the rate of fire of automatic firearms 1,771,132 22 July 1930 (Mascarucci)
- SAIVE, DIEUDONNE J.—WANDRE, BELGIUM  
Tilt locking breechblock for automatic firearms 2,515,315 18 Jul 1950
- SALIGER, ALIUS B.—NEW YORK, N.Y.  
Centrifugal gun 1,311,465 29 July 1919 (Assigned to Intercontinental Co. of Calif.)
- SAN FRANCISCO ARMS CO.—SAN FRANCISCO, CALIF. (\*)  
Recoil operated firearm 574,189 29 Dec 1896 (Carr)  
Recoil-operated firearm 574,350 29 Dec 1896 (Catlin)  
Recoil-operated firearm 584,153 8 June 1897 (Carr)



## SANDERS SMALL ARMS LTD.—LONDON, ENGLAND (\*)

Recoil-loading firearm 2,101,957 14 Dec 1937 (Sanders)

## SANDERS, THOMAS F.—SLOUGH TRADING ESTATE, ENGLAND

Recoil-loading firearm 2,101,957 14 Dec 1937 (Assigned to Sanders Small Arms Ltd.)

## SANFORD, ROY S.—WOODBURY, CONN.

Cartridge feeding mechanism 2,501,143 21 Mar 1950 (Assigned to Autoyre Co.)

Feeding mechanism for automatic guns 2,502,891 4 Apr 1950 (Assigned to Autoyre Co.)

## SAVAGE ARMS CORP.—UTICA, N.Y. (\*)

Machine gun 1,256,923 19 Feb 1918 (Nelson)

Automatic firearm 2,357,047 29 Aug 1944 (Horan)

Gas-operated firearm 1,388,879 30 Aug 1921 (Nelson)

## SAVAGE, HAROLD ARTHUR—BEXLEY-HEATH, ENGLAND

Automatic gun 1,298,887 1 Apr 1919 (Challenger &amp; Savage) (Assigned to Vickers Ltd.)

## SAYLER, DANIEL—ORLAND, CALIF.

Gas gun 1,164,876 21 Dec 1915

## SCARFF, FREDERICK WILLIAM—LONDON, ENGLAND

Machine gun mountings 1,364,525 4 Jan 1921 (Assigned to Vickers Ltd.)

Gun mounting for use on aircraft 1,628,068 10 May 1927 (Assigned to Vickers Ltd.)

## SCHELLENGER, NEWTON C.—SALT LAKE CITY, UTAH

Automatic firearm 1,029,720 18 June 1912

## SCHIRGUN CORP.—NEW YORK, N.Y. (\*)

Gun barrel lock 2,345,833 4 Apr 1944 (Schirokauer)

Gun mechanism 2,378,331 12 June 1945 (Schirokauer)

## SCHIROKAUER, HENRY—NEW YORK, N.Y.

Gun barrel lock 2,345,833 4 Apr 1944 (Assigned to Schirgun Corp.)

Gun mechanism 2,378,331 12 June 1945 (Assigned to Schirgun Corp.)

## SCHMEISSER, LOUIS—MANNHEIM, GERMANY

Recoil-operated firearm 547,454 8 Oct 1895 (Assigned to Theodor Bergmann)

Breech mechanism for self-loading firearm 909,233 12 Jan 1909 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

Automatic firearm 956,340 26 Apr 1910 (Assigned to Rheinische Metallwaren u. Maschinenfabrik)

Automatic firearm 956,431 26 Apr 1910 (Assigned to Rheinische Metallwaren u. Maschinenfabrik)

Automatic firearm 989,432 11 Apr 1911

Breech operating mechanism for automatic firearms 1,002,764 5 Sep 1911 (Assigned to Rheinische Metallwaren u. Maschinenfabrik)

Automatic firearm 1,077,760 4 Nov 1913

## SCHMIDT, FRANZ—DÜSSELDORF, GERMANY

Automatic gun 1,033,625 23 July 1912 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

## SCHNEIDER, ALOIS—SAN FRANCISCO, CALIF.

Rifling, Guns 300,515 17 June 1884

## SCHNEIDER &amp; CIE.—PARIS, FRANCE (\*)

Apparatus for lubricating the bore of firearms during firing 1,481,930 29 Jan 1924 (Schneider)

Multibarrel Gun 1,487,695 18 Mar 1924 (Schneider)

Multibarrel Gun 1,535,619 28 Apr 1925 (Methlien)

## SCHNEIDER, CHARLES P. E.—LECREUSOT, FRANCE

Recoil apparatus for guns 713,691 18 Nov 1902 (Schneider &amp; Canet)

## SCHNEIDER, EUGENE—PARIS, FRANCE

Apparatus for lubricating the bore of firearms during firing 1,481,930 29 Jan 1924 (Assigned to Schneider &amp; Cie.)

Multibarrel Gun 1,487,695 18 Mar 1924 (Assigned to Schneider &amp; Cie.)

## SCHNEIDER, P. F.—HARTFORD, CONN.

Cartridge box, Revolving 56,804 31 July 1866

## SCHOUBOE, THEODOR JENS—RUNGSTED, DENMARK

Automatic firearm 733,681 14 July 1903

Trigger mechanism for automatic firearms 1,230,930 26 June 1917

## SCHULTZE, FREDERICK E.—NEW YORK, N.Y.

Machine gun 208,203 17 Sep 1878 (Assigned 1/2 to F. E. Meyer)

Machine gun 208,204 17 Sep 1878 (Assigned 1/2 to Meyer)

## SCHWARZLOSE ANDREAS WILHELM—SUHL, GERMANY

Recoil-operated firearm 712,730 4 Nov 1902

Recoil-operated firearm 712,972 4 Nov 1902

Automatic gun 863,101 13 Aug 1907

Automatic firearm with forward sliding barrel 918,380 13 Apr 1909

Lock mechanism for automatic firearm 932,183 24 Aug 1909

Automatic firearm with fixed barrel and breech locked 1,026,609 11 May 1912

## SCHWEIZERISCHE INDUSTRIE GESELLSCHAFT — SCHAFFHAUSEN, SWITZERLAND (\*)

Automatic firearm 1,518,498 9 Dec 1924 (Furrer)

Automatic firearm 2,031,305 18 Feb 1936 (End &amp; Gaetzi)

Automatic firearm 2,130,383 20 Sep 1938 (End)

Automatic firearm 2,052,287 25 Aug 1936 (End)

## SCOTT, CHARLES B.—LAS VEGAS, N.MEX.

Machine gun 299,686 3 June 1884

## SCOTT, J. Q. A.—PITTSBURGH, PA.

Magazine firearm 36,174 12 Aug 1862

## SCOTT-PAINE, HUBERT—HYTHE, ENGLAND

Air-cooled gun 2,337,840 28 Dec 1943 (Scott-Paine &amp; Jaggard, W.)

## SEARLE, ELBERT H.—PHILADELPHIA, PA.

Recoil-operated firearm 804,984 21 Nov 1905 (Assigned 3/4 to W. D. Condit)

## SEDGELY, R. F.—PHILADELPHIA, PA.

Machine gun 2,029,839 4 Feb 1936

SEELY, SAMUEL—BROOKLYN, N.Y.

Improvement in portable body batteries 33,854 3 Dec 1861

SEVERANCE, GLEN R.—DETROIT, MICH.

Electrically operated gun 2,340,991 8 Feb 1944 (Assigned to Eureka Vacuum Cleaner Co.)

SHARP, JOHN F.—LOUISVILLE, MISS. (\*)

Machine gun 282,787 7 Aug 1883 (Shields)

SHEPPARD, CREEDY C.—WASHINGTON, D.C.

Automatic firearm 1,376,831 3 May 1921 (Assigned to United States Ordnance Co.)

SHERMAN, THOMAS H.—WASHINGTON, D.C. (\*)

Machine gun 430,206 17 June 1890 (Garland, F. M.)

Machine gun 479,799 2 Aug 1892 (Garland, F. M.)

SHIELDS, FRANCIS M.—COOPWOOD, MISS.

Machine gun 282,787 7 Aug 1883 (Assigned to Shields, Cornwell, Liebenfeld, Herman, Connor, Sharp & Woodward)

SHIELDS, SARAH T.—LOUISVILLE, MISS. (\*)

Machine gun 282,787 7 Aug 1883 (Shields)

SILLOWAY, FREDERICK D.—SPRINGFIELD, ILL.

Steam escape for machine guns with water jackets 1,294,349 11 Feb 1919

SILVERMAN, LOUIS—CRAYFORD, ENGLAND

Automatic machine gun 551,779 24 Dec 1895 (Maxim & Silverman)

Automatic gun 644,969 6 Mar 1900 (Dawson & Silverman) (Assigned to Vickers Sons & Maxim, Ltd.)

Automatic gun 772,700 18 Oct 1904 (Dawson & Silverman) (Assigned to Vickers Sons & Maxim Ltd.)

SIMPSON, CLARENCE E.—SPRINGFIELD, MASS.

Machine gun 1,994,489 19 Mar 1935

Machine gun 1,982,699 4 Dec 1934

Machine gun 2,108,817 22 Feb 1938 (Hoppert, Bull & Simpson)

Firing rate reducer 2,384,854 18 Sep 1945

Machine gun trainer 2,516,926 1 Aug 1950

SIMPSON, WILLIAM EDMUND—MANSFIELD, ENGLAND

Gas-operated gun 589,822 8 Feb 1898

SJOCREN, THEODOR AXEL CARL—STOCKHOLM, SWEDEN

Automatic gun 739,732 22 Sep 1903

SKODA, EMIL—PILSEN, BOHEMIA, AUSTRIA-HUNGARY

Automatic quick-firing gun 429,819 10 June 1890

Quick-firing gun 448,841 24 Mar 1891

SLIWINSKI, ALBIN—PITTSBURGH, PA.

Trigger mechanism for automatic firearms and pistol-swords 1,221,616 3 Apr 1917 (Solomon & Sliwinski)

SMITH, A. B.—CLINTON, PA.

Improved machine gun for throwing projectiles 15,529 12 Aug 1856 (Smith & Weaver)

SMITH, DAVID J.—WASHINGTON, D.C.

Motor-operated gun 1,352,319 7 Sep 1920

SMITH, MORRIS F.—PHILADELPHIA, PA.

Machine gun 548,096 15 Oct 1895

Gas-operated machine gun 784,966 14 Mar 1905 (Assigned 3/4 to W. D. Condit)

Gas-operated machine gun 817,197 10 Apr 1906

Gas-operated gun 1,291,690 14 Jan 1919 ((Assigned to Driggs Ordnance Co. Inc.)

Firearm, Automatic gas-operated 814,242 6 Mar 1906

SMITH, WILLIAM D.—WASHINGTON, D.C.

Means for preventing erosion and over heating of firearms 1,189,011 27 June 1916

SOCIETA ITALIANA ERNESTO BRED A—MILAN, ITALY (\*)

Device for lubricating automatic firearms 1,656,960 24 Jan 1928 (Soncini)

Machine gun and other automatic firearms 1,773,441 19 Aug 1930 (Soncini)

SOCIETE ANONYME DES ANCIENS ETABLISSEMENTS HOTCHKISS & CIE.—SEINE, FRANCE (\*)

Accelerating device for automatic firearms 1,568,005 29 Dec 1925 (Sutter)

Combined loader ejector and safety mechanism for automatic firearms 1,656,845 17 Jan 1928 (Sutter)

Gas-controlled automatic firearm 2,052,368 25 Aug 1936 (Sutter)

Automatic firearm 2,108,026 8 Feb 1938 (Sutter & Bousset)

Automatic firearm 1,317,633 30 Sep 1919 (Squire & Mercie)

SOCIETE ANONYME DES ETABLISSEMENTS DELAUNAY—ST. DENIS, FRANCE (\*)

Automatic firearm 1,382,058 21 June 1921 (Bourdelle)

Machine gun 1,402,564 3 Jan 1922 (Bourdelle)

SOLMS, WILLY J.—PARIS, FRANCE (\*)

Multibarreled machine gun 1,319,882 28 Oct 1919 (Luciani)

SOLOMON, ANTON—PITTSBURGH, PA.

Trigger mechanism for automatic firearms and pistol-swords 1,221,616 3 Apr 1917 (Solomon & Sliwinski)

SOLOTHURN A. G. See WAFFENFABRIK SOLOTHURN A. G.

SONCINI, CESARE—BRESCIA, ITALY

Cartridge feed device for automatic firearms 1,611,289 21 Dec 1926 (Soncini & Castelli)

Automatic firearms with recoiling barrel 1,613,205 4 Jan 1927 (Soncini & Castelli)

Device for lubricating automatic firearms 1,656,960 24 Jan 1928 (Assigned to Società Italiana Ernesto Breda)

Machine gun and other automatic firearms 1,773,441 19 Aug 1930 (Assigned to Società Italiana Ernesto Breda)

SORENSEN, CHRISTIAN A.—LINCOLN, NEBR. (\*)

Machine gun cooling means 2,416,768 4 Mar 1947 (Monner, R. J.)

SPATZ, ED AND JOHN (\*)

Automatic firearm 747,073 15 Dec 1903 (Huntley)



## SPECIALTIES DEVELOPMENT CORP.—BLOOMFIELD, N.J. (\*)

Gun charger 2,411,877 3 Dec 1946 (Heizler)

Gun charger 2,409,623 22 Oct 1946 (Grant)

## SPENCER, CHRISTOPHER M.—SOUTH MANCHESTER, CONN.

Firearm, Breech-loading 34,319 4 Feb 1862

## SPILMAN, J. H.—ATLANTA, GA. (\*)

Machine gun 664,952 1 Jan 1901 (Blackburn, Spilman &amp; Bickart)

## SQUIRE, WILLIAM H.—ST. DENIS, FRANCE

Gas-operated gun 1,082,916 30 Dec 1913

Automatic firearm 1,317,633 30 Sep 1919 (Squire &amp; Mercie) (Assigned to Hotchkiss &amp; Cie.)

## STACEY, ERNEST W.—BEVERLY, MASS.

Ammunition feeder 2,494,728 17 Jan 1950 (Stacey &amp; Reinhold) (Assigned to United Shoe Machinery Corp.)

Ammunition feeder 2,524,132 3 Oct 1950 (Naugler &amp; Stacey) (Assigned to United Shoe Machinery Corp.)

Charger for automatic guns 2,529,822 14 Nov 1950 (Stacey &amp; Willhauck) (Assigned to United Shoe Machinery Corp.)

## STAMBAUGH, HENRY J.—TROY, N.Y.

Automatic gun 1,648,469 8 Nov 1927 (Adamson &amp; Stambaugh)

## STAMM, HANS—ST. GALLEN, SWITZERLAND

Automatic loading firearm 1,096,324 12 May 1914

## STANGE, LOUIS—SOMMERDA, GERMANY

Automatic firearm 1,755,034 15 Apr 1930 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

Automatic firearm 1,801,179 14 Apr 1931 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

Automatic firearm 1,846,156 23 Feb 1932 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

Automatic gun 2,113,202 5 Apr 1938 (Assigned to Rheinische Metallwaren und Maschinenfabrik)

## STAUF, C.—ST. LOUIS, MO.

Improvement in portable battery or platoon guns 34,017 24 Dec 1861 (Stauf &amp; Steinbach)

## STECKE, EDWARD—WARSAW, POLAND

Automatic firearm 2,089,671 10 Aug 1937

## STEINBACH, C. J.—ST. LOUIS, MO.

Improvement in portable battery or platoon guns 34,107 24 Dec 1861 (Stauf &amp; Steinbach)

## STEINBERGER, LOUIS—BROOKLYN, N.Y.

Noiseless, smokeless rapid fire gun 1,316,397 16 Sep 1919

## STENSLAND, CORNELIUS—NAGAUNEE, MICH.

Machine gun 143,729 14 Oct 1873

## STEVENS, JORDAN &amp; HARRISON, INC.—NEW YORK, N.Y. (\*)

Gun 2,387,199 16 Oct 1945 (Vang)

## STINSON, JAMES HENRY—COOKE, MONT.

Gun muffler 959,400 24 May 1910

## STOCKHOLMS VAPENFABRIK, AKTIEBOLAGET See AKTIEBOLAGET STOCKHOLMS VAPENFABRIK

## STODDARD, VAUGHN—CHELSEA, IOWA

Machine gun 1,242,068 2 Oct 1917

## STONE, BERKLEY C.—MIDDLETOWN, CONN. (\*)

Automatic firearm 1,226,479 15 May 1917 (Diehm)

## STONE, J. AUSTIN—WASHINGTON, D.C. (\*)

Fire control means for aircraft machine guns 1,466,951 4 Sep 1923 (Edwards)

## STORLE, OLE O.—TACOMA, WASH.

Machine gun 1,342,358 1 June 1920

## STOW, A. H.—HUNTER, W. VA.

Automatic firearm 726,109 21 Apr 1903

## STRASBURG, ALVIN CHARLES—CRIDERSVILLE, OHIO

Automatic firearm 854,771 28 May 1907

## STUCKEY, A. J.—GALVESTON, TEX.

Machine gun 1,869,738 2 Aug 1932 (Davis, Halett &amp; Stuckey)

## STUDLER, RENE R.—WASHINGTON, D.C.

Blank ammunition firing attachment for automatic guns 2,075,837 6 Apr 1937

## STURGEON, JOHN C.—ERIE, PA.

Automatic gas-operated firearm 1,290,849 7 Jan 1919

Automatic gas-operated firearm 1,290,850 7 Jan 1919

Automatic gun-cartridge supply and feed mechanism 1,290,851 7 Jan 1919

Cooling barrel mechanism for firearm 1,290,853 7 Jan 1919

Automatic rapid-fire gun 1,290,854 7 Jan 1919

## SUMMERBELL, WILLIAM—WASHINGTON, D.C.

Sub-caliber auxiliary barrel and extractor 2,423,471 8 Jun 1947

## SUNDERLAND, OSWALD O.—FAIRFIELD, CONN.

Machine gun fire retarder 2,509,530 30 May 1950 (Rosengren &amp; Sunderland)

Machine gun fire retarder 2,509,540 30 May 1950

## SUNNGARD, HARALD—CHRISTIANIA, NORWAY

Automatic firearm 972,087 4 Oct 1910

## SUSSMAN, WLADYSLAW—BROOKLYN, N.Y.

Automatic rifle 1,367,996 8 Feb 1921

## SUTTER, CHARLES—SURESNES, FRANCE

Accelerating device for automatic firearms 1,568,005 29 Dec 1925 (Assigned to Hotchkiss &amp; Compagnie)

Automatic machine gun 1,431,057 3 Oct 1922

Combined loader, ejector and safety mechanism for automatic firearms 1,656,845 17 Jan 1923 (Assigned to Société Anonyme des Anciens Etablissements Hotchkiss &amp; Co.)

Gas-controlled automatic firearm 2,052,368 25 Aug 1937 (Assigned to Hotchkiss &amp; Co.)

Automatic firearm 2,108,026 8 Feb 1938 (Sutter &amp; Bousel, A.) (Assigned to Hotchkiss &amp; Co.)

## SUTTON, HARRY A.—DAYTON, OHIO

Synchronizing gun control 1,496,749 3 June 1924  
 Cartridge mechanism for automatic guns 1,504,393 12 Aug 1924  
 Synchronizing gun control 1,504,394 12 Aug 1924

## SWAIN, ALFRED F.—BROOKLYN, N.Y.

Machine gun 928,344 20 July 1909

## SWARTZ, WILLIAM L.—WETHERSFIELD, CONN.

Automatic firearm 2,169,083 8 Aug 1939 (Assigned to Colt's Patent Fire Arms Co.)

## SWEBILIUS, CARL G.—HAMDEN, CONN.

Gas-operated self-loading firearm 2,373,204 10 Apr 1945  
 Belt holding pawls for machine guns 2,392,012 1 Jan 1946 (Assigned to High Standard Mfg. Corp.)  
 Extractor switch mechanism for machine guns 2,404,325 16 July 1946 (Assigned to the High Standard Mfg. Co.)  
 Automatic firearm 1,402,459 3 Jan 1922 (Assigned to Marlin Firearms Corp.)  
 Automatic gun 1,450,653 3 Apr 1923 (Assigned to Marlin Firearms Corp.)  
 Automatic firearm 1,444,890 13 Feb 1923 (Assigned to Marlin Firearms Corp.)  
 Automatic gun 1,504,584 12 Aug 1924 (Assigned to Marlin Firearms Corp.)  
 Automatic firearm 1,521,730 6 Jan 1925 (Assigned to Marlin Firearms Corp.)  
 Automatic firearm 1,550,759 25 Aug 1925 (Assigned to Marlin Firearms Corp.)  
 Automatic firearm 1,550,760 25 Aug 1925 (Assigned to Marlin Firearms Corp.)  
 Tubular magazine automatic firearm 2,282,903 12 May 1942 (Assigned to Western Cartridge Co.)  
 Self-loading repeating firearm 2,342,824 29 Feb 1944 (Assigned to High Standard Mfg. Co.)  
 Recoil-operated self-loading firearm 2,328,108 31 Aug 1943 (Assigned to Western Cartridge Co.)  
 Self-loading repeating firearm 2,365,307 19 Dec 1944 (Assigned to High Standard Mfg. Co.)  
 Gun barrel lock 2,437,137 2 Mar 1948  
 Ejector detent 2,500,139 7 Mar 1950

## SWENSON, ERIC A.—BEAUKISS, TEX.

Automatic firearms 2,057,169 13 Oct 1936

## SYMON, ROBERT R.—LONDON, ENGLAND (\*)

Machine gun 317,161 5 May 1885 (Maxim)

## TALIAFERRO, N.—AUGUSTA, KY.

Improvement in revolving ordnance 34,171 14 Jan 1862

## TANSLEY, GEORGE H.—HARTFORD, CONN.

Automatic machine gun 1,493,846 1 July 1924 (Assigned to Colt's Patent Mfg. Co.)  
 Firing mechanism for machine guns 2,050,539 11 Aug 1936 (Tansley & Moore) (Assigned to Colt's Patent Firearms Mfg. Co.)

## TASKER, V. C.—WASHINGTON, D.C.

Rapid-fire gun 613,195 25 Oct 1898 (L. L. Driggs & Tasker) (Assigned to Driggs-Seabury Gun & Ammunition Co.)

## TAYLOR, HAMELIN C.—PHILADELPHIA, PA.

Automatic gun 823,004 12 June 1906 (Assigned to Taylor, Knox)

## TAYLOR, JAMES PATTON—CARTER DEPOT, TENN.

Gun feeder for machine guns 189,811 17 Apr 1877  
 Machine gun 190,645 8 May 1877  
 Machine gun 206,365 23 July 1878 (Assigned 1/2 to John Baxter)  
 Improvement in repeating ordnance 116,775 4 July 1871 (Assigned to self & N. G. Taylor)  
 Improvement in machine guns 174,873 14 Mar 1876 (Assigned 1/2 to J. Baxter)  
 Improvement in machine guns 177,030 2 May 1876 (Assigned 1/2 to J. Baxter)  
 Improvement in machine guns 174,872 14 Mar 1876 (Assigned to J. Baxter)

## TAYLOR, JOHN A.—PICABO, IDAHO

Recoil-operated firearm 1,078,224 11 Nov 1913 (Assigned 1/2 to J. H. Carpenter)

## TAYLOR, NATHANIEL G.—ELIZABETHTON, TENN. (\*)

Improvement in repeating ordnance 116,775 4 July 1871 (Taylor, J. P.)

## TAYLOR, KNOX—HIGH BRIDGE, N.J. (\*)

Automatic gun 823,004 12 June 1906 (Taylor, H. P.)

## TERNSTRÖM, ERNST—PARIS, FRANCE

Automatic machine gun 642,018 23 Jan 1900

## TERREL, CHARLES C.—SHULISBURG, WISC.

Machine gun 14,215 5 Feb 1856 (Assigned to self and Crawford, S.)

## THAYER, C. B.—BOSTON, MASS.

Improvement in centrifugal guns 21,109 3 Aug 1858 (Assigned to Robinson, C.)

## THIELF, KARL—ESSEN-ON-THE-RHINE, GERMANY

Recoil gun 911,849 9 Feb 1909 (Assigned to Fried. Krupp Aktiengesellschaft)

## THOMPSON, EUGENE W.—NEW LONDON, CONN.

Gun silencer and recoil reducer 1,229,675 12 June 1917

## THOMPSON, JOHN T.—WASHINGTON, D.C. (\*)

Machine gun 1,334,052 16 Mar 1920 (Burleigh)

## THOMPSON, JOHN T.—NEWPORT, KY.

Automatic gun 1,425,810 15 Aug 1922 (Assigned to Auto Ordnance Corp.)

## THOMPSON, WALTER—BROOKLYN, N.Y.

Means for preventing the jamming of machine guns 1,371,527 15 Mar 1921

## THORSEN, THEODORE M.—PHILADELPHIA, PA.

Automatic firearm 696,118 25 Mar 1902

## THURLER, EUGENE—FRIBOURG, SWITZERLAND

Device for the suppression of the report of firearms 1,000,702 15 Aug 1911



## TOBORG, GEORGE—CHICAGO, ILL.

Automatic firearm 1,017,119 13 Feb 1912  
Automatic firearm 1,008,498 14 Nov 1911  
Automatic firearm 1,047,337 17 Dec 1912

## TOLL, HERMAN H.—CLARINDA, IOWA

Machine gun 661,897 13 Nov 1900

## TOWNSEND, ALFRED H.—GEORGETOWN, COLO.

Improvement in repeating ordnance 115,659 6 June 1871

## TRAVAGLINI, ANTONIO—PHILADELPHIA, PA.

Gas-operated firearm 630,136 1 Aug 1899 (Assigned 1/2 to Benedictis, C. D.)

## TRAVERSI, ROBERTO A.—RECCIO EMILIA, ITALY

Gun barrel 2,238,670 15 April 1941 (Traversi & Pegna)  
(Assigned to Compagna Commerciale Caproni)

## TREVASKIS, HENRY W.—BIRMINGHAM, ENGLAND

Solenoid 2,403,315 2 July 1946 (Assigned to Dunlop Rubber Co. Ltd.)  
Firing mechanism for automatic gun 2,397,387 26 Mar 1946 (Assigned to Dunlop Rubber Co.)

## TUCKER, LEONARD—LONDON, ENGLAND

Trigger mechanism for machine guns and small arms 1,561,756 17 Nov 1925 (Assigned to Vickers Ltd.)

## TUFTS, TIMOTHY—SOMERVILLE, MASS.

Improvement in repeating cannons 46,762 7 Mar 1865  
(Assigned to Page, J. W. H.)

## TURNER, SAMUEL W.—CLEVELAND, OHIO (\*)

Centrifugal gun 37,159 16 Dec 1862 (Eaton)

## TYPE RELEASE CO., INC.—WILMINGTON, DEL. (\*)

Machine gun 1,362,479 14 Dec 1920 (Dibovsky)

## UMBERTO, ONORATI—TOLEDO, OHIO

Automatic firearm 1,839,621 5 Jan 1932

## UNGE, W. T.—STOCKHOLM, SWEDEN

Firearm operated by gases of explosion 515,064 20 Feb 1894

## UNITED AIRCRAFT CORP.—EAST HARTFORD, CONN. (\*)

Gun charging installation 2,431,079 18 Nov 1947 (Richey)

## UNITED SHOE MACHINERY CORP.—FLEMINGTON, DEL. (\*)

Gun charging mechanism 2,411,934 3 Dec 1946 (Naugler)  
Automatic firearm 2,409,251 15 Oct 1946 (Cantley)  
Examining the interiors of gun barrels 2,405,245 6 Aug 1946 (Ushakoff)  
Gun-loading mechanism 2,425,425 12 Aug 1947 (Jorgensen)  
Firing mechanism for guns 2,440,381 27 Apr 1948 (Phillips)  
Gun ammunition magazine 2,447,092 17 Aug 1948 (Ray)  
Magazine for machine guns 2,489,428 29 Nov 1949 (Mariner)  
Ammunition feeder 2,494,728 17 Jan 1950 (Stacey & Reinhold)  
Ammunition feeder 2,524,132 3 Oct 1950 (Naugler & Stacey)

Charger for automatic guns 2,529,822 14 Nov 1950 (Stacey & Willhauck)

## UNITED STATES ORDNANCE CO.—WASHINGTON, D.C. (\*)

Automatic firearm 1,376,834 3 May 1921 (Sheppard)  
Attachment for gas-operated guns 1,445,583 13 Feb 1923 (Green)

## UNITED STATES ORDNANCE CO.—BOSTON, MASS. (\*)

Machine gun 1,379,339 24 May 1921 (Kaskell)

## UNIVERSAL ELECTRIC ARMS &amp; AMMUNITION CO.—NEW YORK, N.Y. (\*)

Cartridge, Electric 365,842 5 July 1887 (Monfort)  
Electrical breech-loading firearms 365,843 5 July 1887 (Monfort)

## UNIVERSAL PATENTS CO.—RHODE ISLAND (\*)

Machine gun belt 1,243,686 23 Oct 1917 (Batchelder)

## USHAKOFF, ALEXIS E.—BEVERLY, MASS.

Examining the interiors of gun barrels 2,405,245 6 Aug 1946 (Assigned to United Shoe Machinery Corp.)

## UTLEY, GREY—LOUISBURG, N.C.

Improvement in repeating ordnance 20,229 11 May 1858

## VANG, ALFRED—NEWARK, N.J.

Gun 2,387,199 16 Oct 1945 (Assigned to Stevens, Jordan & Harrison, Inc.)

## VANKEIRSBILCK, JOHN—HARTFORD, CONN.

Machine gun 504,517 5 Feb 1893 (Broderick & Vankeirsbilck) (Assigned to Gatling Gun Co.)  
Feed for machine guns 504,516 5 Sep 1893 (Broderick & Vankeirsbilck) (Assigned to Gatling Gun Co.)

## VICKERS, ALBERT—LONDON, ENGLAND (\*)

Machine gun 317,161 5 May 1885 (Maxim)  
Automatic gun 690,799 7 Jan 1902 (Assigned to Vickers Sons & Maxim Ltd.)

## VICKERS-ARMSTRONG LTD.—WESTMINSTER, ENGLAND (\*)

Gas-operated machine gun and automatic small arm 1,811,693 23 June 1931 (Larsson & Higson)  
Drum magazine for machine guns and automatic small arms 1,811,694 23 June 1931 (Larsson & Higson)  
Machine gun and automatic small arm 1,846,035 9 Feb 1932 (Larsson & Higson)  
Machine gun 2,037,244 14 Apr 1936 (Larsson & Higson)  
Machine gun and drum magazine therefor 2,113,793 12 Apr 1938 (Larsson & Higson)  
Machine gun and automatic small arm 2,137,612 22 Nov 1938 (Higson)  
Automatic gun 2,347,559 25 Apr 1944 (Higson)  
Machine gun 2,013,312 3 Sep 1935 (Larsson & Higson)  
Machine gun 2,048,395 21 July 1936 (Larsson & Higson)  
Double-barreled automatic gun 2,509,734 30 May 1950 (Higson)

## VICKERS LIMITED—WESTMINSTER, ENGLAND (\*)

Automatic gun 1,262,169 9 Apr 1918 (Buckham)  
Automatic gun 1,262,181 9 Apr 1918 (Dawson & Buckham)

Bullet deflector for the propellers of aeroplanes and similar aircraft provided with machine guns 1,298,886 1 Apr 1919 (Challenger)

Automatic gun 1,298,887 1 Apr 1919 (Challenger & Savage)

Machine gun 1,312,106 5 Aug 1919 (Dawson & Buckham)

Machine gun 1,314,734 2 Sep 1919 (Dawson & Buckham)

Machine gun 1,327,086 6 Jan 1920 (Dawson & Buckham)

Machine gun mounting 1,364,925 4 Jan 1921 (Scarff)

Machine gun 1,447,246 6 Mar 1923 (Hazelton)

Machine gun 1,453,974 1 May 1923 (Dawson, Buckham & Haskell)

Machine gun 1,479,138 1 Jan 1924 (Hazelton)

Machine gun 1,456,625 29 May 1923 (Dawson & Buckham)

Automatic gun 1,468,262 18 Sep 1923 (Dawson, Buckham & Larsson)

Means for controlling the rate of fire of automatic guns carried by aircraft 1,486,909 18 Mar 1924 (Lucas)

Articulated link for the cartridge belts of machine guns 1,550,787 25 Aug 1925 (Dawson, Buckham & Larsson)

Automatic gun 1,553,992 15 Sep 1925 (Dawson, Buckham & Larsson)

Trigger mechanism for machine guns and small arms 1,561,756 17 Nov 1925 (Tucker)

Gun mounting for use in aircraft 1,628,068 10 May 1927 (Scarff)

#### VICKERS, SONS & MAXIM, LTD.—LONDON, ENGLAND (\*)

Automatic gun 644,969 6 Mar 1900 (Dawson & Silverman)

Automatic machine gun 687,130 19 Nov 1901 (Dawson & Buckham)

Automatic gun 690,799 7 Jan 1902 (Vickers)

Automatic gun 772,700 18 Oct 1904 (Dawson & Silverman)

Muzzle attachment for automatic guns 870,497 5 Nov 1907 (Dawson & Ramsay)

Automatic gun 920,832 4 May 1909 (Dawson & Buckham)

Automatic gun 942,167 7 Dec 1909 (Dawson & Buckham)

Cartridge feed mechanism of Maxim guns 951,999 15 Mar 1910 (Buckham)

Automatic gun 926,052 22 June 1909 (Dawson & Buckham)

Cartridge feed mechanism for automatic guns 1,091,640 31 Mar 1914 (Dawson & Buckham)

Automatic gun 1,077,680 4 Nov 1913 (Dawson & Buckham)

#### VICTOR P. DE KNIGHT GUN CO.—WASHINGTON, D.C. (\*)

Rapid-fire automatic gun 698,107 22 Apr 1902 (De Knight)

Rapid-fire automatic gun 709,880 30 Sep 1902 (De Knight)

Rapid-fire automatic gun 709,881 30 Sep 1902 (De Knight)

Rapid-fire automatic gun 709,883 30 Sep 1902 (De Knight)

#### VILLAR PEROSA, OFFICINI DI—VILLAR PEROSA, ITALY (\*)

Automatic firearm 1,159,417 9 Nov 1915 (Revelli)

Machine gun 1,286,884 3 Dec 1918 (Revelli)

#### VINCON, GUSTAVO—TURIN, ITALY

Automatic firearm 1,464,276 7 Aug 1923

#### VINSON, NEAL L.—MILL VALLEY, CALIF.

Air-cooled gun barrel 2,363,563 28 Nov 1944

#### VOLLER, KARL—DUSSELDORF, GERMANY

Gun with recoiling barrel 855,366 28 May 1907 (Assigned to Rheinische Metallwaren u. Maschinenfabrik)

Recoil mechanism for guns 1,034,171 30 July 1912

Automatic firing mechanism 887,713 12 May 1908 (Assigned to Rheinische Metallwaren u. Maschinenfabrik)

#### VOLLMER, HEINRICH—BIBERACH-RISS, GERMANY

Automatic firearm 2,182,907 12 Dec 1939 (Assigned to Gastav Genschow & Co.)

#### VOLLMER, JOHN—ESSEN, GERMANY

Composite gun barrel assembled by rotary motion of its component parts 1,400,780 20 Dec 1921 (Assigned to Fried. Krupp Aktiengesellschaft)

#### VON JEINSEN, E.—NEW YORK, N.Y.

Breech-loading firearms 84,922 15 Dec 1868

#### WACKERMANN, FRANK—PITTSBURGH, PA.

Recoil-operated firearm 516,417 13 Mar 1894

#### WAFFENFABRIK MAUSER AKTIENGESELLSCHAFT—OBERNDORF, GERMANY (\*)

Rotatable breech bolt for automatic firearm 1,180,784 25 Apr 1916 (Paul Mauser)

Rotatable lug bolt firearm 1,180,785 25 April 1916 (Paul Mauser)

Firearm 1,217,974 6 March 1917 (P. Mauser)

Means for combining the barrel with the receiver in connection with firearms 1,234,783 31 July 1917 (Mauser, Paul)

#### WAFFENFABRIK SOLOTHURN A. G.—SOLOTHURN, SWITZERLAND (\*)

Automatic firearm 2,015,908 1 Oct 1935 (Rakula & Herlach)

Automatic gun 2,067,322 12 Jan 1937 (Heilach & Rakula)

#### WAGNER, PAUL G.—LOS ANGELES, CALIF.

Machine gun starter & recharger 2,180,751 21 Nov 1939

#### WAGNON, IRA W.—CASA GRANDE, ARIZ.

Automatic rifle 1,398,452 29 Nov 1921 (Assigned 1/2 to Brown, J. F.)

#### WALKER, BROOKS—PIEDMONT, CALIF.

Air-cooled gun 2,427,374 16 Sep 1947

#### WALL, ALEXANDER C.—INDIANAPOLIS, IND.

Gun charger 2,389,943 27 Nov 1945 (Assigned to General Electric Co.)

#### WALTHER, CARL—ZELLA, GERMANY

Automatic firearm with stationary barrel 991,398 2 May 1911



**WALTHER, FRITZ—ZELLA-MEHLIS, GERMANY**

Automatic firearm 1,457,477 5 June 1923 (Walther, F. &amp; Walther, G.)

Automatic firearm 1,481,042 15 Jan 1923 (Walther, F. &amp; Walther, G.)

Automatic firearm 2,145,328 31 Jan 1939

**WALTHER, GEORG—ZELLA-MEHLIS, GERMANY**

Automatic firearm 1,457,477 5 June 1923 (Walther, F. &amp; Walther, G.)

Automatic gun 1,481,042 15 Jan 1924 (Walther, F. &amp; Walther, G.)

**WANINGER, CARL—DÜSSELDORF, GERMANY**

Gun loading device 2,151,288 21 Mar 1939 (Assigned to Rheinmetall-Borsig Aktiengesellschaft)

**WARNER, JAMES HAROLD—NEW YORK, N.Y.\***

Machine gun 1,273,078 16 July 1918 (McManus, L. M.)

**WATSON, GLENN C.—CLEVELAND, OHIO**

Automatic rifle 1,377,236 10 May 1921

**WATT, ANDREW K.—LANSING, MICH.**

Feed mechanism for machine guns 2,519,947 22 Aug 1950 (Assigned to General Motors Corp.)

**WEAVER, WM.—CLINTON, PA.**

Improved machine for throwing projectiles 12,529 12 Aug 1856 (Smith &amp; Weaver)

**WEBB, GEORGE—HARTFORD, CONN.**

Automatic firearm &amp; combined accessories 2,359,263 26 Sep 1944 (Assigned to Colt's Firearms Mfg. Co.)

Automatic firearm 2,375,452 8 May 1945 (Assigned to Colt's Patent Fire Arms Mfg. Co.)

**WEBB, HARRY C.—TACOMA, WASH.**

Machine gun 569,899 20 Oct 1896

**WEED, JAMES—RAWLINS, WYO.**

Automatic gun 718,062 6 Jan 1903 (Assigned to Lewis, J. &amp; Brown, A. A.)

**WELIN, ERNST A. M.—LONDON, ENGLAND**

Quick-firing gun 614,414 15 Nov 1898

**WERKZEUG MASCHINENFABRIK OERLIKON—OERLIKON, SWITZERLAND (\*)**

Automatic gun 1,556,225 6 Oct 1925 (Kung)

Bearing surface for breech bolts in automatic firearms 2,509,043 23 May 1950 (Mühlemann)

Automatic inertia-locked firearm with automatic hammer 2,512,014 20 Jun 1950 (Eglin)

Automatic firearm breech bolt lock 2,512,027 20 Jun 1950 (Lippert &amp; Mühlemann)

Automatic firearm breech bolt locking mechanism 2,523,704 26 Sep 1950 (Lippert &amp; Hepperle)

Trigger mechanism for automatic firearms 2,524,258 3 Oct 1950 (Hepperle)

**WESTERN CARTRIDGE CO.—DELAWARE (\*)**

Gas-operated firearm 2,211,405 13 Aug 1940 (Browning)

Tubular magazine automatic firearm 2,282,903 12 May 1942 (Swebilius)

Gas-operated automatic firearm 2,252,754 19 Aug 1941 (Browning)

Gas-operated actuating mechanism for firearms 2,340,962 8 Feb 1944 (Humeston)

Recoil-operated self-loading firearm 2,328,108 31 Aug 1943 (Swebilius)

Gas-operated self-loading firearm 2,346,954 18 Apr 1944 (Williams)

Gas-operated self-loading firearm 2,355,768 15 Apr 1944 (Williams)

Gas-operated self-loading firearm 2,370,233 27 Feb 1945 (Crockett)

Self loading firearm 2,372,339 27 May 1945 (Roemer)

**WESTFALL, WALTER E.—MARYVILLE, MO.**

Silencer for construction firearms 1,111,202 22 Sep 1914

**WHALEN, JAMES A.—BROOKLYN, N.Y.**

Improvement in revolving firearms 25,052 22 Apr 1862

**WHITCOMB, JAMES O.—NEW YORK, N.Y.**

Improvement in magazine field batteries 38,350 28 Apr 1863

**WHITE AUTOMATIC GUN CORP.—PORTLAND, ME. (\*)**

Automatic gun 1,907,163 2 May 1933 (White)

Automatic gun 1,907,164 2 May 1933 (White)

**WHITE, HARRY K.—ANNAPOLIS, MD.**

Recoil-operated magazine firearm 488,409 20 Dec 1892 (Assigned to the White Magazine Rifle Co.)

**WHITE, JOSEPH C.—WAKEFIELD, MASS.**

Automatic gun 1,907,163 2 May 1933 (Assigned to White Automatic Gun Corp.)

Automatic gun 1,907,164 2 May 1933 (Assigned to White Automatic Gun Corp.)

**WHITING, WILLIAM JOHN—HANDSWORTH, ENGLAND**

Automatic revolver firearm 688,216 2 Dec 1901

Automatic revolver firearm 688,217 3 Dec 1901

Automatic firearm 803,948 7 Nov 1905

Automatic firearm 804,694 14 Nov 1905

Automatic firearm 827,488 31 July 1906

Automatic firearm 863,770 30 Aug 1907

Automatic fireman 896,496 18 Aug 1908

Automatic firearm 939,882 9 Nov 1909

**WHITNEY, JAMES S.—LOWELL, MASS.**

Machine gun 311,551 3 Feb 1885

**WHITTIER, WALTER H.—GRAND RAPIDS, MICH.**

Automatic firearm 1,019,937 12 Mar 1912

Automatic firearm 1,034,750 6 Aug 1912

**WIKANDER, OSCAR R.—PITTSBURGH, PA.**

Automatic gun 2,370,835 6 Mar 1945 (Bell &amp; Wikander) (Assigned to Edgewater Steel Co.)

Automatic gun 2,395,211 19 Feb 1946 (Bell &amp; Wikander) (Assigned to Edgewater Steel Co.)

**WILDER, ELIHU—MANCHESTER, N.H.**

Machine gun 182,729 26 Sep 1876

- Machine gun 563,701 7 July 1896 (Assigned to Moses, H. O.)  
Improvement in machine guns 182,729 26 Sep 1876
- WILDNER, FRANZ—BOHEMIA, CZECHOSLOVAKIA  
Silencer for firearms 1,462,158 17 July 1923
- WILLIAMS, DAVID M.—GODWIN, N.C.  
Automatic firearm 2,090,656 24 Aug 1937  
Automatic firearm 2,090,657 24 Aug 1937  
Belt-feeding means for guns 2,027,893 14 Jan 1936  
Gas-operated self-loading firearm 2,346,954 18 Apr 1944 (Assigned to Western Cartridge Co.)  
Gas-operated self-loading firearm 2,355,768 15 Aug 1944 (Assigned to Western Cartridge Co.)  
Piston means for gas-operated firearms 2,376,466 22 May 1945 (Assigned to Olin Industries, Inc.)  
Cartridge-extracting mechanism for firearms 2,412,663 17 Dec 1946 (Assigned to Olin Industries, Inc.)
- WILLIAMS, EDGAR A.—UPPER BLACK EDDY, PA.  
Interchangeable barrel for guns 1,760,731 27 May 1930
- WILSON, ELIJAH—FRENIER, LA. (\*)  
Machine gun 1,174,923 7 Mar 1916 (Woodson)
- WILSON, THOMAS—BIRMINGHAM, ENGLAND  
Revolving magazine gun 481,452 23 Aug 1892
- WINCHESTER REPEATING ARMS CO.—NEW HAVEN, CONN. (\*)  
Magazine for firearms 285,284 18 Sep 1883 (Mason)  
Gas-operated gun 525,151 28 Aug 1894 (Mason)  
Automatic gun 636,196 31 Oct 1899 (Burgess)  
Automatic firearm 681,481 27 Aug 1901 (Johnson)  
Automatic firearm 694,157 25 Feb 1902 (Johnson)  
Automatic firearm 695,781 18 Mar 1902 (Bennett & Mason)  
Recoil operated firearm 768,665 30 Aug 1904 (Johnson)  
Locking block for automatic guns 760,871 24 May 1904 (Johnson)  
Tubular magazine automatic gun 874,856 24 Dec 1907 (Mason)  
Gas-operated gun 877,657 28 Jan 1908 (Mason)  
Gas-operated gun 885,166 21 Apr 1908 (Mason)  
Automatic firearm 846,591 12 Mar 1907 (Mason)  
Automatic firearm 854,707 21 May 1907 (Mason)  
Recoiling barrel gun 941,006 23 Nov 1909 (Burton)  
Automatic firearm 933,254 7 Sep 1909 (Knous)  
Recoiling barrel firearm 945,328 4 Jan 1910 (Johnson)  
Recoiling barrel gun 946,134 11 Jan 1910 (Johnson)  
Cartridge-ejecting mechanism for firearms 2,101,236 7 Dec 1937 (Burton)
- WINKS, JOHN O.—SAN FRANCISCO, CALIF.  
Automatic firearm 1,104,947 28 July 1914  
Automatic firearm 1,190,352 11 July 1916
- WINTER, ALFRED—DÜSSELDORF, GERMANY  
Automatic firearm 2,133,661 18 Oct 1938 (Engel & Winter) (Assigned to Rheinmetall-Borsig Aktiengesellschaft)
- WISMAN, FRANKLIN O.—SOUTH BEND, IND.  
Automatic machine gun charger 2,410,767 5 Nov 1946 (Wisman & Rohm) (Assigned to Bendix Aviation Corp.)
- WOOD, MARSHALL—LEWISBURGH, W.VA.  
Machine gun 130,098 30 July 1872 (Assigned to self and Mathews)
- WOOD, STEPHEN W.—CORNWALL, N.Y.  
Improvement in field artillery 126,607 7 May 1872
- WOODGATE, HERBERT FERDINAND—LONDON, ENGLAND  
Recoil-operated gun 512,437 9 Jan 1894 (Griffiths & Woodgate)
- WOODSON, HENRY D., JR.—FRENIER, LA.  
Machine gun 1,174,923 7 Mar 1916 (Assigned 15/100 to Elijah Wilson)
- WOODWARD, JAMES N.—LOUISVILLE, MISS. (\*)  
Machine gun 282,787 7 Aug 1893 (F. M. Shields)
- WOODWARD, R.—NEW EGYPT, N.J.  
Improvement in firearms 31,933 2 Apr 1861 (McCord)
- WOODY, GEORGE A.—TILDEN, TEXAS  
Operating mechanism for machine guns 1,897,099 14 Feb 1933 (Woody & Coupland)
- WRIGHT, ROBERT LEE—LOS ANGELES, CALIF.  
Machine gun 1,444,768 6 Feb 1923
- WRIGHT, JOSEPH—ENGLAND  
Firing device for automatic guns 2,135,688 8 Nov 1938 (Wright, Park & Trevaskis) (Assigned to Dunlop Rubber Co. Ltd.)
- WURTZBACH, L. E.—LEAD, S.D.  
Silencing device for firearms 1,525,846 10 Feb 1925
- WURZER, MARTIN—PHILADELPHIA, PA.  
Machine gun 2,029,839 4 Feb 1936
- YOUNG, FRANKLIN K.—BOSTON, MASS.  
Automatic firearm 624,145 2 May 1899
- YOUNG, LAUTT F.—CHAFFEE, MO.  
Buffer spring assembly for automatic firearms 2,504,958 25 Apr 1950 (Botts & Young)  
Gun clearing device 2,495,800 31 Jan 1950
- Z. B., See CESKOSLOVENSKA ZBRJOVKA AKCIOVA-SPOLECNOST
- ZBRJOVKA BRNO NARODNI PODNIK — PRAGUE, CZECHOSLOVAKIA (\*)  
Inertia member for retarding breechblock movement in automatic firearms 2,495,460 24 Jan 1950 (Koucky)  
Cartridge feeding means for automatic firearms 2,519,582 22 Aug 1950 (Koucky)



## APPENDIX B

### Tabulated Characteristics of Machine Guns and Aircraft Cannon

This table has been compiled as a handy reference to the world's effort in the field of automatic machine guns and cannon. Due to the vast number of models that have been developed from a basic mechanism, no attempt was made to list them all here. To avoid repetition, a representative weapon was chosen that best illustrated the inventor's (or manufacturer's) family of machine guns. (In the foregoing text all models are covered.) Where a weapon is known by more than one name or designation, it has been cross-indexed under each.

In the table, the following code is employed under "Use":

A—Aircraft  
A-A—Antiaircraft  
A-T—Antitank  
I—Infantry.

## Automatic Machine Guns

| Weapon                       | Bore               | Country of origin | Use | Method of operation               | Type of lock              |
|------------------------------|--------------------|-------------------|-----|-----------------------------------|---------------------------|
| Bang Model 1929              | Cal. .276          | Denmark           | A   | Muzzle blast jerks piston forward | Rotating bolt head        |
| B. A. R.                     | Cal. .30           | U. S. A.          | I   | Gas-actuated piston               | Propped breech            |
| Beardmore-Farquhar           | Cal. .303          | England           | A   | Gas and spring actuated           | Rotating bolt head        |
| Benét-Mercié Model 1909      | 8 mm               | France            | I,A | Gas-actuated piston               | Locking ring              |
| Bergmann Model 1910          | 7.92 mm            | Germany           | I   | Short recoil                      | Sliding block             |
| Bergmann Model 1915 N.A.     | 7.92 mm            | Germany           | A   | Short recoil                      | Sliding block             |
| Berthier Model 1908          | 8 mm               | France            | I   | Gas-actuated piston               | Propped breech            |
| Berthier-Vickers (G. O.)Mk I | cal. .303          | England           | A   | Gas-actuated piston               | Propped breech            |
| Besa Mk I                    | 7.92 mm            | England           | I   | Gas-actuated piston               | Propped breech            |
| Besa Mk I (ZB-60 Mod 38)     | 15 mm              | England           | A-T | Gas-actuated piston               | Propped breech            |
| Breda Model 1924             | 6.5 mm             | Italy             | I   | Short recoil                      | Locking ring              |
| Breda-Fiat Model 1930        | 7.92 mm            | Italy             | I   | Short recoil                      | Locking ring              |
| Breda Model 1935             | 7.7 mm (cal. .303) | Italy             | I   | Short recoil blow-back            | Rolling lock              |
| Breda Model 1937             | 12.7 mm            | Italy             | A   | Gas-actuated piston               | Sliding block vertical    |
| Bren Mk I                    | Cal. .303          | England           | I   | Gas-actuated piston               | Propped Breech            |
| Brixia Model 1920            | 6.5 mm             | Italy             | A   | Short recoil                      | Rolling lock              |
| Browning Model 1918          | Cal. .30           | U. S. A.          | A   | Short recoil                      | Sliding block             |
| Browning M2                  | Cal. .50           | U. S. A.          | A   | Short recoil                      | Sliding block             |
| B. S. A. Model 1924          | Cal. .50           | England           | A   | Short recoil                      | Partial rotation of bolt  |
| Carr                         | Cal. .30           | U. S. A.          | I   | Short recoil                      | Toggle                    |
| Chatellerault Model 1929     | 7.5 mm             | France            | I   | Gas-actuated piston               | Propped breech by linkage |



| Type of feed  | Capacity of feed      | Method of cooling | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|---------------|-----------------------|-------------------|------------------------------------|--------------------------------|-------------------------|
| Link belt     | 250                   | Air               | 21½                                | 2,400                          | 350-450                 |
| Magazine      | 20                    | Air               | 15½                                | 2,680                          | 500                     |
| Drum magazine | 77                    | Air               | 16¼                                | 2,427                          | 450-550                 |
| Strip         | 24-30                 | Air               | 27                                 | 2,296                          | 650                     |
| Fabric belt   | 200                   | Water             | 36                                 | 2,952                          | 480-550                 |
| Fabric belt   | 200                   | Air               | 34                                 | 2,952                          | 750-800                 |
| Magazine      | 20-30                 | Air               | 19                                 | 2,296                          | 240-400                 |
| Flat drum     | 97                    | Air               | 31½                                | 2,427                          | 750-900                 |
| Link belt     | 200                   | Air               | 47                                 | 2,950                          | 550-800                 |
| Link belt     | 40                    | Air               | 125½                               | 3,200                          | 400-500                 |
| Magazine      | 20                    | Air               | 20                                 | 2,080                          | 450-500                 |
| Magazine      | 20                    | Air               | 20                                 | 2,952                          | 450-500                 |
| Link belt     | 250                   | Air               | 27                                 | 2,400                          | 600-650                 |
| Tray          | 20                    | Air               | 42½                                | 2,600                          | 450-500                 |
| Magazine      | 25-40-100             | Air               | 23                                 | 2,400                          | 450-550                 |
| Magazine      | 50                    | Air               | 34                                 | 2,080                          | 500-600                 |
| Link belt     | 250                   | Air               | 30½                                | 2,750                          | 1,100-1,300             |
| Link belt     | Any reasonable amount | Air               | 61                                 | 2,840                          | 750-850                 |
| Flat drum     | 37                    | Air               | 46                                 | 2,600                          | 400-450                 |
| Drum magazine | 248                   | Air               | 82                                 | 2,228                          | 480-500                 |
| Magazine      | 30                    | Air               | 22                                 | 2,700                          | 450-500                 |

## Automatic Machine Guns (continued)

| Weapon                          | Bore     | Country of origin | Use | Method of operation                   | Type of lock            |
|---------------------------------|----------|-------------------|-----|---------------------------------------|-------------------------|
| Chauchat Model 1915             | 8 mm     | France            | I   | Long recoil                           | Rotating bolt head      |
| Colt Model 1895                 | 6 mm     | U. S. A.          | I   | Gas operating swinging lever          | Propped breech          |
| Darne Type 33, Model 29         | 7.5 mm   | France            | A   | Gas-actuated piston                   | Propped breech          |
| De Knight                       | Cal. .30 | U. S. A.          | I   | Gas-actuated piston                   | Pivoting                |
| Dreyse Model 1912               | 7.92 mm  | Germany           | I   | Short recoil                          | Pivoting lock           |
| FG-42                           | 7.92 mm  | Germany           | A   | Gas-actuated piston                   | Rotating bolt           |
| Fiat Model 1914                 | 6.5 mm   | Italy             | I   | Retarded blow back                    | Mechanical disadvantage |
| Fiat Model 1928                 | 7.7 mm   | Italy             | A   | Short recoil                          | Pivoting (linkage)      |
| Furrer Model 1925               | 7.5 mm   | Switzerland       | I   | Short recoil                          | Toggle                  |
| Gast (Double Barrel) Model 1918 | 7.92 mm  | Germany           | A   | Energy from fired bolt operates other | Partial rotation        |
| Hotchkiss Model 1897            | 8 mm     | France            | I   | Gas-actuated piston                   | Swinging                |
| Hotchkiss "Portative"           | 8 mm     | France            | I   | Gas-actuated piston                   | Locking ring            |
| Hotchkiss Anti-Balloon Gun      | 11 mm    | France            | A   | Gas-actuated piston                   | Swinging                |
| Johnson Model 1941              | Cal. .30 | U. S. A.          | I   | Short recoil                          | Rotating bolt           |
| Kjellman                        | 6.5 mm   | Sweden            | I   | Short recoil                          | Pivoting locks (2)      |
| Knorr-Bremse Model 35/36        | 7.92 mm  | Germany           | I   | Gas-actuated piston                   | Propped breech linkage  |
| Lahti Model 26/32               | 7.92 mm  | Finland           | I   | Short recoil accelerator              | Swinging                |
| Lewis Model 1912                | Cal. .30 | U. S. A.          | I,A | Gas-actuated piston                   | Rotating bolt           |
| LS Model 26/32                  | 7.7 mm   | Finland           | I   | Short recoil                          | Swinging                |
| McClellan                       | Cal. .30 | U. S. A.          | I   | Gas                                   | Rotating bolt           |
| Madsen Model 1904               | 8 mm     | Denmark           | I   | Short recoil                          | Pivoting bolt           |



| Type of feed          | Capacity of feed      | Method of cooling     | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|-----------------------|-----------------------|-----------------------|------------------------------------|--------------------------------|-------------------------|
| Magazine              | 20                    | Air                   | 18                                 | 2,300                          | 240                     |
| Fabric belt           | Any reasonable amount | Air                   | 40                                 | 2,500                          | 500                     |
| Link belt             | 250                   | Air                   | 18½                                | 2,700                          | 900-1200                |
| Fabric belt           | 240                   | Water                 | 38½                                | 2,228                          | 600                     |
| Link belt             | 200                   | Water                 | 37½                                | 2,952                          | 550-600                 |
| Magazine              | 20                    | Air                   | 14                                 | 2,750                          | 400-450                 |
| Magazine compartments | 50                    | Water                 | 37½                                | 2,085                          | 450-500                 |
| Link belt             | 250                   | Air                   | 28                                 | 2,400                          | 700-800                 |
| Magazine              | 30                    | Air                   | 18                                 | 2,950                          | 400-450                 |
| Flat drum             | 180 (each drum)       | Air                   | 60                                 | 2,902                          | 1,600-1,800             |
| Strip                 | 24-30                 | Air (metal doughnuts) | 55                                 | 2,400                          | 600                     |
| Strip                 | 24-30                 | Air                   | 27                                 | 2,400                          | 650-700                 |
| Strip                 | 24                    | Air                   | 66                                 | 1,600                          | 400                     |
| Clip                  | 5-20                  | Air                   | 12½                                | 2,750                          | 400-500                 |
| Fabric belt           | 250                   | Water                 | 28                                 | 2,395                          | 500-600                 |
| Magazine              | 25                    | Air                   | 18½                                | 2,952                          | 450-500                 |
| Magazine              | 25-75                 | Air                   | 19½                                | 2,952                          | 450-550                 |
| Magazine flat drum    | 47-96                 | Air radiator          | 25                                 | 2,750                          | 500-600                 |
| Magazine              | 25-75                 | Air                   | 19½                                | 2,400                          | 450-550                 |
| Magazine              | 90                    | Air radiator          | 68                                 | 2,570                          | 550                     |
| Magazine              | 25-40                 | Air or water          | 21                                 | 2,228                          | 500-650                 |

## Automatic Machine Guns (continued)

| Weapon                    | Bore     | Country of origin | Use | Method of operation           | Type of lock             |
|---------------------------|----------|-------------------|-----|-------------------------------|--------------------------|
| Madsen Model 1927         | 11.35 mm | Denmark           | A   | Short recoil                  | Pivoting bolt            |
| Marlin                    | Cal. .30 | U. S. A.          | A   | Gas-actuated piston           | Propped breech           |
| Maxim Prototype of 1884   | Cal. .45 | England           | I   | Short recoil                  | Toggle                   |
| Maxim Model .08           | 7.92 mm  | Germany           | I   | Short recoil                  | Toggle                   |
| Mendoza Model 1937        | 7 mm     | Mexico            | I   | Gas-actuated short piston     | Rotating bolt            |
| MG-15 (Rheinmetall)       | 7.92 mm  | Germany           | A   | Short recoil (muzzle booster) | Locking ring             |
| MG-17 (Rheinmetall)       | 7.92 mm  | Germany           | A   | Short recoil (muzzle booster) | Locking ring             |
| MG-34 (Mauser)            | 7.92 mm  | Germany           | I   | Short recoil (muzzle booster) | Rotating bolt head       |
| MG-42 (Mauser)            | 7.92 mm  | Germany           | I   | Short recoil (muzzle booster) | Roller locking studs     |
| MG-81 (Mauser)            | 7.92 mm  | Germany           | A   | Short recoil accelerator      | Rotating bolt head       |
| Nordenfelt Model 1897     | 8 mm     | France            | I   | Short recoil (and manual)     | Rolling breech lock      |
| Parabellum (Maxim)        | 7.92 mm  | Germany           | A   | Short recoil                  | Toggle                   |
| Perino Model 1908         | 7.7 mm   | Italy             | I   | Short recoil                  | Pivoting                 |
| Puteaux Model 1905        | 8 mm     | France            | I   | Gas-actuated piston           | Swinging                 |
| Revelli Model 1914        | 6.5 mm   | Italy             | I   | Retarded blow back            | Mechanical disadvantage  |
| Revelli Model 1914        | 6.5 mm   | Italy             | A   | Retarded blow back            | Mechanical disadvantage  |
| Rheinmetall-Borsig MG-131 | 13 mm    | Germany           | A   | Short recoil accelerator      | Locking ring             |
| Safat Model 1928          | 7.7 mm   | Italy             | A   | Short recoil                  | Propped breech (linkage) |
| St. Etienne Model 1907    | 8 mm     | France            | I   | Gas actuates piston forward   | Swinging                 |



| Type of feed                         | Capacity of feed      | Method of cooling     | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|--------------------------------------|-----------------------|-----------------------|------------------------------------|--------------------------------|-------------------------|
| Drum                                 | 100                   | Air                   | 37½ (with loaded drum)             | 2,475                          | 850-1,000               |
| Link Belt                            | 250-300               | Air                   | 22                                 | 2,750                          | 600-680                 |
| Belt-magazine-clip                   | 333-334               | Water                 | 60 (with empty jacket)             | 1,200                          | 600                     |
| Fabric belt                          | Any reasonable amount | Water                 | 40½                                | 2,750                          | 600                     |
| Magazine                             | 20-30                 | Air                   | 18½                                | 2,750                          | 400-500                 |
| Link belt                            | 250                   | Air                   | 27½                                | 2,952                          | 750-1,000               |
| Link belt                            | 250                   | Air                   | 27¾                                | 2,552                          | 750-1,000               |
| Link belt                            | 250                   | Air                   | 24½                                | 2,750                          | 750-800                 |
| Link belt magazine                   | 75-250                | Air                   | 24                                 | 2,570                          | 1,200-1,350             |
| Link belt                            | 250                   | Air                   | 13¾                                | 2,750                          | 1,200-1,300             |
| Push out link belt                   | 200                   | Water                 | 37 (empty jacket)                  | 2,300                          | 600                     |
| Fabric belt                          | 250-350               | Air                   | 22                                 | 2,952                          | 600-700                 |
| Metal trays                          | 25                    | Water, Air            | 50                                 | 2,400                          | 600                     |
| Strip                                | 25                    | Air (brass radiator)  | 54                                 | 2,296                          | 650                     |
| Magazine, spring-loaded compartments | 50                    | Water                 | 37½                                | 2,080                          | 450-500                 |
| Magazine compartments                | 50                    | Air                   | 29½                                | 2,080                          | 450-500                 |
| Link belt                            | 250                   | Air                   | 40                                 | 2,560                          | 850-960                 |
| Link belt                            | 250                   | Air                   | 28                                 | 2,640                          | 700-800                 |
| Strip                                | 25                    | Air (brass doughnuts) | 46                                 | 2,300                          | 500                     |

## Automatic Machine Guns (concluded)

| Weapon                        | Bore      | Country of origin | Use | Method of operation                          | Type of lock            |
|-------------------------------|-----------|-------------------|-----|----------------------------------------------|-------------------------|
| Schwarzlose Model 1907        | 7.92 mm   | Austria           | I   | Retarded blow back                           | Mechanical disadvantage |
| Scotti Model 1928             | 7.7 mm    | Italy             | A   | Gas, piston actuated unlocking, and blowback | Rotating bolt head      |
| S. I. A. Model 1918           | 6.5 mm    | Italy             | A   | Short recoil                                 | Cammed-up locking lug   |
| Sistar Model 1932             | 6.5 mm    | Italy             | I   | Retarded blow-back, short recoil unlocking   | Mechanical disadvantage |
| Skoda Model 1902              | 8 mm      | Austria           | I   | Retarded blow-back after unlocking by recoil | Mechanical disadvantage |
| Solothurn Model 29            | 7.92 mm   | Germany           | I   | Short recoil                                 | Locking ring            |
| Solothurn Model 30            | 7.92 mm   | Germany           | I   | Short recoil                                 | Locking ring            |
| T. u. F. (Maxim)              | 12.7 mm   | Germany           | A   | Short recoil                                 | Toggle                  |
| Vickers-Berthier Mk I (G. O.) | Cal. .303 | England           | A   | Gas actuated piston                          | Propped breech          |
| Villar-Perosa (double barrel) | 9 mm      | Italy             | A   | Short recoil and blow back                   | Rotating bolt head      |
| ZB Model 1926                 | 7.92 mm   | Czech             | I   | Gas actuated piston                          | Propped breech          |
| ZB Model 50                   | 7.92 mm   | Czech             | I   | Short recoil accelerator                     | Propped breech          |



| Type of feed  | Capacity of feed | Method of cooling | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|---------------|------------------|-------------------|------------------------------------|--------------------------------|-------------------------|
| Fabric belt   | 250              | Water             | 46½                                | 1,875                          | 400-450                 |
| Belt magazine | 250              | Air               | 22                                 | 2,400                          | 450-500                 |
| Magazine      | 50-100           | Air               | 25½                                | 2,085                          | 650-700                 |
| Magazine      | 20               | Air               | 22                                 | 2,055                          | 650-700                 |
| Hopper        | 25-50-75         | Water             | 38½ (w/o water or loaded hopper)   | 2,100                          | 300-400                 |
| Magazine      | 25-50            | Air               | 17                                 | 2,952                          | 400-450                 |
| Magazine      | 25-50            | Air               | 18½                                | 2,952                          | 450-500                 |
| Fabric belt   | 100              | Air, water        | 84                                 | 2,750                          | 400-450                 |
| Flat drum     | 97               | Air               | 31½                                | 2,400                          | 750-900                 |
| Magazine      | 50               | Air               | 14¼                                | 862                            | 1,500 <sup>1</sup>      |
| Magazine      | 25-40            | Air               | 19½                                | 2,952                          | 450-500                 |
| Link belt     | 200              | Air               | 34                                 | 2,952                          | 550-600                 |

<sup>1</sup> Per barrel.

## Cannon

| Weapon                | Bore  | Country of origin | Use      | Method of operation            | Type of lock             |
|-----------------------|-------|-------------------|----------|--------------------------------|--------------------------|
| American Armament     | 37 mm | U. S. A.          | A        | Long recoil                    | Rotating bolt head       |
| Baldwin               | 37 mm | U. S. A.          | A        | Long recoil                    | Rotating bolt head       |
| Becker                | 20 mm | Germany           | A        | Blow back                      | Inertia                  |
| Bofors                | 20 mm | Sweden            | A        | Short recoil muzzle booster    | Swinging locks           |
| Bofors (Twin)         | 40 mm | Sweden            | A-A      | Short recoil                   | Sliding block (vertical) |
| Breda                 | 20 mm | Italy             | A        | Gas-actuated piston            | Sliding block (vertical) |
| Browning (M4)         | 37 mm | U. S. A.          | A        | Long recoil                    | Sliding block (vertical) |
| C. O. W.              | 37 mm | England           | A        | Long recoil                    | Rotating bolt            |
| Ehrhardt              | 20 mm | Germany           | A        | Short recoil                   | Pivoting lock            |
| Flak 18 (Rheinmetall) | 37 mm | Germany           | A-A      | Short recoil                   | Rotating bolt            |
| Flak 30 (Rheinmetall) | 20 mm | Germany           | A-A      | Short recoil                   | Pivoting lock            |
| Flak 38 (Mauser)      | 20 mm | Germany           | A-A      | Short recoil                   | Rotating bolt head       |
| Furrer                | 20 mm | Switzerland       | A        | Short recoil                   | Toggle                   |
| Gazda                 | 20 mm | Switzerland       | A        | Blow back                      | Inertia                  |
| Hispano-Suiza (404)   | 20 mm | France            | A        | Gas-actuated piston, blow back | Swinging lock            |
| Hotchkiss             | 25 mm | France            | A        | Gas-actuated piston            | Swinging lock            |
| Lahti                 | 20 mm | Finland           | A        | Gas-actuated piston, blow back | Swinging lock            |
| Lübbe                 | 20 mm | Germany           | A<br>A-A | Gas-actuated piston            | Sliding block (vertical) |
| Madsen                | 23 mm | Denmark           | A        | Short recoil                   | Pivoting bolt            |
| MG-151/20 (Mauser)    | 20 mm | Germany           | A        | Short recoil                   | Rotating bolt head       |
| MK-101 (Rheinmetall)  | 30 mm | Germany           | A        | Short recoil                   | Locking ring             |



| Type of feed               | Capacity of feed | Method of cooling | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|----------------------------|------------------|-------------------|------------------------------------|--------------------------------|-------------------------|
| Magazine                   | 5                | Air               | 250                                | 1,200                          | 50-60                   |
| Magazine                   | 5                | Air               | 140                                | 1,320                          | 120                     |
| Magazine                   | 12               | Air               | 66                                 | 1,570                          | 300-350                 |
| Link belt                  | 250              | Air               | 84                                 | 2,750                          | 650-700                 |
| Clip                       | 8 per barrel     | Air               | 2,300                              | 2,890                          | 260-300                 |
| Strip                      | 12               | Air               | 148                                | 2,760                          | 200-220                 |
| Magazine                   | 30               | Air               | 248                                | 2,000                          | 135                     |
| Magazine                   | 5                | Air               | 140                                | 2,000                          | 60                      |
| Magazine                   | 20               | Air               | 160                                | 2,200                          | 250-300                 |
| Magazine                   | 8                | Air               | 595                                | 2,520                          | 160-180                 |
| Magazine                   | 20, 40, 50       | Air               | 141                                | 2,950                          | 200-280                 |
| Magazine                   | 20               | Air               | 123                                | 2,950                          | 420-480                 |
| Link belt                  | 200              | Air               | 98                                 | 2,920                          | 650-700                 |
| Drum magazine              | 60               | Air               | 102                                | 2,750                          | 1,000                   |
| Drum magazine or link belt | 60, 200          | Air               | 110                                | 2,750                          | 450-500                 |
| Magazine                   | 10               | Air               | 164                                | 2,700                          | 150-180                 |
| Drum magazine              | 60               | Air               | 84                                 | 2,750                          | 450-500                 |
| Drum magazine              | 30               | Air               | 107                                | 2,650                          | 360                     |
| Link belt                  | 200              | Air               | 115                                | 2,250                          | 350-400                 |
| Link belt                  | 50               | Air               | 93½                                | 2,590                          | 700-750                 |
| Drum magazine              | 30               | Air               | 335                                | 2,950                          | 230-260                 |

## Cannon (concluded)

| Weapon                  | Bore     | Country of origin | Use      | Method of operation            | Type of lock   |
|-------------------------|----------|-------------------|----------|--------------------------------|----------------|
| MK-103 (Rhein-metall)   | 30 mm    | Germany           | A        | Gas-actuated piston            | Swinging locks |
| MK-108 (Rhein-metall)   | 30 mm    | Germany           | A        | Blow back                      | Inertia        |
| MK-ST-11 (Rhein-metall) | 20 mm    | Germany           | A        | Short recoil                   | Pivoting lock  |
| Nine Tenths (T2)        | Cal. .90 | U. S. A.          | A        | Blow back                      | Inertia        |
| Oerlikon                | 20 mm    | Switzerland       | A        | Blow back                      | Inertia        |
| Polsten                 | 20 mm    | England           | A        | Blow back                      | Inertia        |
| Puteaux                 | 37 mm    | France            | A        | Long recoil                    | Rotating bolt  |
| Revelli                 | 25.4 mm  | Italy             | A        | Short recoil                   | Rotating bolt  |
| Semag                   | 20 mm    | Switzerland       | A<br>A-A | Blow back                      | Inertia        |
| Scotti                  | 20 mm    | Italy             | A        | Gas-actuated piston, blow back | Rotating bolt  |
| Solothurn               | 20 mm    | Germany           | A-A      | Short recoil                   | Pivoting lock  |
| Szakats                 | 20 mm    | Germany           | A        | Blow back                      | Inertia        |
| Vickers Armstrong       | 37 mm    | England           | A        | Long recoil                    | Rotating bolt  |



| Type of feed  | Capacity of feed | Method of cooling | Weight of gun and feed (in pounds) | Muzzle velocity (ft. per sec.) | Rate of fire (r. p. m.) |
|---------------|------------------|-------------------|------------------------------------|--------------------------------|-------------------------|
| Link belt     | 25-100           | Air               | 308                                | 2,820                          | 420                     |
| Link belt     | 200              | Air               | 135                                | 1,640                          | 400-450                 |
| Magazine      | 20               | Air               | 118                                | 2,250                          | 350-380                 |
| Flat magazine | 48               | Air               | 313                                | 2,850                          | 400-450                 |
| Drum magazine | 60               | Air               | 136                                | 2,610                          | 280                     |
| Magazine      | 30               | Air               | 121                                | 2,720                          | 450                     |
| Magazine      | 5                | Air               | 198½                               | 1,250                          | 60                      |
| Magazine      | 8                | Air               | 99                                 | 1,320                          | 150                     |
| Magazine      | 20               | Air               | 94.6                               | 2,100                          | 350                     |
| Magazine      | 60               | Air               | 156                                | 2,650                          | 350-400                 |
| Magazine      | 20               | Air               | 142                                | 2,505                          | 280                     |
| Link belt     | 100              | Air               | 91                                 | 1,500                          | 400-450                 |
| Magazine      | 6                | Air               | 150                                | 2,000                          | 150                     |

# BIBLIOGRAPHY

## BOOKS

- ABBOT, W. J. *Aircraft and Submarines*. 1918.
- ADER, C. *L'Aviation Militaire en France*. 1907.
- Aircraft in War and Commerce*. 1918.
- AMERICAN MACHINIST. *Artillery and Small-Arms Ammunition*. 1942.
- . *Gun Manufacture*. 1942.
- ARNOLD, H. H. *Winged Warfare*. 1941.
- BALLEISEN, CHARLES E. *Principles of Firearms*. 1945.
- BARNES, G. M. *Weapons of World War II*. 1947.
- BARRES, MAURICE. *L'Aviation Pendant la Guerre*. 1916.
- BARTLETT, W. A. and GALLATIN, D. B. *Digest of Cartridges for Small Arms*. 1878.
- . *Weapons of War*. 1883.
- BLACK, ARCHIBALD. *The Story of Flying*. 1943.
- BLANCH, H. J. *A Century of Guns*. 1909.
- BOND, P. S. *Rifle Company Weapons*. 1941.
- BOOTH, HAROLD H. *Combat Planes*. 1944.
- BORUP, H. D. *Hotchkiss Revolving Cannon*. 1886.
- BRADSHAW, STANLEY O. *Flying Memories*. 1934.
- BROWNING ARMS CO. *A History of Browning Guns from 1831*. 1942.
- BRUCHISS, LOUIS. *Aircraft Armament*. 1945.
- BUTZ, A. *MG-34*. 1941.
- CHAMOT, EMILE M. *The Microscopy of Small Arms Primers*. 1922.
- CLAVARINO, ALFEO. *Armi e Tiro*. 1890.
- COLT'S AUTOMATIC FIRE ARMS CO. *A Century of Achievement, 1836-1936*. 1936.
- COLVIN, FRED H. and VIAL, ETHAN. *United States Rifles and Machine Guns*. 1917.
- CRABTREE, J. B. and others. *The Marvels of Modern Mechanism*. 1901.
- CROZIER, WILLIAM. *Ordnance and the World War*. 1920.
- CURTI, P. *Automatische Waffen*. n. d.
- DAVID, EVAN J. *Aircraft*. 1919.
- DU PONT DE NEMOURS, E. I., AND CO. *The Du Pont Company and Munitions*. 1934.
- FAHRENWALD, F. A. *The Development of Non-corrodible Gun Barrels*. 1921.
- FARROW, EDWARD S. *American Guns in the War with Germany*. 1920.
- . *American Small Arms*. 1904.
- . *Military Encyclopedia*. 3 volumes. 1885.
- FFOULKES, CHARLES. *The Gun-Founders of England*. 1937.
- FLECK, A. *Maschinen Gewehre*. 1909-1913.
- FORTUNE (magazine). *Arms and the Men*. 1934.
- FRANCE. MINISTRY OF WAR. *Fusil-mitrailleur, Model 1915*. 1922.
- . *Instruction pour les Unites des Mitrailleses d'Infanterie*. 1932.
- FRANCISCO, SAMOYOA C. *Reglamento Tactico de Ametrallador*. 1944.
- GARDNER, W. *Machine Guns and How to Use Them*. 1882.
- GATLING GUN CO. *The Gatling Gun, Official Reports of Trials*. 1878.
- GENERAL MOTORS CORP. *G. M. Frigidaire at War*. 1944.
- GEORGE, J. N. *English Pistols and Revolvers*. 1938.
- GERMANY. *Luftwaffe. 2 cm Flak 30 Waffe*. 1937.
- GIARDINI, W. *Armi e Tiro*. 1943.
- GREAT BRITAIN. WAR OFFICE. *0.45" Gardner Gun*. 1894.
- . *303-in. Hotchkiss Machine Gun*. 1917.
- . *Instructions, Care, Inspection and Repair, etc. of Small Arms, Machine Guns and Bicycles*. 1933.
- . *303-in Maxim Gun*. 1901.
- . *303 and 303" Converted Maxim Machine Guns*. 1911.
- . *0.45" Maxim m. h. Chamber Machine Gun*. 1890.
- . *1" 4 Barrel Nordenfjelt Gun*. 1889.
- . *0.45-inch 5-Barrel Nordenfjelt Guns, Marks I and II*. 1894.
- . *Textbook of Small Arms*. 1929.
- . *300 Vickers Machine Gun Mechanism Made Easy*. 1942.
- GREY, CHARLES G. *The History of Combat Airplanes*. 1941.
- HAMMERTON, SIR JOHN. *Aerial Wonders of Our Time*. 2 volumes. 1937.
- HARPER, HARRY. *The Aeroplane in War*. 1942.
- HATCHER, JULIAN S. *Hatcher's Notebook*. 1947.
- HATCHER, JULIAN S. and others. *Machine Guns*. 1917.
- HAWKS, ELLISON. *Aircraft Armament, Past and Present*. 1915.
- HEARNE, R. P. *Aerial Warfare*. 1909.
- HEIDEN, HERMANN. *Gewehre Frei!* 1938.
- HICKS, JAMES E. and JANDOT, ANDRE. *Notes on French Ordnance, 1717 to 1936*. 1936.
- HICKS, JAMES E. *Notes on United States Ordnance*. 1940.
- . *Our Arms and Weapons*. 1941.
- HODGES, LEROY. *Notes on Post-war Ordnance Development*. 1923.
- HOHM, I. F. *Die Waffen der Luftstreitkräfte*. n. d.
- HOPKINS, OWEN J. *Drill Manual for the Gatling Gun*. 1900.
- HOTCHKISS ORDNANCE COMPANY, LTD. *Descriptive Catalogue of War Material*. 1893.
- Instruction sur la Mitrailleur Automatique Hotchkiss (Model 1899)*. 1899.
- ITALY. MINISTRY OF WAR. *Istruzione Provvisoria sul Moschetto Automatico Bretta, cal. 8.8, mod. 38A*. 1943.
- JACKLIN, G., and WHIPP, DEREK. *The 303 Lewis Gun*. 1942.
- JANE, F. T. *All the World's Aircraft*. 1917-1919.



- JESSEN, HALVOR. *Automatic Standard Arms of Modern Warfare*. 1946.
- JOHNSON, MELVIN M., JR. *Rifles and Machine Guns*. 1944.
- JOHNSON, MELVIN M., JR. and HAVEN, CHARLES T. *Automatic Arms*. 1941.
- . *Automatic Weapons of the World*. 1945.
- . *Weapons for the Future*. 1943.
- KEITH, C. H. *I Hold My Aim*. 1946.
- KITTREDGE, B. AND CO. *Manual on Breech-loading Gun*. 1876.
- KOEHRNER, ALFRED. *The Hotchkiss Revolving Cannon*. 1879.
- LAHM, FRANK P. *How Our Army Grew Wings*. 1943.
- LEIGH, HOWARD. *Planes of the Great War*. 1934.
- LEONING, G. C. *Military Aeroplanes*. 1918.
- LEWIS, I. N. *Lewis Automatic Machine Rifle*. 1917.
- LONGSTAFF, F. V. and ATTERIDGE, H. A. *The Book of the Machine Gun*. 1917.
- LOW, A. M. *Modern Armaments*. 1940.
- . *Musket to Machine Gun*. 1943.
- McCLINTOCK, MARSHALL. *The Story of War Weapons*. 1945.
- MCLEAN, J. H. *Peace Makers*. 1880.
- MANDEL, ROBERTO. *La Guerra Aerea*. 1933.
- MARIOTTI, *Unser Leichtes Maschinengewehr*. 1942.
- . *Unser Maschinengewehr*. 1940.
- MARSH, ROGER. *The First Model Maxim Automatic Machine Gun*. 1945.
- MAXIM, HIRAM S. *My Life*. 1915.
- MINTON, M. V. *Prontuario de Armento*. 1939.
- MOLTER, BENNET A. *Knights of the Air*. 1918.
- MUSGRAVE, DANIEL. *The Automatic Weapon* (manuscript).
- NEWBOLD, J. T. *How Europe Armed for War, 1871-1914*. 1913.
- NEWMAN, JAMES R. *The Tools of War*. 1942.
- NORDENFELT, THORSTEN. *Nordenfelt Machine Gun*. 1884.
- NORTON, CHARLES B. *American Breech Loading Small Arms*. 1872.
- . *Breech Loading Small Arms*. 1882.
- OWEN. *Mitrailleurs or Machine Guns*. 1874.
- PARKER, JOHN H. *History of the Gatling Gun Detachment at Santiago*. 1898.
- PASSOW, KURT. *Taschenbuch der Heere*. 1939.
- PAYNE, CALLOWAY. *The Cross Bow*. n. d.
- PECK, JAMES L. H. *Armies with Wings*. 1940.
- PIERCE, W. O. D. *Air War*. 1937.
- POLLARD, H. B. C. *A History of Firearms*. 1936.
- PRIDHAM, C. H. B. *Anti-aircraft Defense*. 1941.
- . *Lewis Gun Mechanism Made Easy*. 1942.
- . *Superiority of Fire*. 1945.
- REMINGTON ARMS CO., INC. *A New Chapter in an Old Story. Revelli automatic machine gun*. 1917.
- RHEINISCHE METALLWAREN UND MASCHINENFABRIK, DUSSELDORF. *Machine Gun Dreyse*. 1914.
- ROBERTS, B. S. *Solid Shot and Shells*. 1864.
- ROE, JOSEPH W. *Connecticut Inventors*. 1934.
- SAVAGE ARMS CORP. *Handbook of the Lewis Machine Gun (Airplane Type) Model 1917-1918*. 1919.
- . *Handbook of Lewis Machine Gun, Model 1917*. 1919.
- . *Lewis Automatic Machine Gun*. n. d.
- SIMON, LESLIE E. *Report on German Scientific Establishments*. 1945.
- SKODA, E. *La Mitrailleuse Skoda Mod 1902 et Son Emploi*. 1902.
- SMITH, W. H. B. *Basic Manual of Military Small Arms*. 1945.
- . *Mauser Rifles and Pistols*. 1947.
- SPAIN. Ministry of War. *Instruccion de Tiro con Ametralladoras de Infanteria*. 1911.
- SVESHNIKOFF, W. W. *Some Factors Affecting the Life of Machine Gun Barrels*. 1921.
- TILSON, JOHN Q. *Arms, Ammunition, Airplanes and Gas Masks*. 1918.
- TOMBESI, TITO. *Armamento Aereo*. 1943.
- U. S. ARMY ORDNANCE DEPARTMENT. *Anti-aircraft Matériel for Machine Guns*. 1919.
- . *Base Shop Data. Gun, Automatic, 20 m/m, M1 and M2*. 1943.
- . *Base Shop Data. Gun, Automatic, 37 m/m, M4 (aircraft)*. 1944.
- . *Enemy Ordnance Matériel*. 1945.
- . *Handbook of Ordnance Data*. 1919.
- . *Handbook of the Automatic Machine Rifle, cal. 30, Model of 1909*. 1909.
- . *Handbook of the Colt Automatic Machine Gun (cal. 30)*. 1917.
- . *Handbook of the Maxim Automatic Machine Gun, cal. 30, Model 1904*. 1917.
- . *Handbook of the Vickers Machine Gun, Model of 1915*. 1917.
- . *Handbook on the Colt Machine Gun, Model 1917, cal. 30*. 1917.
- . *History of Machine Guns and Automatic Rifles*. 1922.
- . *Vickers Aircraft Machine Gun, Model of 1918, Service Handbook*. 1919.
- U. S. BUREAU OF AIRCRAFT PRODUCTION. *Handbook of Aircraft Armament*. 1918.
- U. S. CHIEF OF NAVAL OPERATIONS. *U. S. Naval Aviation in the Pacific*. 1947.
- U. S. LIBRARY OF CONGRESS. *Firearms, Ammunition, Explosives and Fireworks: A Selected List*. 1943.
- VERY, EDWARD W. *The Hotchkiss Revolving Cannon*. 1885.
- VICKERS SONS AND MAXIM, LTD. *Modern Types of Battleships, Cruisers and Ordnance, as Manufactured by the Firm*. n. d.
- WALKER, JOHN B. *War in the Air*. 1941.
- WELLS, DAVID A. *Annual of Scientific Discovery*. 1861.
- . *Welt in Waffen*. 1933.
- WHITE, GRAHAME C. and HARPER, HARRY. *The Aeroplane in War*. 1942.
- WILSON, R. K. *Textbook of Automatic Pistols, 1884-1935*.
- WOODHOUSE, HENRY. *Textbook of Military Aeronautics*. 1918.
- . *Textbook of Naval Aeronautics*. 1917.
- ZULOAGA, A. M. C. *La Guerra Aerea*. 1938.

## PERIODICALS

Many magazines and journals were consulted in the preparation of this book and supplied much valuable material. A complete list of these references is not given here. However, the following periodicals were used in preparing the volume:

*Aerial Age Weekly*. 1916-1918.  
*Aero Digest*. 1938-1944.  
*Aeronautics*. 1915-1940.  
*L'Aeroplane*. 1936-1938.  
*Aeroplane*. 1939-1940.  
*Aircraft*. 1943.  
*Aircraft Engineering*. 1947.  
*Aircraft Production*. 1939-1941.  
*Army Ordnance*. 1921-1948.  
*Aviation*. 1917-1929.  
*Aviation and Aircraft Journal*. 1921.  
*Aviation Book*. 1918.  
*Canadian Aviation's News*. 1940.  
*Cassier's Magazine*. 1900.  
*Collier's Weekly*. 1918.  
*Commercial Aviation*. 1944-1945.  
*Current Events*. 1914-1916.  
*Current History*. 1917.  
*Current Literature*. 1900.  
*Deutsche Luftwacht*. *Luftwehr und Luftwissen*. 1934-1940.  
*Flight*. 1934-1943.  
*Flug Sport*. 1934.  
*Flying*. 1914-1919.  
*Flying Aero Club of America*. 1912-1915.  
*Forum*. 1918.  
*La Guerra Aerea*. 1938.  
*Hampton Columbian Magazine*. 1912.  
*Harper's Weekly*. 1898-1903.  
*Hearst's Magazine*. 1913.  
*Illustrated Review*. 1917-1918.  
*Illustrierte Zeitung*. 1916-1917.

*Interavia*. 1935-1938.

*Leslie's Weekly*. 1916-1918.

*Literary Digest*. 1912-1918.

*London News*. 1915-1919.

*North American Review*. 1930.

*Popular Aviation*. 1938-1940.

*Popular Science*. 1872-1918.

*Review of Reviews*. 1908-1928.

*Revista Aeronautica*. 1935-1936.

*Revue d'artillerie*. 1898.

*Revue de l'armee de l'air*. 1934-1939.

*Revue des Forces Aeriennes*. 1930-1933.

*Revista Aeronautica*. 1933-1938.

*Royal Aeronautical Society*. *Journal*. 1936.

*St. Nicholas*. 1918.

*Scientific American and Supplement*. 1881-1927.

*Sea Power*. 1916.

*Technical World Magazine*. 1912-1914.

*United Service Institution*. *Journal*. 1863-1870.

## OTHER SOURCES

Of the sources for this publication, perhaps the most valuable were reports and documents from the files of the United States Government. Such material was obtained, among others, from offices of the Department of Defense, the National Archives, the Library of Congress, the Smithsonian Institute, and the United States Patent Office.

The documents include intelligence reports from military and naval attachés, proving ground reports, annual reports of the Army Ordnance Department and the Navy's Bureau of Ordnance, patents on foreign and domestic mechanisms, handbooks, notes on foreign ordnance, correspondence on contracts, etc., and photographs and other illustrations.

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