THE MACHINE GUN

History, Evolution, and Development
of Manual, Automatic, and Airborne
Repeating Weapons

by

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VOLUME I OF THREE VOLUMES

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PREFACE

With the belief that the next best thing to actual knowledge is knowing where to find it, this research has been compiled by the Bureau of Ordnance, Department of the Navy, in order to place in the hands of those rightfully interested in the art of automatic weapon design, the world's recorded progress in this field of endeavor.

So great a period has been covered on a vast and controversial subject, with practically no precedent to use as a guide, that the sum total of this effort must be regarded somewhat in the nature of an experiment.

While nothing is claimed for this volume except that it is the result of tedious and laborious research, it is believed that in some manner it will help point the way to a better understanding of past development. In so doing, it should help to reduce pitfalls that beset the designer traveling an otherwise dimly lighted path.

A biography is included for each of the great masters of gun design, upon whose countless experiments and basic ideas the automatic armament of the world has been created; thus the reader may better determine the magnitude of their genius and its meaning to history past and future.

Excerpts from actual writings of the inventors, manufacturers and professional critics are given wherever possible. These statements, together with other authoritative matter, are assembled for the most part according to historical sequence.

It is not to be construed that this book is infallible, as it has the inevitable errors of all first editions. Sometimes an apparent digression was thought necessary to help clarify succeeding events, such as gunpowder experiments, ignition improvements, metallurgy formulas and even aviation progress. Without these kindred subjects, present-day ordnance design would not exist.

Great stress has been laid upon the inclusion of actual photographs of early inventors firing their prototype machine guns, to present pictorial proof that the automatic weapons we know today were of as humble origin as the mechanics who created them.

The unholy desire throughout the centuries for man to implement his belligerent impulses with superior tools for conflict, has provided the anvil upon which he has patiently forged the most lethal scourge of the modern world—the Machine Gun.

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Three people were assigned directly to assist the author. Mr. Leo X. Abernethy, a young man well recognized for his designing skill on automatic firing mechanisms, was lent to the project by the Naval Gun Factory, Washington, D. C. His display of talent in classifying basic principles and interpreting patent drawings of all nations, coupled with his ability to evaluate accurately research material of each era, warrants a commendation of the highest order. Too much credit cannot be given to him for whatever measure of success the finished product may enjoy.

The second member was Master Sergeant John H. Moore, USMC, former instructor at the Marine Corps Aviation Ordnance School, Quantico, Virginia. His meticulous care in collecting historical and pictorial research will be gratefully recognized by students of automatic weapons for years to come. His thorough working knowledge of the intricate mechanics of foreign automatic weapons is outstanding and proved of inestimable value in hastening the conclusion of the project.

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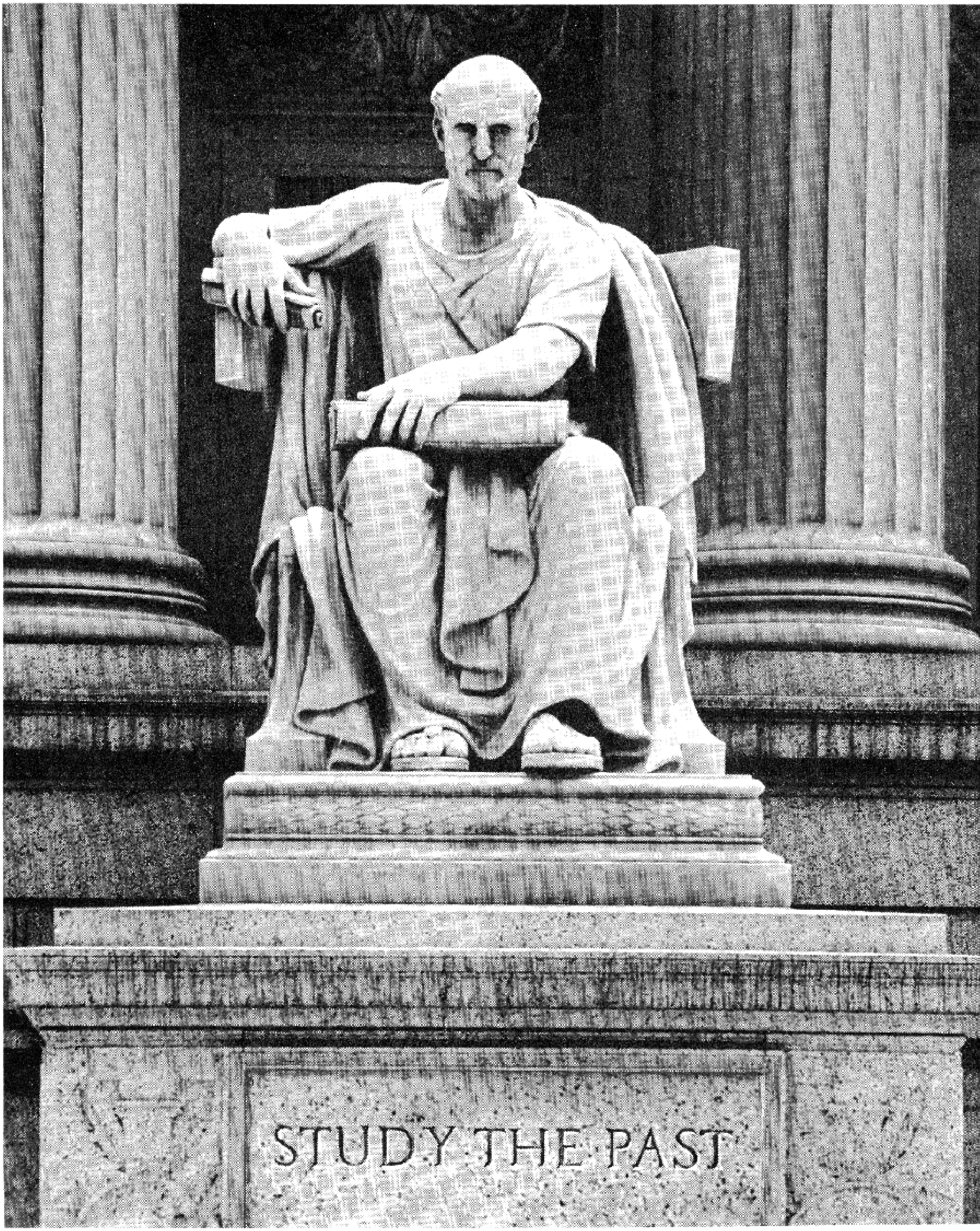


Statue at Entrance to National Archives Building, Washington, D. C.

PART I

FORERUNNERS OF THE MACHINE GUN

Chapter 1

WEAPON HISTORY PRIOR TO GUNPOWDER

Primitive Beginnings

The club was so universally employed by primitive man that, although originally intended as a tool for providing food and collecting wives, it can be considered the ancestor of all weapons of war. It has been a companion arm of man, in one form or another, since the beginning of time. Today, as a reminder of its once devastating force, it is used as a symbol representing the highest authority, i.e., the field marshal's baton and the emperor's scepter—a tribute to the man who best wields the club.

It was indeed an eventful day when prehistoric man stepped from the path of his upward climb for the purpose of starting the world's second oldest profession—that of making war upon his fellow man. In fact, those who have made a study of the causes of conflict insinuate that the second profession probably arose from a disagreement over an incident involving the first.

Waiting in ambush with a club, the first aggressor little dreamed he was setting the tragic pattern of later generations which, marveling at their own cleverness, underestimate their opponent's ability to devise a defense in an emergency. He felt secure in his ability to annihilate his enemy with one blow. His own hunting skill was unexcelled, his club combined many improvements of which his fathers had never dreamed, and the object of his wrath was approaching unaware of danger.

It is easy to picture the utter surprise of this early tactician when his intended victim survived the initial assault. Driven more by self-preservation than forethought, the latter made a successful escape by evasive action and the use of an entirely new principle of attack—throwing rocks.

Having to retreat before the rain of missiles, the aggressor realized that new dangers now lay in his every movement if the enemy was not promptly destroyed. He gathered his relatives to witness that he had been unfairly attacked and to convince them that the security of all rested on their ability to help him eliminate the menace.

The adversary likewise had friends and relatives, who banded together on hearing of their clansman's attempted annihilation and his successful counter-attack. Sensing danger, and realizing that a new weapon was at their disposal, they moved to high ground, where they could observe the approaching foe and throw down rocks or roll boulders on him.

These simple acts cover all the basic arts known and practiced in warfare today. The most important was the employment of missiles for the first time as a weapon. Man has traveled far along the path of progress. 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. However, he has yet to achieve the mental capacity to replace, either in conquest or defense, the earliest of his discoveries—the missile weapon.

True, throughout the centuries countless man hours and sums of money have been expended to break away from this mode of lethal delivery. However, the result has been only a refinement—evolutionary, but in no sense revolutionary.

Even the club did not remain unchanged. Man, in his unholy desire to conquer, made early refinements. In the stone age, for instance, a rock with a sharp edge was fastened to his club to form an ax. When iron or copper was first smelted, a metal spear blade added much to the cutting and puncturing ability of the club. It soon evolved into a very versatile instrument that could kill a man by three methods—cutting, concussion, or perforation. These techniques have remained basic throughout the years. The double-edged battleax with a pike on the blade end and a spiked ball secured by a short chain to the rear of the handle represents the last word in the development of the club from a single-purpose bone-crushing affair to a tri-method instrument of death.

The discovery that under the influence of heat metals could be cast and worked into different forms not only brought about an improvement in club design but opened the avenue for other types of weapons, already thought of, but heretofore found impracticable because of lack of appropriate materials. The best example of this type is the knife.

When the possibilities of metal-working were realized, knives and daggers appeared in thousands of shapes—short and long, blunt and sharp, heavy cleavers, and long slim rapier blades. All continued to be produced in endless procession. The finest art known to metalwork can be found in the early elaborate designs and scrollwork on the knife and sword. In an attempt to beautify the finished product, inlays of precious stones and pictorial scenes carved on the handles and blades were common.

The origin of our present metallurgy begins with man's efforts to temper the cutting edge of his weapons. Nothing was left undone in his constant experimentation—including quenching the red-hot blade in a living human body, in the belief that the blood gave the blade a superior cutting power.

Each of the many designs was for a specific purpose. The dagger originated as a weapon to be inserted through the vulnerable joints and openings in armor. The broad sword was short, wide, and sharp on both edges, and was used like a cleaver to split an enemy down the middle. Later swords were again narrowed and straightened for use in thrusting, to take the place of the powerful slicing stroke.

The Far East contributed the scimitar with its crescent-shaped blade sharpened on one side only. The curve added much to the slicing power. And in due time its influence reached Europe to be incorporated in the cavalry saber with its long single-edged blade slightly curved.

The First Projectile Throwers

Projectile-throwing devices were developed also and used in conjunction with the club and knife. From the first rock throwing and rolling came the sling, bow, and catapult.

The bow is one of the earliest projectile throwers devised by man. Some insist it preceded the sling, and attempt to substantiate their claim by the pictures of bows drawn by the prehistoric hunter-artists in the caves of southern France and Cantabria in the tenth millenium B. C. However, there are others who contend the cavemen-cartoonists were merely depicting better weapons than the slings of their forefathers.

The sling in its simplest form is thought to have come from the observation that when a stone was attached to a club or bludgeon and came loose as the club was swung, it traveled a much greater distance than if thrown by hand.

The Phoenicians were credited by ancient writers with invention of the sling. These inhabitants of the Balearic Isles used leaden projectiles with a purported range of over 600 yards. Ancient Egyptian and Assryian soldiers also used slings.

In 1062 B. C. David of Israel used one to defeat Goliath of Gath. However, David's accomplishment in overcoming the giant, with the resulting destruction of the Philistine army by King Saul's men, was only secondary to the military lesson pointed out by his actions preceding the battle. His handling of the problem was perfect. Seeing that he was outclassed by his opponent in the application of orthodox warfare, he chose the weapon that best utilized his skill, and calmly decided on the number of missiles he could carry without impairing his mobility and the correct caliber to destroy completely his opponent with one direct hit. He then confidently carried the fighting to the enemy.

Nor was David's act an isolated case of marksmanship, in which luck played more part than skill. The Bible also credits to the tribe of Benjamin phenomenal accuracy with this weapon: "Among all this people there were seven hundred chosen men left-handed; every one could sling a stone at an hair and not miss."

The Roman Legions called the slingman the "funditor," and considered him an integral part of the army. The slingman continued long after his legendary acts had been outmoded in distance and accuracy by the innovation of mechanical means of propulsion. It was finally recognized that human muscle had reached its limit. The sling's last major military appearance was during the Huguenot Wars.

Among the hand projectile-launchers, however, the bow served man more efficiently than anything of a similar nature. The earliest ones were generally made from any tough straight-grained wood that would bend and snap smartly forward, without having a tendency to break.

A cord of sinew, gut, or hemp kept the bow in a graceful arc, and served as the agent for transmitting the stored energy of the bow. Arrows were originally long thin tubular pieces of wood tipped with chipped stone. A small group of feathers on the aft end tended to keep the arrow on its true course to the target. Some of the achievements credited to bows and arrows are almost unbelievable.

The constant search to better his existing weapons led the prehistoric warrior to experiment with the construction of bows. The horns of animals were steamed and cut into strips. They were then dried, glued, and scraped into the desired shape. In addition to laminated horn, combinations of woods and the ribs of animals were used. They were wrapped with strips of inner tree bark, or animal gut, in the belief that greater throwing power was given.

The most popular and efficient was a plain solid wood affair, sometimes tipped with horn to prevent splitting, and to facilitate removing or replacing the bowstring. The choice of wood depended on geographical location, as every section had varieties that adequately met the needs of the early bow maker.

The idea of a more powerful weapon to outrange the bow and sling, received serious constructive study in the East during the ninth and eighth centuries B. C. According to the Bible, Uzziah, who reigned from 808 to 756 B. C., "made in Jerusalem engines invented by cunning men, to be in the towers and upon the bulwarks, to shoot arrows and great stones withal." Ezekiel records that Nebuchadnezzar in besieging Tyre set engines of war against the walls. This siege took place at the beginning of the sixth century B. C.

The Greeks were slower to adopt such improvements. Diodorus records an expedition of Dionysius, tyrant of Syracuse, against the Carthaginians in 397 B. C.: "The Syracusians . . . killed great numbers of the enemy by their sharp arrows, shot out of their engines of battery." From Syracuse the war engine was introduced into Greece.

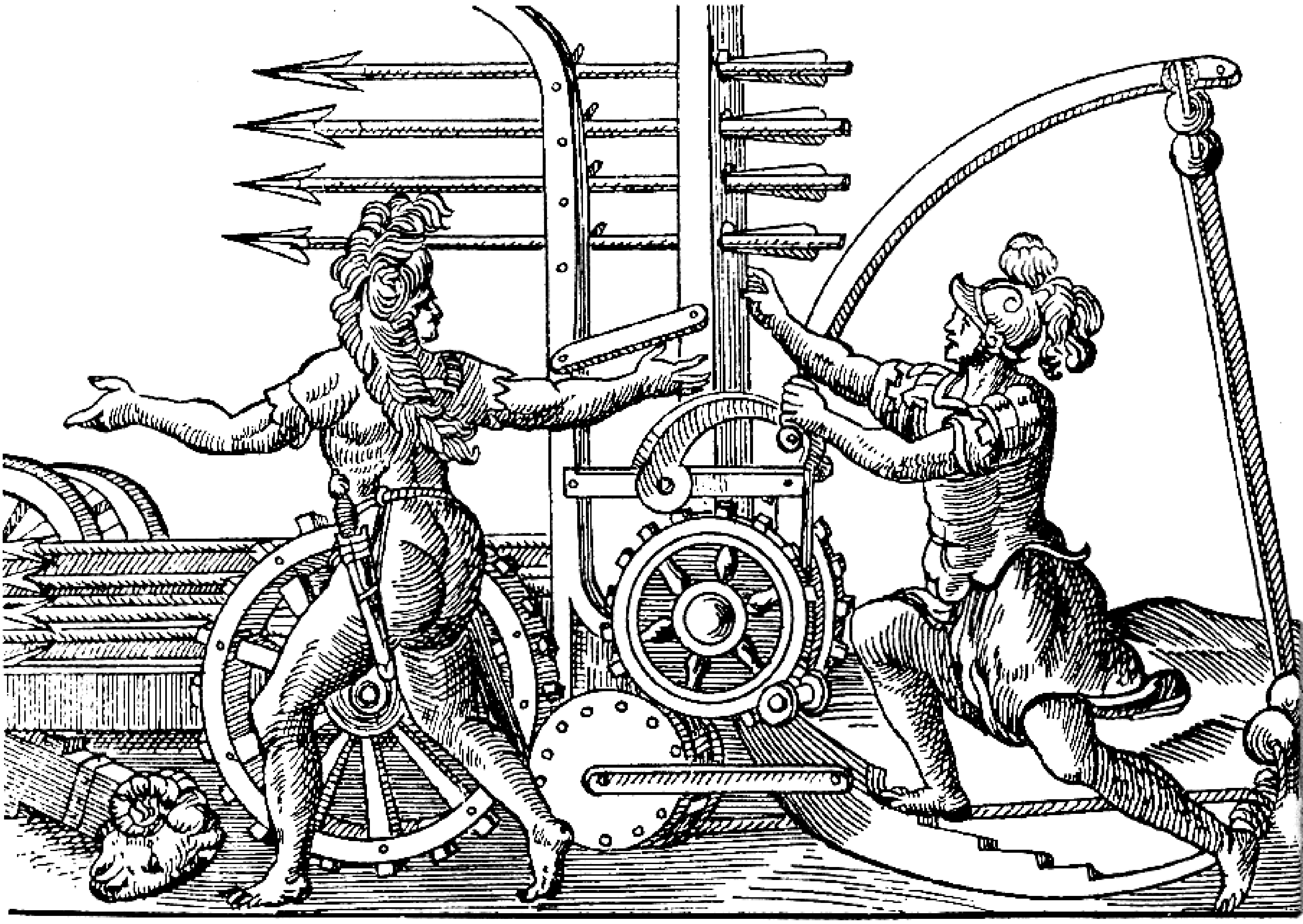
Dionysius also attempted to improve upon the single bow by inventing a weapon called the *Polybolus,* or repeater thrower, which projected a succession of arrows supplied from a kind of magazine. This is the first recorded example of a mechanical means of sustained fire, giving the soldier who operated it the firepower of several men. There was an interval of thirteen centuries before another advance in fire power warrants mention. At the Battle of Hastings a few archers were equipped with a mechanical bow arrangement designed to discharge several arrows at a time.

"Engines of War," mentioned by Biblical and classical writers, usually were variations of the catapult and the ballista. The first was for high, and the second for low, angle fire. In either case the propelling force was transmitted by tightly twisted skeins of hemp, hair, or sinews. (Replicas of these instruments have been made, but the method of maintaining the elasticity of the sinew remains unsolved.)

The origin of the catapult seems to have been a bent-over, forked sapling for hurling rocks. However, this idea was improved till it became a bulwark in offensive and defensive warfare.

A heavy wooden framework carried strong rope strands across the base. Into these twisted ropes went the tossing beam, with a cuplike holder at the top. Winches pulled back the thrower, twisting the rope so that a great force was stored as in an elastic cord or spring. When released, the throwing beam whirled up and forward, struck against the brake timber, and tossed its rock from the cup a few hundred yards. Catapults were not very accurate, but a battery of them could pound a wall or fort to dust in a few days.

The scorpion type catapult is described by the historian Amianus Marcellinus (A. D. 400): "In the middle of the ropes (twisted skein) rises a wooden arm like a chariot pole. . . . To the top of the arm hangs a sling. . . . When battle



A Spring Engine.

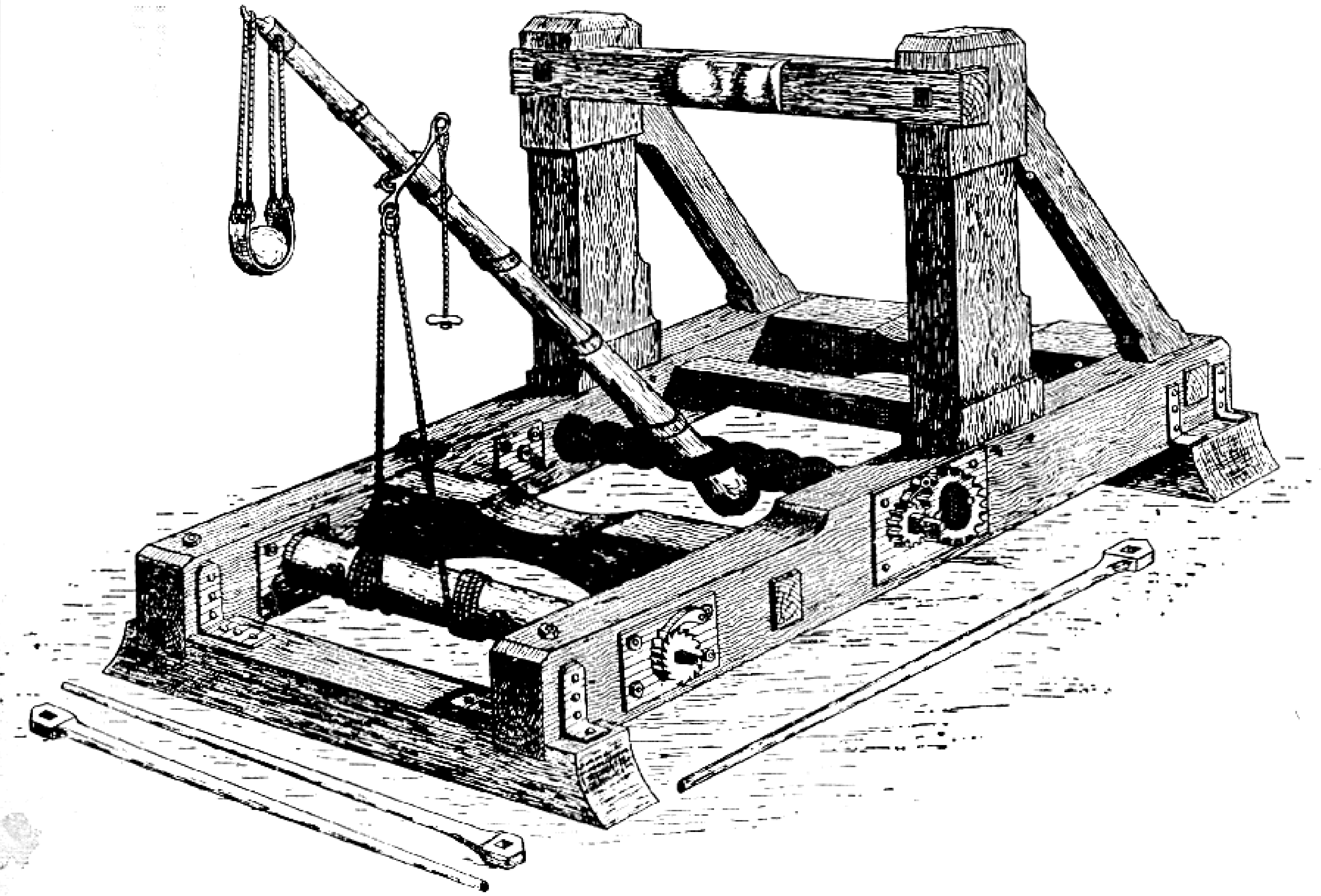
is commenced a round stone is placed in the sling . . . four soldiers on each side of the engine wind the arm down till it is almost level with the ground. . . . When the arm is set free it springs up and hurls forth from its sling the stone, which is certain to crush whatever it strikes." This engine was called a scorpion because of its shape.

The sling on the scorpion added greatly to the range of the catapult. The maximum distance for a round stone weighing one talent (approximately 58 pounds) was recorded at 400 yards. Ranges varied up to 800 yards depending on the weight of the missile used. The projectiles were not always stones that had been rounded. Sometimes they were pebbles molded with clay into balls and baked to a pottery finish. These shattered upon impact, throwing fragments which the enemy could not reuse in his own machines.

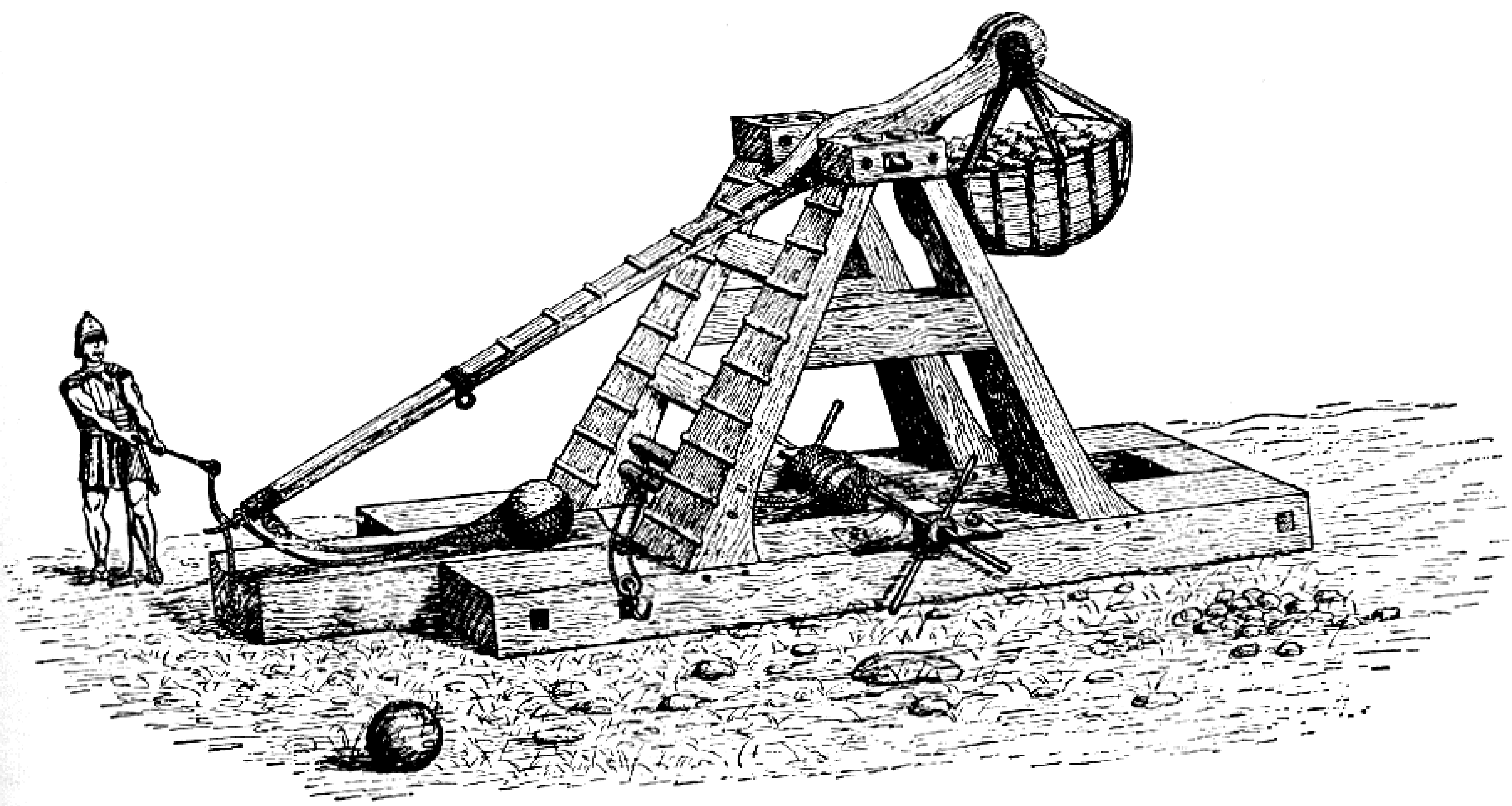
Medieval Instruments of War

The trebuchet was a medieval contribution t
the rock-throwing devices. It got its power, n
from a taut cord or twisted rope, but from
heavy counterweight. The throwing beam w
swiveled on a strong axle near the top of th
framework. The bottom carried heavy weight
and the top a throwing cup. Winches pulle
back the top so that the bottom weight move
up and forward. Upon release, the weighte
beam swung down like a huge pendulum. Th
top struck the brake beam, and the rock w
hurled in the general direction of the enemy
fortifications.

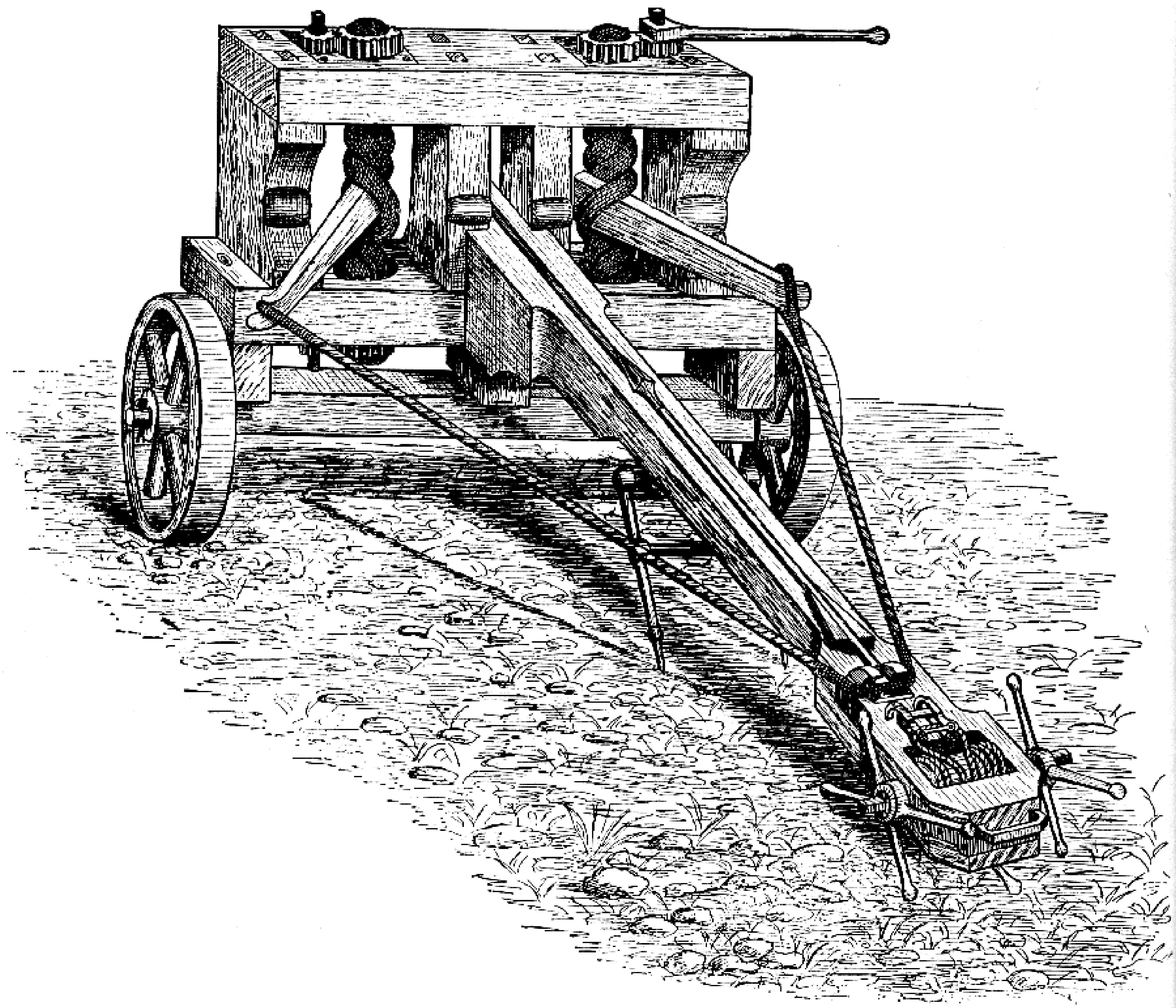
These siege engines threw other missiles b
sides stones and javelins. They threw millstone
flaming projectiles, putrid corpses, and live me
A dead horse in the last stage of decompositio
bundled up and shot by a trebuchet into a tow



A Catapult for Slinging Stones.



The Trebuchet.



The Ballista.

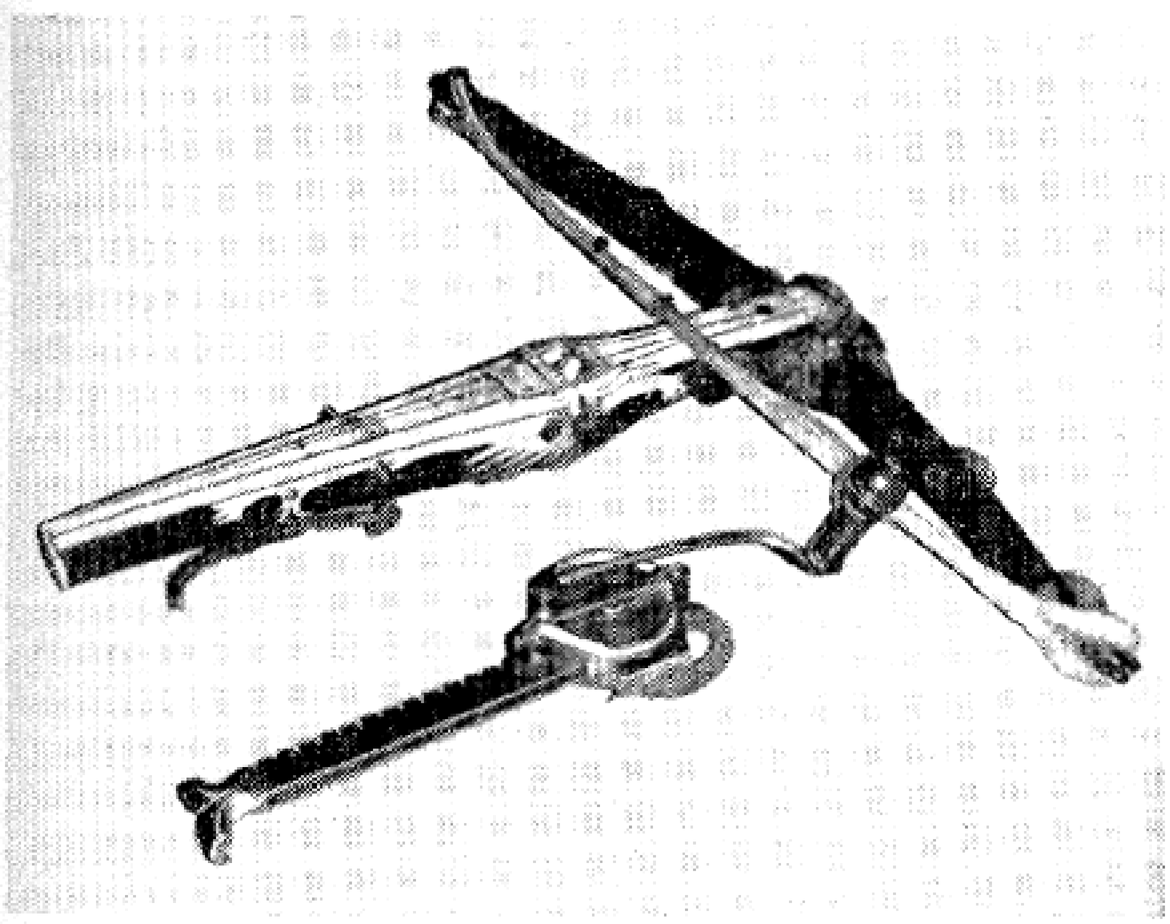
of which the defenders were half dead with starvation, started a pestilence.

The ballista usually consisted of a sturdy framework which held a horizontal bow of strong laminated wood. From its ends extended a heavy cord of hemp or gut which was pulled back by winches until a very heavy tension was obtained. The gut string worked in a grooved frame into which a javelin 10 or 12 feet long was placed. When the release allowed the arms to snap forward, the javelin was driven 450 to 500 yards with a tremendous force and unusual accuracy for this type of weapon.

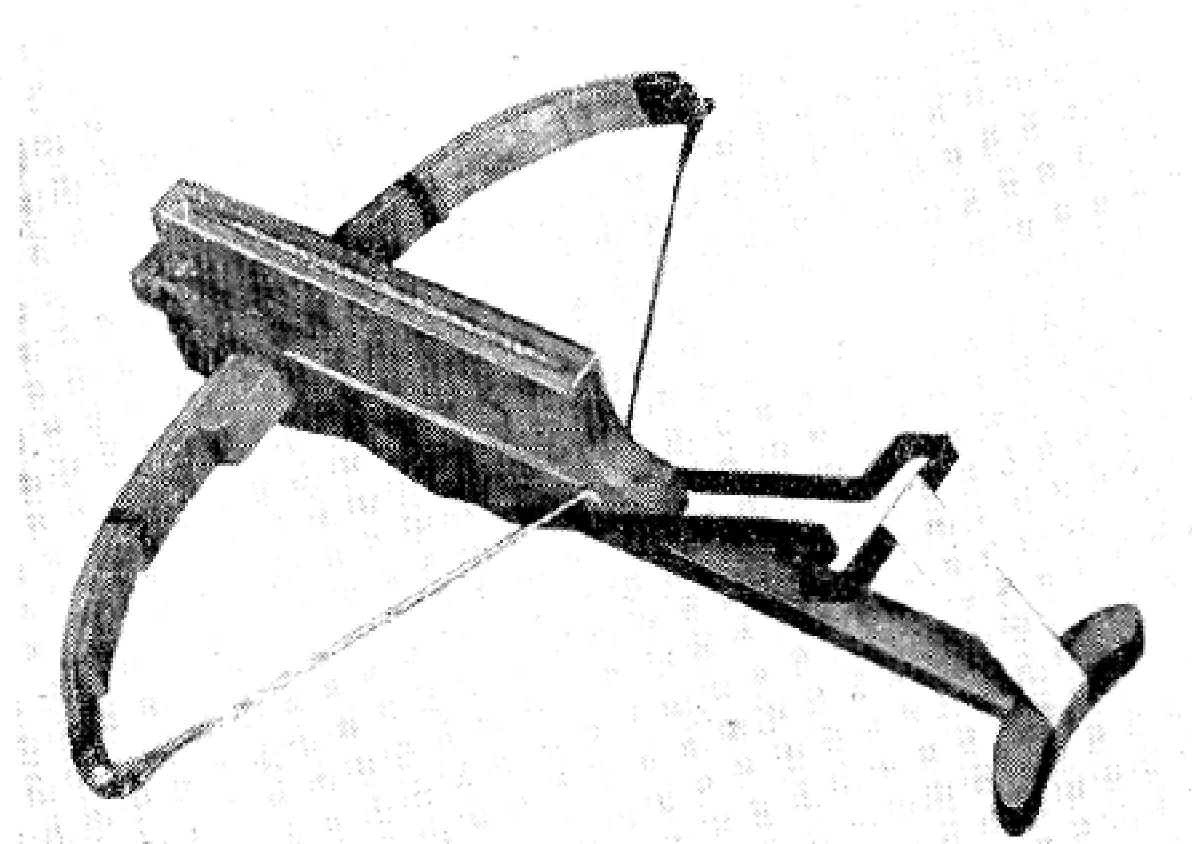
Another form of ballista used twisted rope made from hair and sinew for elasticity. Even small engines of this type with 2-foot arms and 4-inch ropes could throw a 1-pound round stone 300 to 350 yards.

An improved arrangement of the ballista had an upright frame carrying two pairs of vertical ropes which, when twisted, furnished the necessary energy. A wooden piece was thrust between each pair of ropes forming the two arms of the bow. These were connected at their other ends by a bowstring. A slotted stock in the frame served as a guide along which the bowstring propelled the missile (either bolt or ball). Tension was applied by a winch.

One type of ballista employed an oversized bow laid horizontally and cocked mechanically. This heavy device was much older than the in-



A Heavy German Crossbow and a Cranequin for Cocking.



A Crossbow with Magazine Feed.

dividual soldier's crossbow, that it so closely resembled. The latter was an eleventh century adaptation of the larger weapon, combining the basic working principles of the bow and catapult and reducing the size and weight until it could be operated by a single soldier.

Norman artisans are credited with invention of the crossbow. Its use was general throughout the armies of Europe after its introduction, but it was by no means looked upon with favor by all the rulers of the time. Pope Innocent II in 1139, after the Second Lateran Council, called it "a most barbarous and cruel weapon" and forbade its use among warring Christian nations under penalty of anathema as "a weapon hateful to God and unfit for Christians."

The hiring of foreign crossbowmen was also prohibited by the Magna Charta. However, its use in war against the infidels had the blessings of the Church. As a weapon it was much admired by Richard Cœur de Lion. On his crusade against the unbelievers he took a thousand crossbowmen with him. After he popularized it, the crossbow came into general use in all European armies in spite of anathema. Therefore, Richard's death from a crossbow quarrel was considered a judgment from heaven, for he had championed a weapon that could "proletarianize war."

Although England gave the crossbow the needed stimulus to overcome the objections of the Church, it was the first country to realize its military shortcomings. As a weapon it was secondary to the simpler and more powerful longbow. Therefore, the crossbow was replaced quickly in England by the latter.

The English longbow, which gained prevalence in the fourteenth century, is considered the highest degree of refinement of the bow. It was used effectively, and with fair accuracy, at ranges of 600 to 800 yards. The phenomenal success of the English archer was no matter of chance but the result of deliberate planning.

From the reign of Edward I (1271–1307) to the sixteenth century, there were placed in the English code statutes which later became known as the Archery Laws. These compelled every male citizen from 12 to 60 years of age, except nobility, to practice with a longbow on Sundays and holidays. Archery ranges were erected in every town at community expense; and the village officials were charged with providing equipment, and with the planning of community meets.

During this period the design of the longbow was standardized. Specifications stated that it must be constructed of elm, 6 feet 4 inches in length, and capable of driving "an arrow at a hundred yards through a 4-inch oak door until the arrow and shaft protruded from the other side the width of a hand's breadth." A fair price was also set to encourage ownership. A plain bow could be purchased for one shilling. A painted bow cost 1 shilling and 6 pence. Standard arrows three feet long were furnished at a rate of two dozen for 1 shilling and 2 pence.

One has only to read early English history to realize the important part these laws played

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in building the English archer into the most respected soldier of his day. The outline of the longbow can be seen clearly in the colorful chapters of continuous conflict with the best armies central Europe could muster.

The Battle of Crecy, fought on 26 August 1346, represents the peak efficiency of the longbow as a military weapon. The English army, commanded by Edward III (1327–77), was outnumbered 4 to 1. Yet, it routed and practically annihilated the powerful army of Philip VI of Valois. The perfect marksmanship of the English longbowmen maintained throughout the battle a superiority of fire of ten arrows against one from the crossbows of Philip's Genoese. It was common for the expert English archers to have three arrows in the air at one time from the same bow. Not only did they have a higher rate of fire, but they greatly outranged Philip's soldiers. The English arrows easily pierced the light armor of the French horsemen, upon whose charges Philip had relied to bring him ultimate victory. Although the cavalry made 16 attempts to break the English lines, not one attack was even partially successful. The battle lasted only a few hours, but the English bowmen pumped volley after volley of arrows into the hapless French forces, until they were a struggling mass of wounded horse and foot soldiers trying to escape.

This state of affairs allowed the English to massacre them. A fair picture of the deadliness of the bow in the hands of these skilled longbowmen can be drawn from the fact that of the 40,000 men in King Philip's original army, over 20,000 were casualties in one form or another. The English losses were listed as negligible, in the amount of 50 men.

With the overwhelming victory at Crecy, the English longbow was firmly established as the paramount military weapon of the day. The English army, as a result, enjoyed its greatest reputation throughout Europe. The French, in justifiable alarm, sought the services of Italian metalsmiths to design coats-of-mail capable of resisting the penetrating powers of the high-velocity longbow arrows.

At the Battle of Auray, in 1365, the French and English again met under conditions somewhat similar to Crecy. However, this time the French felt secure in their new armor. It took but a short time for the English to discover that their formerly lethal arrows were being deflected harmlessly to the ground. They also observed, in an equally short time, that while the French soldier had protected himself against the arrows, he had done so at the expense of mobility. Each individual was so loaded with his own armor that movement was very difficult. The English promptly threw down their longbows, not in disgust, but because they sensed an easier solution to the work at hand. They advanced boldly on their stiffly encased foes, and seizing the Frenchmen's own axes and pikes, they beheaded and bludgeoned thousands, inflicting losses that were even greater in comparison than those at Crecy. Oddly enough, the reputation of the longbow was even more enhanced by this fact. For, it was quickly realized throughout the military world that to protect oneself adequately against longbow arrows required wearing such cumbersome armor that the wearer would be exposed to almost certain death from other means.

It can safely be said that the bow was the first-line instrument of war for several thousand years. But never in all history has the skill of the English archer of the fourteenth century been closely approached.

Chapter 2

FIREARM DEVELOPMENT TO PERCUSSION IGNITION

Origins of Gunpowder

Strange as it may seem, the Battle of Crecy, which showed the longbow at its best, was also the scene of an incident that sounded the death knell, not only of the bow, but of all merely mechanical means of missile propulsion. This battle saw the first recorded use of artillery in an engagement between major armies and heralded explosives as a means of missile propulsion. However, the justified praise of the longbow was so great at this time that were it not for the meticulous writings of a few historians of the day, it would have gone unnoticed that Edward III employed stampede cannon on his flanks. These devices represented artillery in its crudest form, and were mainly used, as the name implies, to scare the enemy's horses and strike terror into the untrained foot soldier. Missile throwing ability was secondary. Earliest cannon design appears to have been that of an iron tube incased in wood to give it further support, and still keep it light. The explosive was a crude black powder to which generally was added various kinds of wax, the mixture being made into balls. The balls, when discharged, produced an effect somewhat like an oversized Roman candle. The cannon's front end was supported by a metal fork and, to take care of recoil, the butt simply was placed against a convenient knoll. Firearm development stems from this modest beginning.

Just as human muscle had its limitation, so did the awkward and bulky mechanical missile throwers, which in turn gave way to a newer more efficient means for waging war; namely, the chemically stored energy called gunpowder.

That the Chinese knew of gunpowder centuries before, there is no doubt. Their Gentoo Code of Laws, credited with having been written about the time of Moses, contains a thought-provoking section which has been translated as follows:

"The Magistrate will not make war with any deceitful machine, or poisonous weapons, or with cannon or guns, or any kind of firearms."

With the first application of gunpowder to propel a missile, the technological phase of warfare begins and human elements, both physical and moral, are minimized, intellect alone remaining supreme. This has done more to democratize fighting than any other event in history.

While a natural interest is attached to the antiquity of any material which so revolutionized warfare, yet the actual date of the discovery is of little military significance compared to that of its first use as a fuel for the engines of war.

Both Roger Bacon and Barthold Schwartz, a German monk, are erroneously credited with the discovery of gunpowder. Their contribution was the preparation of explosive mixtures. Gunpowder, as such, did not exist till the mixtures were applied to the propelling of missiles.

Roger Bacon describes black powder in his *Concerning the Marvelous Power of Art and Nature, and Concerning the Nullity of Magic* (1252). This document was addressed by the author to a high official of the church and was written to defend himself against the charge that he had been devoting too much time to magic and the practice of black arts.

He pointed out that many phenomena commonly attributed to magic are due only to the operations of nature. He further fortified his position by referring to many natural things which are understood by a chosen few, but considered marvelous by others: "For, regardless of the power of Nature, Art using Nature for an instrument is more powerful by virtue of this fact."

Bacon spoke of the simple deceits which are practiced by jugglers and ventriloquists, and commented that 'popular opinion does anything that men wish it to do, so long as men are agreed about it.

"In addition to these marvels, there are certain others which do not involve particular constructions. We can prepare from saltpeter and other materials an artificial fire which will burn at whatever distance we please . . . Beyond these are still other stupendous things in Nature. For the sound of thunder may be artificially produced in the air with greater resulting horror than if it had been produced by natural causes. A moderate amount of the proper material, of the size of a thumb, will make a horrible sound and violent coruscation."

Bacon speaks also of the purification of saltpeter by dissolving the salt into water, and boiling until the scum has risen to the top. The scum is then removed and the solution is allowed to crystallize. The mother liquid is evaporated for another crop of crystals, which are then piled up in a warm place to dry. Such was the method of refining the basic ingredient of black powder by Roger Bacon (1219–92) in his half magical laboratory.

Without saltpeter there could have been no refined gunpowder. As there is no mention of it before the thirteenth century, it is quite possible that Bacon discovered its absolute importance in the chemical mixture of "seven parts of saltpeter, five of young hazelwood (charcoal), and five of sulphur." This was the standard military formula for many years following the *Epistolae de Secretis Operibus Artis et Naturae et de Nullitate Magiae.*

Although Bacon suggests several military uses for his explosive (for instance, "an enemy might be either blown up bodily or put to flight by the terror caused by the explosion"), there was nothing to be found in any of his writings to show he ever once contemplated its use as a missile-throwing agent. The identity of the individual who first thought of propelling a projectile through a tube from the force generated by gunpowder still remains a mystery.

An Arabic document dated 1304 mentions a mortar type cannon. Two records at Ghent dated 1313 and 1314 also refer to such weapons. Christ Church of Oxford, England, owns an illuminated manuscript which pictures the early "dart-throwing vase," or "pot-de-fer." This weapon was used in the siege of Metz (1324) and by Edward III in Scotland in 1327. (But stampede cannon were recognized by Edward III to be of more tactical value.)

The German monk, Barthold Schwartz, of Cologne (1310–84), has often been credited with originating gunpowder. He undoubtedly invented a system for casting bronze cannon, and established a workshop in Venice in 1377. He was ordered put to death by the Venetian Senate for insisting he be paid for his work on cannon design.

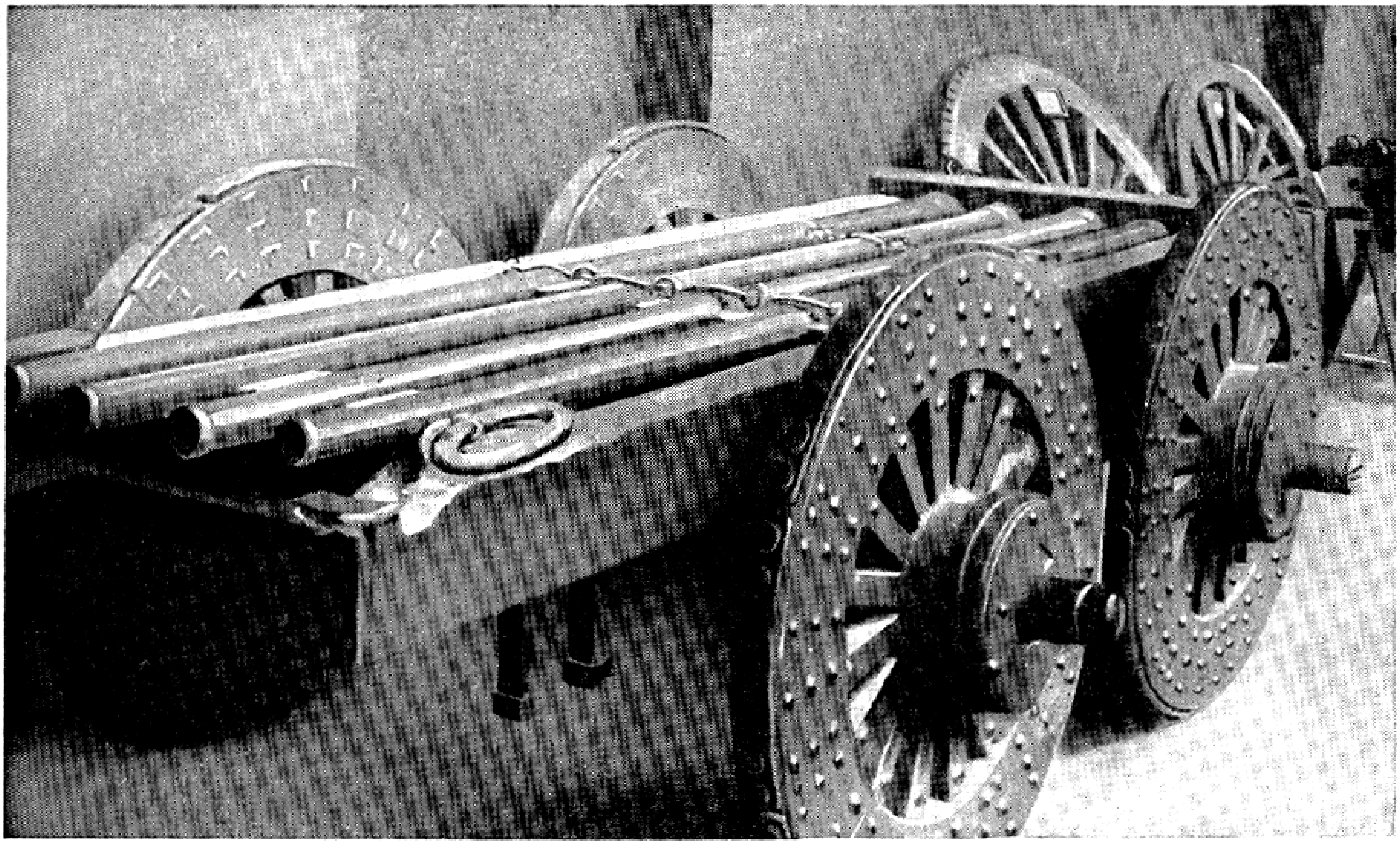
Schwartz's experiments with cannon and the art of casting naturally brought him into constant contact with the unrefined mixtures that were used to load the weapons. He even made attempts to better the concoctions. On one occasion these efforts resulted in an explosion that almost completely demolished his crude laboratory. From this and other stories arose the belief that he discovered gunpowder.

The Uffizi Museum in Florence is credited with having formerly possessed a picture by Giacomo Crespi (late fifteenth century artist) which showed Schwartz in his laboratory with many workmen making powder. The existence of this painting has been questioned, although it has been used as evidence by many gunpowder historians. However, any artist depicting a historical character, predating him by a century, must necessarily use imagination. Such a work cannot be considered as documentary evidence. Schwartz never claimed to have originated gunpowder or firearms, but he did attempt to improve both.

Between 1345 and 1349 the Wardrobe Account of Edward III of England carries an entry crediting one Thomas of Roldeston for work on the king's guns and for 912 pounds of saltpeter and 886 pounds of live sulphur. This tends to show that other craftsmen were working on gunpowder as a propelling charge in guns before Schwartz opened his workshop in Venice.

Early Multibarrel Firearms

In 1339 mention is first made of a new type of firearm called the "ribauld" or "ribauldequin." This was a primitive multibarrel affair that consisted of several iron tubes, so arranged as to be fired simultaneously. Its purpose was to blast an opening in the solid rank of heavily armored



An Early Chinese Organ Gun.

pikemen who were supposed to keep the cavalry from the bowmen.

In one of England's wars with France, Edward III used this weapon to good advantage in conjunction with his battle-tested stampede cannon. For, even at this early date, the theory of volume fire was being considered by the military.

The desire for a multifiring weapon predated the first use of gunpowder in battle. The various experiments to accomplish this end have led, over the years, to an epidemic of designs, all of which were to serve but one purpose—to fire a volley of balls in the direction of the enemy, and to do so repeatedly with the employment of a minimum number of soldiers.

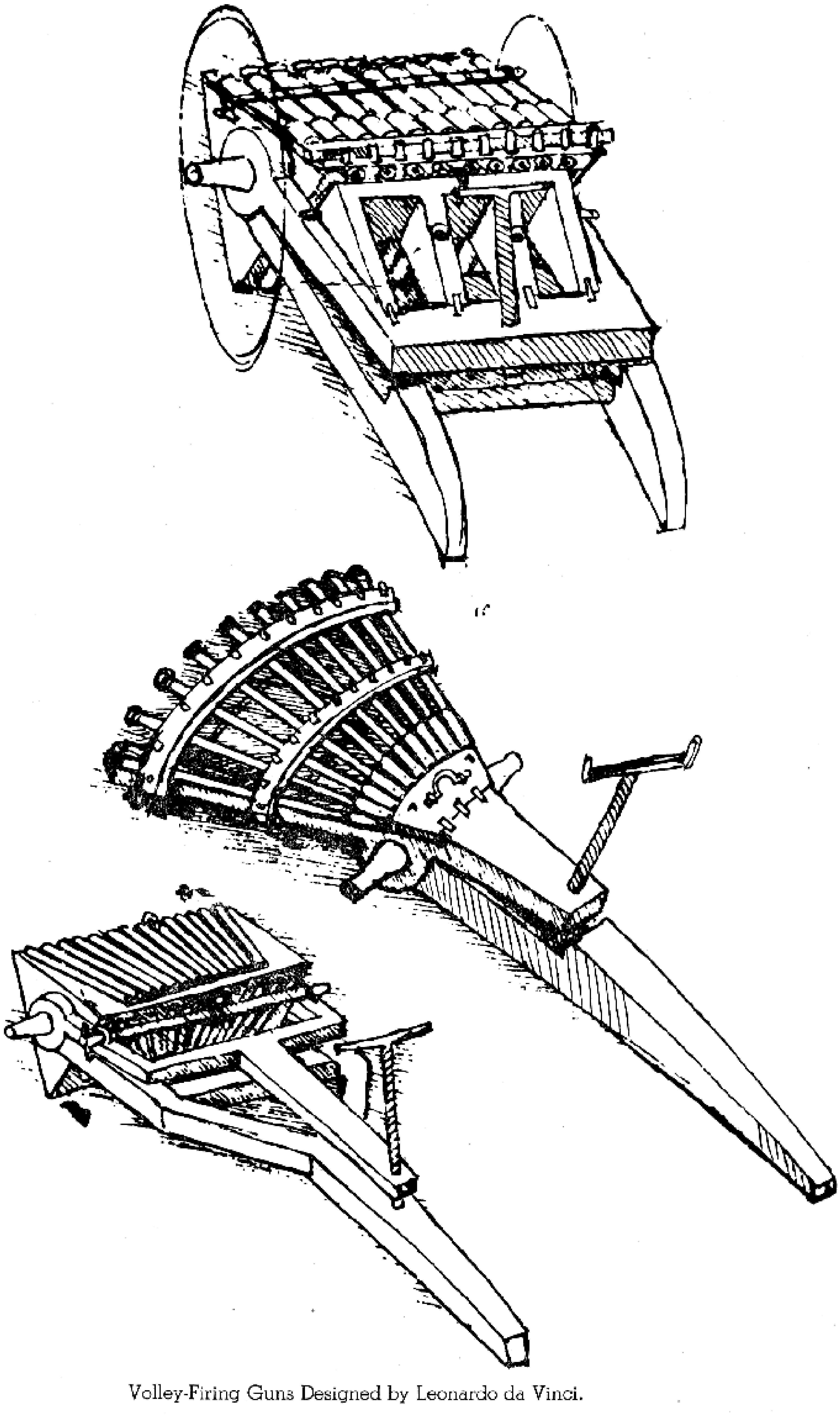
One of the most progressive types of firearms in the fourteenth century was a wrought iron single-shot breech-loading gun, the breech of which was wedged after being dropped into position. The principle was somewhat the same as the present-day system of locking. It is a curious fact that gunmakers should have developed so advanced a method of charging and then abandoned it in favor of the inferior muzzle loading.

Considering the crude work of the fourteenth century mechanic, the religious restrictions of the times, and the total ignorance of metallurgy in relation to powder pressure, the progress in firearms was comparatively rapid.

In those days of muzzle-loading battery guns, the universal method of placing the barrels in stacks side by side in a frame led these assemblies to be called "organ guns" or "orgues des bombardes."

The iron ball missile that came into use in 1381 to replace the pebbles and rounded stones, was considered the answer to the armored foot soldier. The attempts to deliver these missiles in a concentrated area led to the many types of early battery guns.

In 1382 the army at Ghent had 200 "chars de cannon" in the field. These weapons consisted of a number of barrels fastened horizontally on two-wheeled carts with pikes and heavy sharp blades attached to the hubs as a further lethal garnishment. In 1411 the Burgundian army had 2,000 of these weapons.



Volley-Firing Guns Designed by Leonardo da Vinci.

A more elaborate design having 144 barrels was constructed in 1387. These were grouped in batteries, allowing 12 salvos of 12 balls each to be fired against the enemy.

Regardless of the clumsy mounting and great transportation difficulties of the organ gun, the demand for fire power, even then, led to their use in many theaters of operation. The Venetian general, Colleoni, employed the "orgues des bombardes" as a mobile auxiliary in connection with his armored cavalry at the battle of Piccardini (Picardy) in 1457. Pedro Navarro also used this weapon against the French, by placing 30 carts of multibarrel guns in front of his foot soldiers.

Yet, the development of powder-propelled missiles was not exclusively a Christian project. An infidel is known as the first great gunner of history. Mohammed II (1451–81) in his conquest of Constantinople (1453) recognized the advantages of a new weapon. Fabulous accounts state the largest of his cannon threw 1,200-pound stones having a diameter of 30 inches. This weapon was called a bombard and needed between 50 and 70 oxen to transport it while 400 men were required to attend it. The rate of fire was seven rounds a day, two hours being required for reloading. Some authorities credit as many as 13 of these monstrosities to Mohammed II's artillery, which included 14 batteries and 50-odd cannon of assorted sizes and shapes. But, whatever the statistics, it is claimed that this was the first use of cannon as the principal weapon in an engagement between major armies.

On good authority, Louis XII (1498–1515) is said to have employed a gun having 50 barrels, so arranged that all of them could be fired in one volley.

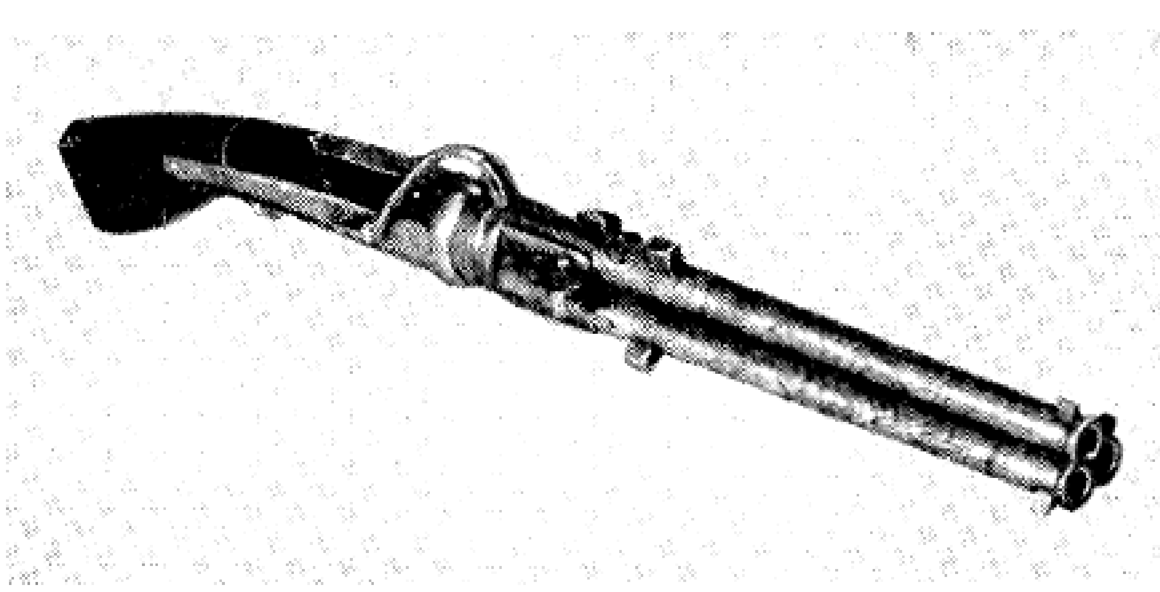
As a whole, early multifiring weapons could be termed only a moderate success. They were extremely heavy and clumsy to handle. While all the barrels could either be fired at once or in rapid succession, the advantage of momentary volume of fire thus attained was soon canceled out by the long periods of inaction caused by the need to muzzle-load each individual barrel. This inability to deliver sustained fire restricted its use to supporting or auxiliary employment. But at a critical point in battle, one could be maneuvered into a position where a concentrated blast would have a serious effect. In order that all barrels be fired simultaneously, or as nearly so as possible, the train of ignition from one barrel to another was shortened. This was about the only refinement attempted on these weapons.

The most notable accomplishment along this line was done by the great Leonardo da Vinci (1452–1519), who designed a fan-shaped affair that more than cut in half the distance between touch holes. Study of other multibarrel weapons contemplated by da Vinci, shows he had in mind a way to drop the breech on the weapon for rear-end loading with some crude sort of fixed ammunition. No doubt the problem of ignition was his main stumbling block.

Improvements in Ignition

From an historical point of view the development of powder has closely followed the improvements of ignition. The first practical system of ignition was a manually applied slow-match, or fuse. A touch hole was first primed with a finely granulated powder and, when ready, the gunner made contact with the primer by using a live ember or the burning end of an impregnated piece of twisted jute.

The period from the thirteenth to the early sixteenth century may be called the slow-match era. Some improvements were made to this haphazard form of ignition, such as putting the slow match in a crooked arm that could be made to dip into the priming pan when the trigger was actuated. The touch hole also was moved from the top to the side of the barrel, to take it out of the line of sight. None of the so-called refine-



Three-Barrel Match Lock. Barrels are Revolved by Hand.

ments, however, altered the fact that actual fire had to be constantly present to discharge the weapon.

From the sixteenth century to 1807 there was an era of mechanical methods for producing fire by friction. In most instances, ignition was brought about by sharp contact of flint on steel, causing a shower of sparks to fall into a pan in which was nested the primer.

Odd as it may seem, the most perfect and elaborate of these systems came first. It was made in the form of a spring-loaded wheel with a knurled edge that rested against a portion of flint or pyrite. Upon releasing the wheel held under tension, the knurled edge rotated rapidly against the flint, and a shower of sparks was directed into the powder train. This mode of ignition is known as the wheel-lock system.

While this method was very reliable, only the very wealthy could afford such a contrivance; and necessity again proved to be the mother of invention. Thieves, working under cover of darkness, realized their presence would be made known by the glowing slow-match. Since they could not afford the costly wheel-lock, they improvised a cheaper substitute arrangement.

A chunk of flint was held in a jaw. Upon being pulled to the rear, a horizontally placed **U**-shaped spring was compressed and held under tension by a notch engaging a searing device. It was released by a rearward pull on the trigger. This allowed the flint to snap smartly forward striking an inclined and pivoted piece of roughened steel. This sudden blow resulted in sparks being directed into the priming pan that was located beneath.

This system of ignition was for 200 years known as the "Snap-hance." Translated from the original Dutch, this means "chicken thieves." It should be self explanatory what profession was followed by the inventors of this most reliable and practical method of ignition.

The flintlock proved reliable enough to be used at one time or another by every nation on earth. Nor was its application confined to single shot weapons, although the very nature of the mechanism had a tendency to restrict this particular use.

Beginnings of Revolving and Volley-Fire Guns

During the slow match and flintlock era, there were many peculiar designs in weapons, including many proposed multifiring devices, all in an attempt to solve the three major problems that confronted the inventor planning a gun. They were: First, an adequate chamber and tube to house the powder charge and direct the missile; second, some method of igniting the propellant at the instant the gunner brought the piece to bear on the target; and third, provision of ways and means of firing successive shots with a minimum of effort and a maxim[illegible] of speed.

There was also a serious effort to apply the multifire idea to shoulder arms. The bulk, weight, and various accessories necessary for the individual soldier to support and fire the piece, made its practical use as a weapon out of the question. However fanciful pictures of the ti[illegible] often depict wishful thinking rather than an efficient firing device.

During the sixteenth century there appeared for the first time an attempt to take the multi-barrels out of the flat method of mounting [illegible] placing them in a circle. In doing this, th[illegible] of the revolving type of firearm came into [illegible]

For a hundred years or more there was little or no actual development in volley-fire weapons, other than a few isolated cases, such as the 1626 patent granted in Scotland to William Drummond by Charles I. This patent was to apply in Scotland only, and was to be void if one or more guns were not produced within 3 years. It is described by the inventor as "being a machine in which a number of musket barrels are fastened together in such a manner as to allow one man to take the place of a hundred musketeers in battle."

The arrangement consisted of 50 barrels put together organ-gun fashion for the purpose of sustained fire. The method of firing volley after volley from the same muzzle-loading barrel was novel, but by no means practical. Each barrel was loaded with one charge upon the other, the powder of each charge being aligned with a touch hole all the way up the barrel. Drummond's idea was to discharge each barrel by moving adjustable fuse holding devices until they lined up with the touch holes. This was supposed to fire alternately each charge somewhat on the order of the Roman candle principle.

Drummond's description further leads one to believe that the barrels were mounted in a circular manner and could be rotated by hand. Thus, when the outside barrels, or tubes, were discharged, they could easily be removed for loading. If any attempt was made to use this manual system, it no doubt resulted in more casualties to the king's gunners than to the enemy.

These very early experiments reveal that fire power was the paramount theme in each and every weapon offered for governmental consideration. The ruling heads also thought in this fashion and encouraged the design and construction of practically anything that might produce results.

Theories for such instruments of war were devised by men of letters as far back as 1663. *Transactions of the Royal Society 1663–64* contained a paper by a man named Palmer. In it he explored the possibilities, not only of using the forces of recoil, but also of trapping the gases along the barrel and using this heretofore wasted energy [illegible]l, discharge, and reload the weapon. He aptly described it as "the piece to shoot as fast as it could be and yet to be stopped at pleasure, and wherein the motion of the fire and bullet within was made to charge the piece with powder and bullet, to prime it, and to pull back the cock."

Needless to say Palmer was a couple of centuries ahead of his time. But it is one thing to theorize, and quite another to construct. There is no record of Palmer making any attempt to produce a working model utilizing either gas or recoil forces. It is very possible that the idea was greeted by so much skepticism that he never dared mention it again.

Most of the records of this particular era are more or less vague references to certain developments that cannot be fully authenticated. Such is the story of "the repeating gun of 1688," the records of which were uncovered by a French researcher, Abbé J. Rouquette. In the archives of the province of Languedoc at Montpellier he found a curious and interesting document. This stated that on 21 August 1688, a man who called himself Abraham Soyer was picked up on some minor charge, and brought before Abbé du Chayla, archpriest and inspector of the mission of the Cevennes.

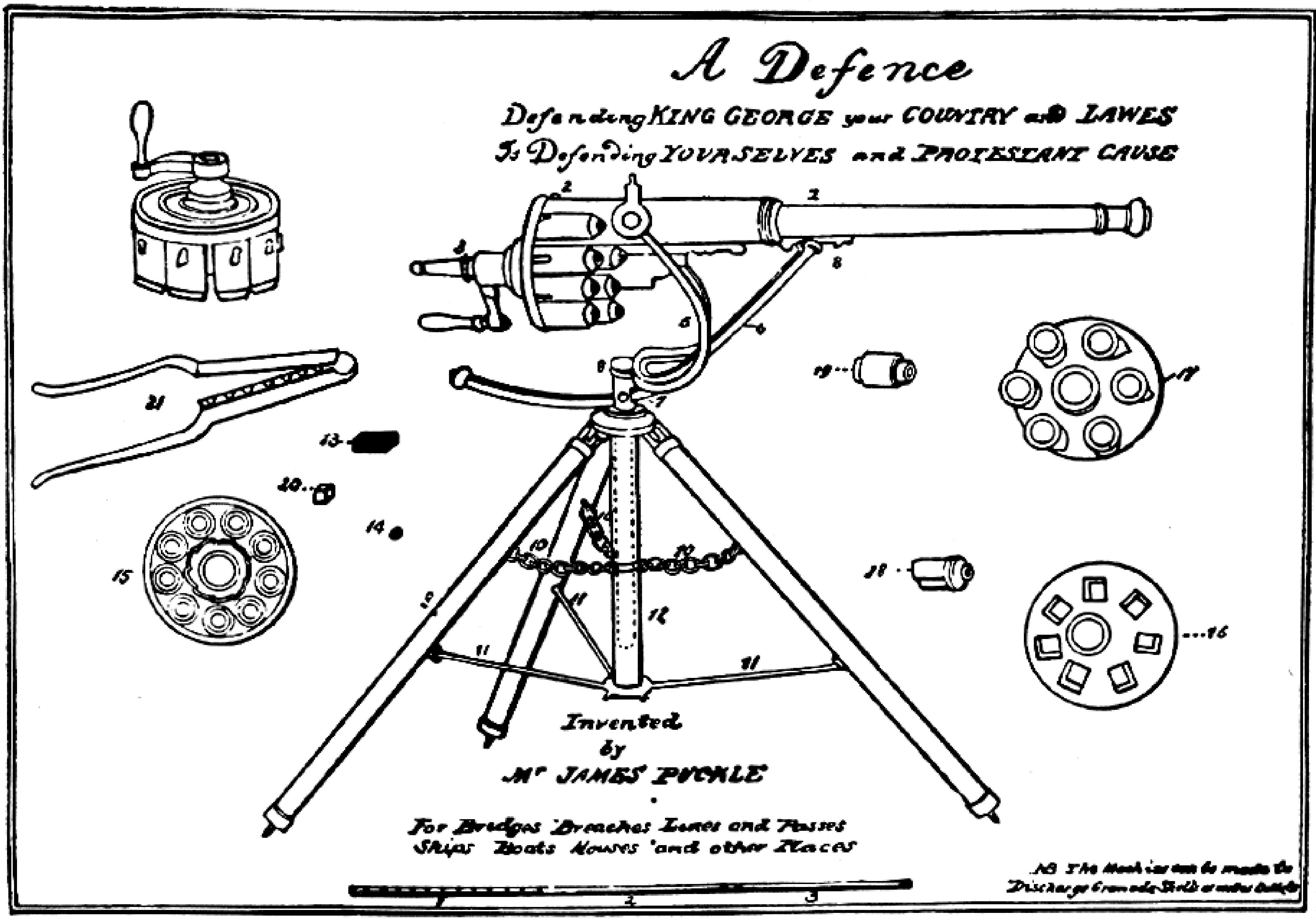
In the prisoner's luggage was found a small weapon that he was carrying to St. Etienne to turn over to the gunsmiths there as a working model. Evidently this was Soyer's idea of the way to get the gun into production. If the additional information given is correct, the weapon was indeed a clever firing device for that day. It is alleged to have had a breech that allowed it to be loaded through the butt end of the stock (using, perhaps, some crude cartridge to accomplish this). A clear description was not given in the records. The reason can well be imagined when the nature of the device and the troubled times are taken into consideration.

In London, England, on 15 May 1718, there was issued patent number 418 to James Puckle on a revolver type of firearm that has proved one of the most controversial in all weapon history.

This odd-looking weapon, which according to the inventor was "a portable gun or machine that discharges so often and so many bullets, and be so quickly loaded as renders it next to impossible to carry any ship by boarding," has perhaps caused more discussion than any other weapon of its kind. The drawings are unusually clear, considering the time; and many new and clever features are shown, especially in mounting. However, Puckle's specification that round bullets be used on Christians, and square ones on Turks makes one wonder if it were really a serious attempt to produce a repeating weapon. Puckle seems to have been more interested in using the King's patent office as an expedient to advertise his patriotism and church affiliations.

An authority on multifiring weapons in the nineteenth century had the following comment on Puckle's invention:

"As the science of gunnery progressed, the gun maker sought not only to increase the range of the arm but also the rapidity of fire, and it would appear that a large number of the early inventors first thought of the revolver principle as the means which would best lend itself most readily to this end. Nothing would seem simpler than to make the rear of the arm in such a man-



Whereas our Sovereign Lord King George by his Letters pattents bearing date the Fifteenth day of May in the Fourth Year of his Majesties Reign was Graciously pleas'd to Give & Grant unto me James Puckle of London Gent my Exors Admors & Assignes the sole privilege & Authority to Make Exercise Work & use a Portable Gun or Machine (by me lately Invented) call'd a Defence in that part of his Majesties Kingdom of Great Britain call'd England his Dominion of Wales, Town of Berwick upon Tweed and his Majesties Kingdom of Ireland in such manner & with such Materials as Should be ascertain'd to be the sd New Invention by writing under my Hand & Seal and Inrolled in the High court of Chancery within Three Calendar Months from the date of the sd pattent as in & by his Majties Letters Pattents Relacon being thereunto had Doth & may amongst other things more fully & at large appear NOW I the said James Puckle Do hereby Declare that the Materials whereof the sd Machine is Made are Steel Iron & Brass and that the Tripied whereon it Stands is Wood & Iron And that in the above print (to which I hereby Refer) the said Gun or Machine by me Invented is Delineated & Described July the 25th 1718.

Ja Puckle

James Puckle's Revolving Gun.

ner that a loaded cylinder carrying several charges could be inserted, and these charges brought successively in line with the barrel and fired. The revolver was, in fact, among the first systems thought of by a considerable number of inventors. But it would appear that very little was actually accomplished, the inventors, for the most part, contenting themselves with making a single example of their arm, and these were looked upon more as curiosities than as useful weapons. The inventor at that time, not having the percussion cap, was obliged to employ a somewhat cumbersome means of igniting his charge, and this was the probable reason why revolvers were so long in coming to the front.

"It will be observed that the inventor proposes to use round bullets against Christians, presumably Catholics, and square ones against Turks. Had his Majesty King George been at war with any heathen nation at the time, it may be presumed that he would have recommended a bullet to be used against them still more angular than that recommended for Turks, while he might have recommended the employment of soft bullets made of cork or wood against his own erring co-religionists, the Protestants. However, the illustrations forming part of the patents are certainly interesting in their way. It will be seen that the arm is mounted upon a tripod which very closely resembles the tripods employed with guns of today, that a too great spreading of the legs is prevented by a chain, that stiff rods are used for holding the legs in position, and that for holding the guns at any degree of elevation a device is employed almost identical with that used on some recent forms of machine guns. This arm, I think, may be considered as the first mitrailleuse ever patented in England."

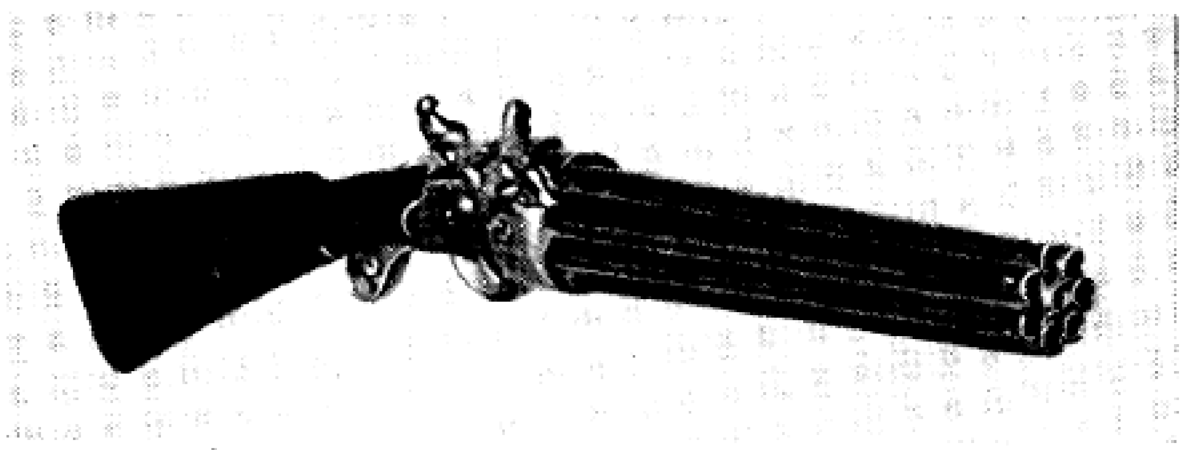
This authority ignored the earlier Scottish patent issued to William Drummond by Charles I.

Whether Puckle's "Defense" represents the first patented manually operated revolving-type machine gun, or not, is immaterial. Its importance lies in the fact that it certainly represents the most refined design to be found in the whole slow-match era. It also shows that the mechanisms involved in getting a weapon to fire repeatedly had far outstripped the method of igniting successively the charges as they came into alinement.

A prominent American gun inventor, during an early visit to London, was shown in the tower of London an actual weapon that had nearly all the basic principles of the modern revolver, with the exception of the ignition system. This consisted of a split hammer clasping a slow-match which moved forward under trigger pressure to touch the primer. Each chamber was provided with a priming pan covered by a swinging lid. Before firing, the protecting lid was pushed aside by the finger, exposing the powder to the lighted end of the slow-match.

He was also shown another revolver weapon of a more recent date that was a considerable improvement over the preceding one. It had six chambers and a rotating breech, and was provided with flint lock and one priming pan, arranged to fire the chambers one at a time, or all together. The pan was fitted with a sliding cover. A vertical wheel with a serrated edge projected into it, not quite touching the powder in the pan. To this wheel a rapid whirling motion was given by action of a trigger spring on a lever attached to the axis of the wheel, which caused the teeth on the wheel to strike against the pyrite. A cam brought the action down until a shower of sparks was certain to reach the primer. If the gunner cared to fire it single shot, the breech was rotated by hand until it alined with each individual barrel. To fire all barrels in one volley, all pans were connected by a tubelike affair which, when fired, would simultaneously discharge all the barrels.

This type of revolver flintlock gun was made in various designs, both in England and France. The French went so far as to build a similar weapon that employed eight barrels revolving around a common axis. Each barrel was fired as it revolved into alinement with a fixed flintlock firing system.



Seven-Barrel Revolving Flintlock Rifle.

At about the same time a Bostonian named Elisha H. Collier, after first trying to interest various people in this country in his revolving flintlock firing system, went to England with the design. His gun was very popular and was used by the English army in India. It was considered the finest weapon of its kind and did not suffer in comparison with any known foreign gun.

After his success in England and France, Collier closed his gun shop in London and returned to the United States. He set up a similar gun business in Boston for the purpose of making his revolving flintlock guns. These had such improved features as a self-priming pan and gas-tight joints between cylinder and barrel, formed by camming forward the cylinder counter-bored at the forward end to mate with the breech end of the barrel. A novel way of rotating the cylinder was used; upon releasing the trigger after firing, it was indexed by tension of a spring that had previously been hand wound.

There was little or no actual development in the flintlock period of ignition other than refinement of existing weapons and the substitution of the flint and steel spark-throwing arrangements in lieu of the slow match. True, there was a tendency to reduce the excessive weight of shoulder arms that the earliest weapon designers had simply ignored. Also a better knowledge of, and experience in, working steel produced a more serviceable but streamlined gun.

The art of gunsmithing was considered, during this era, one of the highest skilled trades. This view is justified by comparing the finely designed, reliable weapons of that day with the clumsy freaks of earlier times, and the slipshod gadgets which followed them.

For at least a hundred years, every military power used the flintlock system. This did more to standardize weapons than any other thing. The very nature of this system did not easily lend itself to multifiring, other than to serve as the source of the initial ignition. If other barrels were to be discharged, either one at a time or simultaneously, a chain of priming had to be ignited from the first flash; or the cumbersome mechanism had to be rotated around the primed pans.

Although the reliable flintlock system had long outlived its usefulness and had become a definite bottleneck to future progress in gun design, only a few people realized this. Opinion at the time was agreed that no improvement was needed, it being a foregone conclusion that nothing could serve more adequately the purpose than the flint- and steel-ignited weapons men's fathers had used.

Application of the Detonating Principle to Firing

It is very understandable that when Berthollet discovered in 1786 that chlorate could be exploded by a sudden blow with a metallic hammer, the public was not even mildly interested in the fact. Likewise when Howard in 1799 found that mercury fulminate could be rolled into pellets and ignited by percussion, the event was barely recorded for posterity. Regardless of the attitude of scientists and gunsmiths of the day, the latter discovery was the greatest single achievement to be made in the long and interesting history of firearms development. For the discovery of detonating powder introduced the percussion system of ignition and, while it has gone through many radical improvements, it is still with us today.

Whether Berthollet's work may have led Howard to seek something more stable in detonating mixtures is not known. It is universally accepted, however, that this discovery might have lain dormant for years had not an enterprising Scottish minister of Presbyterian faith, the Rev. John Alexander Forsyth (1768–1843), immediately recognized the great advance made in this field. He patented on 11 April 1807, the "Application of the detonating principle to exploding gunpowder firearms."

There are reasons to believe that in both France and Germany the idea of substituting a detonating mixture in place of flint and steel was being worked out simultaneously and independently. Pauly, the famous Parisian gunsmith, was making paper percussion caps as early as 1812. These were made by sealing a small portion of mercury fulminate between two thin layers of paper, producing a cap.

Reverend Forsyth designed and built several guns employing what he called "pill locks." He placed on the side of the barrel a nipple that led to the powder charge. The upper end of the nipple had a slightly enlarged opening in which was placed a small pellet, or "pill," of the fulminate of mercury mixture. He later improved on this by making a mechanical device to place the pill on the nipple by actuating the hammer. The ease and certainty of fire of this system first became popular with the civilian population and its earliest use is to be found in sporting guns.

Napoleon was the first to become interested in this departure from the time-honored flintlock system, and offered Forsyth £20,000 for his invention. Forsyth, evidently being a very patriotic man, refused the offer and gave the rights to his government. To the memory of this Aberdeenshire minister, a plaque has been erected in the Tower of London. This was a joint gift from arms guilds, whole British regiments, and a host of Scotch and English sportsmen, and is the only memorial in honor of an individual ever erected within the precincts of the 800-year-old Tower, often called the "heart of the British Empire."

An improvement in Forsyth's invention followed immediately. An American sea captain, Joshua E. Shaw, of Philadelphia, evidently in one of his ports of call, had been brought into contact with the fulminate of mercury ignition system. He immediately set about to correct the worse features of the loose pill placed on the nipple of the gun; and conceived the idea of housing the mixture in a pewter cap that could be placed over the nipple. This not only protected the primer from weather conditions, but also rendered it practically impossible to lose as the cap was designed to grip firmly the sides of the nipple.

Shaw, however, did not reckon with American patent laws that refused him a patent (in 1814) on the grounds that his many travels had kept him away from home for more than 2 years. One had to be a bona fide resident for at least 2 years before a patent could be granted.

In the long run this delay proved advantageous. During the period of establishing residence, Shaw found that pewter, the material he originally planned using for his fulminate cap, crushed too easily. Also the crown of the cap had a tendency to melt when subjected to the intense heat generated by the rapid burning of the powder. A portion of molten pewter would plug the priming hole, and thus render the weapon useless until the obstruction had been removed. When his patent was finally approved, in 1816, he had changed the material from pewter to copper.

It may be said that the combined intellect of three men from the most contrasting professions imaginable (an apothecary, a minister, and a sea captain) prepared the way for the wholesale experiments in the development of weapons. Many of the principles involved in these new designs had been but useless theories to former inventors and armorers.

In 1817 the government had 100 Hall rifles modified to take the percussion cap. Later Congress granted Shaw a $20,000 bonus for his invention.

The Hall rifle was the first breech-loading arm used by American military forces. Its inventor, Capt. John H. Hall, United States Army, also originated gage application to dimension with tolerances that resulted in our modern conception of interchangeability.

Pioneer American Gunsmiths

Eli Whitney, inventor of the cotton gin, had already given the armed services a very simple lesson in mass production. He delivered to the army many kegs full of triggers, hammers, barrels, ramrods, stocks, etc. Upon arrival before a group of astonished officials, he used a dozen common mechanics to assemble the component parts. Then he took the finished pieces to the range and personally proofed each weapon. He showed, once and for all, if each part was made to specification, assembly could be done with mediocre skill, thereby doing away with the old theory that a gunsmith had to produce each weapon in its entirety.

By making each component fit a master template, every part was capable of being interchanged with a similar piece. This principle was instantly added to the many other mechanical tricks in the art of gunsmithing, of which the New England States were beginning to be the center.

Any individual who felt he had a high degree of skill in mechanics generally wound up in the production of firearms. Regardless of the cleverness of his ideas on methods for sowing rice, ginning cotton, or planting corn, he eventually was forced to center on gun production as a means of livelihood. It was the one and only mechanical trade where, should a product be first quality, the sale was certain and profitable.

For once, a restless civilian population was creating a demand for weapons far greater than any war had ever done. The pioneer settler could plant his grain in the manner of his forefathers; he could gin his cotton by hand; and the luxury of a buggy was unthinkable. But he demanded, and would pay for in cash to his last cent, the best that could be created in weapons. His specifications were simple: the arm must be reliable, accurate, rugged, simple in design, as light as practical, and with all the firepower the ingeniousness of the inventor could build into it.

Every inventor knew that, on building honestly a superior weapon, his name would be praised, his fortune made, and nothing on earth could change this situation except a competitor producing a better gun. Then he knew his public, governed by self preservation, would leave him over night, since a second best gun was considered worse than no gun at all.

The three-quarters of a century following the percussion cap patent saw more accomplished in development, design, and performance of weapons than in all previous history.

True, repeating cannon had been used to good effect by our Navy in the War of 1812. A few of these weapons are now to be found in various museums. Their ignition was of the fire-to-primer type, but they used the revolving chamber system in reverse. The axis of the cylinder was horizontal to the gun, and perpendicular to the center line of the bore. This allowed the cannoneers to load the rear of the cylinder while the forward side was in position for firing.

It was not until 1829 that such a weapon was patented. To Samuel L. Farries of Middletown, Ohio, goes the honor of receiving the first "machine gun" patent issued by the United States Patent Office. This grant seems to imply that the name "machine gun" was to be assigned to any mechanically operated weapon of rifle caliber and above—regardless of whether the energy necessary for sustained fire is derived manually or from some other power source.

Because of the slowness of muzzle loading, there was no incentive to use improved methods of ignition. Even up to the Civil War, it was standard practice to set off artillery by flaming brand, linstock, slow match, red hot iron, or other fire-to-powder methods.

It is particularly interesting that the third machine gun patent issued in the United States was for a type that has been patented with regularity for over a hundred years. Innumerable hours of labor and millions of dollars have gone into its development. Unsuccessful tests have been run on this kind of weapon by the government from 1838 to the beginning of World War II. It is to the machine gun field what perpetual motion is to the mechanical world: an idea that has been approached so close, but still remains so far—the centrifugal machine gun.

The military class, as a whole, both here and abroad, was very slow to accept the percussion system, even in small arms. It remained for a civilian, Samuel Colt, to give the multifiring idea the impetus needed to start an unparalleled wave of gun design and development in the United States. In 1830, at the age of 16, on the brig "Corlo" bound for India, Colt conceived an idea for a revolving type of firearm. In watching the steering wheel of the ship, he noted that no matter which way the wheel was turned, each spoke passed directly in line with a fixed clutch and could be held fast at any chosen spoke, if desired. From this he visualized his future revolver.

Although the idea of a revolving firearm had been attempted centuries before, the importance of Colt's invention is that it was the first practical revolving weapon employing the percussion cap in conjunction with the automatic revolution and locking of the cylinder by the act of cocking the hammer.

On 5 March 1836, Colt founded the Patent Fire Arms Co., of Paterson, New Jersey, with a capitalization of $230,000. The company established the first Colt factory in an abandoned silk mill. After producing several models, the venture at Paterson came to an end. Colt, seeking better manufacturing facilities, contracted with

Eli Whitney (son of the cotton gin inventor), who was one of the largest producers of firearms in the United States, to manufacture some revolvers of improved design at Whitneyville, Conn.

As a result of this brief association, mass production combined with the assembly line was introduced into American weapon manufacture. Whitney, Sr., had contributed the first; and Colt, the latter. The innovations in production methods were copied by other gun producers throughout New England. This gave to a limited eastern seaboard area a manufacturing supremacy in firearms production that was unchallenged by the rest of the world for more than a century. Though the business association of Colt and Whitney was of short duration, the ideas of manufacturing interchangeable parts, and of combining the components by the assembly line method have remained the principal cornerstone of American manufacturing supremacy.

Colt, in 1848, established his own plant at Hartford, Conn. Some of the finest rapid-firing weapons known from that day to this were produced in this factory.

The popularity of Colt's early multifiring revolvers assured recognition of the application of the percussion cap in relation to other kinds of weapons for military use.

The conventional gunpowder weapons, operating by various means, had reached such a state of development in the United States by 1855, that John A. Reynolds of Elmira, N. Y., patented a device for the cooling of gun barrels. The wording of the patent claim admits the idea of a water jacket, even then, was not original.

"This improvement is peculiarly adapted to and applicable to the manifold firearm of which I am the inventor, rendering that improvement more valuable and efficient by this simple means of cooling the barrels or tubes, necessarily heated by the rapid and repeated discharges through them from the revolving chambers . . .

"I am aware that the application of a jacket to the breech of a gun, in which the gun itself forms a part of the jacket, is not new. . . . The application of a refrigerator construction as described, to the barrels or tubes of firearms for the purpose of keeping said barrels or tubes from undue heating is substantially in the manner set forth in the foregoing specification."

Chapter 3

BACKGROUND OF MACHINE GUN DEVELOPMENT

First Models of Percussion Multifiring Weapons

The first serious effort abroad to adapt percussion ignition to a multi-firing weapon of war was done by a former officer of the Belgian Army. He completed a model in 1857, which was composed of 50 barrels of rifle caliber, assembled parallel to each other in a prismic group. It had the appearance and weight of a cannon. Records show this unusual weapon's rate of fire to have been a hundred shots a minute; its range, 2,000 meters (1¼ miles), was unusually long for that period.

At the same time, Sir James S. Lille attempted to build a similar weapon in London. It is now in the Woolwich Museum labeled as a "freak" device. Lille attempted to combine the revolving chamber with the multibarrel system. Twelve barrels were arranged in two rows, fastened several inches apart. To the rear of the breech end was a revolving cylinder, chambered for 20 charges. Each chamber was fitted with a nipple and percussion cap which could be exploded when a charge was manually alined with a barrel. The firing was carried out by turning a crank that manipulated a series of rods, serving as hammers, striking the percussion caps in turn. The problem of servicing and loading must have been appalling. It is understandable why this weapon was termed a freak even at a time when radical design was usually heralded as an improvement.

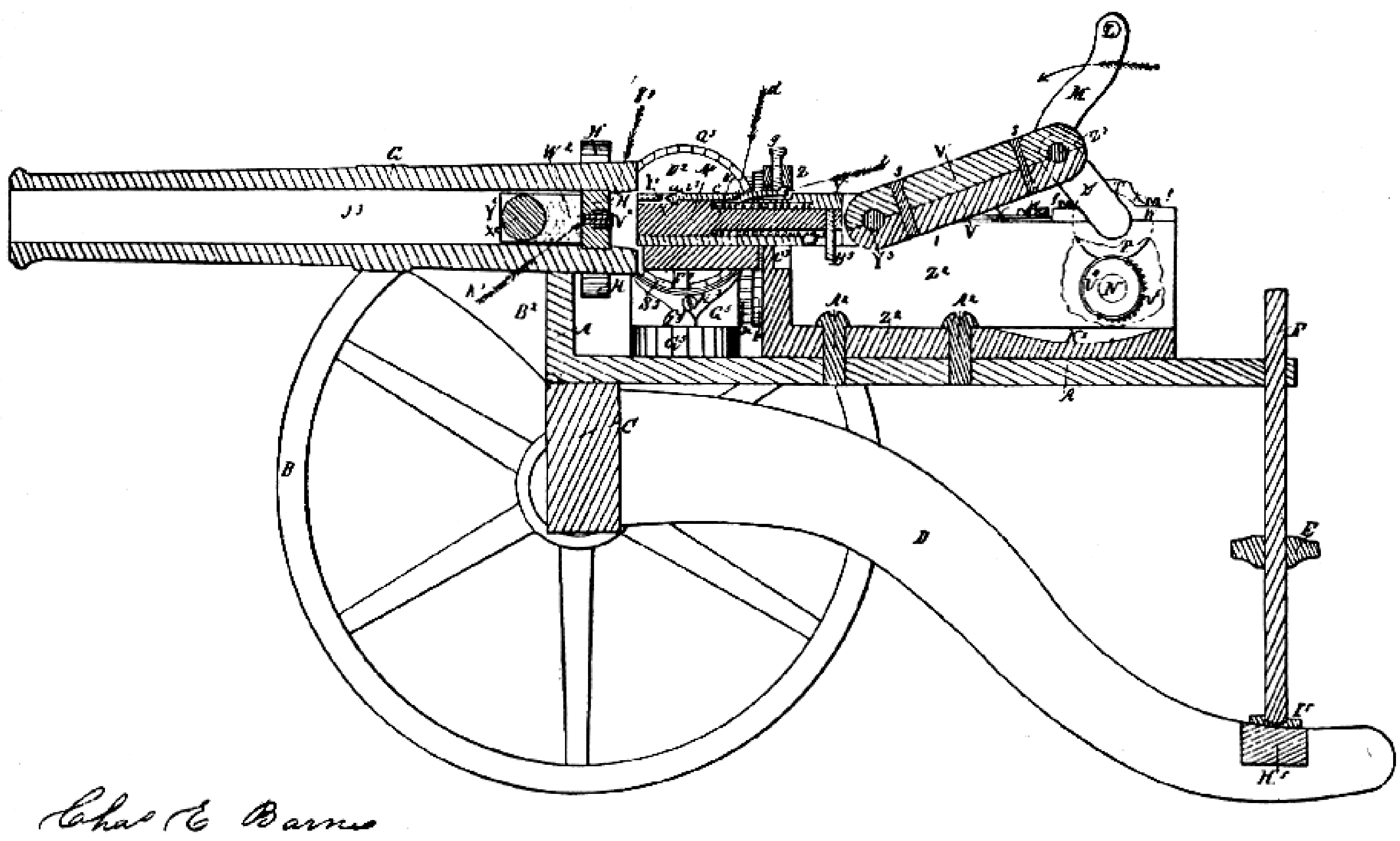
In 1854 Sir Henry Bessemer patented in England a self-acting breech-loading gun that used steam to perform the functions of feeding, locking, and firing of the piece. The weapon's recoil opened the valve after the projectile had safely cleared the bore. This is the first time any outside agent other than manual operation was employed in an attempt to produce sustained fire.

There is no record of the existence of even a working model of this unusual weapon. Bessemer also patented what is known as the "Bessemer process" for making steel. This was so successful and so revolutionary to the steel business that Bessemer lost all interest in his earlier patents.

An earlier British steam gun, however, was witnessed by the Duke of Wellington. When asked by the proud inventor, a Mr. Perkins, what he thought of the idea of steam propulsion of missiles, the Iron Duke replied, "It would be a very good thing if gunpowder had not been invented."

Thomas E. Linden, also of London, filed a specification in May 1856 for a gas-operated piston beneath the barrel of a weapon. This piston actuated a device that was used to fire and raise a hinged chamber to receive a paper cartridge. The weapon, however, had to be cocked manually and to have a percussion cap placed on the nipple after each shot. The principle, nevertheless, was a clear application of mechanical breech opening.

The United States Patent Office on 8 July 1856 issued patent number 15,315 to C. E. Barnes of Lowell, Mass., for a crank-operated machine cannon. This weapon had many original improvements, and was the forerunner of a series of crank-operated weapons. The gun's locking system employed a toggle joint arrangement that rammed a fixed charge home. The stiff linen cartridge was fed from a tray located on the left side of the breech end of the gun. A very clever method was used to place a percussion cap on the nipple mechanically after the weapon was safely locked. The cap was fired by a continued forward movement of the crank action which tripped a sear. The hammer, similar to a piston, was confined in a cylinder. A part of the force of the explosion in the chamber came back through the nipple and imparted enough energy against the head of the hammer to compress the firing pin spring allowing a sear to engage this



Barnes Machine Gun. Patented 1856.

part. This was a novel employment of gas pressure from the chamber for the purpose of cocking the piece.

The rate of fire depended solely upon the speed with which the crank could be turned. This weapon was far ahead of its time, and its development would have placed a reliable machine gun in the armed forces several years prior to the Civil War.

The design of the flintlock system limited its application in weapon construction, but the percussion method of firing seemed to invite attention to its unlimited application. The ignition, now a small separate unit, could be used in many reliable ways, some of which were more ingenious than others.

Development of Cartridges

As mechanical improvements continued, the idea of incorporating the detonating cap as an integral part of the fixed charge was inevitable. This 20-year period (1856–76) saw more varied and distinct types of breech-loading arms developed than any other equal period in the history of arms. Many of these required their own peculiar type of cartridge.

Christian Sharps' self-consuming cartridge made of linen was introduced in 1852. It was made at his Fairmount, Pennsylvania, gun factory. This was a definite improvement over the fragile paper-filled envelopes previously used. The linen could be held in shape and would stand more abuse than the paper cartridge. That cartridges, in one form or another, were beginning to be used throughout the service is verified by a record showing the purchase of 393,304 paper cartridges by the United States Army in 1851.

Col. Samuel Colt collaborated with the Ely brothers of England in making further improvements on his patented self-consuming cartridge. This cartridge was made of a stiffer and more durable paper, and could be held to close manufacturing tolerances. The paper cartridge case was impregnated with a mixture of potassium nitrate. The explosion of the powder charge completely consumed the cartridge case. The

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percussion cap had sufficient force to rupture the paper and drive fire through to the powder charge.

Smith and Wesson of Springfield, Mass., in 1857 manufactured the first really successful rim-fire version of a metallic cartridge, self-contained and reasonably waterproof. This ammunition, with added improvements, to the present day is still produced by various American companies.

On 22 January 1856, the unusual method of housing both detonator and propelling charge in the base of a bullet was introduced and patented. The Winchester Arms Co. made a repeating weapon called the "Volcanic" using this odd principle. As the propelling ingredients were all contained in the bullet itself, there was naturally no problem of case ejection. This radical design was to compete with the impregnated self-consuming paper cartridge cases.

The volcanic bullet had a small charge of finely granulated powder, and a larger portion of fulminate of mercury mixture housed in a thin metal cup, all of which was protected from the elements by a thin cork insert. When the ball was fed into the arm, a spring-loaded firing pin was cammed forward and forced through the cork until it was brought to bear on the primer cup. A smart blow from the hammer ignited the detonating mixture, forcing the flame through the openings provided, and exploded the powder in the upper conical cavity of the bullet.

During the middle of the nineteenth century, the introduction of various methods of producing cartridge cases, the development of the conical bullet, and the idea of integrating the detonating cap in the cartridge were undoubtedly responsible for the rapid and radical designs of the innumerable weapons constructed to fire them.

Even skin cartridge cases were used successfully. They not only furnished a waterproof container, but also were easily made into the self-consuming case that seemed to be a military "must" of the day. To produce this cartridge case, pig's intestines were used. After cleaning and while still wet, they were stretched over forms of the required cartridge dimensions. When dried, the powder and bullet were put in place. The skin case was then treated with a compound consisting of "eighteen parts by weight of nitrate of potassium, pure, and seventeen parts of sulphuric acid—pure, after which it was washed to free it from the soluble salts and excess of acids, and then dried by blotting . . . in order to render it perfectly waterproof, a light coat of shellac varnish was applied."

It is easy to see how multifiring weapon development went hand in hand with cartridge design. As each different type of cartridge was introduced, inventors followed closely with a mechanical firing system, designed to use the new idea. No matter how radical a departure any new cartridge may have been from the heretofore accepted methods, there was a gun with an equally original design to shoot it.

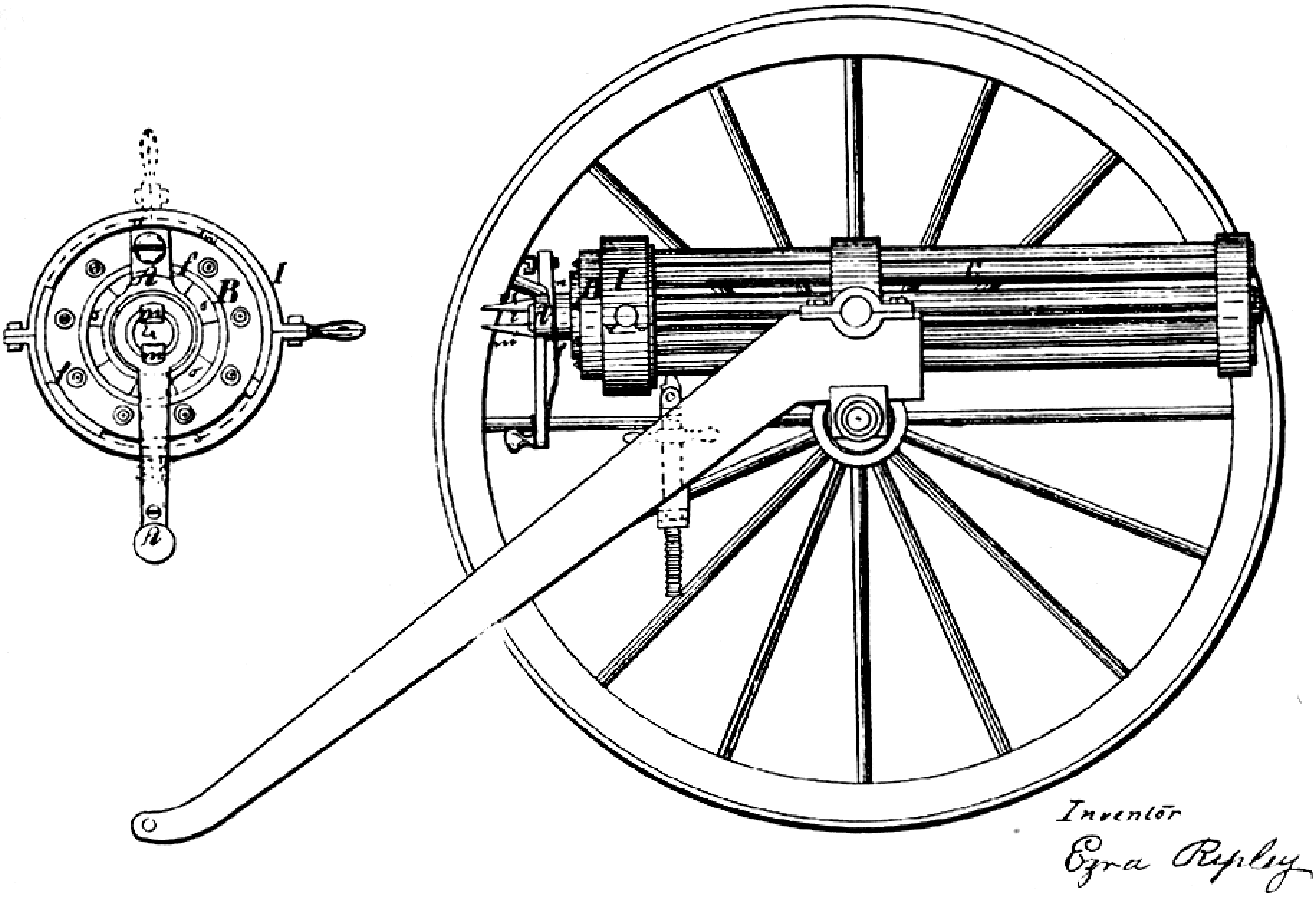
The greatest problem in ammunition development was finally solved by George W. Morse's invention in 1858—the first true attempt at a metallic cartridge with a center fire primer and an inside anvil. It marked the most important step in the whole history of cartridge design. All other methods, experiments, and alleged improvements were but attempts to do what Morse successfully accomplished.

But experimentation and development had gone too far to be stopped suddenly by the issuing of this patent. In fact, it was many years before the idea was universally used, and the gun people and cartridge makers continued on in an orgy of original development.

As soon as a patent was filed on an obvious improvement, it seemed to be a challenge to the rest of the profession to see in how many ways the original idea could be circumvented. To compete against the expensive, hard-to-manufacture brass cartridge case, a steel tube with a percussion nipple on the end was often used. This could be easily loaded by shoving a self-consuming paper cartridge into the forward end, and quickly securing a copper detonating cap on the nipple. With this progressive step, the inventor had at his disposal the nucleus of a practical, reliable weapon with increased firepower.

Ripley Gun

Ezra Ripley of Troy, N. Y., took advantage of the paper cartridge to patent a machine gun. Sustained volley fire was obtained by a compact firing assembly that allowed the gunner to fire



Ripley Machine Gun. Patented 1861.

one shot, or the whole volley, by a quick turn of the handle.

The weapon consists of a series of barrels, grouped around a common axis, that are open at both ends for breech loading. The barrels remain stationary during firing.

The breechblock made in the shape of a revolving cylinder is loaded with the conventional paper cartridge from the forward end of the chamber. On a nipple that protrudes from the center rear of the chamber is placed the percussion cap. The cylinder is then placed on the breech end of the weapon—the holes in the cylinder alining with the rear end of the barrels.

The breech is locked in place by securing the operating handle. This feature makes accidental firing of the weapon impossible before the breech is locked. With a clockwise turn of the handle, the firing pin is forced rearward by the action of a ratchet-type cam which compresses the firing pin spring. Upon alinement with the nipple, it sears off the high point of the cam, allowing it to snap forward and fire the piece.

The weapon can be prepared for firing by releasing a spring-loaded catch that locks the handle in place. The gunner then pulls the firing assembly rearward and removes the empty chambered cylinder for inserting the paper cartridges. By reversing the procedure, the gun is ready for action. The firing arrangement gives the operator a choice of firing rates, from single shot to slow and rapid fire.

As a number of preloaded cylinders were made available, the individual soldier was able to produce more sustained fire than could a company of men using the standard muzzle loading musket. The Ripley weapon also showed for the first time a consideration for weight saving in field pieces that had been previously ignored. If the weapon is closely studied, it will show many basic features that greatly influenced machine gun design for years to come.

The Ripley gun was no exception to the rule that success depends as much on the personality of the inventor as it does on careful details of design. To introduce a complete innovation of ordnance to the conservative authorities of the day was, in itself, a feat requiring abilities superior to those necessary for actually inventing the weapon.

This gun was light enough in weight to be very mobile, with a desirable method of loading rapidly from the breech end, and it had a simple, foolproof way to control rates of fire. Why it was passed over in favor of the many crude types of organ guns can only be answered by presuming that Ripley let the matter drop after his idea was greeted with skepticism and objections to everything from overheating of barrels to problems of ammunition supply.

The weapon may never have fired a shot, and it is doubtful if a working model was ever made. Yet Ezra Ripley certainly did originate many new and basic principles, which he coupled with the most progressive ideas of others, and patented these features in a weapon that had very definite possibilities.

Refinements in American Gunsmithing

The Colt revolver and similar weapons enjoyed the confidence of the public as it began to push westward and demanded the best in weapons that money could buy. All the New England gun makers were operating at peak capacity. The war with Mexico had come to a conclusion, Texas was being settled, and gold had been discovered at Sutter's Mill. Colt's name was a household byword, but fine weapons were also being produced by many others. Among them were the Wesson brothers, Oliver Winchester, Elihu Remington, Henry Deringer, James Cooper, Edmund Savage and Christian Sharps. Their factories began to attract the finest mechanical skill. They invited competition, feeling it presented a means of showing their ability, and prided themselves on being able to present a mechanical solution to any firearms problem brought to their attention.

The industry was built on strict competition to meet public demand. There was practically no encouragement from the government by military orders for improved weapons.

After 36 years of civilian use had proved the reliability of the percussion cap, the army finally gave up the time-honored flintlock, but seemed content to advance no further. Many predicted that even this modern step was too extreme and the army would rue the day it had discarded the flintlock. General Winfield Scott is credited with outfitting a regiment of his own with flintlocks, after the adoption of the percussion system was approved over his strenuous objection.

Fortunately, civilian demand made up for the lack of military orders for the various firearms improvements. The market was practically equal to the adult population; for each male citizen, physically able to do so, usually owned and often carried some form of firearm.

During this period, the military ordered little more than the conventional small arms. For this reason guns like the Ripley were of little or no interest to firearm factories. The military would not consider such guns, and the civilians had no use for them.

Had there been an incentive, and a ready market, no doubt the head engineers of the big companies would have produced a reliable manually operated machine gun at this time. For in no other era have there been more gifted men in actual competition in gun production than during this period: Fordyce Beals and John Rider of Remington; Warner and Leavitt of Wesson Brothers; Tyler Henry of Winchester; Eben Starr; Christopher Spencer; John H. Hall; Simon North; Christian Sharps—to name all the outstanding gunsmiths would easily fill a directory. Any of these, no doubt, could have produced some mechanical means of sustained fire, as advanced as the many reliable hand and shoulder weapons they perfected.

There were many experiments, conducted by individuals, that resulted in reliable repeating shoulder weapons. The most successful variation was that of combining a shoulder stock with the cumbersome revolver. Thus six shots could be fired with great rapidity, and with remarkable accuracy. To increase the range, the revolvers were made with abnormally long barrels, and deeper recessed chambers. The increased powder charge caused the large caliber bullet to jump the lands and resulted in an unstable trajectory and damage to the rifling of the barrel.

To overcome this, the Colt Co. resorted to "progressive" rifling, whereby the lands and grooves gained in twist as they progressed through the barrel.

This system of rifling became quite popular—especially with large bore weapons designed for high velocities. Progressive rifling, with lands and grooves machined to a parabolic curve, was the only way to overcome the error of having a soft lead bullet propelled by an abnormally large powder charge. The experiments, if of no other value, proved the need for a metal jacket bullet; as the various methods of rifling used were but an expensive mechanical attempt to obtain results that could be gotten with a properly balanced metal-covered projectile.

Of all the designs suggested along this line, perhaps the most unusual was that patented by A. Schneider. He proposed to give the lands a progressive clockwise twist half the length of the bore. At this point the rifling abruptly became counterclockwise. This latter twist would continue increasing to the muzzle end. Just how this sudden reverse torque on the bullet, when it was halfway through the bore, was expected to stabilize the projectile better in flight or increase range and muzzle velocity must ever remain a mystery. It is an example of the extremes resorted to by inventors, when a new idea became popular. The gain twist adequately served its purpose, and gradually disappeared when the problem of bullet design became more fully understood.

Industrial By-Products of the Gun Trade

The United States was going through an industrial revolution. Lack of transportation and British repressive legislation had thwarted the national aptitude for inventions in the colonial period. Now, for the first time, Yankee ingenuity was beginning to make itself felt. In the isolation of the farms during the long winters, many clever devices were conceived. Since weapon development was a great problem of the day, it naturally received a large share of attention, and an amazing number of new methods of approach were devised to solve current difficulties. But regardless of how obvious an improvement might be, it was worthless unless put into production. As the earliest gun producing plants were in Connecticut, and the Government's manufacturing arsenal was close by in Massachusetts, gun inventors trekked toward this area. If an idea were accepted by the public, its originator stayed on to practice his professional skill in production or in further improvements.

In order to protect himself from his enemy, man has been forced from prehistoric time to the present to produce more effective weapons. While his sole idea might be to create and produce a superior weapon, sometimes the means devised to accomplish this could be used even more successfully in the production of other things that had no relation to guns. For instance, the conception and perfection of machine tools first came into being in this area as an attempt to speed up and to economize on weapon production. The methods spread rapidly to other fields.

In the history of weapon progress, the advent of the machine age rivals the discovery of gunpowder. Power tools accomplished the impossible with the guns of the day, and opened means for the progressive inventor to write an unequaled chapter of development.

The influence of machine tools in modern life is little appreciated by the average person. The New York Museum of Science and Industry has on its wall a panel stating that the origin of machine tools has made possible all generated light, heat, and power; all modern transportation by rail, water, and air; all forms of electric communication; and has likewise caused to be produced all the machinery used in agriculture, textiles, printing, paper making, and all the instruments used in every science. "Everything we use at work, at home, at play, is either a child or a grandchild of a machine tool." But the Adam and Eve of the machine tool, and its application to mass production, were the early Connecticut and Massachusetts gunsmiths.

Good mechanics have been found in every nation, yet for some reason, most of the important machine tools used throughout the world originated in only two places: Great Britain and New England. The English craftsmen, traditionally lovers of the hand-finished product, benefited little from this fact. They have furnished no serious competition in this field since the 1850's when undisputed leadership shifted to New England. This section of the United States became, practically, a manufacturing arsenal. Its mechanics were recognized as the world's best. In fact, some of their contributions to the power tool industry have affected the course of history more through industrial progress than their fine weapons did on the battlefield.

Among the little-known inventions of these men can be found the first milling machine with a power feed which was devised by the original Eli Whitney; it was the direct predecessor of what is known today as the power miller. Christopher M. Spencer, who was noted for his repeating rifles, patented a great improvement on the drop hammer, and perfected a cam control, or "brain wheel," whereby the operation of lathes was made automatic. This invention was one of the few for which the original drawing was so perfectly devised that it is still used today. Another gunsmith, Henry Stone, developed the turret principle for lathes. The high speed automatic lathe of today is a combination of the work of Spencer and Stone. The two men originated many improvements which extend from farm machinery to silk winding machines, but their first success was in weapon design.

Francis A. Pratt was one of the best designers of machine tools. After founding the Pratt & Whitney Co. for manufacturing guns, he found other products so profitable that, today, few people know of the influence of firearms on this outstanding manufacturing concern.

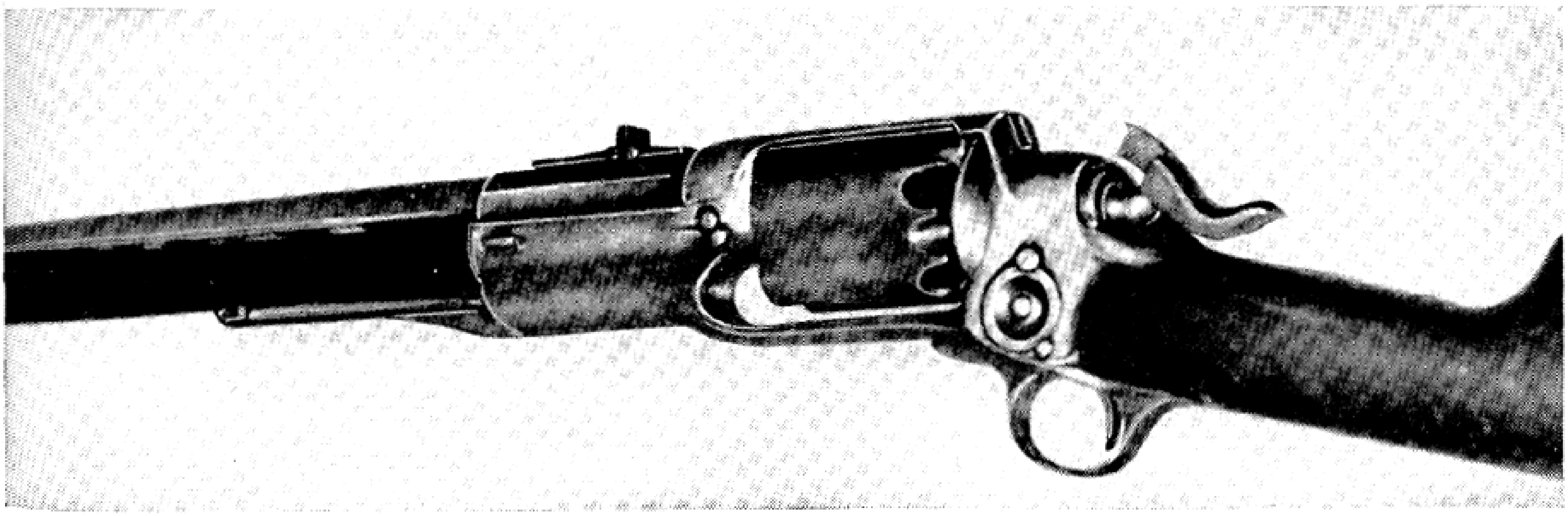
Asa Cook, a brother-in-law of Pratt, and a former Colt mechanic, was the inventor and manufacturer of machines to make screws and bolts automatically. Eli J. Manville, a former Pratt & Whitney engineer, established with his five sons at Waterbury, Conn., a plant which has been conspicuous in the design of presses, bolt headers, and thread rollers for the brass industry.

The arms plants proved training schools for inventors. Guns were made as long as profitable, but with changing times these versatile men began to make things entirely unrelated to firearms. Many became so successful in other manufacturing ventures that today it is often hard to associate a large telescope company or a successful sewing machine plant with its original founder, a master craftsman, working patiently on the development of a new firearm. Yet the fact still remains that American domination of manufacturing "know how" came largely from the honest effort of gun producers just before the Civil War to compete with each other in providing the world's finest weapons.

It did not take long for American gun makers to carry the gospel of machine tool performance across the seven seas. As early as 1851, a Vermont firm showed at a London fair guns with interchangeable components manufactured by mass production methods. The British government was so impressed that it ordered the making of 20,000 Enfield rifles in American factories by this method. Three years later Great Britain ordered from the company that made these weapons 157 gun milling machines, which were the first automatic tools to be used in Europe. Among them was the eccentric lathe invented by Thomas Blanchard of the Springfield Armory. This device allowed wooden gun stocks to be machine carved with great rapidity in lieu of the laborious hand method formerly employed. The machine turned out irregular (eccentric) forms, from patterns, with automatic speed and precision; and has undergone practically no change in design since it was invented by Blanchard. Like innumerable other weapon-inspired tools, it contributed not only to American domination of the armament business but also helped to reshape the entire structure of the manufacturing world.

Colt Revolving Rifle, Model 1855

The early civilian method of fastening a shoulder stock on the heavy barrel revolvers and making a serviceable repeating shoulder arm led the Colt Co. to apply the same idea to a full fledged rifle. Consequently the 1855 model revolving rifle was produced. It became the first repeating rifle adopted by the armed service of the United States. This caliber .58 weapon had a full length rifle barrel. The cylinder was long enough to hold the large powder charge and conical bullet. The Colt method of ramming the charge in the cylinder by a hinged lever was employed, a device which had proved popular on revolvers.



The Colt Revolving Rifle.

One of the features of the weapon failed to work properly under field conditions. The nipples that held the percussion cap were set in a recessed opening in an attempt to protect the cap and primer from weather conditions, which they did successfully. But in field use, as the soldier loaded the cylinders, he placed too much pressure on the loading lever. This force would rupture the paper cartridge where it bottomed at the aft end of the cylinder, causing loose powder to spill through the hole in the nipple. Since it was too dangerous to cover the nipple with a percussion cap while loading, the grains of powder would lodge in the recess connected to other nipples.

During firing the heavy rifle barrel had to be supported by hand. This had not been necessary in the revolver equipped with the shoulder stock. Sometimes loose powder from a faulty cap or gas leak would cause other chambers to be ignited. When this happened, the soldier using the piece lost his hand or the portion of his arm that happened to be in front of the exploding cylinder.

One such accident in a regiment destroyed not only confidence in the weapon, but the morale of soldiers and officers alike. Before the Civil War many a regular was on the pension roll for having lost his hand in line of duty—the duty being, in most cases, nothing more than target practice with the new repeating rifle.

These accidents had become so common that some company commanders ordered the men to lower the loading lever and to hold it in the left hand. This placed the hand out of range of the gas leak where the cylinder chamber alined with the bore of the barrel. Thus, should the chamber explode, the shooter was safe from the hail of lead and steel. Other officers protected their men in a different manner, having the soldiers load just one of the chambers. By this simple method of converting to a single shot weapon, they eliminated the hazard of blowing up the piece.

The total failure of the Army's first official attempt to introduce a repeating shoulder weapon into the service gave the conservative element a chance to point out the inevitable disaster that always follows any such departure from what has proved successful over the years.

Finally a board of officers met. After hearing all the evidence, they ordered that the Colt's use be discontinued and the pieces sold for whatever price could be obtained. The highest bid was 42 cents a rifle.

While the weapon's danger to personnel using it had undoubtedly been bad, the effect of its reputation on the trend toward repeating-action guns was almost fatal, so far as our military forces were concerned. For, after the discreditable showing of the Colt revolving rifle, no officer cared to stake his career on any such contrivance, especially since the Colt revolver, which the weapon so closely copied, had been such a huge success. They simply could not understand why a trivial change in design could result in such disaster. It was accepted as proving that one could not go beyond a hand gun in this type of weapon.

PART II

MANUALLY OPERATED MACHINE GUNS

Chapter 1

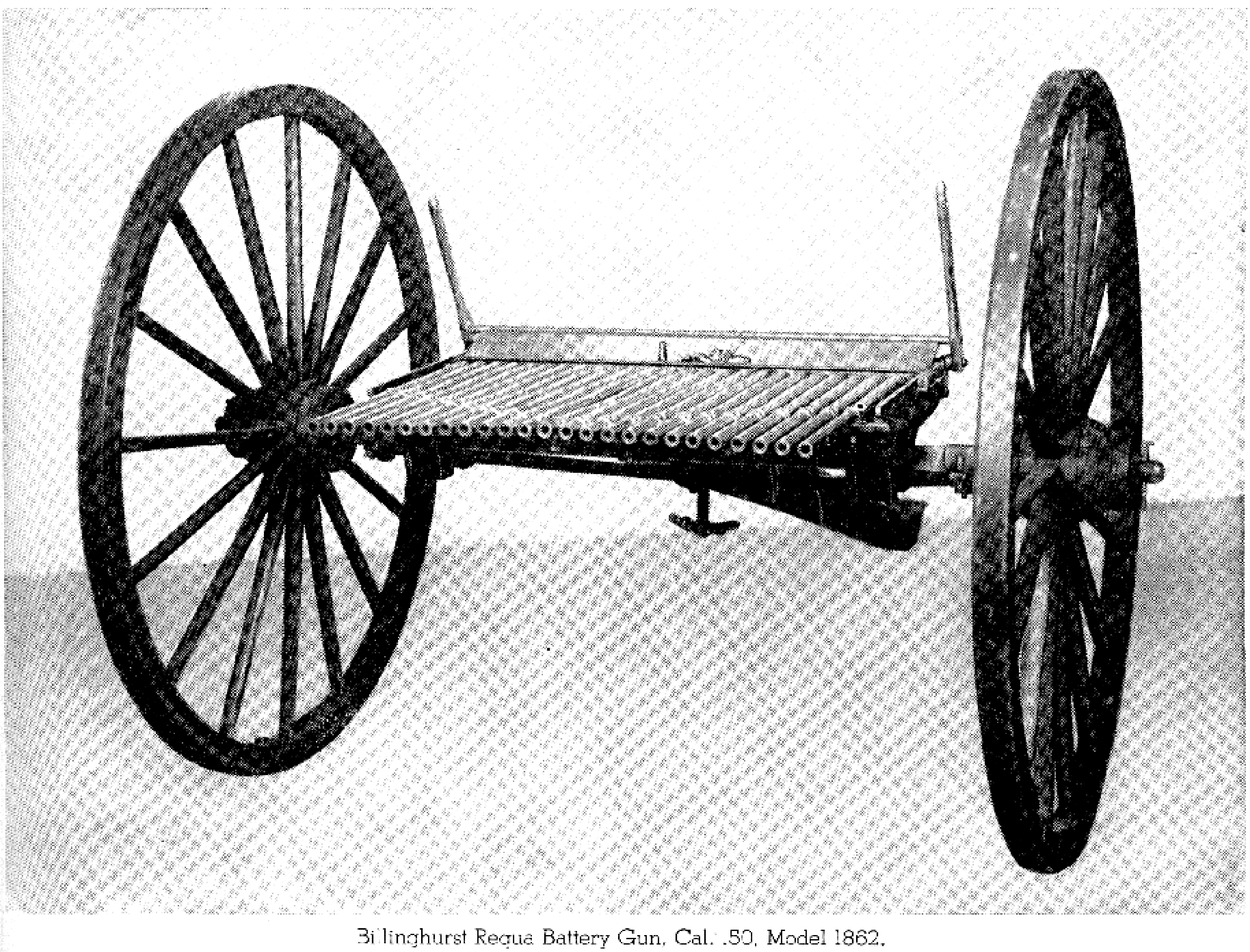
BILLINGHURST REQUA BATTERY

The effect of the failure of the Colt revolving rifle was to turn development of new weapons entirely over to civilians. The military authorities refused to be interested in anything beyond some means of producing volley fire, similar in arrangement to the early organ gun.

The civilian inventors realized they had a difficult sales problem. When they produced a reliable weapon, they arranged to have its performance witnessed and endorsed by public officials and retired officers of high rank. By this they hoped to prove that their weapon merited trial. The professional standing of the distinguished endorsers was used as a warranty of the product.

The great lengths to which they all went in attempting to market their weapons resulted in many reliable records. These establish, beyond doubt, if one accepts the United States Patent Office definition, that "Machine Guns" were used in battle by both Union and Confederate forces during the Civil War.

Perhaps the weapon most in keeping with the acceptable idea of producing volley fire was the Requa battery. This caliber .58 gun was built



Billinghurst Requa Battery Gun, Cal. .50, Model 1862.

late in 1861 by the Billinghurst Co. of Rochester, New York. It was publicly demonstrated in front of the Stock Exchange Building in New York City in the hope of interesting private capital in manufacturing it for army use.

This gun had 25 barrels, mounted flat on a light metal platform. The sliding breech mechanism was operated by a lever. Charging was accomplished by means of cartridges held in special clips. These cartridges were of light steel with an oval base that had an opening in the center for ignition. They were spaced in the 25-round clip so as to mate with the open rear end of the barrels.

After the breech was locked, each cartridge came to rest with its opening alined to a channel filled with priming powder. All 25 barrels were fired simultaneously by a single nipple and percussion cap, which ignited the powder train, passing the rear hole of each cartridge. A single hammer, manually cocked and released by lanyard, served as the firing mechanism.

The Requa battery did not employ paper cartridges inserted in the steel cases. Instead, the cylinders were loaded by hand with loose powder, and a patched ball was used in the belief it gave the weapon greater accuracy.

This early weapon, though crude, had a few unusual features that warrant mention. The clip loading, and the quick means of locking and unlocking, allowed a fair rate of fire.

This gun became known as the "covered bridge" gun. During the Civil War, practically every important crossing over a stream was in the form of a wooden bridge, with roof and side-walls to protect the floor and under-structures from the weather. As these covered bridges were usually long and narrow, one of these weapons in the hands of an alert crew could break up a quick charge by the enemy, either on horse or afoot. The 25 barrels could be adjusted to the necessary height and width. With a crew of 3 men, the weapon could be fired at the rate of 7 volleys, or 175 shots per minute. The effective range was 1,300 yards.

In the field, however, the Requa battery had its limitations. Dampness in the unpr[illegible] powder train would render it useless. [illegible]quently, it was unfit for offensive service[illegible] very effective in defense of restricted fields of fire.

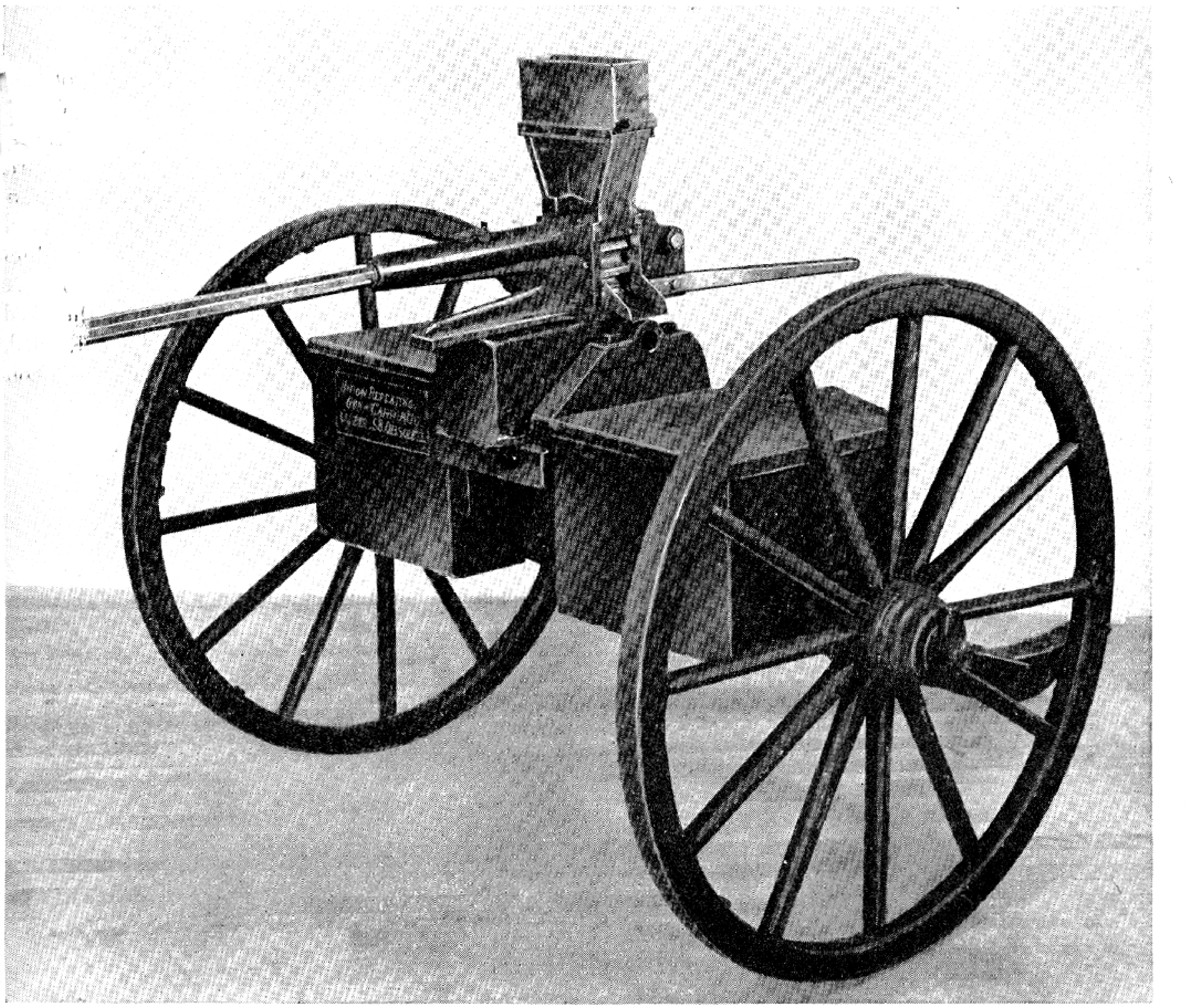
There is a record of possession by the Confederate forces of a gun of this design on a [illegible] at Charleston, South Carolina. As it was used for defensive purposes only, and there was no [illegible]lem of mobility, it was heavier than th[illegible] piece type of the North. The Con[illegible] weapon weighed 1,382 pounds and was of considerably larger caliber than the Northern version.

Chapter 2

AGER "COFFEE MILL" GUN

The next machine gun to be used by the Union forces was the Ager, better known as the "coffee mill" gun. The nickname was derived from its being crank operated with a hopper feed located on top so that it closely resembled the contemporary kitchen coffee grinder. This gun was the invention of Wilson Ager, an American citizen, who for some unknown reason patented his weapon only in Great Britain, although he did patent in this country many industrial devices, such as rice cleaners and corn planters.

The coffee mill gun is a hand-cranked, revolver-type weapon that can use either loose



Ager Machine Gun, Serial No. 2.

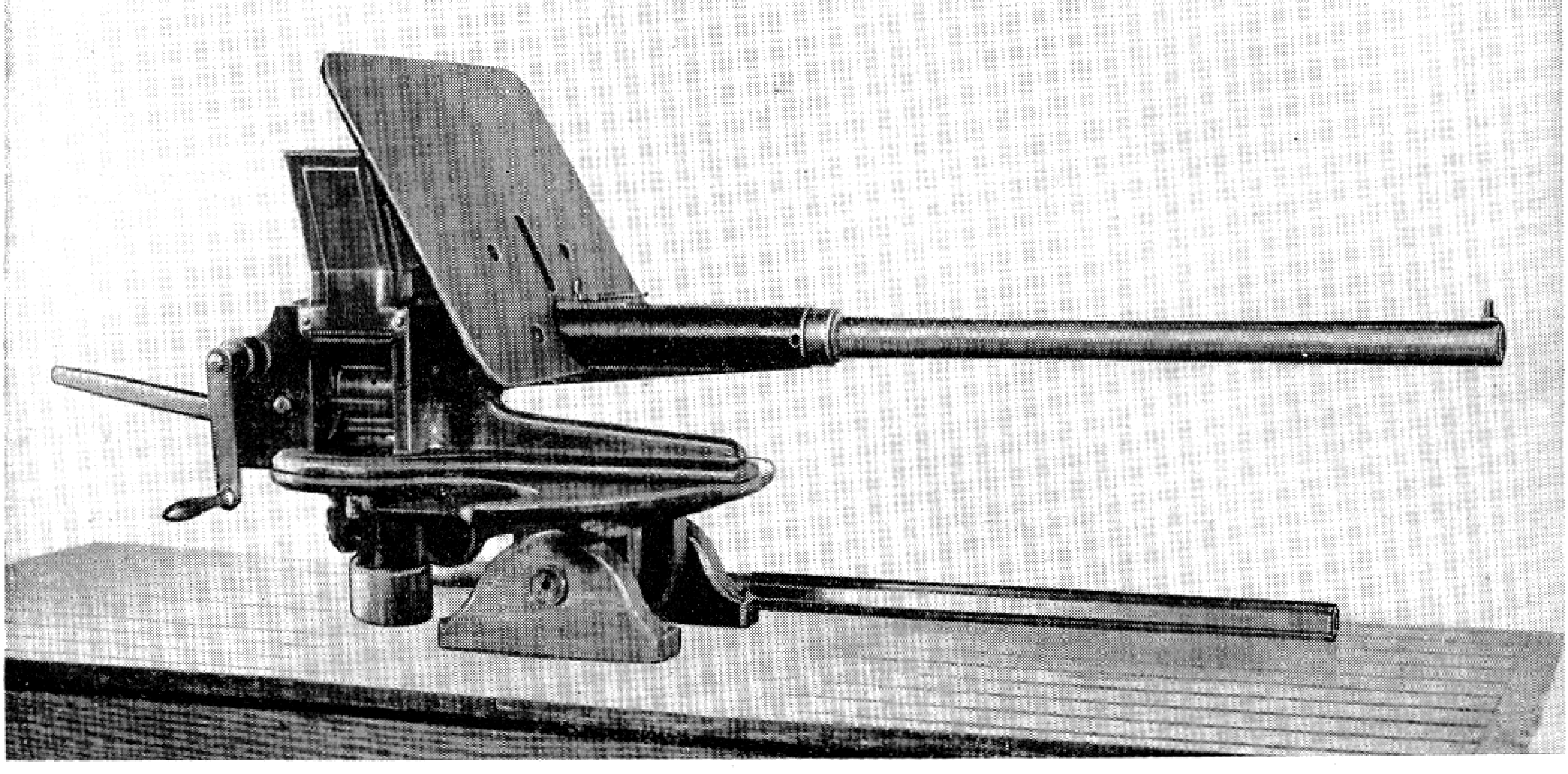
powder and caliber .58 ball projectile, or an impregnated paper cartridge. The ammunition is loaded into steel containers which do the double duty of being cartridges and explosion chambers. The cartridge does not enter the barrel, but is held in alinement and cammed forward by a wedge lock, the chamber being rotated and held fast behind a stationary barrel, somewhat like a revolver.

To prepare the gun for firing, a number of containers are loaded, either with powder and ball, or a paper cartridge. A percussion cap is placed on a nipple that is screwed into the rear end of the steel container.

These loaded containers are then placed in a rectangular box, or hopper, so mounted on top of the weapon as to allow the containers to roll down, by gravity, one at a time, into a recess formed in the rear of the gun barrel. A crank, turning a system of cogged wheels, allows the charged chamber to be shoved forward forming a prolongation of the barrel. A wedge, rising behind it, locks it in place. Continued turning of the crank secures it firmly for the instant, and while so held, a hammer operating from a camming arrangement falls on the cap, firing the piece. As the crank continues to revolve, the wedge relaxes its pressure. A lever device shoves the discharged container out of the recess, and a loaded container instantly drops into place.

The Ager weapon was purposely made not to exceed a speed of 120 shots per minute, since it used only a single barrel. The heat from rapid firing was considered a serious drawback. Subsequently the inventor arranged a very ingenious cooling device. The superabundant heat was rapidly carried away by a stream of air driven through the barrel and around a jacket surrounding it. The air was forced through the barrel by the action of a turbine type of fan connected to, and operated by, the same turning of the crank that also charged, fired, and ejected the empty containers. This affair also helped blow away any unconsumed particles of paper cartridge that were in the vicinity of the chambers or bore of the weapon.

Besides this artificial cooling, it also had many construction features that were either new or improved, such as a quickly detachable barrel. Two spares were carried as a further means of overcoming the heating problem. Speedy elevation and traversing was effected by a ball and socket joint mounting, which could be locked at any desired position. The barrel was rifled,



Ager Machine Gun, Cal. .58, without Carriage.

and the maximum effective range, using the caliber .58 Minié-type bullet and a 750-grain powder charge, was 1,000 yards.

The gun was mounted on a light, two-wheeled carriage, with ammunition boxes at either end of the axle, very similar to that used by the mountain guns of the period. It also came equipped with a "manlet" to protect the operator from the fire of small arms.

The Ager gun was a very advanced weapon for the Civil War era. But there was no military demand for a machine gun. Contemporary authorities condemned it as requiring too much ammunition ever to be practical. Also, from the fact that it had only one barrel, they reasoned it could never reach sustained fire to the extent of being considered as an effective arm. Quite a few guns were bought, but they were relegated to covered bridge duty with the Requa battery, there being only a few isolated instances where they were actually used in battle.

The fact that an adequate machine gun mechanism capable of sustained fire existed during the Civil War period can best be verified by a report by a British officer, Major Fosbery, who witnessed a demonstration of the Ager weapon. In his opinion, any weapon consuming such quantities of ammunition was prohibitive from the standpoint of cost and supply. He scoffed at the idea of a single barrel being able to stand the unheard-of feat of discharging from 100 to 120 bullets a minute.

Major Fosbery, an inventor in his own right, felt he had expressed adequately the consensus of all military reasoning when he appended the following to his report: "The only thing forgotten seems to be that, when firing at the rate of 100 discharges a minute, the flame of 7,500 grains of exploded powder and nearly 7 pounds of lead would pass through a single barrel in that time. The effect during the trial proved that the barrel first grew red and nearly white hot, and large drops of fused metal poured from the muzzle, and the firing had to be discontinued from fear of worse consequences."

Further proof of the existence of a serviceable machine gun during the Civil War is unnecessary. It would be considered a severe test even now to fire a weapon either continuously or in short bursts of sufficient duration to heat the barrel until molten metal ran from the muzzle end.

As early as 1861, the Ager gun was being considered for service. The gun's reliability, during test, had been proved, and the armed forces were at last interested, but the official records show that no one would request unreservedly its purchase.

President Lincoln, himself, made a direct inquiry about the feelers that were being put out by the Army concerning the possible use of the coffee mill guns, and asked whether the Army actually wanted them or not.

The following exchange of correspondence and memoranda among the President, a representative of the makers of the gun, and General McClellan illustrates clearly the reluctance of the armed service to demand boldly something new—even if the time was desperate and the weapon in question had been proved to be reliable enough for consideration.

"EXECUTIVE MANSION
Washington, December 12, 1861

"MY DEAR SIR:

"I do not intend to order any more of the 'coffee mill' guns unless upon General McClellan's distinctly indicating in writing that he wishes it done, in which case I will very cheerfully do it. This is very plain: He knows whether the guns will be serviceable; I do not. It avails nothing for him to intimate that he has no *objection* to my purchasing them.

"Yours truly,

"A. LINCOLN.

"J. D. MILLS, ESQ."

"WILLARD'S HOTEL
Washington, December 12, 1861

"DEAR SIR:

"The President is under the impression, after seeing the copies of your application to the Secretary of War for fifty guns, and the reply of Colonel Scott, Assistant Secretary, that, as it does not expressly say so, perhaps you do not want them, and that, if you say you want them, in writing, he is ready to order them. He has addressed me a note, of which the foregoing is a copy, for the sake of ascertaining from you in writing the simple fact that you want the guns. Your early reply will give him the desired information, and much oblige.

"Your obedient servant,

"J. D. MILLS

"MAJ. GEN. GEORGE B. McCLELLAN,
Commander In Chief, United States Army."

"I would recommend that fifty of the 'coffee-mill' guns be purchased, at twenty per cent advance on cost price, which cost may be ascertained by competent Ordnance Officers. I think $1,200 entirely too high.

"GEORGE B. McCLELLAN
Major General, Commanding."

"December 19, 1861

"Let the fifty guns be ordered on the terms above recommended by General McClellan, and not otherwise.

"A. LINCOLN."

"July 3, 1862

"If the fifty guns have been made or tendered according to the above recommendation of General McClellan and conditional order of myself, let them be received and paid for.

"A. LINCOLN."

The extreme caution evinced in these letters was due no doubt to the dismal failure of the 1855 model Colt revolving rifle.

Chapter 3

CLAXTON FIRING MECHANISM

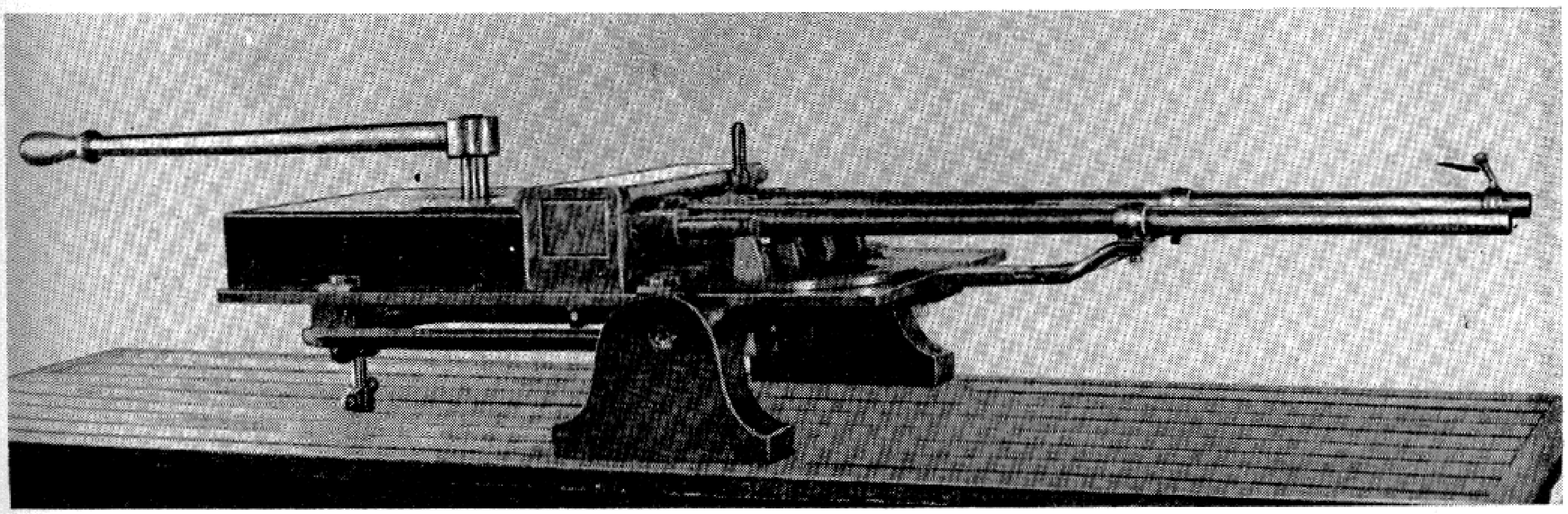
Of the other firing mechanisms that appeared soon after the stimulus of war, the most notable was the Claxton. This weapon consisted of two rifle barrels placed side by side on a framework in such a manner that the pair of the barrels were always in alinement with the two sliding breech mechanisms. This temporarily formed a double-barrel breech-loading rifle that operated by the manipulation of a pump handle located between the two breech actions.

The handle was worked by one man, while another fed the cartridges by hand into a short magazine feeder. Rapidity of fire was governed by the physical ability of the soldier to work the handle to and fro.

The gun could be mounted on a carriage somewhat like the Ager, and with the same kind of shield arrangement to protect the operator. This device was of ingenious construction in that it gave full protection to the gunner and still allowed freedom of action in operating and servicing the weapon.

The various officers and military representatives who attended the tests and demonstrations, conducted by the producers of the Claxton weapon, were not impressed by its performance. According to the general opinion, it was of too frail a construction. The manual feeding was far from positive and had a tendency towards an erratic rate of fire. The whole procedure was slowed until 80 rounds a minute was considered maximum.

The weapon was invented by F. S. Claxton, son of Alexander Claxton, a well-known American naval officer. After the weapon failed to receive the interest expected, young Claxton took his invention to France and introduced it to the French service. The same weakness in construction was noted in France. It was later taken to England and manufactured by the Guthrie & Lee Explosive Arms Co., and is sometimes erroneously known as the Guthrie and Lee. Records of its actual use are very limited. However, its mechanism was revised by a Scandinavian engineer and after much refinement was popularized two decades later as an original European design.



Claxton Machine Gun, Cal. .69.

Chapter 4

MACHINE GUNS USED BY THE CONFEDERACY

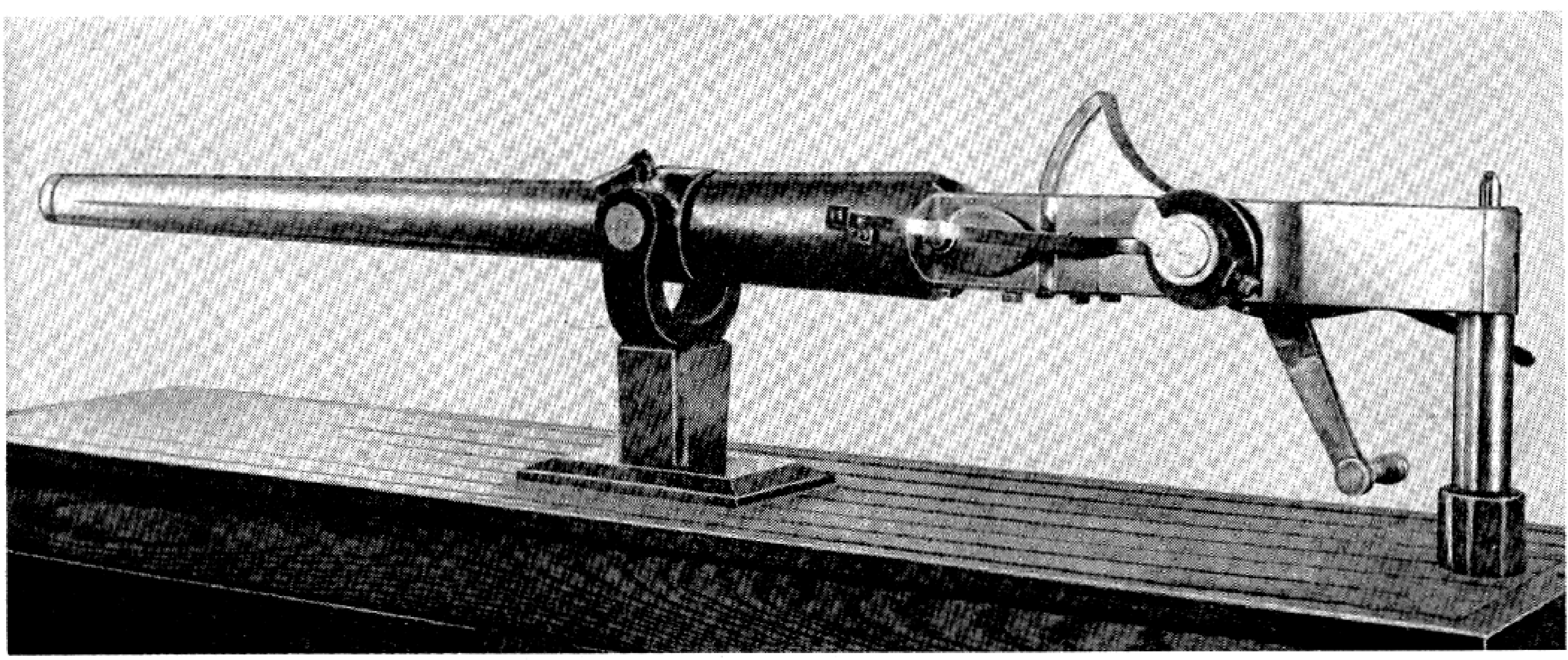
Williams Machine Gun

To Capt. D. R. Williams, C. S. A., of Covington, Ky., goes the distinction of inventing the first machine gun to be used successfully in battle. This weapon, a 1-pounder, with a bore of 1.57 inches and a barrel 4 feet in length, was mounted on a mountain-howitzer-style limber and drawn between shafts by a horse. It was adopted by the Bureau of Ordnance, C. S. A., at the very beginning of the Civil War, and looked upon as a secret weapon.

The firing mechanism was operated by a hand crank located on the right side. When rotated clockwise, an eccentric actuated by the crank alternately retracted and pushed forward the breech lock, which was so arranged that the striker was released simultaneously with the locking of the piece. The weapon used a self-consuming paper cartridge. The latter was dropped by hand into position to be fed by the reciprocating breech lock into its loading recess. The mechanism was so arranged that, when the cartridge was fired, the shock of the explosion was taken by the shaft on which the breech lock moves by the partial revolution of an eccentric. This transferred the force of the discharge from the breech lock to the shaft.

The rate of fire was 65 shots per minute and by actual test in battle the mechanism proved very reliable. The only trouble encountered was that after prolonged firing the breech would expand from the heat. A resulting failure to lock securely would take place until the barrel had cooled enough to permit the bolt to go fully into battery. A report was made on this type of malfunction by Capt. T. M. Freeman, C. S. A., Houston, Tex., of Giltner's Brigade. This officer commanded a battery of six of these weapons.

The extreme range of the Williams gun was set at 2,000 yards and, when several were operating at one time, unheard of fire power for this era was attained. The most effective official use was its initial test in battle when on 3 May 1862, at the battle of the Seven Pines, Va., under the direction of the inventor, a battery of the weapons opened fire on the Union forces with telling effect. This battery was attached to Pickett's



Williams Smooth Bore Machine Gun, Cal. 1.56.

Brigade. Later, when some Union officers were captured by the same Confederate forces, their first inquiry was concerning the strange rapid-firing guns used on them at Seven Pines. It clearly made a great impression on the Northern troops.

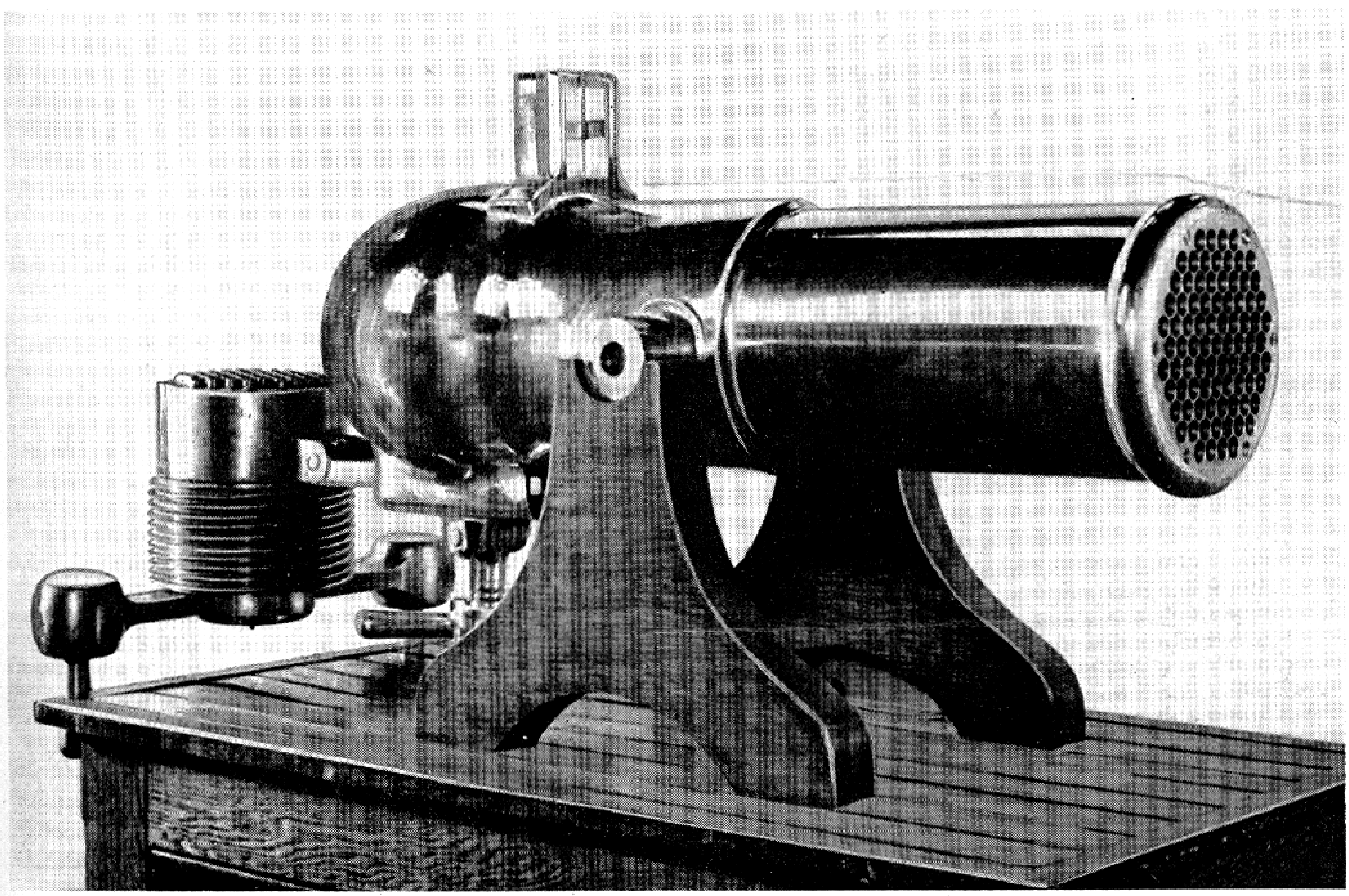
These weapons were used by the Confederacy all through the Civil War with a great deal of success, as attested by the written reports of various officers and men of the Union army that met this innovation in warfare. One of the most graphic descriptions was given by Capt. T. T. Allen of the Seventh Ohio Cavalry, who in his writings expressed amazement at the rapidity of fire and devastation wrought by the guns in the Battle of Blue Springs, in east Tennessee, 10 October 1863.

Two batteries of six guns each were constructed at Lynchburg, Va., and four batteries at Richmond, Va., by the Tredegor Iron Works, and one battery at Mobile, Ala. Gen. Simon Bolivar Buckner, C. S. A., placed those made at Mobile into the artillery branch of the army under his command. One of these guns, with all accessories, was captured by the Union army at Danville, Va., in April 1865 and sent to the West Point Museum as a trophy of war. The unique gas check on this weapon was later adapted to the first breech-loading field piece adopted by the United States Army.

Vandenberg Volley Gun

The Vandenberg volley gun, manufactured in England, was a weapon of questionable value. It was the invention of an American, Gen. O. Vandenberg, who tried to market his weapon in Britain. He delivered a lecture on 9 May 1862, which was published in the *Journal of the Royal United Service Institution* (British). In his address he discussed his "new system of artillery, for projecting a group or cluster of shot."

The Vandenberg gun closely resembled an earlier Belgian weapon. However, when made



Vandenberg Volley Gun, Cal. .50. 85-Barrel Model Used by the Confederates.

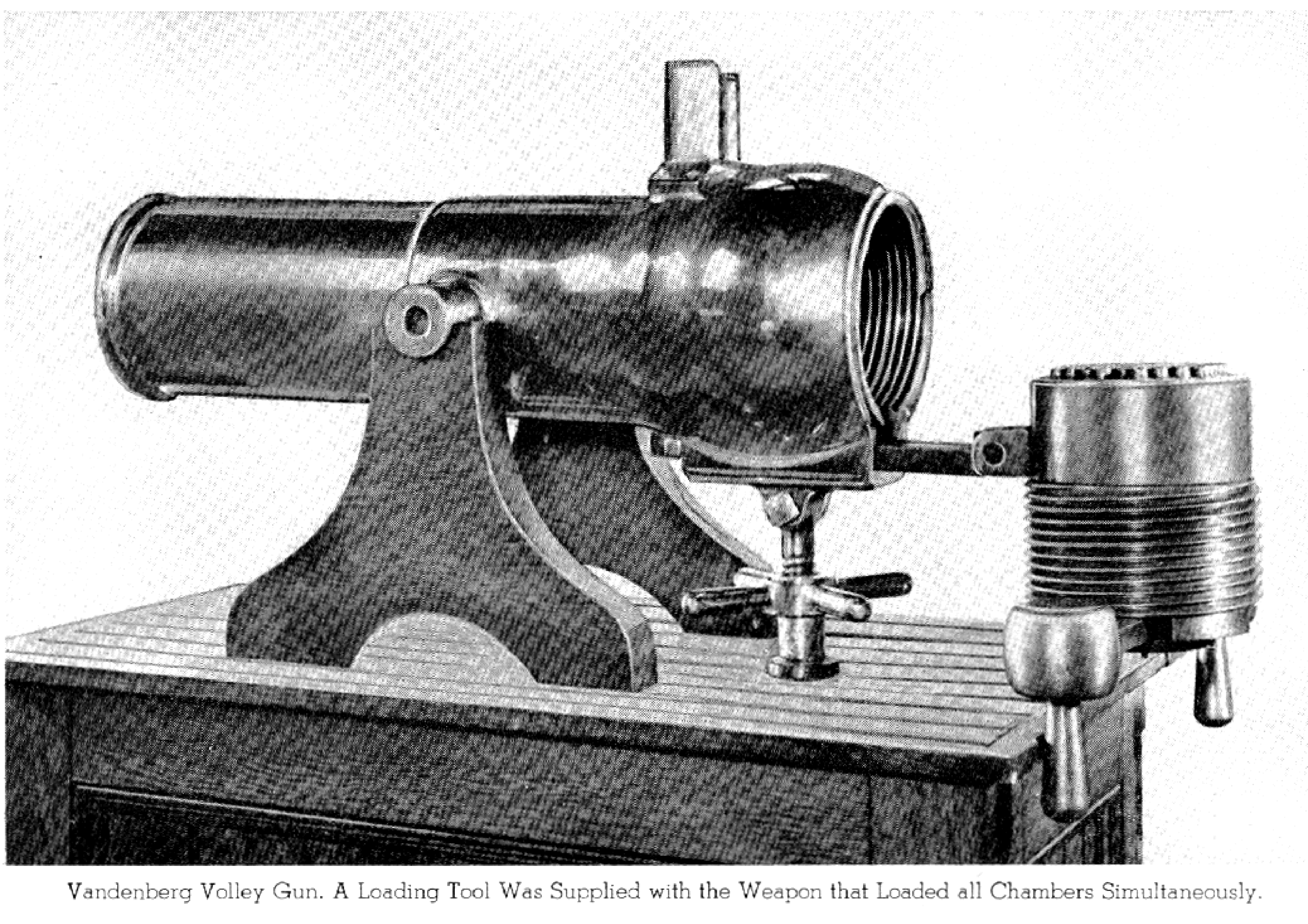
in caliber .45 using a 530-grain lead bullet, many authorities of that day considered it superior to the continental model. Depending on the size of the projectile for which it was designed, the gun had from 85 to 451 barrels. The breech was removable, and was positioned fore and aft by a screw; it was guided into place by a key-way, which, when fitted, brought the holes in the breech end in alinement with those in the stationary barrels.

In order to overcome the escape of gas and smoke at the point where the breech end joined the barrels, the forward end of each chamber was counterbored, and a short copper sleeve, cone-shaped, was placed ahead of the bullet. Upon forcing the breech in place by the screw leverage, the copper piece was crushed into position to form a gas-tight seal or gasket.

The method of ignition was unique in that the center charge was fired by percussion and ignited the whole volley simultaneously. However, by plugging off the vents, or ignition galleries, in advance, the discharge of the piece could be regulated to fire by sections of one-sixth, one-third, or one-half of the group. The other sections remained charged, ready to be fired by inserting a new percussion cap, and opening the formerly plugged orifices.

General Vandenberg also made a loading machine for facilitating the charging of the many chambers in the breech. The device, when placed on dowels, was in proper position over the holes in the chambers. By manipulating a lever, measured charges of powder were dropped simultaneously into every chamber. This mechanism could be removed quickly, to be replaced by another containing lead balls. When properly positioned, the latter dropped the bullets into place. A ramming device was then put on, and all charges were compressed at once by the action of a lever on the loading plungers.

It can readily be seen how by three operations all chambers could be loaded in a relatively short time. An elongated lead ball was used that was



Vandenberg Volley Gun. A Loading Tool Was Supplied with the Weapon that Loaded all Chambers Simultaneously.

.010 inch larger than bore size. The resulting pressure, as it started to engage the rifling, was sufficient to compress the soft lead enough to seal off any gas leakage that might otherwise have resulted.

A test of this weapon in a 91-barrel version showed that it could place nine-tenths of the volley in a target 6 feet square at 100 yards. The British showed an interest in its shipboard use against enemy personnel but, because of its terrific weight, it had little future as a land weapon.

General Vandenberg, at the outbreak of the Civil War, made many attempts to sell the arm to the United States Government. He even went so far as to offer to ship the gun from England for experimentation, free of charge.

When no interest was shown, he wrote a letter on 18 February 1864 to Brig. Gen. George D. Ramsey, Chief of Army Ordnance. In it he stated that he would either send or bring three of his guns to this country, and present them to the President, or the Secretary of War, as an "offering to our country and government."

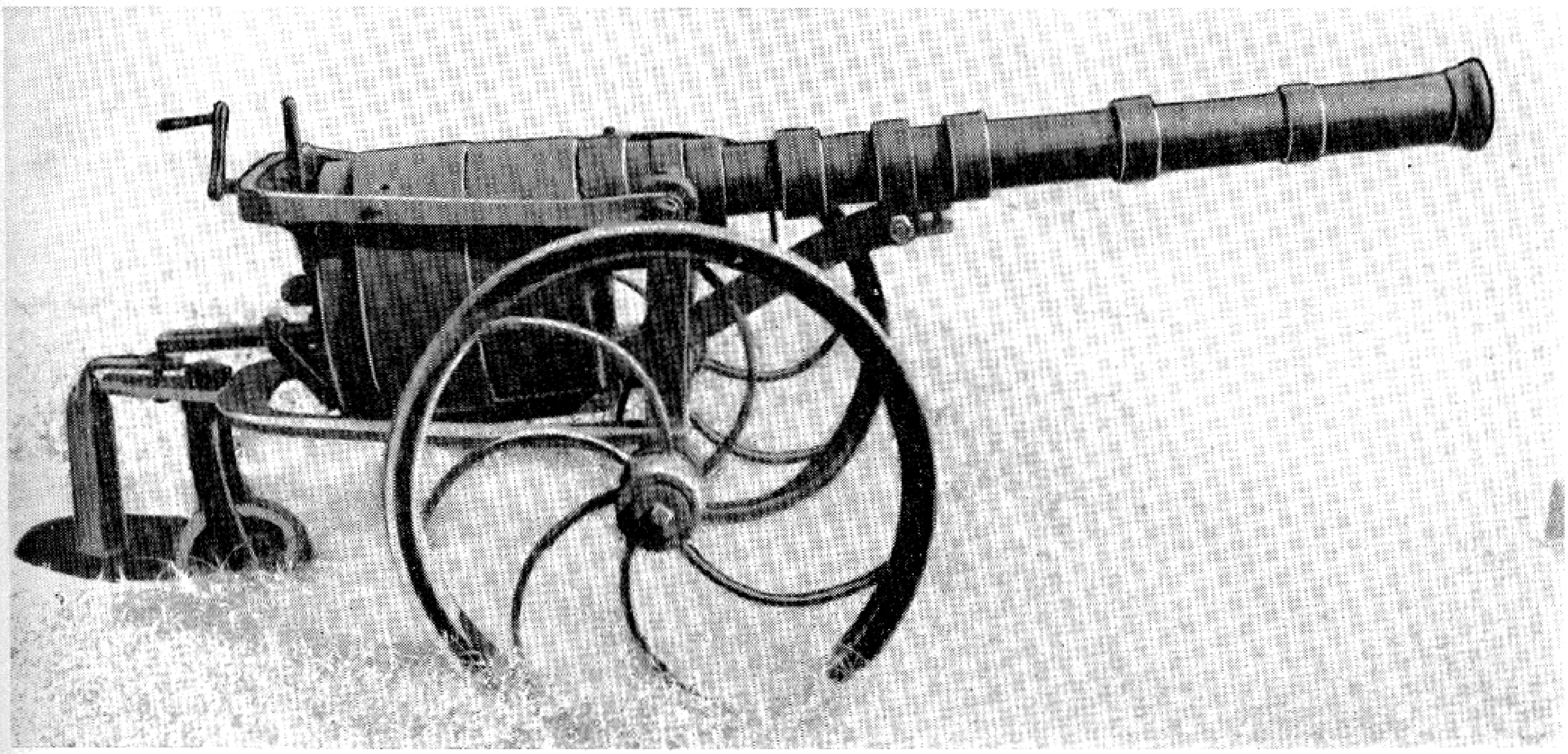
The three guns were later shipped. Upon arrival they were tested with little delay by Captain Benton, United States Army Ordnance. After a very comprehensive test, he reported that they were not acceptable for Government service. Many improvements would have to be made before they could even be considered for further testing.

Captain Benton, being a very thorough man, decided, after testing the weapon, to clean it, keeping account of the time required to do so. He found it took 9 hours for one man to clean the bore and chambers of the weapon adequately. This maintenance problem, alone, made its usefulness doubtful in the field.

At this stage, General Vandenberg, perturbed over what he termed a "purely negative attitude" with regard to his artillery, requested that the Government either put the guns in order and further test them, or make payment in full. The Government, after much correspondence, put the weapons in the same condition as received and returned them to him.

The use of several of the guns in the South demonstrates that the Confederate forces did not concur in Captain Benton's views on the subject. However, on these Southern weapons the name of the British firm, Robinson and Cottam, is stamped. Undoubtedly, General Vandenberg was "too patriotic" to allow them to be sold to the South marked with his name.

There is a record of one being used in the defense of Petersburg, Va. Another was purchased by Gov. Zebulon B. Vance of North Carolina, and called by his skeptical constituents "Vance's folly." Later this weapon was captured by a



Confederate Revolving Cannon.

Union cavalry unit under Maj. Gen. George Stoneman at Salisbury, N. C., in April 1865.

Confederate Cannon

The Confederacy also developed a 2-inch bore 5-shot machine gun during the war. It was used in the siege of Petersburg, Va., and was later captured on 27 April 1865, at Danville, Va., by Union troops and sent to the Ordnance Laboratory, United States Military Academy, West Point, N. Y.

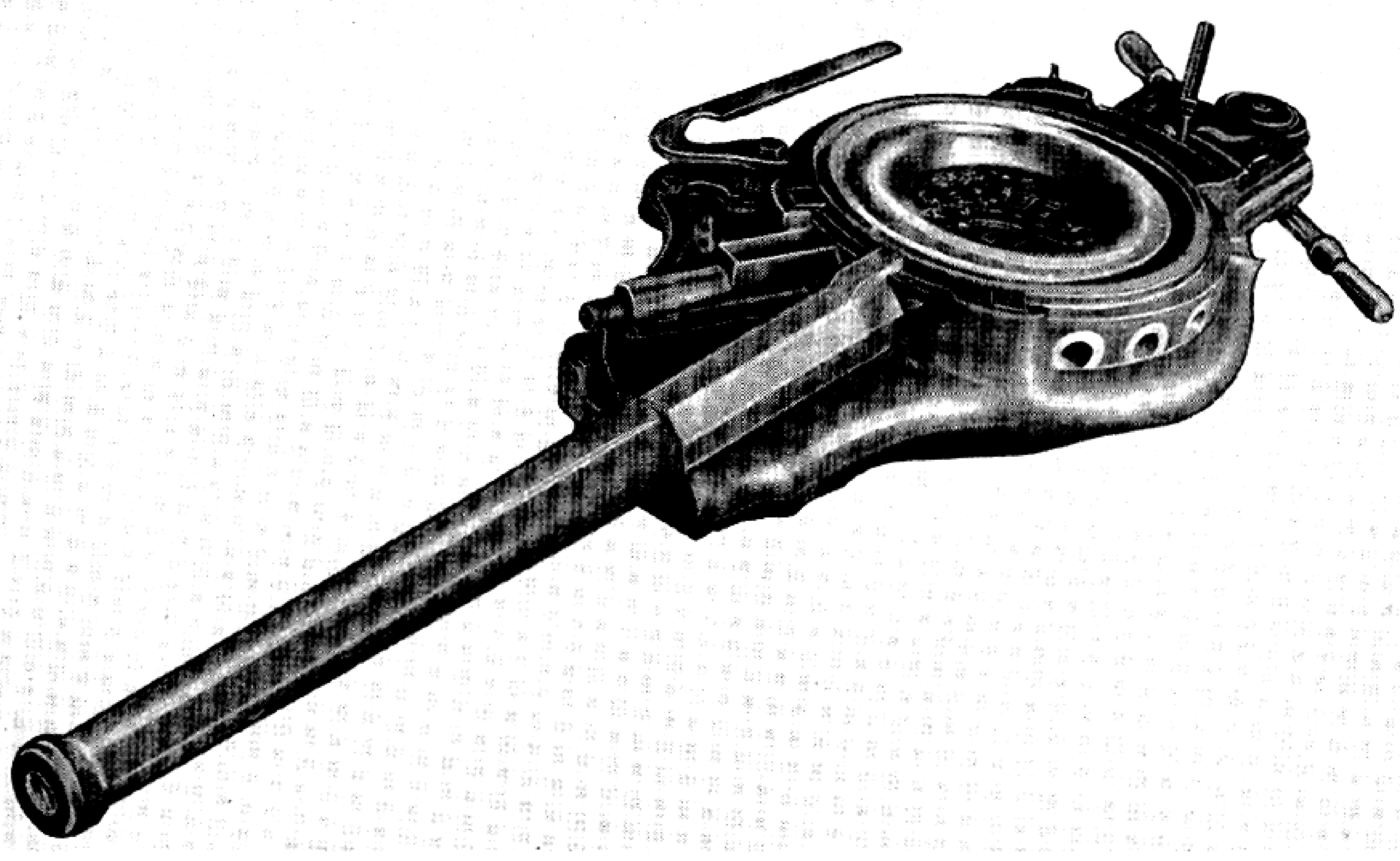
The weapon uses the principle of the service revolver whereby rotation of the cylinder indexes a loaded chamber with the breech end of the barrel. It is held in alinement by a spring-loaded dog slipping into a recess in the cylinder. To cut gas leakage to a minimum, a screw arrangement at the rear jacks the cylinder forward after positioning until a tight joint is effected between the front of the chamber in the cylinder and the breech end of the barrel.

The chambers are ignited by use of a percussion cap on a nipple. The cap is struck by a huge spring-actuated striker built into the flat strip that supports the chambers at their aft end. The cylinder is moved one-fifth of a revolution and lined up for firing by the moving of a lever from left to right. The lever is attached to a ratchet arrangement, the distance moved being regulated by its mounting in the frame in such a manner as to control the revolving of the cylinder. The lever, when brought to the left as far as possible and swung to the right as much as the frame will permit, turns the cylinder one-fifth of a revolution and indexes the loaded chamber.

While its use at this time showed the serious effort of the Confederacy to develop a weapon capable of sustained fire, this bit of experimentation added nothing but a bit of colorful history. All the principles involved were as old as the use of gunpowder in warfare.

Gorgas Machine Gun

Another machine gun, under construction by the Southern forces, was the invention of their Chief of Ordnance, Maj. Gen. Josiah Gorgas, C. S. A., (1818–83). It was a single-barrel, cast-iron, smooth-bore affair, caliber 1.25 inches.



Gorgas Machine Gun, Cal. 1.25.

The barrel is fastened by an eye and wedge key to a heavy cast-iron horizontal plate. This plate extends under part of the barrel, is circular in rear of the barrel and has an extension to the rear; the rear part contains gearing which is operated by a hand lever. This gearing rotates a horizontal ring contained in the circular portion of the horizontal plate. There are 18 copper-lined muzzle loading chambers on the outside circumference of the ring, and 18 corresponding percussion cap nipples on the inner circumference. Under these nipples and on the ring are the same number of cams; these cams act successively on a lever which withdraws a hammer and compresses a firing spring when the ring is rotated from left to right. The hammer is released as it reaches the end of the cam. The trunnion piece is pivoted underneath the front of the horizontal plate. A lever and loading piston, on the right of the barrel and attached to the horizontal plate, rams home the charges in succession as the ring is rotated and the chambers are seated behind the barrel. The gun is mounted on a pivot that allows it to be moved in azimuth.

General Gorgas was born in Dauphin County, Pa., was a West Point graduate, class of 1841, and an outstanding artilleryman during the Mexican War; he resigned his commission in 1861 and was made Chief of Ordnance of the Confederacy. His own version of a machine gun was not perfected in time to be tested in battle. However, his tactical use of the light and mobile smooth bore cannon, using canister or grapeshot, somewhat in the form of an oversized shotgun, was employed with deadly effect against personnel. It showed the lethal results of concentrated fire and the need for controlling dispersion. This, no doubt, made foreign observers take an interest in any weapon that might come in this category.

Chapter 5

GATLING MACHINE GUNS

The Model 1862 Gun

The North was deprived of a great ordnance officer when Major General Gorgas joined the Confederacy, but this loss was more than offset when Richard Jordan Gatling moved to the North in 1844, hoping to manufacture and market several of his mechanical inventions.

Gatling was born in Hertford County, N. C., on 12 September 1818. His parents were Mary Barnes and Jordan Gatling, both descended from English colonists in North Carolina. His father, while still a young man, had invented a machine for planting cotton and another for thinning the plants to a stand. Richard Jordan Gatling assisted in the construction of these mechanical aids and, in his own name, patented a rice planter. The younger Gatling, believing that the prospects of a northern market were more profitable, adapted his rice planter to other grain, and moved to various cities in Missouri, Ohio, and Indiana.

In 1847–48, he studied medicine at Laporte, Ind. The following year he entered Ohio Medical College from which he received a degree. While he was ever afterwards known as Dr. Gatling, there is no record of his ever practicing medicine. It is claimed that he studied only to protect his family from the ravages of the smallpox epidemics which were regularly sweeping the country.

Purportedly at a suggestion by Col. R. A. Maxwell that a special objectives weapon was needed, Gatling drew up plans for a machine gun. Conceived in 1861 and patented in 1862, it was designed to defend buildings, causeways, and bridges. The first model was only a crude forerunner of the gun he soon perfected, the prototype of one of the most remarkable firing mechanisms of all ordnance history—the Gatling gun.

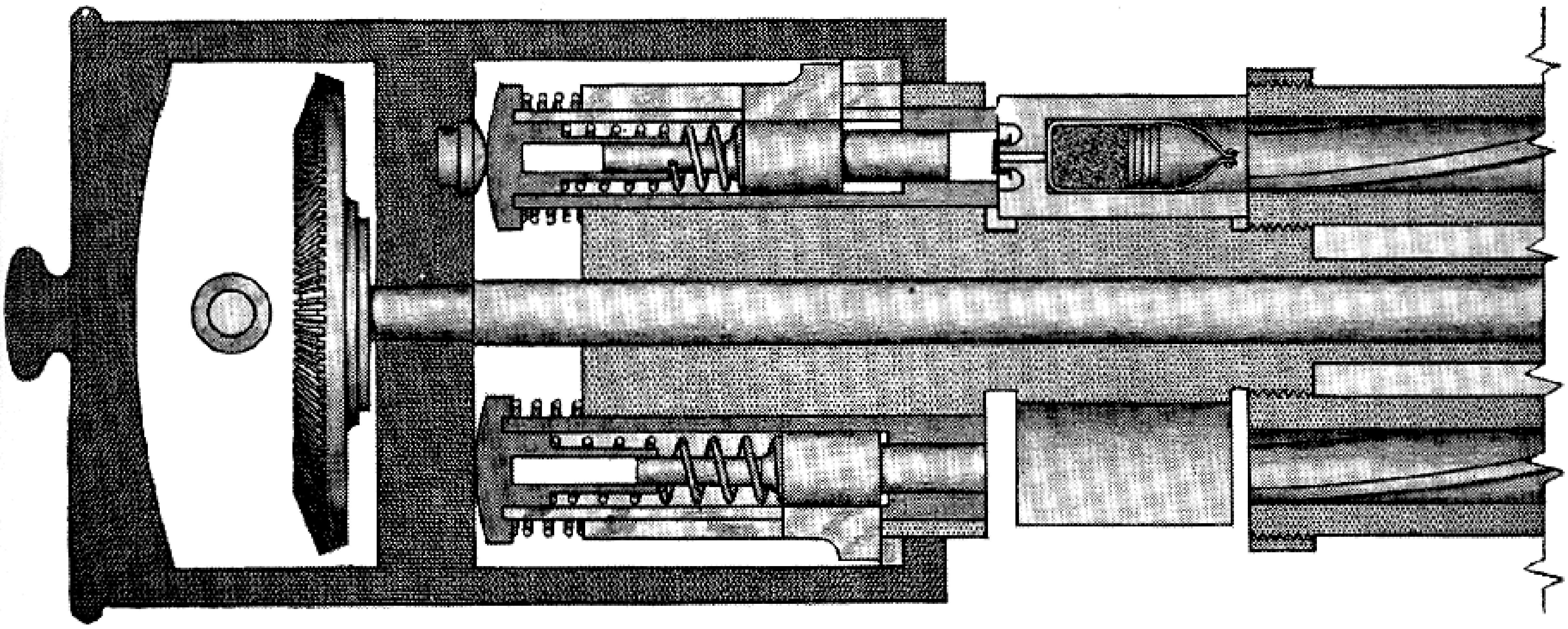
The weapon was the logical outgrowth of the trends portrayed in the Ager and Ripley guns. Gatling combined the best principles of both and overcame their most objectionable features. His successful results caused him to be credited generally with being the father of the machine gun.

The 1862 Gatling guns, types I and II, were fundamentally the Ager principle, improved by the multibarrel arrangement of the Ripley gun. In these models the engineering difficulties had not been completely overcome. However, his first gun laid the basic design groundwork. It was crank-operated with six revolving barrels, having a bolt for each barrel. Cocking and firing were performed by cam action and the weapon was gear driven. By taking advantage of the machine tool progress, he was the first to have used successfully a method of camming to insure positive action and certainty of fire.

This model had many of the bad features of its forerunner, the Ager. It used paper cartridges and steel chargers that acted as firing chambers. The chargers were primed with percussion caps on nipples and the bolts acted as strikers to fire the caps. The chargers were supported during combustion by a cylindrical piece that housed the striker. A hopper gravity feed similar to that of the Ager was also used.

As early as 1862 enough progress had been made on the weapon that a model, actually in working order, was exhibited before thousands of people in Indianapolis. One of the most interested spectators was the Hon. O. P. Morton, Governor of Indiana. This gentleman wrote to P. H. Watson, then Assistant Secretary of War, advising him of the weapon's unusual performance. He suggested that Dr. Gatling's gun be permitted officially to prove its worth.

With this encouragement, Gatling continued to perfect his prototype until he deemed it reliable enough to pass any government test. Financial backers were sought in order to produce the weapon in sufficient quantities should



A Section View Showing the Action of Gatling's First Model Gun.

the armed services become interested. With all the capital he could muster, Gatling went to Cincinnati, Ohio. There Miles Greenwood & Co. contracted to make six weapons in accordance with his patent of 4 November 1862.

Unfortunately for Gatling, this factory, together with the weapons then near completion, blueprints and patterns, was destroyed by fire. The inventor was subjected to a heavy loss, both in money and in irreplaceable pilot models used in constructing these first weapons.

But he was not easily discouraged. After a very short interval he was again in business, now backed by McWhinny, Rindge & Co., also of Cincinnati. This time 12 guns of the 1862 model were manufactured.

Constantly seeking perfection, Gatling made several basic construction changes soon after the guns left the factory. For instance, the prototype and the November 1862 weapons employed a steel container with a percussion cap on the end and paper cartridges for the charge. Soon after the guns were completed by McWhinny, Rindge & Co., Gatling decided to use copper in place of paper in the cartridge cases. These metal cartridges were rim fire, which necessitated the placing of two projections on the bolt head to strike the rim-fire primer. The striker served both as firing pin and as a hammer while eliminating the use of the percussion cap on a nipple. In view of these modifications the gun can be classified correctly as type II of the 1862 model.

Results were so successful that, while the inventor retained the steel chambers on this model, he always used metal cartridges thereafter.

The copper-cased rim-fire ammunition was a definite step forward. It made the 1862 model Gatling easier to load and more certain to fire. However, it did not overcome the one difficulty that plagues all revolver-type firearms: the excessive gas leakage that takes place between the forward end of the cylinder and the breech end of the barrel.

Gatling tried to solve this in both of his 1862 types by using a fixed steel cam, so placed as to wedge the chargers tightly against the barrel at the moment of firing. This arrangement was not too efficient. It made the crank hard to turn and caused excessive wear on the parts involved. To some extent this galling action could be compensated for by an adjusting screw that controlled the fore and aft position of the cartridge container.

Both types of the 1862 model were made with six barrels and in rifle caliber .58 only. One of the oddest things about the design of the guns was a tapered bore, which was used to overcome mismatch of the barrels with the steel chargers in the cylindrical carrier. However, this proved very unsatisfactory. Recovered projectiles often showed no engraving marks of the rifling and generally struck the target sideways. An attempt was made to remedy this by increasing the taper and reducing the bore at the muzzle.

Tests and Demonstrations

Dr. Gatling and Mr. Rindge, one of his partners, demonstrated the gun themselves. They made no attempt to conceal the characteristics or construction of the weapon, but published fully illustrated accounts of its design and performance. These eventually found their way to all parts of the world, and aroused foreign inquiry. Nevertheless, our military authorities did not consider the invention especially desirable.

On one of his numerous trips to Washington to interest the Army, Gatling called on Brig. Gen. J. W. Ripley, Chief of Ordnance, and asked that the weapon be given tests with a view of adopting it. General Ripley refused point blank to take the gun under consideration; no doubt he was influenced by confidential reports on the inventor's southern sympathies as much as by any other factor.

A few days later, one of Gatling's representatives met Gen. Benjamin F. Butler in Baltimore, and asked permission to demonstrate the weapon. At the same time he neglected to mention General Ripley's refusal to become interested. Butler was enthusiastic over the resulting exhibition. He immediately purchased 12 guns, paying $12,000 for the weapons, on carriages, complete with 12,000 rounds of ammunition, and personally directed their use in battle during the siege of Petersburg, Va.

Gatling was not the kind to hide his light under a bushel. Ever the opportunist, he had written to Maj. R. Maldon of the French Royal Artillery as early as 29 October 1863, suggesting the devastating possibilities of his gun in warfare, and enclosing a full and accurate description of the weapon. He proposed that should the major think it ethical, this might be the appropriate time to show the description and drawings to the Emperor Napoleon III.

Gatling did not have to wait long for a reply. A request, in the name of the French Government, promptly came making specific inquiry on test reports, type of ammunition, the kind considered best for field conditions, proof of reliability, and the possibility of obtaining one of the weapons with ammunition for conducting a conclusive test.

It is of particular interest that the text of the letter showed the keen awareness of the French Government toward this gun. Its observers during the Civil War, knowing the effectiveness of grapeshot fired from cannon against personnel had recognized the need for an even more efficient weapon. Undoubtedly they had already dispatched information concerning the Gatling gun to their own ordnance department, and discussed the possibilities of its deadly use in European warfare.

To the French inquiry, Gatling promptly responded by sending all the data requested, including published endorsements from high ranking military and civilian persons who maintained that the weapon was revolutionary and the most destructive engine of war ever invented. He likewise informed the French that he would not sell them one gun, as requested; but he could deliver them a hundred if needed, as he was now in a position to manufacture them in a reasonable length of time. This proposition was declined—fortunately; since the United States Government, shortly thereafter, forbade the exporting of arms and munitions of war.

Gatling's correspondence with the French authorities definitely proves that his gun was known to the French high command as early as October 1863.

This occurred considerably before Napoleon III ordered Commandant de Reffye, the leading French ordnance engineer, to produce a weapon that would actually do what records of tests and statements of individuals claimed was possible for the Gatling. It is conclusive proof that Gatling had a reliable and practical weapon for military use, long before any similar gun of European origin was beyond the blueprint stage.

With the hope of getting the necessary Union authorities interested in the matter, Gatling wrote President Lincoln, and pointed out that his deadly invention was an act of Providence for suppressing the rebellion in short order.

This brings to light a peculiar thing about the personality of this extraordinary man. At the same time he was describing his gun as the tool of Providence to help the North defeat the South, Army authorities were investigating his personal life. Henry B. Carrington, commanding general of the District of Indiana, reported that Gatling belonged to the Order of American

Knights, a group of Confederate sympathizers busily engaged in aiding the Southern cause by acts of sabotage; and described Dr. Gatling, "inventor of the gun so named," and the jailer of Louisville, Ky., as the most active and dangerous of the entire organization. Furthermore, he reported that at Louisville a Federal supply boat had been recently burned by them.

Having been born in North Carolina, Gatling's loyalties were naturally assumed to be with the South. This is believed to have influenced the location of his place of manufacture in Cincinnati, on the opposite side of the Ohio River from the South. Should he have gotten into quantity production, it would be a strategic position for selling his product to both the North and the South. He could either have delivered guns, or let them be seized in his shop by a quick Southern raid.

Whatever his incentive was for locating in Cincinnati, nothing materialized. Gatling did not receive from the armed services of either side the recognition he expected. Therefore his production was meager. However, during this period his gun was given an official trial at the Washington Navy Yard and was successful enough for Admiral Dahlgren to approve the weapon's adoption by any fleet or squadron commander who requisitioned it.

The Model 1865 Gatling

As bad features appeared during tests, Gatling observed them and a short time later made corrections. In the autumn of 1864 he made his first attempt to prepare changes that would correct the parts causing malfunctions, so common to all prototype or first model weapons.

With the completion of what he thought was the solution, Gatling ended his partnership with McWhinny, Rindge & Co., of Cincinnati, and contracted with the Cooper Fire Arms Manufacturing Co. of Frankford (Philadelphia), Pa., for the production of the improved gun. James Maslin Cooper already had an outstanding reputation for precision-built weapons. Therefore, the Gatling guns made under this contract between 1865 and 1866 were a marked improvement over the earlier models.

Incorporated in these later guns were all the things thought necessary to correct the objectionable features of the previous design. Gatling ended the gas leakage problem by redesigning the weapon, and combining the cartridge chamber with the barrel; which, in effect, resulted in a breech-loading musket barrel, chambered to receive the metallic cartridge. At the same time he introduced reciprocating motion to a bolt of new design. While this piece revolved with the barrels, a fixed helical cam imparted a shuttle movement that performed the functions of loading, firing, extracting, and ejecting.

Since the cartridge was placed in the chamber of the barrel, a method of extraction had to be put into the gun. This was done by adding a spring leaf attachment on the side of the bolt. When the bolt was in battery, the notched lip of the extractor cammed itself over the rim of the cartridge in order to pull the empty case rearward immediately after it was fired.

This modified Gatling design used the caliber .58 with a rim-fire copper cartridge case, having a powder charge of 54 grains, and a Minié bullet of 566 grains. It had six barrels, as did the earlier models. However, this gun design resulted in the excellent piece that was so universally accepted.

The operation of the weapon is very simple. One man installs a loaded feeder while the operator aims the gun and turns the crank. A set of beveled gears revolves the main shaft, carrying with it the bolt cylinder, carrier, barrels, and bolts. As the barrels rotate, the cartridges, one by one, drop into the grooves of the carrier from the feed. Instantly the bolt, by its engagement in the spiral cam surfaces, moves forward pushing the incoming round into the chamber. On the continued forward movement of the bolt, the spring is fully compressed by the cocking lug of the striker reaching the highest projection on the cam. Upon being released at this point, the spring drives the striker forward into the primer, firing the cartridge.

As the rotation continues, the bolt starts rearward. The extractor hooks loosen the empty case, and carry it to a point where its base hits the ejector, knocking the empty brass through an opening in the housing, clear of the mechanism.

Each barrel is discharged in turn as it reaches the lower right hand position, the cycle of operation of any single bolt and barrel assembly

Indianapolis Ind
Feby 18th 1864.

To His Excellency
A. Lincoln
President of U.S.

Sir

Pardon me for the liberty I have taken in addressing you this letter.

I enclose herewith a circular giving a description of the "Gatling Gun" of which I am inventor and patentee.

The arm in question, is an invention of no ordinary character. It is regarded, by all who have seen it operate, as the most effective implement of warfare invented during the war, and it is just the thing needed to aid in crushing the present rebellion.

The gun is very simple in its construction, strong and durable and can be used effectively by men of ordinary intelligence.

The gun, was, months ago, tested at the Washington Navy Yard and gave entire satisfaction to the officers who attended the trial, and it was adopted by the Naval Bureau with the understanding that any requisitions for the guns, made by Naval officers would be allowed, since which time a number of requisitions have been sent in for the guns by different Naval officers, but none of said requisitions have been granted to my knowledge.

Genl Banks, commanding at New Orleans, has also made requisitions for a number of the guns to be placed on transport vessels in his Department, when they would be found, no doubt, very serviceable. Many other army officers are very anxious to obtain the guns.

Messrs McWhinney & Rindge—partners of mine, in the manufacture & sale of the gun—are now in Washington with a sample gun and I hope ere long to hear of its adoption by the War Department. Its use, will, undoubtedly be of great service to our armies now in the field

May I ask your kindly aid and assistance in getting the gun in use? I know of a truth that it will do good & effective service.

Such an invention, at a time like the present, seems to be providential, to be used as a means in crushing the rebellion.

With very great consideration
I am your obt Servt
R. J. Gatling

(over)

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J.K.I. 224

I have seen an inferior arm known as the "Coffee Mill Gun" which I am informed has not given satisfaction in practical tests on the battle field. I assure you my invention is no "Coffee Mill Gun"—but is entirely a different arm, and is entirely free from the accidents and objections raised against that arm.

R. J. G.

being completed in one revolution. The firing continues as long as the crank is turned and the feeder remains loaded.

One of these weapons was finished in late December 1864. One month later it was sent to Washington and submitted by the Gatling representative, Gen. John Lowe, to the Army Ordnance Department for test.

A trial was ordered and carried out satisfactorily within a month. The improvements made by Gatling were hailed as a great success. The fact that it had completely overcome all gas leakage at the breech was accepted as the greatest accomplishment of all. After these tests he was granted a patent on the changes (9 May 1865).

General Dyer, the new Chief of Army Ordnance, suggested that additional guns be designed in 1-inch caliber. These were to use either a solid lead ball, or a ball and buckshot load for close shooting—such as might be needed for street fighting and bridge protection. If the design changes could be accomplished, Dyer agreed to order Government trials at the Frankford Arsenal at Philadelphia where machinery would be especially constructed to make the 1-inch rim-fire cartridges. It was decided to build eight such weapons and Gatling personally supervised their construction at the Cooper plant.

When these weapons were completed, they were turned over to Col. S. V. Benét, officer in charge of the Frankford Arsenal. He was to conduct tests for the purpose of improving the ammunition design, since it was very difficult not only to manufacture the conventional rim-fire ammunition, but also to maintain even distribution of mercury fulminate all around the inside of the rim. The latter was necessary to insure positive ignition.

While the weapons were in the hands of Colonel Benét, who later became the Army's Chief of Ordnance with the rank of general, many demonstrations were conducted for high ranking officers. Among those who witnessed a firing in Washington were Generals Grant, Hancock, Dyer, Manadier, and Hagner, as well as other Army and Government officials.

With respect to these various exhibitions, and the expenditure of thousands of rounds of ammunition, Colonel Benét, in a summation that was unique in its brevity, stated: "The gun worked smoothly in all its parts."

Adoption by the United States

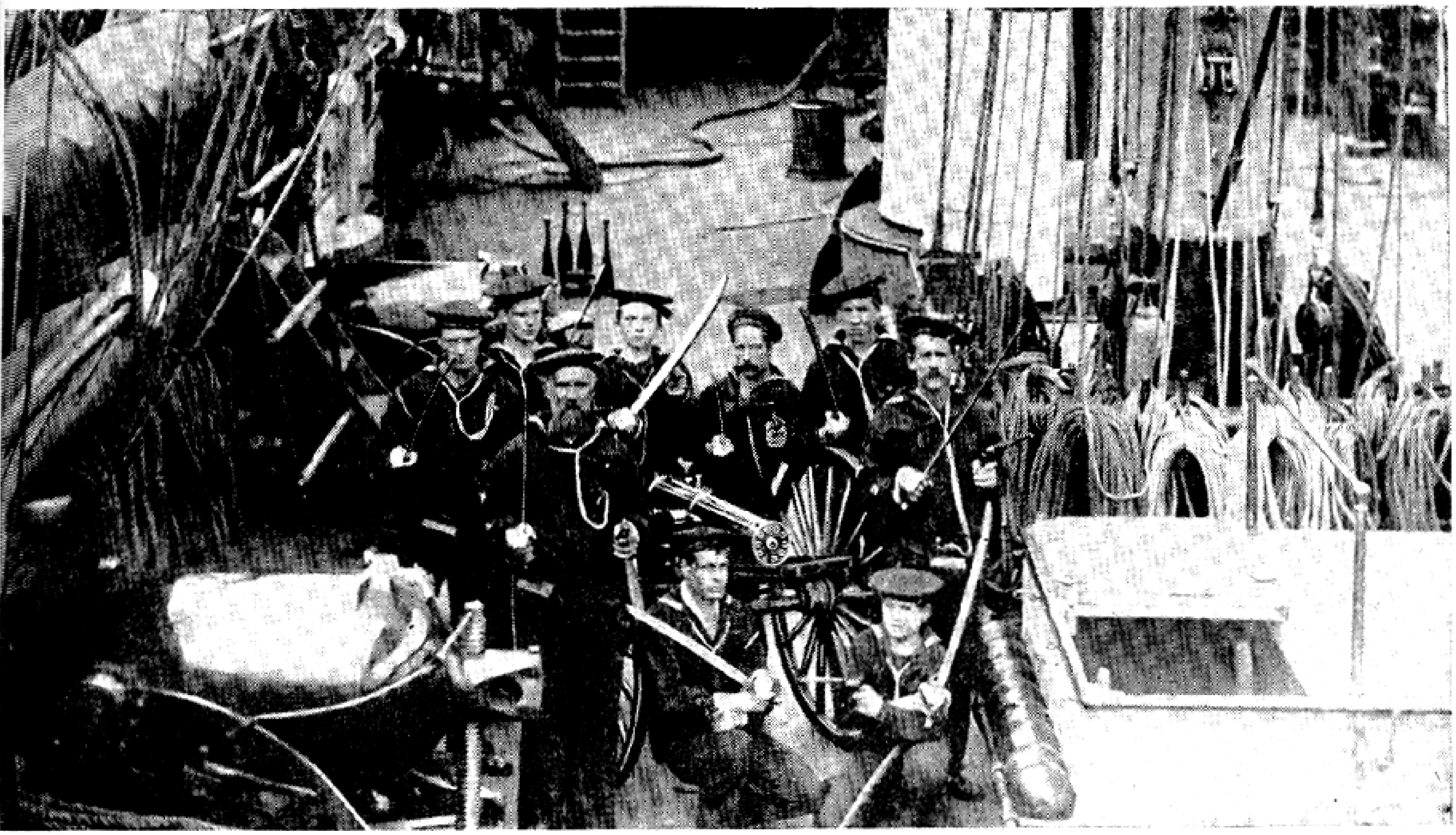
The development of this type of weapon divided military men into two schools of thought. One believed that it should be an artillery support; the other considered it a special objectives gun for bridges or street defense. Neither recognized its true mission as an infantry weapon.

Many of the trials included its being fired in competition with howitzers and cannon. In each instance the Gatling placed more bullets in the target than did the artillery if allowed to fire as many bullets as the number of grapeshot fired. On the basis of these results, the gun was officially adopted by the United States Army on 24 August 1866. In 18 months' time the 1-inch weapon had been manufactured, given strenuous tests, and adopted by the Army. An order was placed for 100 guns. Fifty were to have 1-inch caliber. The remainder were to use the service ammunition for the caliber .50 army rifle. These 1-inch and caliber .50 rounds were the outgrowth of experimentation and development by Colonel Benét to produce a successful center-fire cartridge.

While maintaining, as before, his Indianapolis main office, Gatling made another change in manufacturing connections. This time he entered into contract with Colt's Patent Fire Arms Co., Hartford, Conn., to build the 100 guns for delivery in 1867. This business connection proved so satisfactory that as long as the service used the Gatling, it was manufactured by the Colt Co.

To adapt the gun to the improved cartridges of Colonel Benét, Gatling again modified his bolt in order to convert from the caliber .58 rim fire to the caliber .50 center-fire ammunition. By this improvement he completed in four short years an evolution in design. He divorced the machine gun for all time from the percussion nipple on a steel cartridge container and substituted instead the center-fire brass cartridge. In doing this he developed the kind of bolt assembly used in so-called "modern" machine guns.

Among the guns in this 1866 group were the first deviations from the original six-barrel de-



Gatling Gun Aboard the USS Alliance.

sign. A 10-barrel version was made in both the 1-inch and the caliber .50 dimensions.

With the Civil War over and the arms embargo lifted, the Colt Co. appointed representatives for the purpose of introducing and selling Gatling guns throughout the world. They met in open competition the best that Europe had to offer. In every instance where a properly designed cartridge was used, the Gatling gun outshot everything else under consideration, and successfully met dispersion trials against artillery loaded with grape.

The United States Navy on 30 May 1868, concluded its trials on both the caliber .50 and the 1-inch guns at the Navy Yard, Washington, D.C. The weapons performed in such a creditable manner that the improved model was recommended to replace the few obsolete caliber .58 rim-fire Gatlings that were on hand. A letter praising the weapon's over-all performance was sent on that day to Gideon Welles, Secretary of the Navy, apprising him of these facts. The board, appointed by the Navy's Bureau of Ordnance, concluded its report by saying that to its knowledge, the gun tested by them had no superior.

International Acceptance of the Weapon

Shortly after the adoption of the 1865 model Gatling by the armed forces of this country, the weapon was manufactured in Europe by the Messrs. Paget & Co., Vienna, Austria, and the W. G. Armstrong Co., Newcastle-on-Tyne, England. These firms made the guns with 10 barrels, which were chambered to whatever musket cartridge was used by the various governments. Some of the off sizes included a caliber .65 using a solid 3¼-ounce bullet, and a caliber .75 with a lead projectile of 4½ ounces. All were 10-barrel guns, the only exception being the 1-inch model which was made in both 6- and 10-barrel sizes.

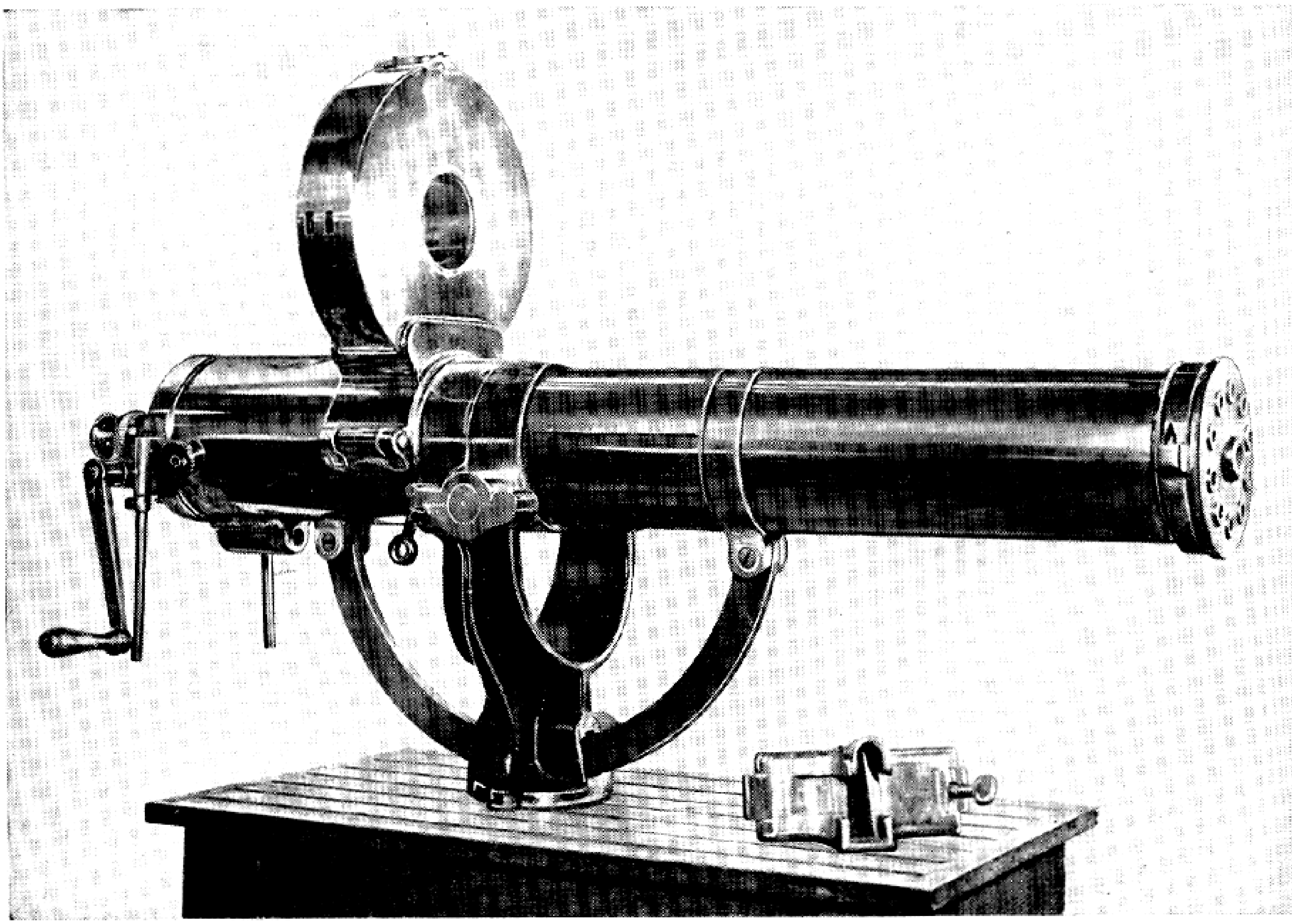
Some of the European governments, in order to prove certain tactical points, subjected the weapons to most unusual competitive events. For instance, in Carlsbad, Baden, in 1869 there were pitted against the rifle-caliber Gatling, 100 picked infantry soldiers, armed with the celebrated needle gun and trained to fire by volley. The machine gun was to fire the same amount of ammunition as the 100 riflemen at a distance of 800 meters. The results showed that the Gatling put 88 percent of its bullets into the target, while the soldiers succeeded in scoring only 27 percent hits. Doubtless the difference would have been even greater had the firing taken place during the heat and smoke of battle.

Even after such a show had clearly demonstrated the Gatling gun's superiority as a death-dealing instrument, its general acceptance was not too enthusiastic. The *London Times* accused the Russian Government of making "undue haste" in adopting this American invention, and ordering a number of guns without even more rigorous trials than had already been conducted.

British distrust of the Gatling at this particular time was due to stubbornness in demanding that all tests be conducted with the famous Boxer cartridge, invented in 1865 by the then Chief of British Ordnance, Colonel Boxer. This was far inferior to American ammunition. The Boxer cartridge case, instead of being made of solid drawn copper, was formed by rolling a thin brass plate around a mandrel, and after soldering, attaching an iron base to it. The bullet had a hollow base with a clay plug. Later, for stability at long range, the clay was replaced with a wooden plug. In 1866 the Boxer cartridge was officially adopted as the standard ammunition of all the English armed forces. The persistence of English authorities in conducting tests of highly efficient manually operated machine guns with this outmoded ammunition led to many failures through no fault of the weapon.

During the first Gatling trials in England, the Boxer cartridge was used. On every burst attempted, the extractor, at some point in the firing, invariably tore the head off the cartridge and left the remaining brass in the chamber to block the incoming round and jam the gun.

At later trials in Vienna, continued malfunction was caused by the use of ill-fitting ammunition. The Gatling gun, which had been advertised as firing 300 to 500 shots a minute, barely succeeded in doing more than 200 a minute.



Gatling Gun, Model 1883. Ten-Barrel, Cal. .45, with Accles Feed Drum.

However, any time reliably constructed ammunition was used, the weapon's performance was equal to, and sometimes beyond, the claims of its promoters.

When the British finally developed cartridges suitable for the Gatling, they ordered a demonstration at Shoeburyness. There they put the gun in competition with everything and anything that could be mustered; all ranges and various sizes of targets, both stationary and moving, were included. It was concluded that the arm in no way matched certain types of field guns, but that no artillery branch of an army would be complete without Gatlings as auxiliary or supporting weapons.

Although almost ignored in the Civil War and practically untested in battle, the Gatling slowly but surely impressed observers of all nations that, when used with suitable ammunition, it was the most reliable firing mechanism yet designed. Its drum-type gravity feed was improved by the invention of a positive cartridge-positioning device by James G. Accles of Hartford, Conn. This corrected a feature in the gun's design that had heretofore limited the angle of fire.

The Gatling Gun Co. sent expert operators to every part of the world. In their enthusiasm to put on a good show, they have been known to set up their guns against the enemy of a prospective customer and repel a charge, just to show its effectiveness as an instrument of annihilation.

After the United States Navy and Army had adopted the Gatling, in 1862 and 1866 respectively, the French successfully used a few in the Franco-Prussian War, while the much publicized rapid-firing weapons of European origin were being proved utter failures. For more than 40 years thereafter, the Gatling was used by practically every major power and influenced world events in no small manner.

The Colt Co.'s greatest feat of salesmanship was in Russia. That government, one of the first foreign powers to adopt the Gatling (1871), sent General Gorloff to Hartford as head of a mission to witness the construction of the weapons, and, if thought advisable, to purchase an additional number. They were to be chambered for the Russian infantry rifle cartridge. Four hundred guns were made and delivered in less than a year, but not until each gun was stamped in Russian with Gorloff's name, since he had supervised their construction. Years later Gatlings were manufactured in Russia's own arsenals, but under the Gorloff name. Finally, when the Russo-Turkish War came, the Russians were fully equipped with Gorloffs. The Turks had the same weapons, but theirs were called Gatlings.

Performance and Improvement During the Nineteenth Century

The endurance of the Gatling gun seems almost phenomenal when judged by modern standards. On 23, 24, and 25 October 1873, at Fort Madison near Annapolis, Md., 100,000 rounds of center-fire caliber .50 ammunition were fired from one gun to test not only the durability of the 1865 model gun, but also the quality of the cartridges. Lt. Comdr. J. D. Marbin supervised these trials under the auspices of Commodore William Nicholson Jeffers, Chief of the Navy Bureau of Ordnance. Excerpts of the official report are given below:

"October 23, 10:33 a. m., commenced firing in the presence of Chief of Bureau of Ordnance and others. Ten drums, each holding 400 cartridges (making 4,000), were fired rapidly, occupying in actual time of firing ten minutes and forty-eight seconds. The firing was then discontinued to witness experimental firing of the 15-inch Navy rifle. The firing of the Gatling gun was resumed in the afternoon, when some 28,000 cartridges were fired. Commenced firing at 8:50 a. m., October 24, the gun having been cleaned.

"One hundred and fifty-nine drums, of 400 cartridges each, making a total of 63,600 cartridges, were fired without stopping to wipe out or clean the barrels. At the close of the firing, which extended over a period of five hours and fifty-seven minutes, although the actual time of firing was less than four hours, the barrels were not foul to any extent; in proof of which a very good target was made at 300 yards range before cleaning the barrels. On the 25th day of October the remainder of the 100,000 cartridges were fired. The working of the gun, throughout this severe trial was eminently satisfactory, no derangements of any importance whatever occurring."

Colt representatives sold the rifle-caliber guns,

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with the improved feed, to Egypt, Morocco, China, Japan, and practically all South American countries. However, it remained for Britain to give the gun more world-wide use in its empire building than any other nation had done. It not only adopted the weapon as the first-line machine gun for its army and navy, but manufactured Gatlings under royalty rights from the Colt Co. In fact, the gun was looked on so favorably by English authorities that it paved the way for the long list of American inventors who have since designed machine guns for the British Empire (there being no record of an Englishman designing any that were officially adopted by his own government).

As other gun designers attempted to encroach on Gatling's world market, he boldly stood his ground. An English publication in September 1881 carried the following:

"A CHALLENGE.
"THE GATLING GUN.

"Recently many articles have appeared in the press claiming superior advantages for . . . other machine guns over the Gatling system. In order to test the question which is the better gun, the undersigned offers to fire his gun (the Gatling) against any other gun on the following wagers, viz:

"First—£100 that the Gatling can fire more shots in a given time, say one minute, than any other gun in the world.

"Second—£100 that the Gatling can give more hits on a target, firing, say one minute, at a range of 800 or 1000 yards, than any other gun.

"The winning party to contribute the wagers won to charitable objects.

"The time and place for the trials to be mutually agreed upon. Trials of the above character will do more to determine the efficiency of the guns than newspaper articles ever so cleverly written.

"(Signed) R. J. Gatling
Of Hartford, Conn., U. S. A."

The English Navy used Gatlings against the Peruvians in 1877, put them ashore against the Zulus in 1879, and at Alexandria in 1882. Historians claim the British Christianized the uncivilized world with the Gatling. In fact, it,

General Custer, Who Left his Gallings Behind When He Met Sitting Bull at Little Big Horn.

more than any other weapon, helped change the odds in their favor during their days of empire building.

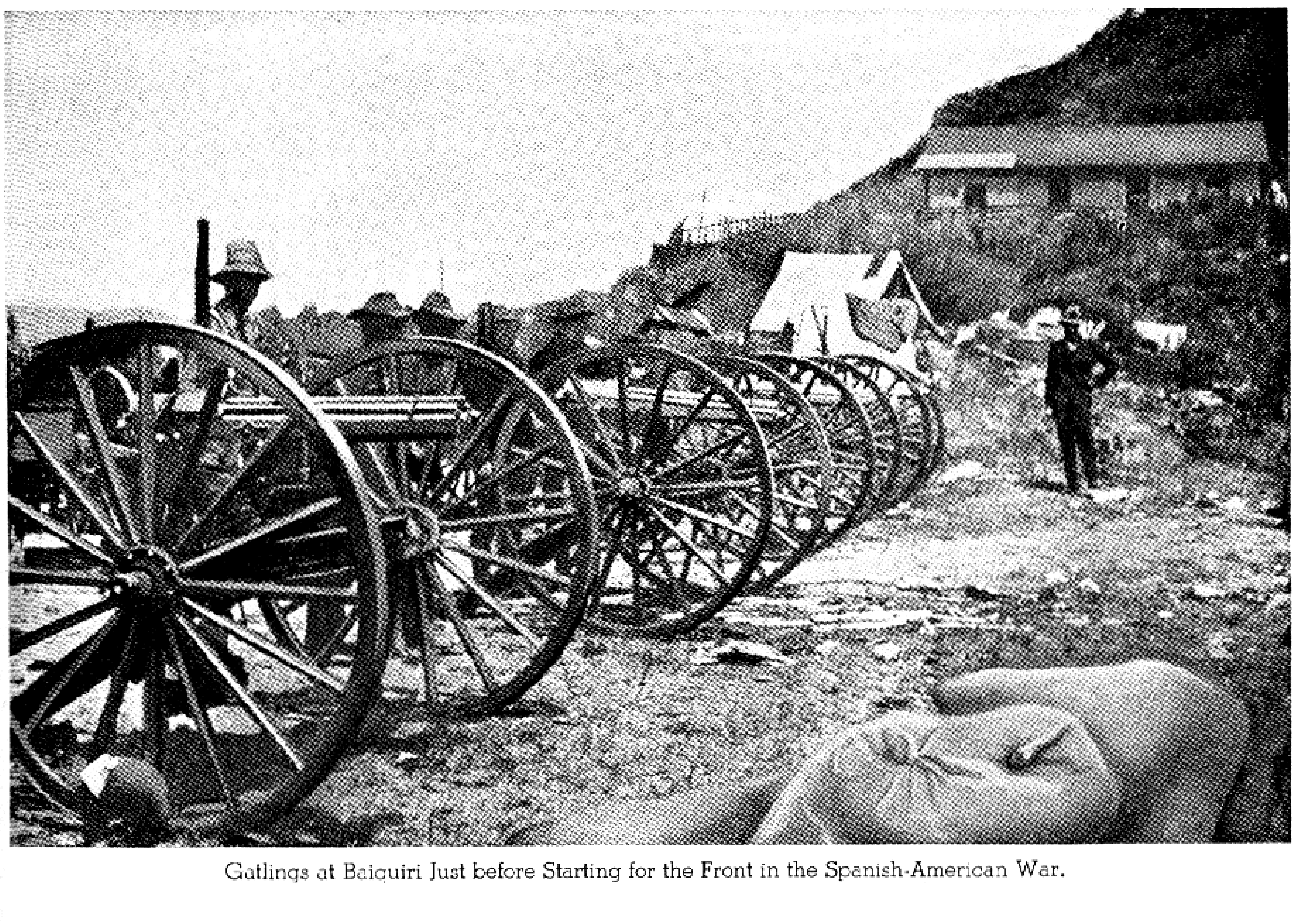
The United States, however, was in the midst of peace. There was nothing to warrant the expenditure of ammunition except an occasional Indian uprising, which was suppressed by the regular army. The old-line military men were still not inclined to accept anything as revolutionary as the Gatling. Although it is recorded that each detachment in the field had several of these guns on its allowance list, nothing can be found to show their use in the Indian warfare of the Western plains.

For the purpose of conjecture and discussion, it should be noted that when Gen. George Custer's entire troop was annihilated at Little Big Horn in 1876, his headquarters had on hand four of the 90-pound Gatlings having a rate of fire of 1,000 rounds a minute. These perfected weapons were designed especially for animal transportation, and could be fired from horseback or from the ground on a tripod mounting. They were chambered for the Army standard caliber .45–70–405 infantry center-fire rifle cartridge. Had General Custer taken with him only one of the four that were available, the phrase "Custer massacre," so well known to every school child, would have had a reverse meaning—as one can hardly visualize a more perfect target for a tripod-mounted machine gun than a band of Indians galloping in a circle.

Conditions remained about the same until the war with Spain in 1898. Then, for the first time, American troops fired a Gatling gun at a foreign enemy. This event might well have never taken place had it not been for the audacity of one man, Capt. John H. ("Gatling Gun") Parker. Having recognized the potentialities of this new kind of weapon, he asked that he be allowed to organize a Gatling unit against the Spaniards at Santiago in Cuba. His immediate superior opposed Parker's plans. However, he carried the request to the commanding officer, Gen. Joe Wheeler, who not only liked the suggestion, but directed Parker to get together the proper men and equipment to operate and maintain the guns.

Parker's effective work against the enemy is a matter of history. As a result of his theories on the employment of the machine gun, the high command of the Army commissioned him to "devise a form of organization for machine guns to be attached to regiments of infantry." For the first time, 36 years after the Gatling was used by General Butler, the Army recognized the value of the weapon in offensive warfare, and gave it a place in future planning.

Machine gun development owes much to Parker, for he organized with great foresight, laying the groundwork of tactical application, and creating in the military a place for future weapons of such a nature. Were it not for Parker, it is quite possible that the Gatling, first-line machine gun at the time of all the major powers in the world, although conceived, developed, and



Gatlings at Baiquiri Just before Starting for the Front in the Spanish-American War.

perfected here, could have been declared obsolete by this country without firing a shot against a foreign foe. The weapon was finally abandoned and its manufacture discontinued in 1911, after surviving its inventor by 8 years.

The 37 years that Gatling lived, following the official adoption of his gun by the United States, were spent as head of the Gatling Gun Co. (a section of Colt's Patent Fire Arms Co., Hartford, Conn.), where he constantly sought to keep the weapon ready to meet changing conditions.

In 1871 Gatling patented his first improvement on the gun, namely, the introduction of a center-fire firing pin. In the next year he was granted a patent on general improvements allowing him to reduce the size and weight of the gun. This patent covered most of the features of his caliber .45 camel gun, so called because it could be easily transported on mules, horses, or camels, and was useful in mountainous desert countries. The gun had 10 barrels, weighed 125 pounds, and fired at a rate of 600 rounds per minute. An automatic traversing mechanism was described, but not claimed in this patent. The patent also shows an alteration in the breech housing to facilitate the use of the drum-type gravity feeder. The feeders came in two sizes, holding 200 and 400 rounds. The heavy guns were equipped with two of the large drums.

In 1873 Gatling patented his automatic traversing mechanism. The same year he began experimenting with a five-barrel model with a direct-drive crank in the rear replacing the side crank with reduction gears.

In 1875 the Springfield Armory issued a pamphlet with field instructions for maintenance and use of the weapon. In this handbook, under the heading *Precautions,* it was noted that the headspace of the gun was customarily adjusted to the ammunition to be used before being issued to the service. In the event this critical measurement was changed, through use or disassembly, and the weapon started separating brass from excessive headspace, a simple field adjustment could put it back in safe operation. By removing the front cover, and tightening the adjusting screw on the front of the main shaft, headspace could be shortened, allowing a minimum clearance for freedom of action between rotating barrels and breechblock. If a case should rupture during firing, or a block should fail on any barrel, there came as standard equipment with every gun a steel insert that would prevent an attempt to feed the fouled chamber and eliminate jams, while permitting the remaining chambers to function.

The same handbook cautioned the man in the field to limit bursts to 10 minutes, or 4,000 rounds. It had been observed that a burst of this duration was sufficient, by color test, to heat the barrels to a point where ammunition in the feed might be exploded from contact with the hot mechanism.

In 1876 the Gatling gun received the only award for machine guns at the International Exhibition in Philadelphia. The gun shown there was a 5-barrel one using a caliber .45 infantry rifle cartridge. It had a traversing mechanism that, at the choice of the gunner, could either fire at a single target or spread its field of fire automatically over a large lateral area. The weight of this gun was a little over 90 pounds. It fired sustained bursts at 700 rounds per minute and short bursts at 1,000 rounds per minute. At this time the Colt Co. was also making a 10-barrel model with all the improvements of the smaller gun.

By 1880 Gatling was getting fire at a rate of 1,200 rounds per minute from his light gun. Three years later, James G. Accles, an employee of the Gatling firm, patented what has since been known as the Accles feed. This made the weapon even more reliable, and is the grandfather of the drum feed we know today.

In 1886 Gatling developed a new type of gun alloy, composed of steel and aluminum, which was successfully adapted to gun manufacture. In this case, like other inventors of the era, Gatling was forced by popular demand into a field in which he had no business.

About this time Congress granted him $40,000 to develop a method of casting large steel gun barrels in one piece. An 8-inch cannon was made at the Otis Steel Works, Cleveland, Ohio, and taken to Sandy Hook Proving Ground to be test fired. On the first shot, the gun blew up. Gatling called on an astronomer-mathematician, John Stockwell, to explain the accident. This choice was indeed a wise one, because Stockwell's report was such a mass of scientific confusion and improbable probabilities that Gatling was given the


Compliments of R. J. Gatling
Hartford, May, 1st 1893.

Hg

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON

In replying refer to No. 37888/3038

April 18, 1914.

Mr. W. H. Ireland,
4124 Second Avenue,
Pittsburgh, Pa.

Mailed APR 18 1914

Sir:

1. Referring to your letter without date, received April 16, 1914 (O.O. 37888/3034), requesting information as to the make of gun in this or foreign countries possessing the greatest rapidity of fire, I am instructed by the Chief of Ordnance to inform you that no gun has ever exceeded the rate of fire of the Gatling gun, motor driven. It is understood that with this gun a rate of fire of 3,000 rounds per minute from its ten barrels is possible.

2. The greatest rate of fire from a single barrel is possessed by the automatic gun manufactured by the Vickers Company which will fire from the single barrel approximately 800 rounds per minute.

Respectfully,

Rw

L T HILLMAN

Major, Ord. Dept., U.S. Army.

War Department Letter Attesting Capabilities of Gatling Mechanism.

benefit of the doubt, and the whole thing forgotten.

In 1886 L. F. Bruce, also employed by the Colt firm, received three patents on a gravity-type vertical feeder for use with the light model gun. The novel feature of this feeder was that ammunition could be loaded into it just as it came packaged from the factory. To load, the operator removed the top of the box and in one motion could insert all 20 rounds.

Two patents were granted Gatling in 1893 for a flat strip type feed and for a rifle caliber gun with an electric motor built into the rear of the gun casing. The motor could be detached and replaced by a hand crank should no power be available.

By this time the Gatling gun was totally obsolete, because the word "automatic" was now part of the ordnance vocabulary. Gatling, still a man of determination, proved his vision by designing this built-in electric motor drive. The gun was chambered for the smokeless caliber .30–40 Krag-Jorgensen rifle cartridge.

The power-driven weapon in tests was fired at the phenomenal rate of 3,000 rounds per minute. Production of a reliable mechanism capable of this terrific volume of fire placed Gatling's design as far ahead in the power-driven field as his reliable hand-cranked gun had been with respect to the manually operated weapons of 1865.

As a final defiant gesture to the "full automatic" trend, a device was designed in 1895 for eliminating the electric motor and converting Gatling machine guns to automatic. It did not entirely eliminate the hand crank, but depended on it only to sear off the first round. Thereafter, the gun became gas-operated in the following manner: A spring loaded pivoted lever was mounted on the front of the gun housing. Near the muzzle of each barrel there was a gas orifice. Upon firing the initial round, the orifice of the discharged barrel was positioned against the lever. This allowed the gas to bleed through this vent driving the lever down. The lever, upon being returned by its spring, indexed the gun through a ratchet assembly bringing the next barrel into position to be fired. This permitted a constant rate of fire to be obtained by correlating the size of the gas orifice with the spring pressure on the lever arm.

No automatic Gatling, either electric or gas operated, was ever accepted by the armed forces of the Nation. However, the crank-operated guns were rechambered for the latest model cartridges caliber .30–40 and .30/06, and the Colt firm continued to produce them until they were declared obsolete by the United States Army in 1911. James Accles, inventor of the feed, went to England, became associated with Shelldrake Arms Co., of Birmingham, and continued to produce the gun.

Gatling lived to see his weapon progress from loose powder and percussion cap to primed metallic ammunition, from black to smokeless powder, and from hand crank to electric drive and thence to full automatic.

MITRAILLEUSE TYPE WEAPONS

The successful employment by the Confederates of light cannon firing grapeshot caused a wave of inventions to correct the greatest weakness in this method of using artillery. The cannon were smooth bore, and, like fowling pieces, had limited accuracy. The gunner had little or no control over the placement of the individual grapeshot.

The inventors reasoned that if there were 50 balls in a charge or canister, and 30 were wasted in the scatter effect, a concentrated accurate fire, using an equal number of projectiles, would be even more deadly than the already revolutionary tactics of Generals Gorgas and Bragg.

Developmental approach was along two lines, representing separate and distinct schools of thought. One was the volley system, strongly favored by European armies, whereby a number of barrels were grouped in a plane, parallel or in stacks; and could be fired simultaneously and reloaded rapidly. The other viewpoint, strictly American, employed one or more barrels that did not fire simultaneously, but instead developed a high rate of fire from simplicity of action. In lieu of the volley, it fired in rapid succession a veritable stream of bullets.

To impress military authorities and advertise an improved means of delivering the universally used grapeshot, European inventors called their firing mechanisms "mitrailleuse," meaning "grapeshooter," or more literally "grapeshot shooter." By this name they hoped to imply that theirs was a system for controlling the dispersion of grapeshot.

The general principle was not new. It appears to have been invented originally by Captain Fafschamps of the Belgian Army in 1851. His rough prototype and finished mechanical drawings were offered to Joseph Montigny. This noted Belgian engineer and armorer had his factory at Fontaine l'Eveque, and a branch of his gun business at Brussels.

Later, Montigny constructed some guns of this kind for the defense of the Belgian fortifications. In 1867 he persuaded Emperor Napoleon III of France to introduce the improved Fafschamps gun (now bearing Montigny's name) to the military authorities. Napoleon III was so impressed with the gun that he ordered its manufacture under great secrecy by Commandant de Reffye at the arsenal at Meudon. Montigny had been aided by Louis Christophe, another Belgian ordnance engineer, who added some unique features.

The Montigny gun consists of 37 rifled barrels contained in a wrought iron tube, loaded by an iron plate bored with 37 holes corresponding in position and [illegible] the barrels. A cartridge is inserted in each [illegible] of the loading plate. The firing mechanism is operated by a hand crank, one turn of which in a clockwise direction fires all 37 rounds in less than a second. If the gunner prefers, each barrel may be fired alternately at any speed desired. The average rate of fire by a competent crew has been recorded as 12 bursts, or 444 shots a minute.

When the loading plate is dropped into position, the encased cartridges are alined with their chambers. Grooves formed on the face of the breechblock receive the plate which, upon being dropped into it, is guided by the advance or withdrawal of that piece.

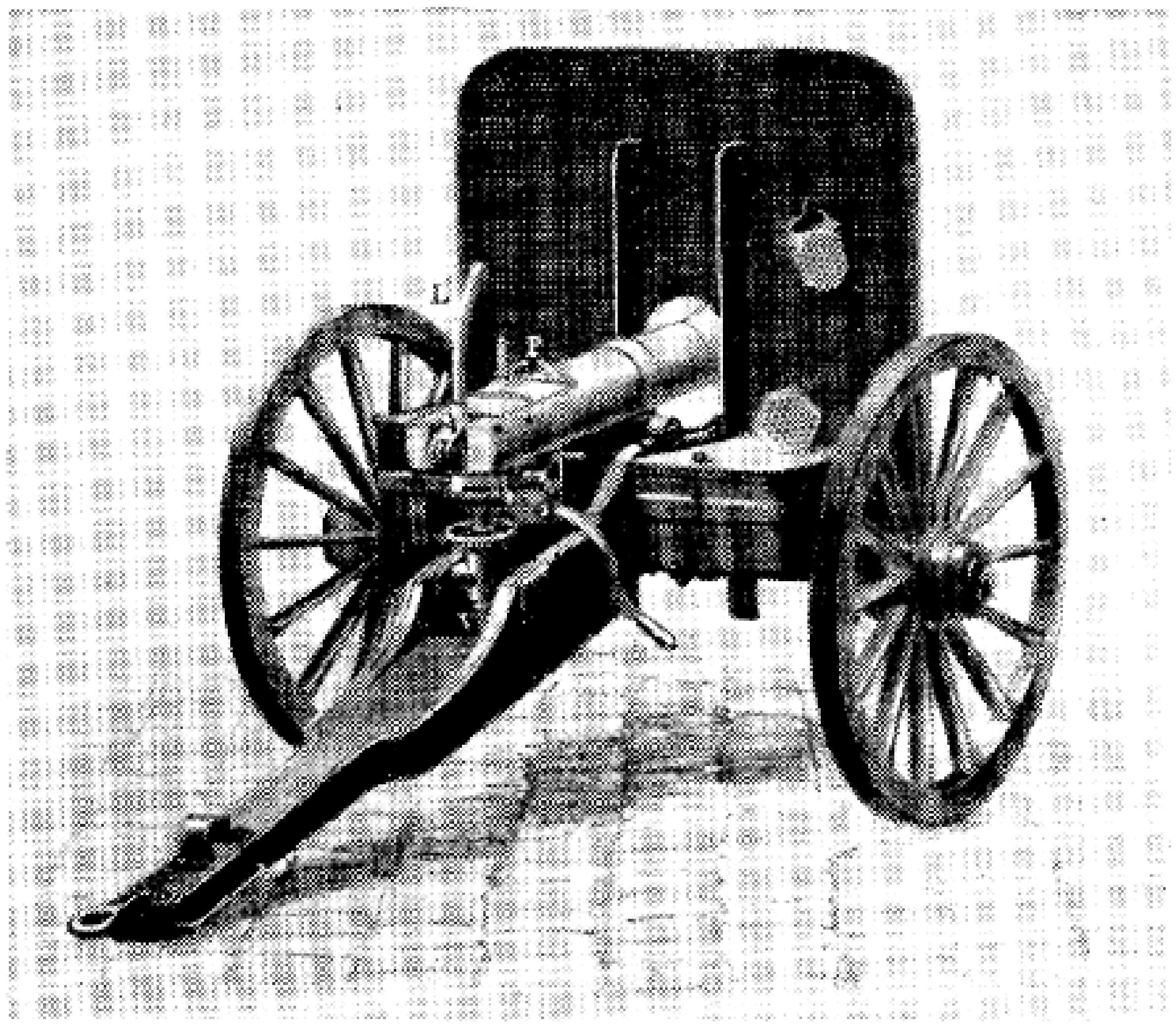
With the cartridges in place, the gunner rotates the loading crank with his left hand. The breechblock advances, pushing the plate forward until the projectiles enter their appropriate barrels. The plate serves as firing chamber. By this act of locking the weapon, the spring-loaded firing pins are brought back to the seared position, ready for firing. As it cannot be cocked until the weapon is securely locked, accidental discharge is impossible. The neck of the cartridge case extends into the barrel just enough to form a tight seal preventing gas leakage.

The gunner now quits the loading crank and takes his position by the firing crank at the right side of the gun. He can fire all of the barrels by one swift turn, or slowly space each shot as he sees fit. When the last barrel has been discharged, the operator backs off the loading crank, opening the breech. He then reverses the firing crank, returning the scar, and withdraws the empty cases from the barrels by means of the plate, which now performs the function of an extractor—or rather 37 extractors in one. The plate is then lifted from the positioning grooves carrying with it the empty cases, and is replaced by one filled with loaded cartridges ready for repeating the operation.

A clever device on the gun trail enables the ordnance man in charge of loading to clear and reload the plate very rapidly. It consists of a [illegible] of pins matched to the holes in the loading [illegible] The plate is placed over these holes, and [illegible] down on a hand or foot lever the [illegible] are jacked sufficiently to free them. [illegible]ridges are then put in the empty chambers, and the plate is ready to be returned to the gun. Use of several plates was recommended for each gun to eliminate any loading lag.

The weapon weighs in the neighborhood of 2 tons, with limber and 2,100 rounds of an especially designed Chassepot ammunition. This cartridge, used in the French version, is composed of a heavy paper case with a brass base, a powder charge, conical bullet and center-fire cap filled with mercury fulminate. The case features a cone-shaped collar that holds the bullet more securely in place. A light coating of tallow over the entire cartridge helps preserve the round. The over-all length of this ammunition is 4 11/16 inches. It carries a bullet weighing 776 grains and 185 grains of propellant, topped by a felt wad. The powder is formed into cylindrical pellets.

Commandant de Reffye made some corrections on the working drawings. For this reason the weapon has often been called the de Reffye mitrailleuse. The barrels were reduced in number from 37 to 25, the Medford type rifling was adopted, and the ammunition changed from an ill-designed cartridge to the Chassepot, at the suggestion of Major Fosbery of the British Army.

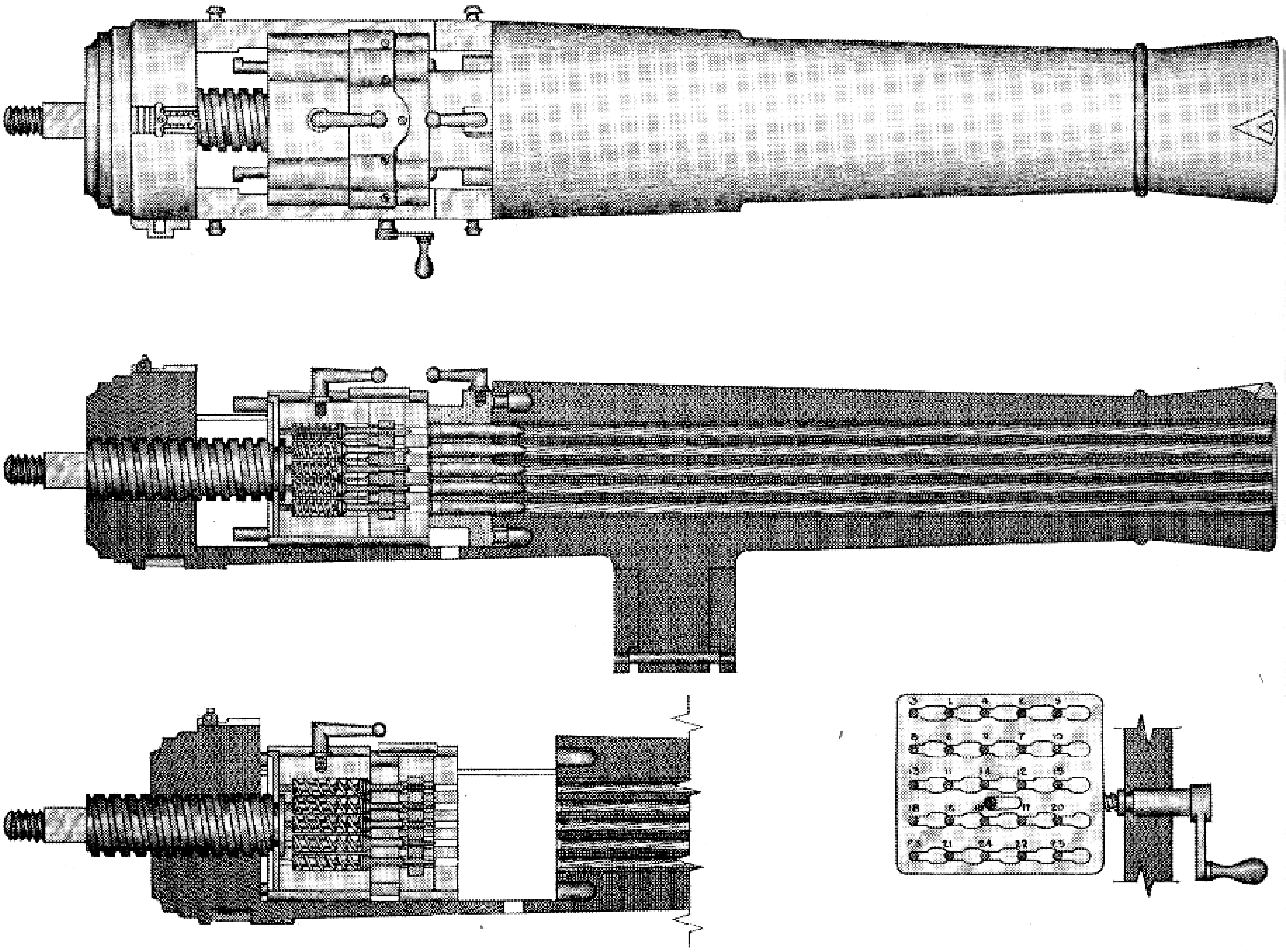


Montigny Mitrailleuse, a Belgian-Designed Volley Firing Gun.

From the arsenal, where the weapon was being produced with much security, came fantastic stories of France's terrible secret weapon. Only the officers and men who worked on its production were ever allowed to see or handle it. When one was completed, it was moved from the factory to storage under tarpaulins and accompanied by armed guards. This air of mystery gave the French press a field day. Stories appeared regularly, intimating the weapon was capable of doing just about anything desired by the military.

The fantastic publicity was intended to intimidate their victorious Prussian neighbors, whose surprising military success over Austria, in 1866, had been due in great measure to a new infantry weapon, the bolt-action needle gun, a product of the German inventor, Johann Nikolaus von Dreyse (1798–1868). All Europe suddenly became aware of this rifle, and muzzleloaders were eliminated, either by substitution of new models or by conversion from muzzle- to breech-loading.

France had attempted to supply her infantry with the Chassepot rifle, her answer in the armament race, but had found it impossible to restock the army quickly enough to prepare for coming trouble. The political events of 1867 foreshadowed the Franco-Prussian conflict. Napoleon III sought desperately to overcome the



De Reffye Mitrailleuse, a 25 Barreled Version as Modified by the French Ordnance Officer.

German arms supremacy. He felt the morale of the French army had been endangered by the achievements of the Prussians with their Zundnadelgewehr (needle gun), and required some strong stimulus to regain prestige. His attention had been called to the Gatling gun, but national pride rebelled at accepting a foreign weapon. However, when he saw the weapon on exhibit at the Paris World's Fair of 1867, he had it withdrawn to Versailles to be tested in his presence. Presumably this weapon embodied Gatling's 1865 improvements, but the French ammunition was of inferior design. The tests were unimpressive; and the Montigny mitrailleuse, already adopted, continued to be ordered as the standard French equipment, 190 being in service at the outbreak of hostilities 3 years later.

The Franco-Prussian War proved the downfall of the weapon. Too many separate operations needed to be done by hand, and in sequence, any one of which, if neglected, would prevent the gun from firing. The firing crank must be reversed after the loading crank has pulled back the breech, otherwise the gun would not sear. The loading crank must then close the breech after the replacement of the loading plate with discharged cases by one filled with complete rounds. Where the Gatling depended on steady rotation of a single crank, its French competitor required constantly changing operations: forward and reverse rotation of two separate cranks, and a pause while the loader removed and replaced the loading plate between each 25 shots. Contemporary foreign writers commented on this complexity and marveled that the French, who usually insisted on simplicity above all else in their guns, should have adopted such a weapon.

If the mitrailleuse had been used against rifle fire, it might have been successful, for it was shooting rifle ammunition and had only a small arms range. However, the military command insisted on matching it against field artillery where it was completely outclassed.

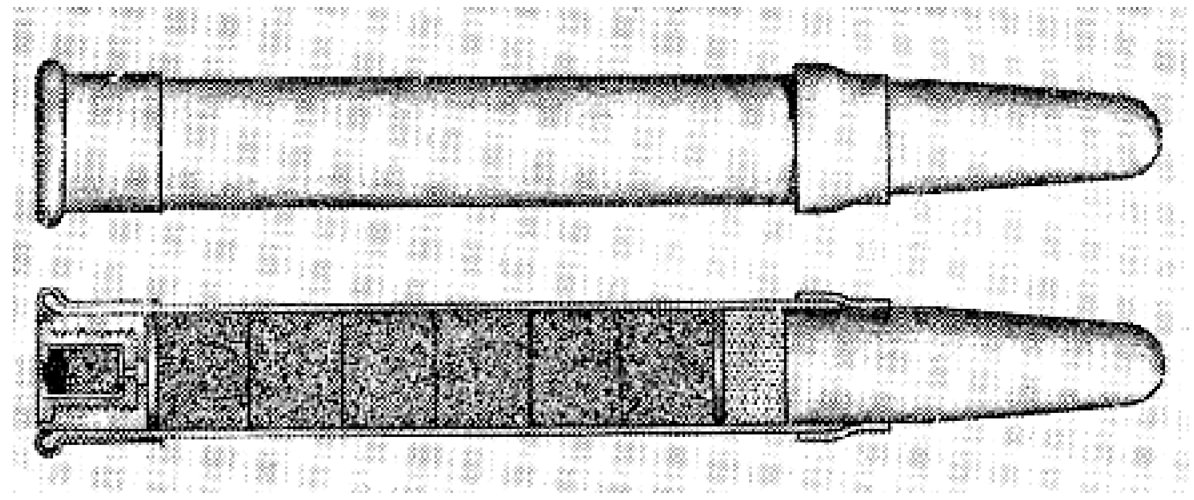
Though the first engagement using mitrailleuse, on 2 August 1870, at Saarbrücken was a mere skirmish, it was glowingly publicized as a devastating victory for the new weapon. Later battles, however, proved disastrous. The open location of these guns made them conspicuous targets, and they were quickly put out of action by Prussian artillery fire.

Apparently the secret weapon had been concealed only from the French. The rest of the world had accurate information about it, and the enemy had profited by devising effective countermeasures. Even during the first battle, with only a few hundred Prussian infantry pitted against a complete French division, the Germans deployed themselves in extended skirmish lines, and offered the worst possible target for machine-gun fire.

At Wissembourg 2 days later, the mitrailleuse was matched against the field guns of the Prussian Eleventh Corps advance guard. The French position at the Château of Geisburg was under fire. A battery of mitrailleuse was brought up and positioned on an unprotected knoll. It was immediately spotted by the Prussian artillery. One of its ammunition wagons was blown up by enemy shell fire; and the commanding general, Douay, was mortally wounded, after which the battery was withdrawn.

The army, in spite of these lessons, continued to bring its mitrailleuse into action side by side with field pieces. Naturally, the Krupp guns had little difficulty in destroying them. The Parisian newspapers, however, continued to lull the French with imaginative pictures of the enemy being mowed down by this weapon like grass before a scythe.

Whenever the gun was used as a reinforcement for infantry, it was successful, but these occasions were given little publicity. It had been mounted as a field gun, and was too heavy for the infantry, which insisted on treating it as artillery.



The Chassepot Rifle Cartridge that Was Used in the Mitrailleuse.

Even Major Fosbery, in a contemporary paper, discussed the chances of a duel between a field gun and the French mitrailleuse. He contended that "if both were loaded, and the first shot from the gun failed to smash the mitrailleur, the gun could not be loaded a second time; nor would a horse or a man belonging to it survive the first minute's practice from the weapon opposed to it." However, the major granted this would be a very unusual circumstance, since the field gun could come into action at a distance beyond range of the machine gun.

On 18 August 1870, the first successful use of the Montigny weapons occurred at the Battle of Gravelotte. Here, they were placed with the infantry firing line, and protected by a cluster of trees. The Prussians suffered heavy losses. One battery of these weapons was responsible for the capture of the only field guns lost by the enemy during the entire war. The French did not analyze the victory and profit by its lessons. They did not recognize that success had been due to a difference in tactics.

Machine guns proved of little use to the French. Nearly half of their guns were captured by the Prussians at Sedan. The rest were shut up in the siege of Metz. Colonel de Reffye attempted to increase the supply by operating workshops for their manufacture along the Loire River. In the meantime foreign machine guns were purchased. America supplied Billinghurst's Requa battery and some Gatlings. However, few Frenchmen knew how to operate these weapons.

By January 1871, Gatling guns were successfully defending the plateau of Anvours and the river crossings. A few were also in trenches. Wherever the mitrailleuse machine gun was used from a protected spot and for short ranges, it was successful. In spite of this the French authorities recognized but one fact: the weapon had been unsuccessful in 9 out of every 10 encounters. They ignored the factors that made the tenth use a success, and were defeated by their own secrecy, for they failed to correlate design and practical tactics.

There was another model, type IV, patented by Montigny and Christophe in 1872 after the French had lost the war. It simplified the locking, and was controlled by means of a jointed lever. This cut in half the time heretofore necessary for securing the breechblock in place, as the toggle joint lock could be opened and closed by two swift movements of the lever. The loading plate was reduced to $^{11}\!/_{16}$-inch thickness in place of the heavier plate that had been drilled practically the entire length of the cartridge. By this time, however, the mitrailleuse was doomed, following its discreditable showing in the war with Prussia. Although 20 years were spent in its development until it appeared on the battlefield, it lasted less than a year before total failure in action gained it the dubious honor of being the shortest-lived rapid-fire weapon to be adopted by a major power. About all it contributed to the development of quick-firing weapons is the name, "mitrailleuse," used to this day by the French when referring to their most modern machine guns.

The Feld (or Feldle) machine gun was also used during the Franco-Prussian War. It was employed by the Germans in the siege of Paris, in the Loire campaign, and at Orleans. It was a mitrailleuse type weapon of the Bavarian Army, but was not considered mechanically reliable. It had 24 barrels mounted in parallel rows, and worked by a crank handle, firing about 300 shots per minute. The extreme range was 1,300 to 1,400 meters. It used Bavarian infantry rifle ammunition. These cartridges were unsatisfactory for the purpose. The gun frequently jammed. The barrels overheated easily, warped permanently in their frame, and had to be replaced. The Feld gun's failure contributed to the general dislike for machine guns which prevailed in the German Army for many years after the war of 1870.

American gunmakers, nevertheless, continued to study the problem of sustained fire. Lacking the European prejudice fostered by the mitrailleuse, they came up with some effective hand-operated machine guns.

Chapter 7

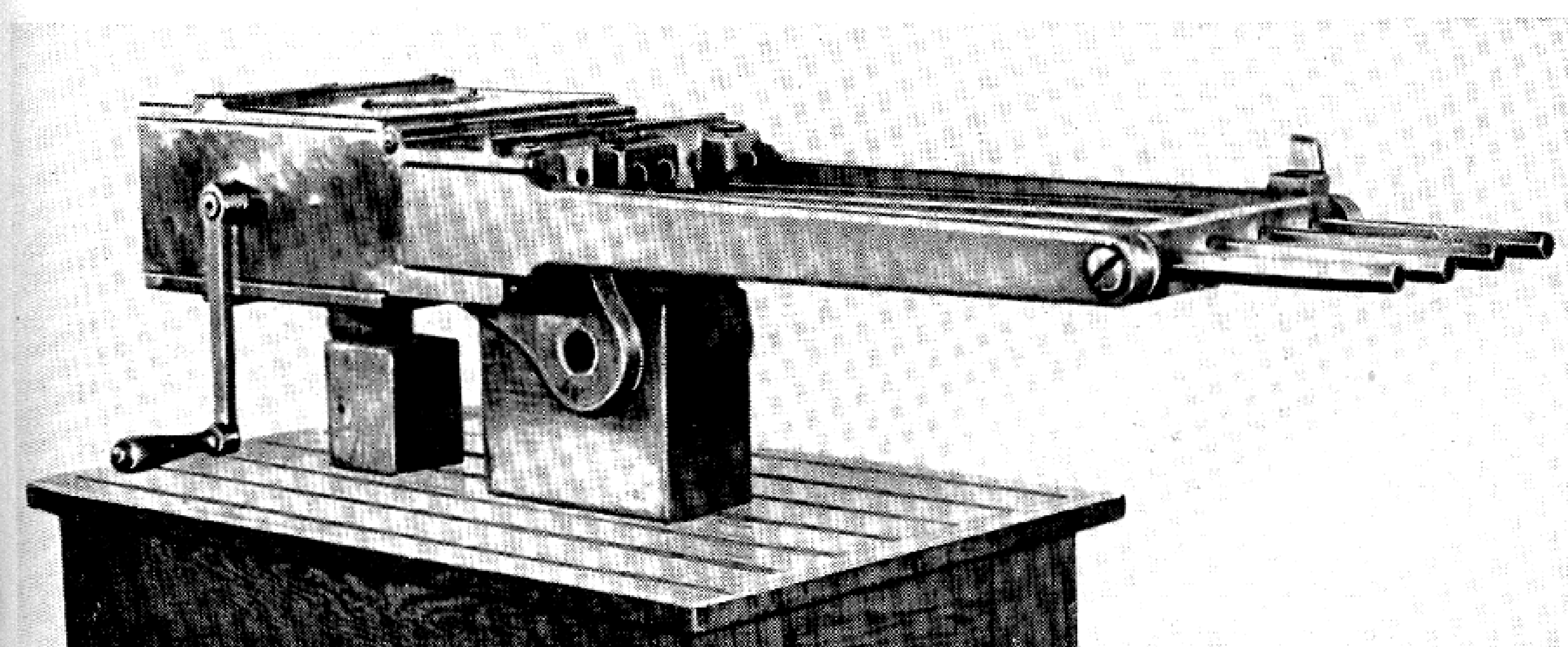
FARWELL MACHINE GUN

A machine gun of novel design was originated by Mr. W. B. Farwell of New York City in 1870. This weapon, while quite odd from an operational standpoint, was similar in appearance to the many multibarrel guns that were introduced shortly after the Civil War. It was of very heavy metal construction and had four octagon-shaped barrels chambered for the black powder caliber .45–70 standard infantry rifle cartridge.

The operating mechanism consists primarily of an assembly of gear racks and heavy screw threads. It is actuated by the clockwise rotation of a handle located on the right side of the gun. Each barrel has its own individual bolt, having an upper and a lower rack attached to its rear end, through which the bolts are given a reciprocating motion by segmental pinions. At each revolution of the gear wheel the clutch causes the pin to engage temporarily the drive wheel to which is imparted a partial stoppage in the rotation movement. This pause takes place immediately after firing, thereby providing a time lag in case of a hangfire. The cartridges are fed by means of a box located over and to the rear of the chambers. The ammunition container has four double-feed slots, or a set of two for each barrel. A peculiar arrangement called the shutter by the inventor is also incorporated in the feed system. Actuated by the bolt's retracting action, this device permits the dropping of a cartridge in the feed slot only when the bolt is far enough back to allow the positioning of the round for chambering.

When the feeder is loaded and latched on top of the gun, a double row of ammunition sits above the loading recess of each barrel. However, the rounds will not drop until the feeder is moved slightly to the right or left enough to create an opening greater than the over-all width of the case. When the weapon is firing, the shutter merely moves the feed box right and left as the empty loading recesses are opened by the rearward action of the bolt.

The operating mechanism is unusual in design, especially the locking and retraction methods. These novel features employ telescoping tubing both as bolt and breech lock. The inner



Farwell Machine Gun, Cal. .45 (Experimental Model).

tube carries the firing pin assembly and also serves as the final support behind the base of the cartridge when fired. The outer tube has a rotary rather than a longitudinal movement. It is provided internally with a screw thread which when revolved imparts the reciprocating action to the inner tube. The forward advance of the lower tube chambers the round and fires it while its withdrawal rearward extracts and ejects the empty cartridge case. The rate of fire is probably unusually low, since the actuation of the parts is dependent upon the screw thread method for reciprocating motion.

The weapon could be assembled and disassembled readily with all working parts easily removable for inspection or cleaning. The inventor claimed that, while firing, each barrel could be moved so as to give converging or scattered fire. The mounting of the large flat ammunition box made it necessary to incorporate an offset sight. It was the first appearance of a feature that was used extensively in later years. Only one of the guns was ever made. Since there were so many better weapons already in existence, no one could be interested in financing its production.

Chapter 8

HOTCHKISS MACHINE GUN

Benjamin Berkley Hotchkiss, born in Watertown, Conn., in 1826, served his apprenticeship and became a master mechanic at the Hartford plant of the Colt's Patent Fire Arms Co. He is credited with helping to design and perfect various models of the world-famous Colt revolver.

As early as 1856 he built a rifled field piece that was purchased by the Mexican Government. In 1860 he submitted to the United States Government an improved system of rifling and a new kind of percussion fuze for projectiles. The latter was adopted and was manufactured in New York City. Hotchkiss was placed in charge of the City Arsenal there during the draft riots of 1860.

Like so many other inventors of this time, Hotchkiss felt that his gun knowledge was not being given the recognition it deserved. Therefore, he went to France in 1867 and demonstrated an improved metallic cartridge case to replace the poorly designed paper ones used in the Chassepot rifle.

The French Government ordered the immediate manufacture of his cartridge case at St. Etienne. Hotchkiss was induced to remain in France, when orders were placed in advance for a machine gun he had in mind. Hotchkiss had a theory that the most efficient use of such a weapon could be obtained by combining the destructive forces of the explosive shell with machine-gun rapidity of fire. In 1871 he had developed his gun, a revolving cannon type, to such a point of perfection that it was hailed as a novel and successful weapon.

Four years later he organized Hotchkiss & Co., with offices in Paris and a manufacturing plant in the neighboring town of St. Denis. It was intended to make, not only the weapon itself, but the mounts and ammunition as well.

Hotchkiss had earned his first reputation in ordnance by designing artillery projectiles and systems of firing. From this background he proceeded to formulate what he considered the best caliber to produce maximum devastation on personnel while the arm remained light enough to be fired with great rapidity.

It is interesting to note that the St. Petersburg Convention in 1868 had specified 450 grams as the minimum weight of a projectile carrying explosives intended for antipersonnel use. This total included the projectile and bursting charge. To be on the safe side, Hotchkiss allowed himself 455 grams minimum. When he arrived at the proper caliber with bursting charge cavity of correct dimensions and a balanced fuzed nose, he had a 37-mm projectile. So accurate were his calculations that, though Hotchkiss originated this dimension, it is still considered absolutely the largest projectile that can be fired with any semblance of machine-gun rapidity.

A pamphlet, prepared by the company in 1874, described the gun, its action and ammunition. The publication was incorrect, however, because improvements had been added to the gun during manufacture. The brochure, by this very fact, indirectly shows the rapid progress made by the factory. Early malfunctions were corrected and a reliable gun was turned out that was able to overcome the official prejudice against repeating weapons dating from the dismal failure of the Montigny mitrailleuse.

The Hotchkiss gun was primarily designed for flank defense. To perfect this feature, a peculiar modification was introduced. Each of the five barrels was rifled with a different pitch. This insured that the weapon, having once been correctly installed and aimed, would never require alteration, but could sweep the target area with a shower of shrapnel, 1,500 lethal fragments being obtained from a 60-round burst.

Although planned as an army gun, the introduction of the torpedo boat gave the Hotchkiss a chance to prove its usefulness to the navy. The appearance in 1877 of the high-speed torpedo

Hotchkiss 37-mm Revolving Cannon Mounted on Ship's Gunwale.

boat as a new weapon of naval warfare created the demand for a new type of gun for naval defense that would combine the highest degree of destructive power, rapidity of fire, quickness of aim, and reliability.

The Gatling had by this time been generally adopted by all the leading navies of the world, but the power of its solid lead projectiles was totally inadequate as a defense against the torpedo boats.

The English Navy felt that a gun of Swedish origin, on which it was conducting trials, would meet the new exigencies if the caliber were increased to an adequate size. However, the British discovered the general arrangement of the weapon was so unwieldy that if its total weight were limited to that of the Hotchkiss revolving cannon, it was necessary to make the projectiles no larger than 1 inch (less than 26 millimeters). This precluded the use of an explosive shell under the terms of the St. Petersburg convention. This clearly illustrates Hotchkiss's foresight and engineering ability, for the Swedish gun was thus eliminated from competition in weight design. As the size of the torpedo boat increased, and its armor plate thickened, the need for the Hotchkiss and its explosive nose fuzed projectile became more apparent.

The French had been taught a bitter lesson in secret weapons by their stupid handling of the production and testing of the mitrailleuse. They were taking no chances with the Hotchkiss, which was making them again a power to be reckoned with. Although the nation was at peace and no immediate war was in prospect, ordnance writers agree that no French machine gun ever received so thorough an investigation as did the Hotchkiss revolving cannon. Even though the weapon was considered reliable when adopted (and later events verified this conclusion), for 10 years the gun was fired at the French Naval Testing Grounds at Le Havre. During this period every possible point connected with the gun, or its ammunition, was exhaustively studied and reported. When this prolonged trial was finally ended, all the data covering the test were assembled and properly classified.

A mass of information was obtained that enabled the authorities to form a true and exact judgment, not only of the absolute value of the gun itself, but also of the comparative value of all other machine guns that were considered competitors.

Various models were constructed to suit the special requirements for which they were designed. These different types varied in ballistic features, weight, dimensions, and manner in which they were mounted; but the general system of the mechanism was common to all calibers.

Although the Hotchkiss revolving cannon bears a marked resemblance to the Gatling, the design is original throughout and has many peculiar characteristics found only in this gun. For instance, it has intermittent rotation of the barrels without turning the breech mechanism. The barrels remain stationary at the moment of discharge, thus suppressing the centrifugal motion normally imparted to projectiles at the commencement of flight when fired from a continuously rotating barrel. Extracting and initial loading take place simultaneously in other barrels during this pause. Also, the time lag is adequate to handle hang-fires safely. One firing pin and spring for discharging all barrels and a single loading piston give greater simplicity to the mechanism of the Hotchkiss. Therefore all parts could be made sufficiently strong and heavy to withstand the rough usage to which guns are subjected in actual service.

The shock of discharge is received against a massive, immovable breech, which distributes the force evenly to the whole system. This permits the employment of charges and projectiles whose only limits on weight and size are those dictated by the rapidity of fire. As further proof of superb engineering, the weapon is so well designed that it can be completely disassembled and assembled without the aid of tools.

The Hotchkiss revolving cannon is composed of four distinct groups: (a) The barrels, (b) the frame carrying the trunnions and serving as a bearing for the forward end of the central shaft, (c) the breech containing operating parts, and (d) the actuating mechanism.

The five rifled barrels are made of compressed steel, which was thought to be the best metal for their construction. They are rigidly mounted parallel to each other around a central shaft, between two metal discs, and rest in the frame carrying the trunnions. They are rotated and controlled by means of a hand crank placed on the right side of the breech. The loading, firing, and extracting also are controlled by this mechanism.

The frame is composed of two channel-shaped beams carrying the trunnions. The rear end of the frame forms the rest for the breechblock which is carried by and fastened to the two parallel members.

The breech itself is cast steel, massively constructed to receive the impact of firing. Since it is very heavy, it absorbs the greater part of the recoil. The rear portion of the weapon contains the actuating mechanism, all of which is accessible through a latched door.

The mechanism for rotating the barrels and performing the functions of loading, firing, and extracting is composed of a crankshaft carrying a worm which works in a pinwheel on the rotating axis of the barrels. The worm is of irregular design, partially helical, partially circular, and during operation of the weapon it rotates continuously. The helical portion causes the barrel assembly to rotate 72°, from one indexed position to the next. The circular portion locks the barrels at indexed position, during which period there are three simultaneous actions, each in different barrels, loading, firing, and extracting.

A spiral cam, on the side of the worm, cocks and discharges the piece at the proper time by action of a lug on the firing pin bearing against the cam. Rotation of the worm retracts the firing pin against a leaf spring and allows it to fly

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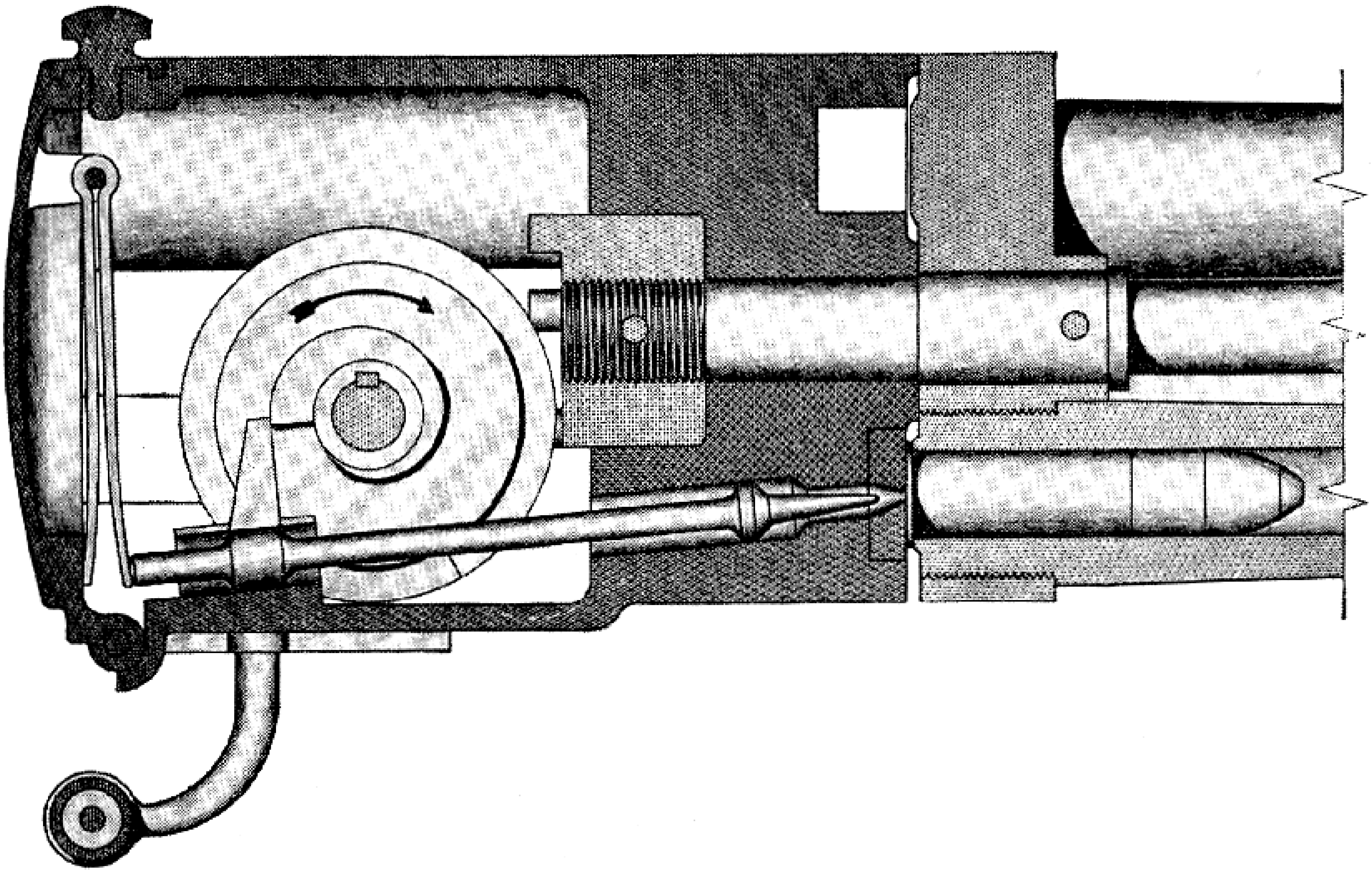
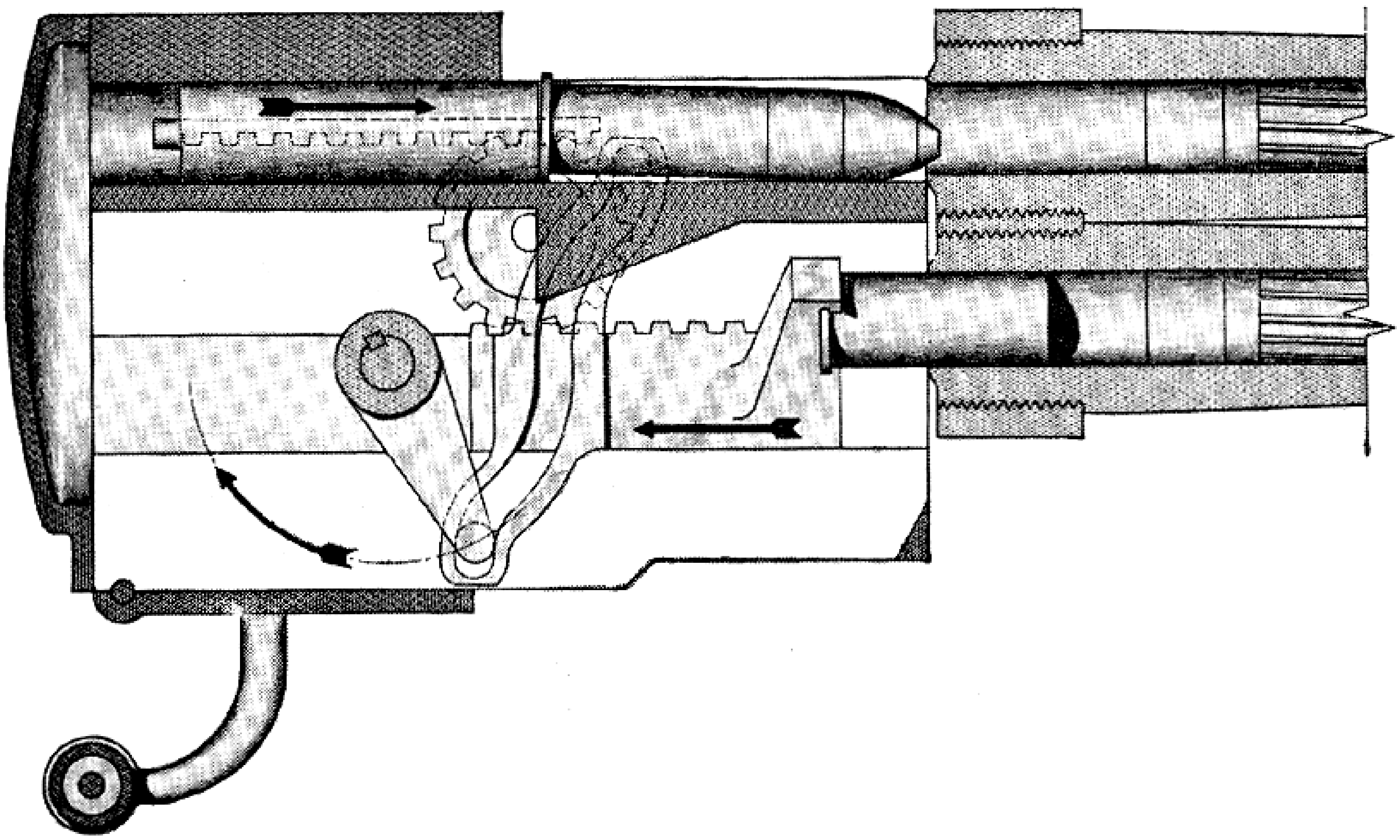
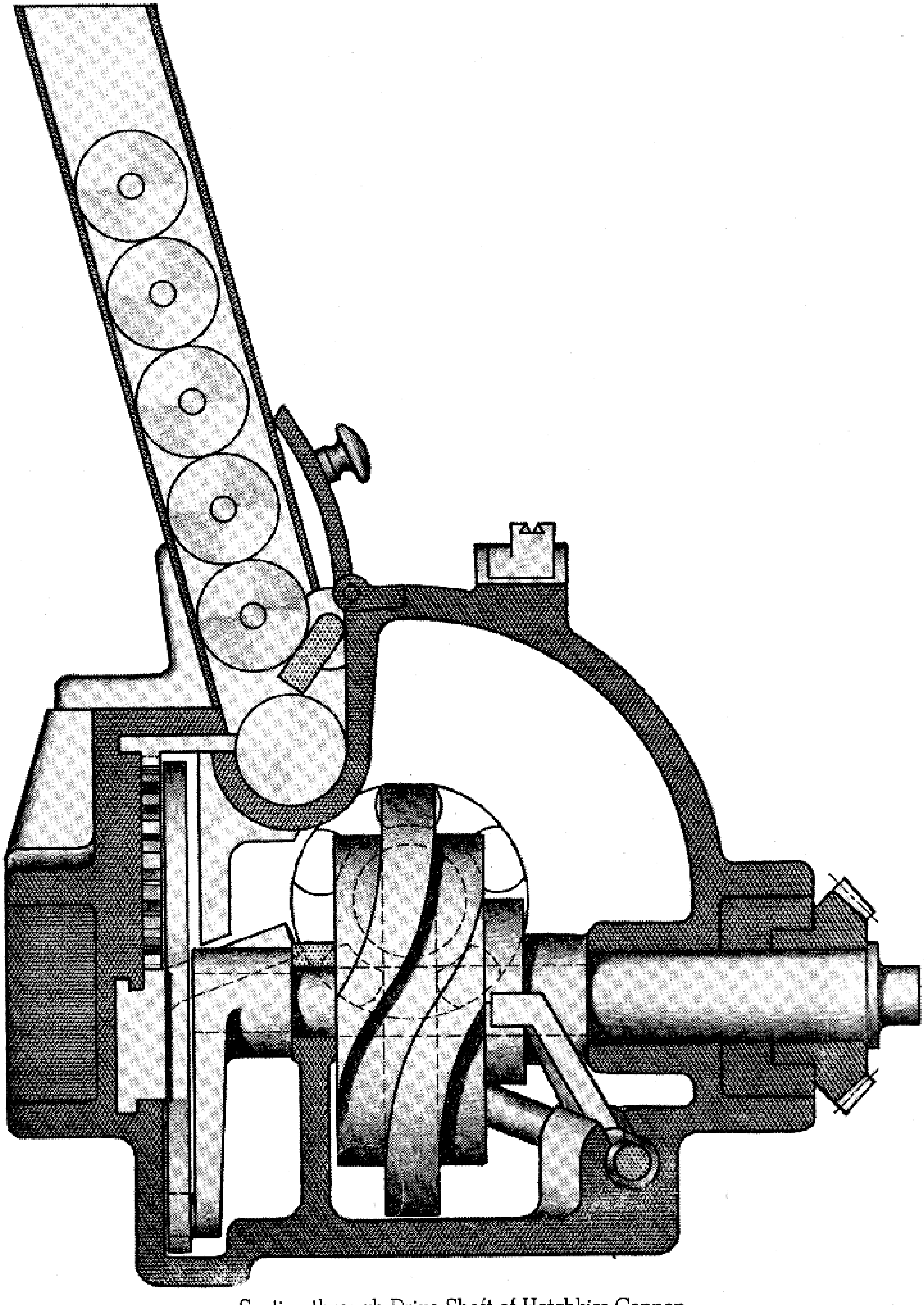


Section through Worm Wheel of Hotchkiss Cannon.



Section through Loading Rack of Hotchkiss Cannon.



Section through Drive Shaft of Hotchkiss Cannon.

forward at the right moment to strike the primer and discharge the cartridge.

Loading and extracting are accomplished by an eccentric on the crank shaft that imparts a reciprocal motion to the extractor, which is geared to the loading piston. The rotation imparts an alternating and opposite movement to the two racks, so that while one is being retracted, the other is going forward. Thus, a fired cartridge is extracted from the lower left barrel at the same time a loaded round is placed in the upper left-hand chamber.

The cartridge is not driven home in one complete thrust, but is cammed the last fraction of an inch into position by further rotation of the screw. This completes a gradual introduction of the cartridge into the chamber without shock.

After the case is extracted from the chamber, it strikes against an ejector prong which pushes it out of the extractor and allows it to fall through an opening in the under part of the breech. The extractor does not depend on a spring at any time to retain its hold on the cartridge, the action being made positive by camming.

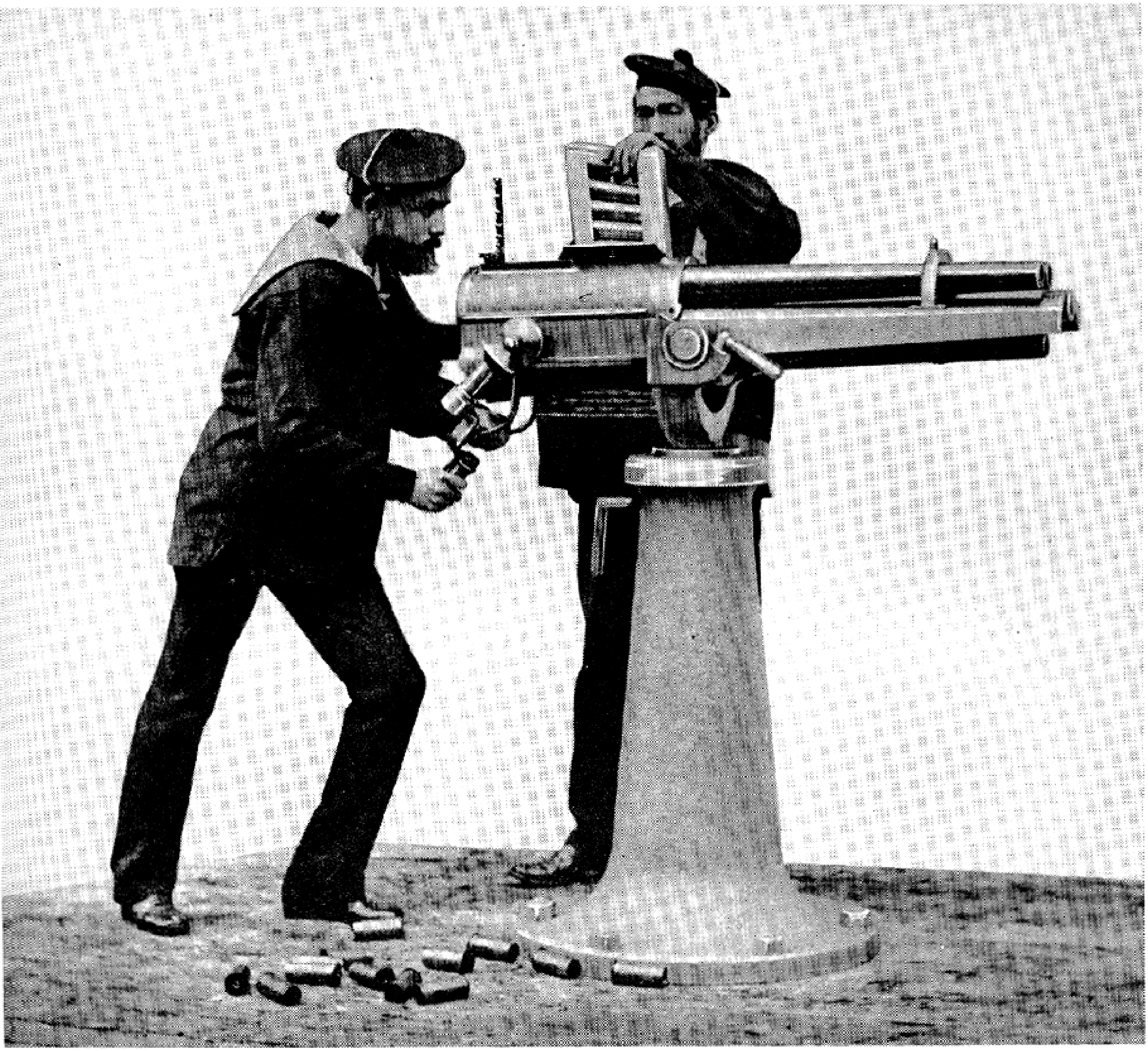
To obviate the difficulties that existed in other machine-gun systems when the cartridges in the act of loading were piled one upon another, there is used an introduction trough, or feeder, through which the loading piston works. As the piston moves forward to load, a gate rises and isolates the other gravity-fed cartridges from the one in the act of being placed in the chamber. In this manner all jamming of cartridges during rapid firing is prevented by the even spacing of the incoming rounds.

The Hotchkiss gun was new in that it occupied an intermediate position between the light machine gun shooting solid small-caliber bullets and the rapid-fire cannon employing an explosive shell. When mounted correctly, the weapon could easily be operated by one man. However, the average crew was composed of a loader, an operator, and a man on the crank. The operator can control the fire by means of a searing arrangement that permits him to stop the firing even when the man on the crank still continues to rotate the mechanism. The weapon can be fired single shot until the exact range is determined. Then, if rapid fire is desired, feed cases with 10 cartridges each are inserted in the feed trough. In this manner 60 to 80 rounds can be fired. The projectiles were of the type known as shrapnel, containing 24 lead balls, .71 inch in diameter, arranged in 8 tiers of 3 balls each, and having the interstices packed with sawdust. When a rate of 80 rounds a minute is attained, the target area is sprayed with over 2,000 pieces of jagged iron and lead bullets a minute.

The 37-mm cartridge proper consisted of a soldered tube of tin, with one end closed to form a cup. This end was reinforced both within and without by two iron caps, and fastened with three rivets to a wider round iron plate, which formed the true base of the cartridge. This bore the pressure of the gases and afforded a lip for the extractor. The percussion cap was also fixed permanently in the center of this plate. The load was 3½ ounces of powder and had a thick felt wad between it and the projectile. The cartridge case had a total length of 3.66 inches without the projectile. A complete round weighing 2.42 pounds was 6.68 inches long.

The 37-mm gun, when mounted for shipboard use, weighed 1,181 pounds and measured 70 inches over-all. However, there were six models of the crank-operated Hotchkiss made for specific purposes: the light 37-mm for field use; a high velocity 37-mm for flank defense and fortifications; the 37-mm designed for shipboard use only; a 40-mm for fortifications; a 47-mm gun for naval use; and a 57-mm weapon, also for naval use.

The Hotchkiss Co. was a success from the start and enjoyed the confidence of the French authorities, who felt they had the services of the greatest machine-gun designer of the age. The company not only received large governmental orders, but was allowed to export arms to the rest of the world. It normally employed a thousand craftsmen who built and assembled weapons. Long before the revolving cannon had ended its usefulness, Hotchkiss turned his attention to the development of other weapons, and experimented at great lengths with a machine gun to fire a 75-mm projectile that automatically opened and closed a drop breech. The principle was so sound it is used today on the French 75-mm gun.



Hotchkiss 37-mm Revolving Cannon on Naval Deck Mount.

In 1884, the business having outgrown the St. Denis factory, a connection was made with William Armstrong & Co. of England for the manufacture of Hotchkiss guns at the Elswick works. At the height of his fame on 14 February 1885, Hotchkiss died. For a while the company was operated under a trusteeship, but in 1887 the affairs of both companies were placed under the control of the French corporation, and renamed respectively the Société Anonyme des Anciens Etablissements Hotchkiss et Cie. of France and the Hotchkiss Ordnance Co. Ltd. in England. In 1891 the company acquired certain patent rights allowing it to manufacture magazine small arms and automatic machine guns. For this, they built a separate factory outside Paris.

From the establishment of the original company to the building of the new plant to produce automatic guns, the firm built and delivered to the French Navy alone, over 10,000 revolving cannon and 4,000,000 rounds of ammunition. The revolving cannon was used by practically every navy in the world at one time or another, including Germany, England, Holland, Italy, Denmark, Austria, Russia, Turkey, and the United States.

The inventor's theory of combining rapidity of fire with destructiveness of exploding projectiles was recognized by all nations, and the great company he originated in France carried on his policies until his death. One of the most successful methods of selling a weapon to a foreign power was first to make the gun as good as honest work and engineering skill could produce, then to seek out some person of high rank who could be interested in promoting the weapon. This man's own name was then attached in such a complimentary way that such individuals were sometimes mistakenly credited with inventing the weapon itself.

Hotchkiss contributed much to the development of repeating arms and left conscientious workmen who carried on his progressive ideas after his death. In fact, with the coming of an entirely different trend in machine-gun design, they were prepared to exploit this new principle.

Chapter 9

GARDNER MACHINE GUN

Notwithstanding the wide variety of inventions during this era covering all classes of machine guns, few justified the term "improved" which was invariably mentioned at the beginning of each patent claim. One of the noteworthy exceptions was the Gardner machine gun, invented by William Gardner of Toledo, Ohio, who during the Civil War served in the Union Army as a volunteer in an Ohio regiment and rose to the rank of captain. Being unable to finance production of the weapon, he sold American patent rights to the newly formed company of Pratt & Whitney, Hartford, Conn., after an agreement had been reached whereby the inventor would receive a royalty on each gun delivered. This proved to be a wise move on Gardner's part, for Francis Pratt was no novice in gun design. Being a master mechanic and having spent many years in the employ of Colt's Patent Fire Arms Co., Pratt had attained a reputation for being one of the best gun designers in the field.

The original gun, invented in 1874, was built by hand. The prototype was turned over to Pratt & Whitney, who in less than 1 year produced a weapon thought capable of meeting military requirements.

The Gardner gun consisted of two breech-loading barrels placed parallel to each other, an inch and a quarter apart. The barrels were fastened at the breech ends and housed in a single casing. They were loaded, fired, and ejected alternately by one complete revolution of the hand crank.

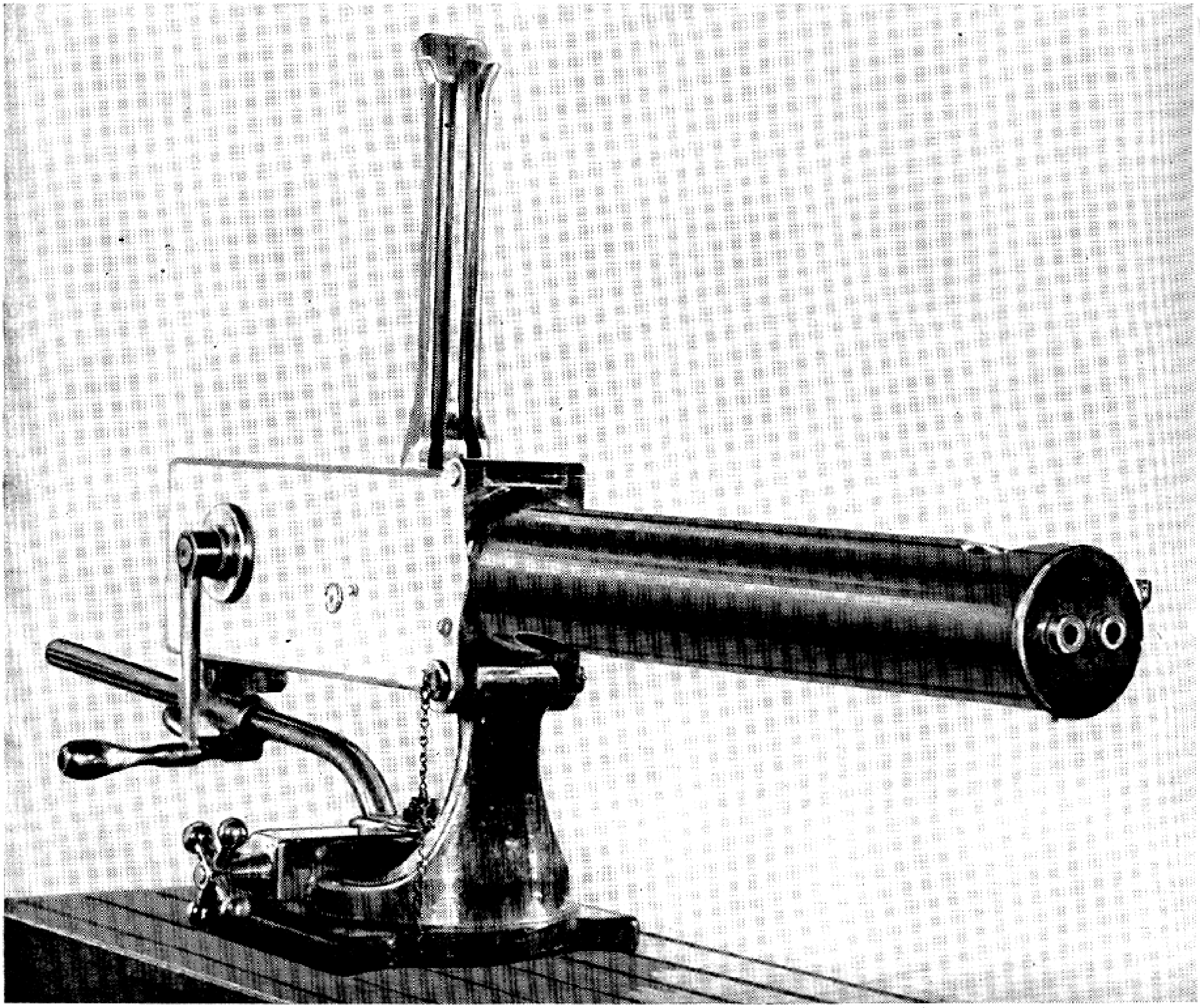
To facilitate loading, a special wooden block was filled with ammunition, rim end protruding. This insured fast alinement of the base of the round with the slots in the feed guide. These two T slots, machined in a vertical post, dropped the loaded cartridges in correct position for the feed entrance.

To load and fire, one man inserted the rim end of the ammunition projecting from the loading block into the feed guide, then withdrew the box from the rounds. Another turned the crank and aimed the piece. As the cartridges were fed from the guide, they were replenished by the loader. In this manner the weapon could be fired continuously.

At the request of Commodore William N. Jeffers, Chief of the Bureau of Ordnance, a test was held at the United States Navy Yard, Washington, D.C., in November 1875. In this trial the system was greatly commended by the officers who supervised the test. They suggested that Pratt & Whitney be allowed to take the weapon back to the factory in order to perfect the new feed system, invented by E. G. Parkhurst, an engineer of that company. This simple and efficient feed was an arrangement of cammed levers that transferred the cartridge from the feed guide to the perforated plate, and positively positioned the round in place, retaining the empty case until ejected. The method eliminated the unreliable gravity feed for which the weapon was originally designed.

A very unique feature was incorporated in the gun's design. In order to overcome extraction difficulties, a device known as a "shell starter" was used. This arrangement consisted of two crescent-shaped pieces pinned to the receiver that engaged the rim of the discharged round before unlocking was fully accomplished and cammed it free in the chamber. A loose cartridge case was thus left to be removed by the conventional extractors. This method of initial extraction was also a development by Parkhurst, who added many new and improved parts to this already reliable mechanism.

The official report on the working of the Gardner gun mechanism stated that it possessed every quality desirable in a machine gun, namely: lightness, strength, simplicity and durability; all working parts readily accessible; prospects of a



Gardner Machine Gun, Model 1879, Cal. .45.

feed that positively alined the incoming rounds independently for each barrel: and an adaptation for firing each barrel at will. The mechanism worked perfectly and "commends itself to the critical examination and consideration" of the Government.

The weapon had other unusual features, such as a firing pin that was slowly cocked, thereby preventing any sudden impact; and a safety device that allowed ammunition to be run through the weapon without the possibility of discharging the cartridges.

Although General Benét, Chief of Ordnance, was present at the first test at the Navy Yard, the Army showed no inclination to be interested in the Gardner gun, feeling, no doubt, that the Gatling was sufficient for Army needs.

In 1877 additional tests were held to try the new feed system, which was deemed reliable, and to determine the initial velocity, which was measured as 1,280 feet a second.

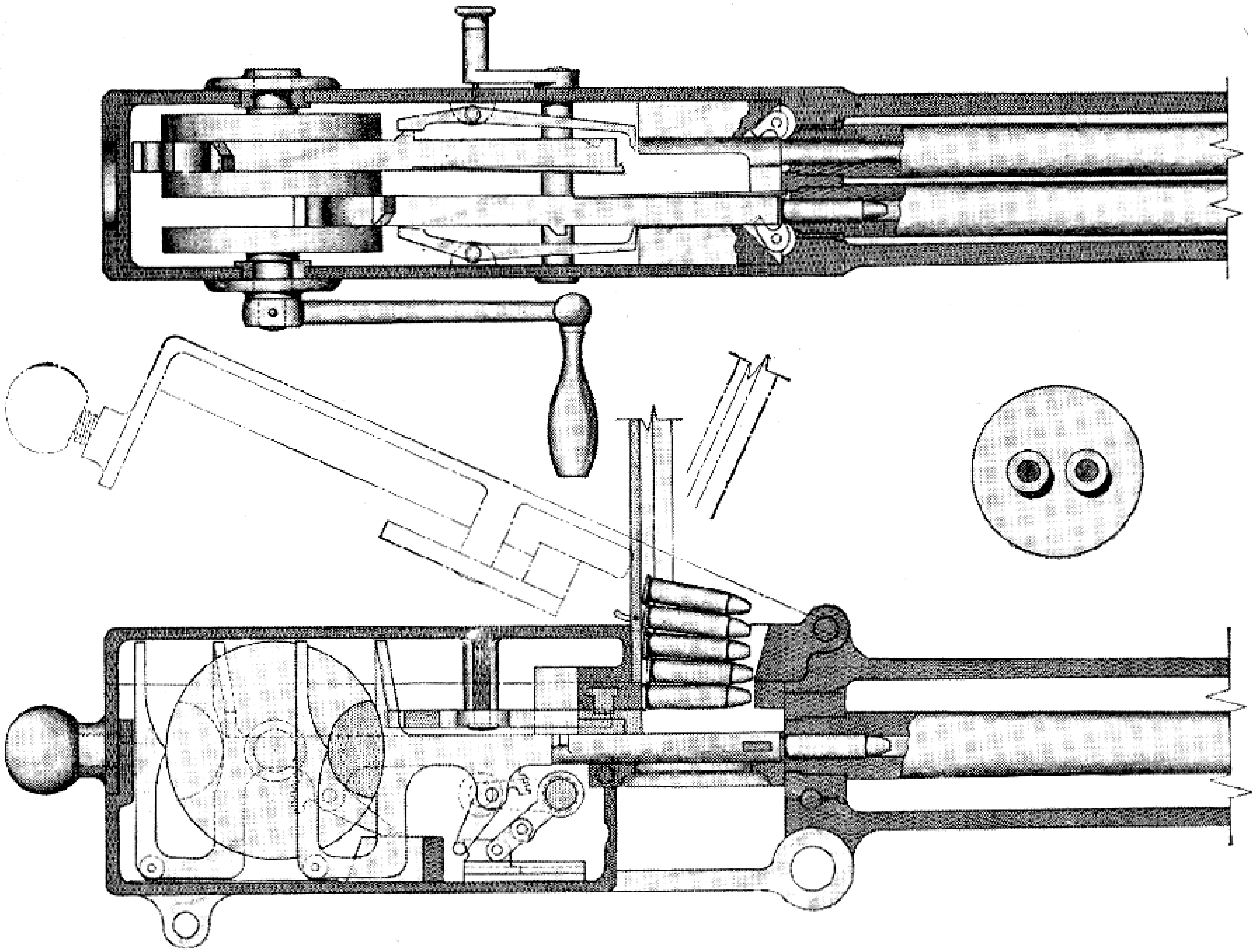
The weapon used a center-fire metallic-cased caliber .45 infantry rifle cartridge, manufactured by the Union Metallic Cartridge Co. of Bridgeport, Conn.

The barrels are securely screwed into the rear barrel ring, which is pinned fast to the case. The muzzles pass through a similar part called the front barrel ring. The rear ring extends from the back of the housing far enough to contain all bolts, together with operating crank and safety stop. A swinging cover, hinged at the forward end of the case, is locked firmly in position by a quick opening latch. When the cover is raised, the whole operating mechanism is fully exposed, which permits the hasty clearing of malfunctions. The manually operated hand crank is pinned to the crankshaft which is supported by journal boxes. These boxes are locked into the rear of the case and serve to protect the swinging cover from side thrusts. The body of the crankshaft is circular in construction and has journals, or crank pins, for operating the bolts. These pins are diametrically opposite each other for alternate firing and are eccentric enough to give the necessary motion to the bolts as they moved to the front and back, performing the functions of loading the live round, and extracting and ejecting the empty cartridge case.

The center portion of the driven side of the bolt is machined to fit the periphery of the driving cam. This is for the purpose of holding the bolt stationary about one-fifth of a revolution of the crank, so that the time lapse after the firing pin falls will be ample security against hang-fires.

Each bolt is so constructed that it resembles the letter **U**, having a horizontal extension which contains the firing pin, firing-pin spring, and extractor. The **U** part of the bolt, which works under and around the crank pin, is curved at the inner point to correspond with the outer circle of the crank. The purpose of the curved front is to hold the bolt in position at the instant of firing. The firing pin extends from the head of the lock through the firing pin spring and sector sleeve, ending in a flange, for locking it into a sear.

The latter is made in the form of a bell crank,



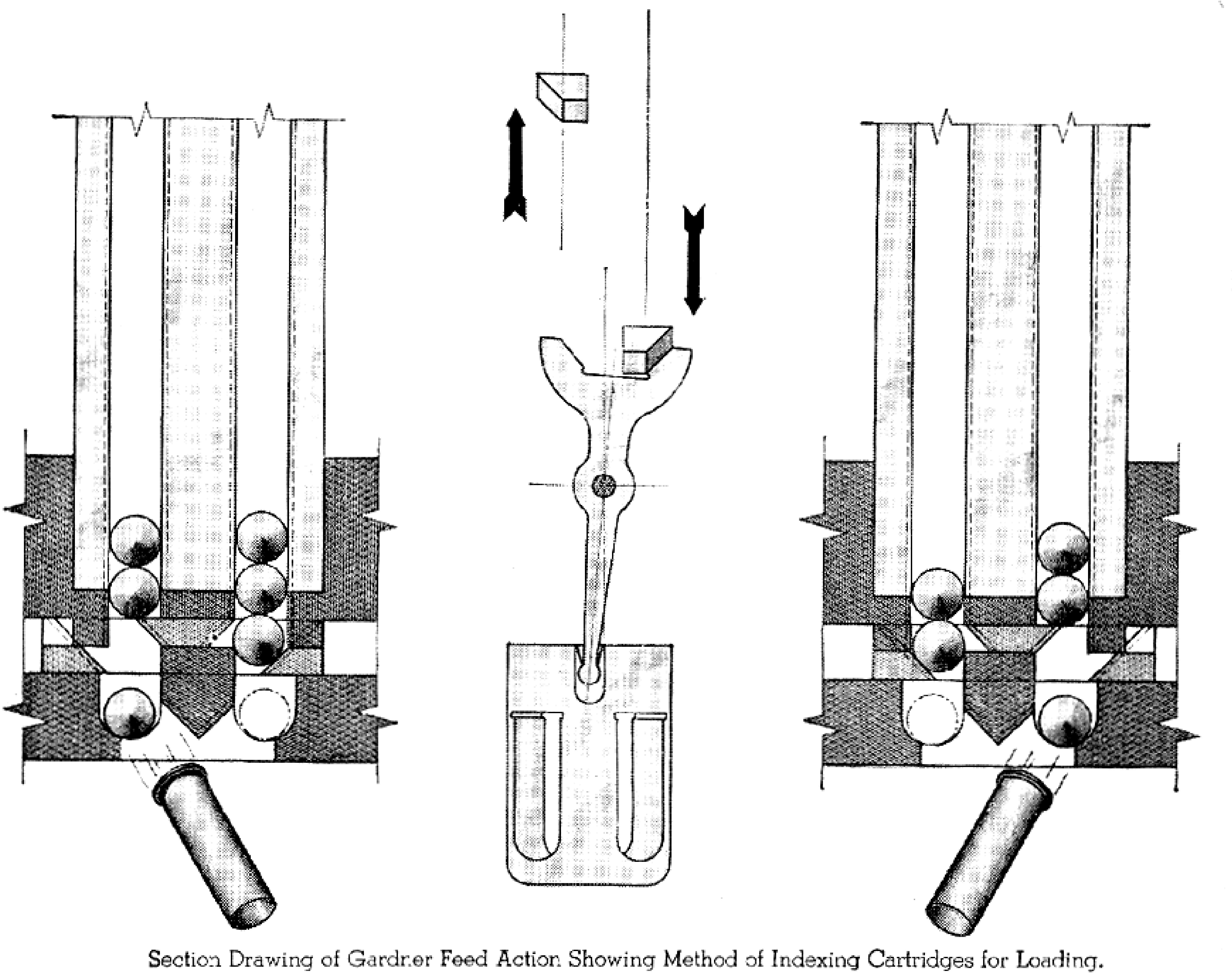
Section Drawing of Gardner Machine Gun.

pivoted in the center of the bolt. It holds the firing pin securely and prevents it from coming in contact with the primer until purposely released from its position by action of the crank journal after the lock is in battery in its extreme forward position. The cocking device, called the sector, or spring compressor, is hinged in a recess of the bolt and engages by means of gear teeth. This pivoting arm is forced against the safety stop, as the main crank advances. The firing pin is then compressed through the medium of the sector sleeve and held safe from accidental discharge but under tension, until released by the action of the sear.

The face of the bolt now receives the recoil from the charge's explosion, but is backed up by the crankshaft, thus presenting at the time of discharge practically a solid member. Each bolt carries a hook-type extractor which cams itself over the rim of the round as it is seated in the chamber. When the bolt is retracted, the extractor pulls the empty cases from the receiver. It also performs a double function of preventing cartridges from falling through the perforated plate, as they are mechanically forced down through a kind of feed valve.

This valve is operated off the feed-plate lever, attached to the hinged cover and actuated by the motion of the locks. It utilizes about one-eighth the stroke of the crank in its forward motion. The valve is thus given sufficient time to hold both cartridge and empty case down in position while one is loaded and the other ejected. The valve, which is also fastened to the hinged cover, has a reciprocating movement across the perforated plate, containing two angular openings the size and shape of the cartridges. The centers of the openings are equidistant from the center line of the chambers of the barrels.

After a cartridge has dropped one-half its



Section Drawing of Gardner Feed Action Showing Method of Indexing Cartridges for Loading.

diameter into the valve, it is forced by the action of the latter into position for loading, and held positively against the cartridge support. As the valve is moved back into its original position, the cartridge is cammed downward into the slot in the plate. At the same time it cuts off the incoming rounds in the feed system, and prevents their obstructing the progress of the one being chambered.

The upper end of the Gardner's feed guide has a trumpet-shaped mouth to facilitate the entrance of the rimmed cartridge heads. The lower end has a stop which holds the remaining ammunition in the guide whenever the latter is lifted out of its supporting cover.

The safety is an oblong block with two positions. It has an angular face against which the projections of the cocking device in the locks may engage when they are moved forward by the operation of the crank. The block is held in position by two links, which are moved by an arm pinned fast to a shaft passing through the rear of the receiver. The stop is fastened to the outer end of the shaft. This arrangement is constructed in the form of a crank having a stop spindle placed in the handle.

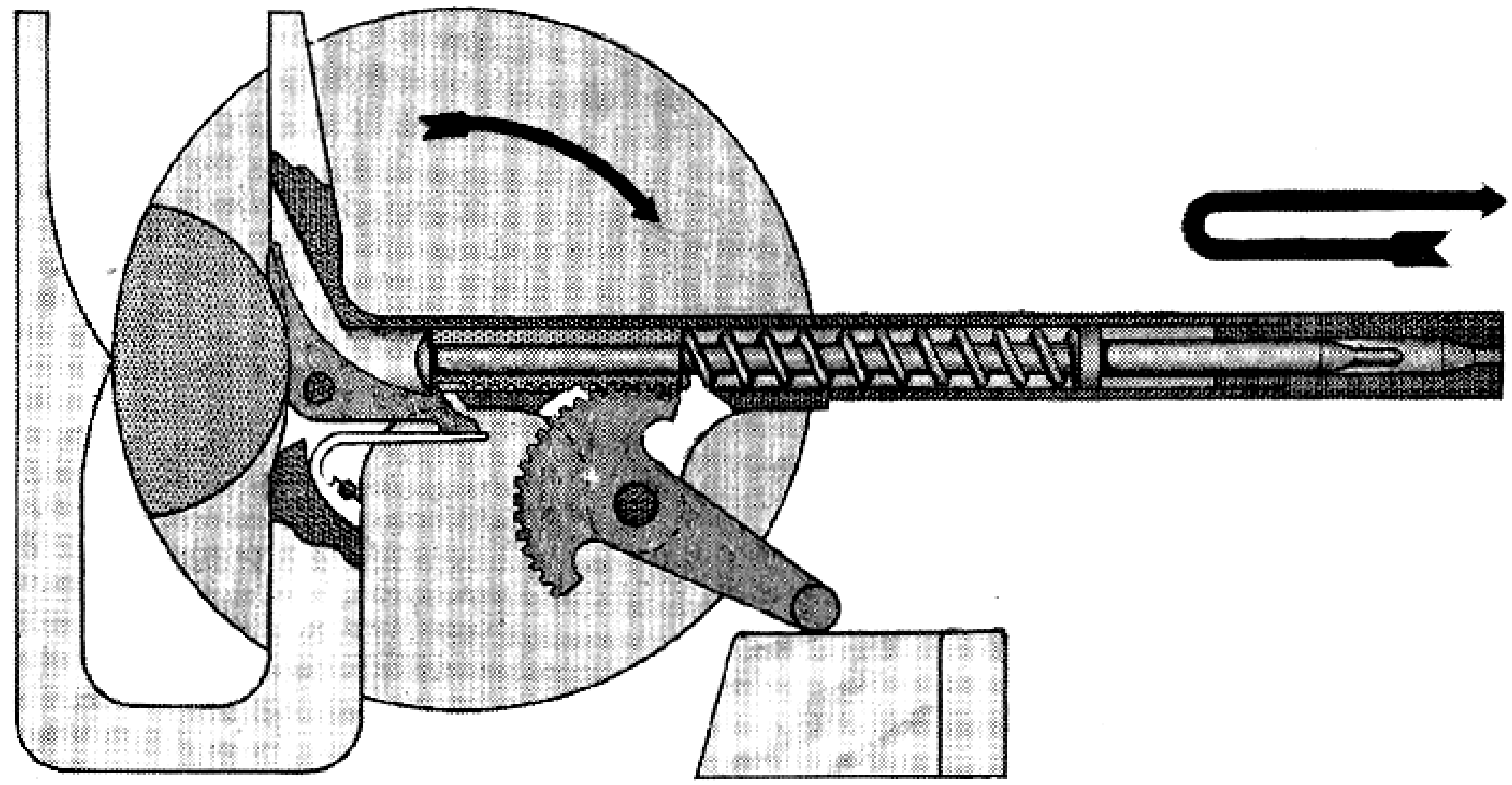
Behind the shoulder a spring is located that forces the spindle out of the arm into either of two stop holes, upper and lower. When the spindle is in the upper hole, the arm is in line with the barrels and the safety stop is thrown in contact with the cocking arm, by which the firing-pin springs are compressed. This makes the weapon safe, although in a cocked position. However, with the spindle in the lower hole the safety stop places the cocking arrangement out of gear, making it possible to turn the operating crank without compressing the firing pin springs. As a result the operator may crank live ammunition through the weapon with perfect safety.

When worked in conjunction with the feed valve, which can be made to block the remaining ammunition in the feeder, the loaded rounds can be removed from the chambers. Yet the feeder will remain fully loaded, ready to be put in action instantly. Thereafter, the crank working the gun can be turned without loading the chambers. The double safety feature of the Gardner gun has many advantages, both for testing and combat, especially when combined with the unique feature of being able to fire the barrels individually or simultaneously.

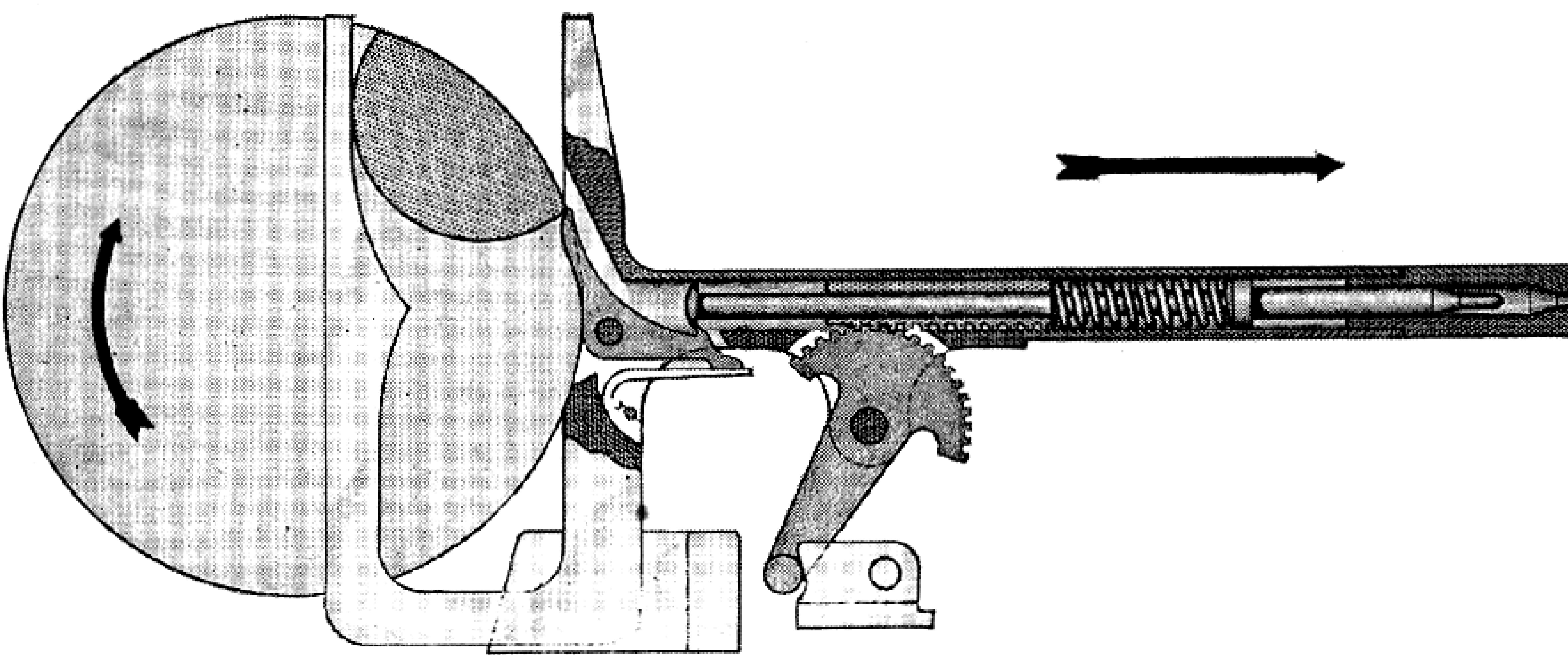
The barrels can be changed in short order by driving out a lock pin, and then unscrewing, with the use of a wrench, the flats which are machined on the barrels and made accessible by a large opening on top of the barrel jacket near the muzzle end. This feature is very necessary in this type of machine gun, because it uses a black powder cartridge. The arrangement permits a visual check and is an easy way to keep the chambers free from the residue left by this kind of propellant.

All these features were incorporated in the Gardner weapon, test fired to the satisfaction of company officials, and proved successful. Finally, after many delays and much correspondence the Navy again took it under consideration. Commodore Jeffers ordered a final test to be run on the gun, and specified that it be conducted at the Washington Navy Yard range under the supervision of Commander H. L. Howison. The weapon was brought to the Navy Yard by Francis Pratt and Amos Whitney, who not only explained the mechanism and general characteristics, but took turns at the crank operating it during the day set aside for the test, 17 June 1879.

The weapon was first examined by the board and found to be in good condition, with all parts working smoothly. The locks were lightly lubricated with a coating of tallow to keep the black powder residue in a fluid state. At a given signal the test got underway, with Pratt cranking, and a company representative, Mr. Saunders, feeding the gun. A 200-round warm-up burst was fired, and the operating parts were examined and found to be in perfect condition. Then two ammunition boxes were placed on the left side of the gun so that continuous feeding could be accomplished and a 1,000-round burst was fired without incident. Another check then showed that the fouling on the parts was soft because of the tallow, and the barrel cover was quite hot, but not enough to stop the test. Firing was resumed again. When the ammunition was expended from the boxes, a burst of 431 rounds had been fired. The barrels were then found to be moderately fouled. The mechanism was visually inspected and pronounced in good shape. However, the barrels and their cover had be-



Section of Gardner Bolt Assembly Retracted.



Section of Gardner Bolt Assembly in Battery.

come so hot that in clearing the weapon of cartridges at the end of the burst, it was recorded that "the live round taken from the right barrel was too hot to hold in the hand." (It is clear that no one had ever experienced a "cook off" up to this time.)

It was decided at this point that the gun should be given a burst that would prove the reliability of the weapon. A total of 5,000 rounds were prepared for continuous feeding. It was recorded that the time taken in bringing up the cartridges and putting them in the special feeding block allowed some cooling of the weapon before firing commenced. With 2 men feeding and a third ordnance man helping Whitney on the crank, firing was resumed, and 3,019 rounds were fired without stopping. The weapon then had its first malfunction when the extractor in the right-hand barrel failed to withdraw the empty case.

There was a delay of 1 minute 15 seconds (according to Navy records) before the brass could be removed and firing resumed. Then after a burst of 359 shots the same malfunction occurred. The officer in charge allowed the gun's proprietors to take the lock out and examine the extractor hooks. They appeared in good condition, but when flexed by hand, the right extractor shank appeared not to be as stiff as the left one. The extractor recess and the grooves in the barrel were observed to be moderately fouled, but they were not cleaned as the test continued. Since each failure occurred with the right extractor, it was evident that the ammunition was not at fault.

On the next attempt 690 rounds were fired and another stoppage occurred. After two more bursts consumed 870 rounds, the ammunition that had been prepared for the 5,000-round test was entirely expended, and firing was concluded for the morning. The total time consumed in the actual firing of 6,631 rounds, not counting the delay for cleaning, was found to be 18 minutes 55 seconds. The five stoppages from failure to extract from the right-hand barrel were recorded as taking 5 minutes 34 seconds.

At noon Messrs. Pratt and Whitney were allowed to remove the locks in an attempt to put the right-hand extractor in working order. The hook on this piece was found to be dulled and it was filed by hand to provide more bite into the inside rim of the cartridge. The shank was bent inward a bit to increase spring tension.

When firing was resumed after lunch, the jackets covering the barrels were found to be still too hot to pick up the gun by hand. The afternoon test was to be for the purpose of obtaining the best rate of fire. The company elected to fire a 2,000-round burst, with an average of 380 rounds a minute. Pratt was not satisfied with this performance and, turning the crank himself, fired a short burst of 100 rounds in exactly 11 seconds, or a rate of 545 rounds per minute.

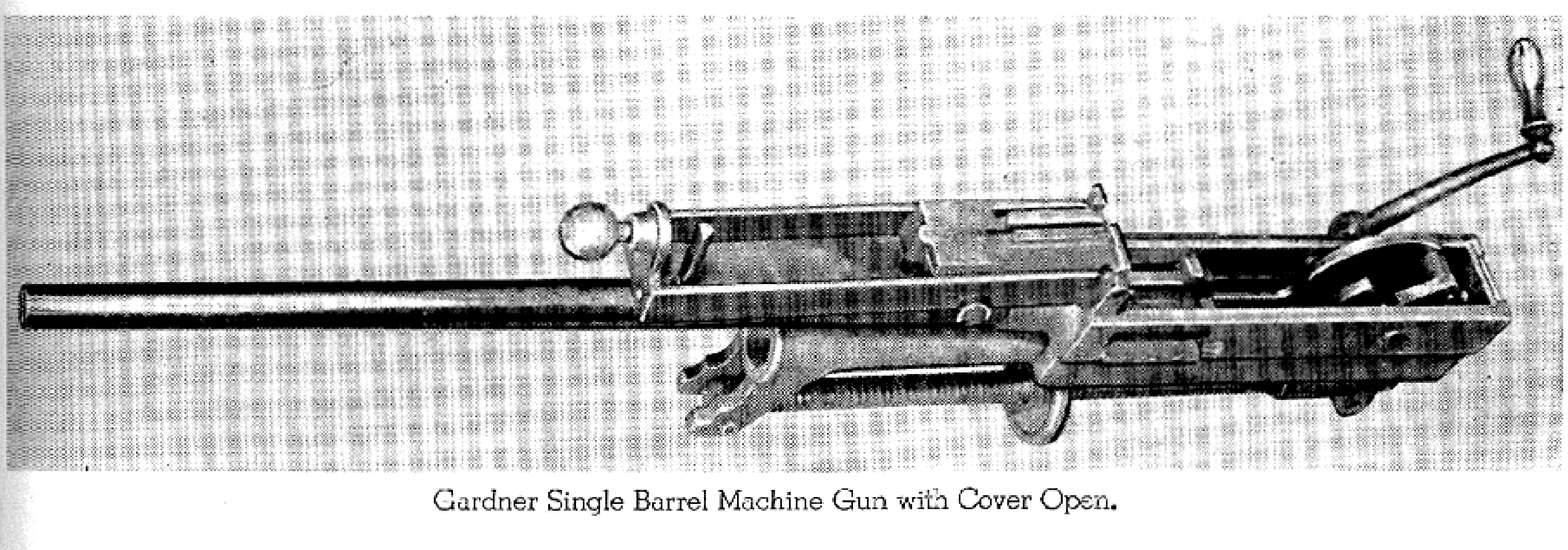
The barrels were so hot by this time that permission was asked and granted to pour water through the bores until they cooled down to a safe operating temperature. The weapon then was moved to the sea wall and the muzzle depressed 29°. With two ordnance men feeding and two assisting on the crank, 430 rounds were run through in a 1-minute burst. With 3 men feeding and a like number on the crank, the remaining ammunition of the 5,000 to be used in the afternoon test were fired, but the rate of fire was not recorded.

No failure to extract took place in the afternoon firing, as the quick fix resorted to by company officials to overcome the malfunction most certainly proved to be the correct diagnosis and cure. The total time for actually firing the 10,000 rounds, again omitting the 5 minutes 35 seconds delay, was 27 minutes 36 seconds.

Mention should be made that Gardner also designed a one-barrel gun, which was bought in limited quantities by the United States Navy.

Unfortunately for Gardner, the firm of Pratt & Whitney, and the United States Government, the armed services had no interest at this time in the further development of machine guns. The services were supplied with the Gatling and even this reliable weapon was seldom, if ever, brought into action against the Indians, whose spasmodic uprisings were the only events that warranted the use of such weapons.

The result was that though the Gardner met successfully every test ordered, nothing was done other than the support given by the Navy, which adopted the weapon and purchased a limited number. Gardner was the first inventor to take into consideration the terrific weight factor involved in the design of hand-transported weapons capable of a high rate of sustained fire. His single-barrel gun weighed only 70 pounds and



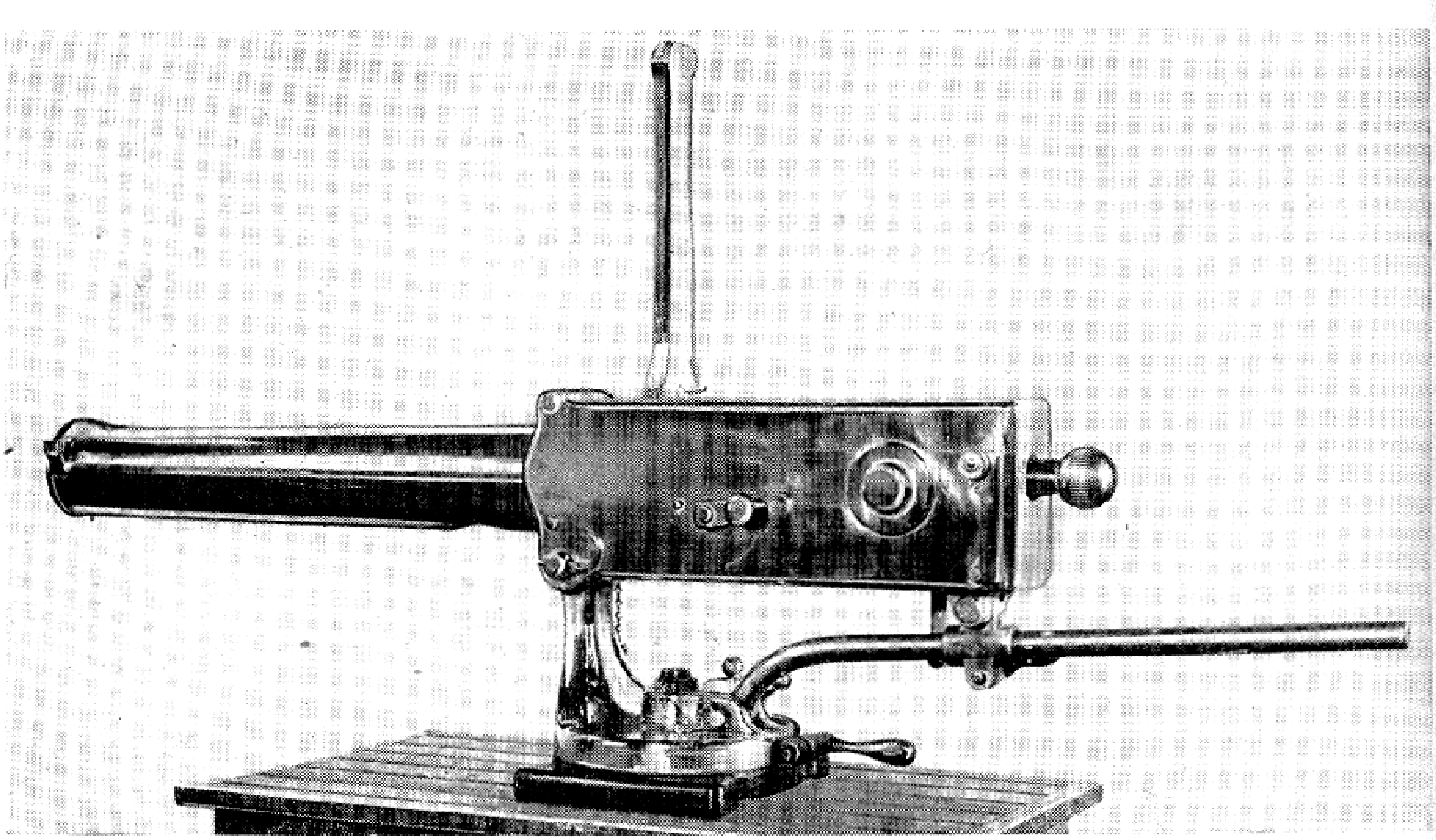
Gardner Single Barrel Machine Gun with Cover Open.

its fire power depended solely on how fast the operator could turn the handle. This feature was recognized by the Navy as desirable for mounting in the rigging and for easy handling aloft and by landing parties where weight and bulk were quite critical.

The Army on 15 January and 17 March 1880, ran duplicate trials at Sandy Hook Proving Grounds before a board consisting of Lieut. Cols. S. Crispen and T. G. Baylor and Maj. Clifton Comly. After a successful performance the board stated that the weapon was reliable, simply constructed, light in weight, and easily operated. It recommended that the War Department buy a limited number for actual use in the field service, especially since the cost of the weapon was so much less than that of other machine guns offered to the Government. Despite these recommendations, nothing was ever done officially by the Army to utilize the weapon. By its inaction the United States lost the benefits of one of the best machine-gun designs of all time. For, the British Navy was quick to capitalize on the great contribution Gardner made to weapon development.

Influenced by its successful employment of the reliable Gatling, the British Navy had long respected the engineering ability of American gun designers. The light, inexpensively produced, highly mobile Gardner, to be used in conjunction with the Gatlings, answered some pressing naval problems. Gardner accepted a cordial invitation to visit England and exhibit his weapon. The Admiralty not only adopted the gun after trials proved its worth, but it also purchased manufacturing rights whereby the Government would erect a factory for building the arms, provided the inventor would remain in England to supervise their construction. Gardner agreed, and after terminating his business connections with Pratt & Whitney, he moved to England where he resided until his death.

That the British Admiralty knew what it was after is evidenced by the fact that the army, noting the navy's successful trials of the weapon, also became interested in machine guns. The government was requested to order a selection committee to examine all existing systems of machine guns for the purpose of military adoption. This move was very flattering to the navy's foresight in promoting this gun and proving its extreme serviceability, for the army had hereto-



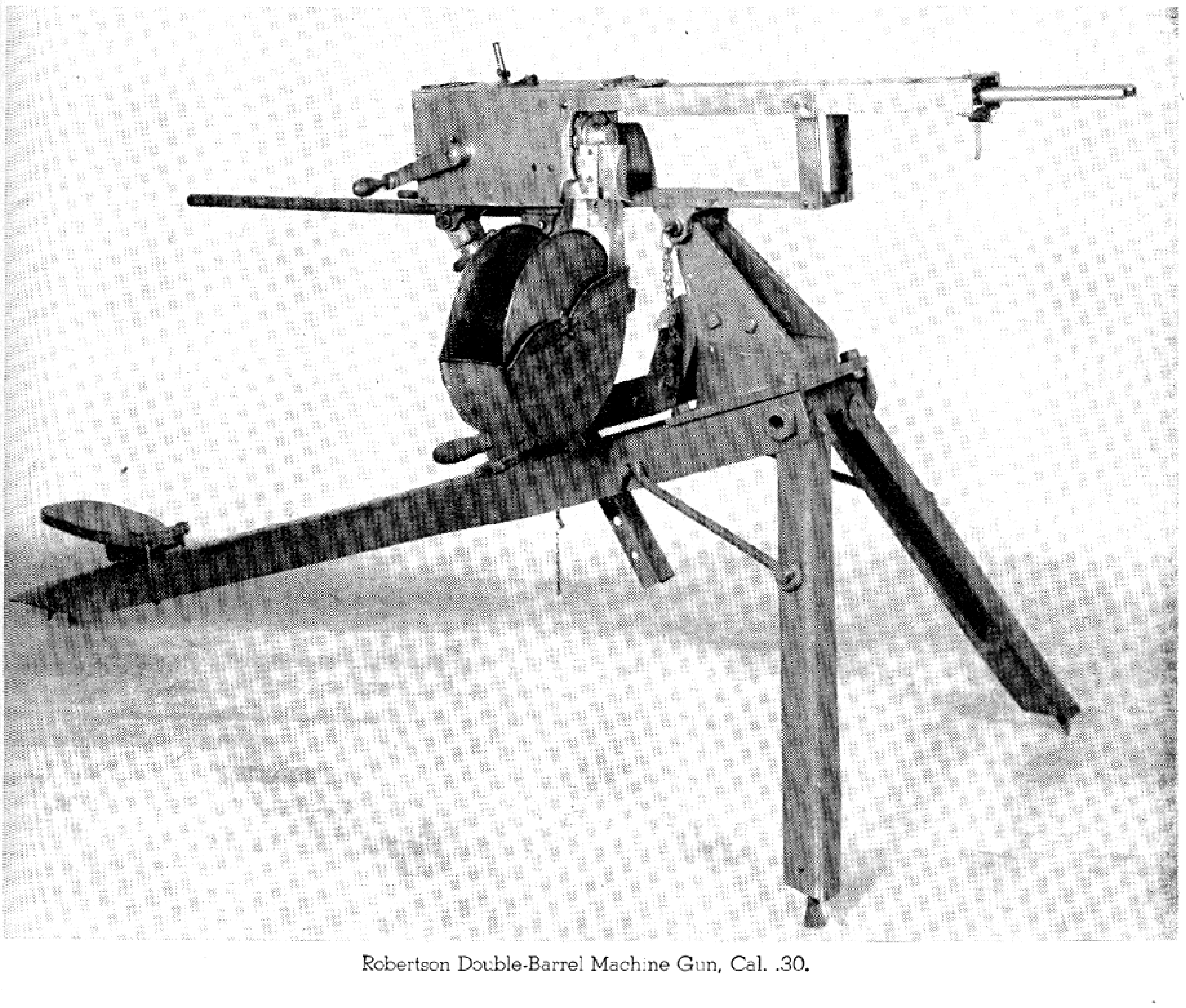
Gardner Machine Gun, Cal. .45. This Weapon Could Be Used Either Water- or Air-Cooled.

fore been violently opposed to any form of machine gun.

The British Government granted the request. The committee, on 21 March 1881, reported that, after exhaustive trials of different machine guns on 10 points of comparison, the Gardner had been preferred in 9. It recommended the adoption of the two-barrel gun for all branches of the service where a light weapon could be used and a limber or similar artillery transportation was not required.

The extremely rigorous workout given the weapons under consideration by the committee can be best illustrated by using its own statistics. The Gardner 5-barrel gun fired 16,754 rounds before a failure occurred, which was considerably more than was done by any of the other 8 guns on trial. Then, each of the 5 barrels fired singly 1,500 shots. The total number of malfunctions was 24, or a percentage of 0.14. Several of the jams were at the very beginning of the trial before the gun, which was new, had been perfectly adjusted. In the last 7,500 rounds fired for endurance, there were but 5 stops: 4 failures to extract and 1 cartridge bent in the feeder. Two of these jams were officially credited to accidental dropping of ammunition in the mud by inexperienced loaders. Leaving out these two stoppages, the percentage drops to 0.04, or 4 malfunctions in 10,000 rounds.

As another example of the strenuous demands placed on these guns during this examination, the weapons were left uncleaned and exposed to the weather for a full week before firing was re-



Robertson Double-Barrel Machine Gun, Cal. .30.

sumed. The 5-barrel Gardner fired without hesitation at the rate of 812 rounds a minute.

The committee unanimously agreed that the Boxer cartridge should be eliminated, or at least perfected, as it gave trouble when tried in the Gardner, as it did in the Gatling tests.

That the Royal Navy adopted this lightweight gun long before its official use by the army is credited to hostile opposition from the Woolwich Headquarters of the Royal Artillery. This branch was prejudiced against machine guns of this type, since the lightweight construction of the weapon removed it from the jurisdiction of this organization. Artillerymen, though tolerating cannon-type machine guns for flank defense, always regarded them as inferior field pieces.

While speaking on the rapid machine gun development of the British Navy, Capt. Charles Beresford in July 1884, in a lecture given before the Royal United Service Institute, stated, "It must be remembered that the navy had had more actual experience in the working of machine guns in the field than any other branch of Her Majesty's Service, as guns for this purpose were supplied to the navy, but not to the army."

The early encouragement to Gardner from the British Government in giving him limited orders for the navy was soon followed by the purchase of large quantities of the weapon for all branches of the service. Its value was proved in Sudan at the battles of El Teb and Tamasi, and with the naval brigades in the Upper Nile in 1884 and 1885. A superior method of mounting was designed by a naval engineer which eliminated the limber system and resulted in a tripod arrangement that was used quite successfully.

Long after the Gardner and other hand-cranked guns had ceased to be considered first-line weapons, due to the method of feed and the employment of black powder cartridges, the British attempted to bring this type of weapon up to a point where it would again be a gun with great possibilities.

The most serious effort along this line was a belt-fed design that used smokeless powder cartridges. It was commonly known in this country as the Robertson, being named for the British engineer who was responsible for the devisement. As the only improvement deserving mention was the belt-feed arrangement, it should rightfully be called the Gardner-Robertson, there being too many features of the earlier gun present not to be given credit.

This hybrid was tested in the United States in competition with other mechanisms and failed so many times during the trial it was withdrawn by its sponsors. Existing records indicate it was never again entered in trials.

Chapter 10

LOWELL MACHINE GUN

The next competitor in the field of machine guns was produced in 1875 by the Lowell Manufacturing Co., Lowell, Mass. It was the invention of DeWitt Clinton Farrington. He organized the company at this time, to produce the Lowell weapon, which he contended was more reliable than any known firing mechanism. Many concurred in his opinion and the official tests conducted by the Navy at its Experimental Battery at Annapolis, Md., brought out a number of original and improved features. It most certainly did show Farrington to be a man with the single purpose of producing the best machine gun in existence. It seemed to matter little to him that the Government already had similar weapons whose performance, according to ordnance experts, could not be surpassed.

The Lowell is of unusual design. It has 4 barrels mounted between two supporting discs, arranged to revolve in a circle. The ring at the center of the barrels is provided with trunnions which work in the frame connecting the barrels with the breech mechanism. When in position, the rear ring and enclosed disc lock with the frame. By a fastening and pivoting arrangement, the barrels can be disconnected and the breech end tilted up. This allows the bore to be readily inspected or cleaned and makes it relatively easy to remove any residue, or a stuck case, from the chambers.

One of its most original features is that only the upper barrel is fired. When it becomes overheated, it is rotated out of the way by a lever, and another is locked in place. This change can be made in a matter of seconds, without cutting off the feeder, thus allowing the operator to fire continuously with the assurance of a cool barrel at all times.

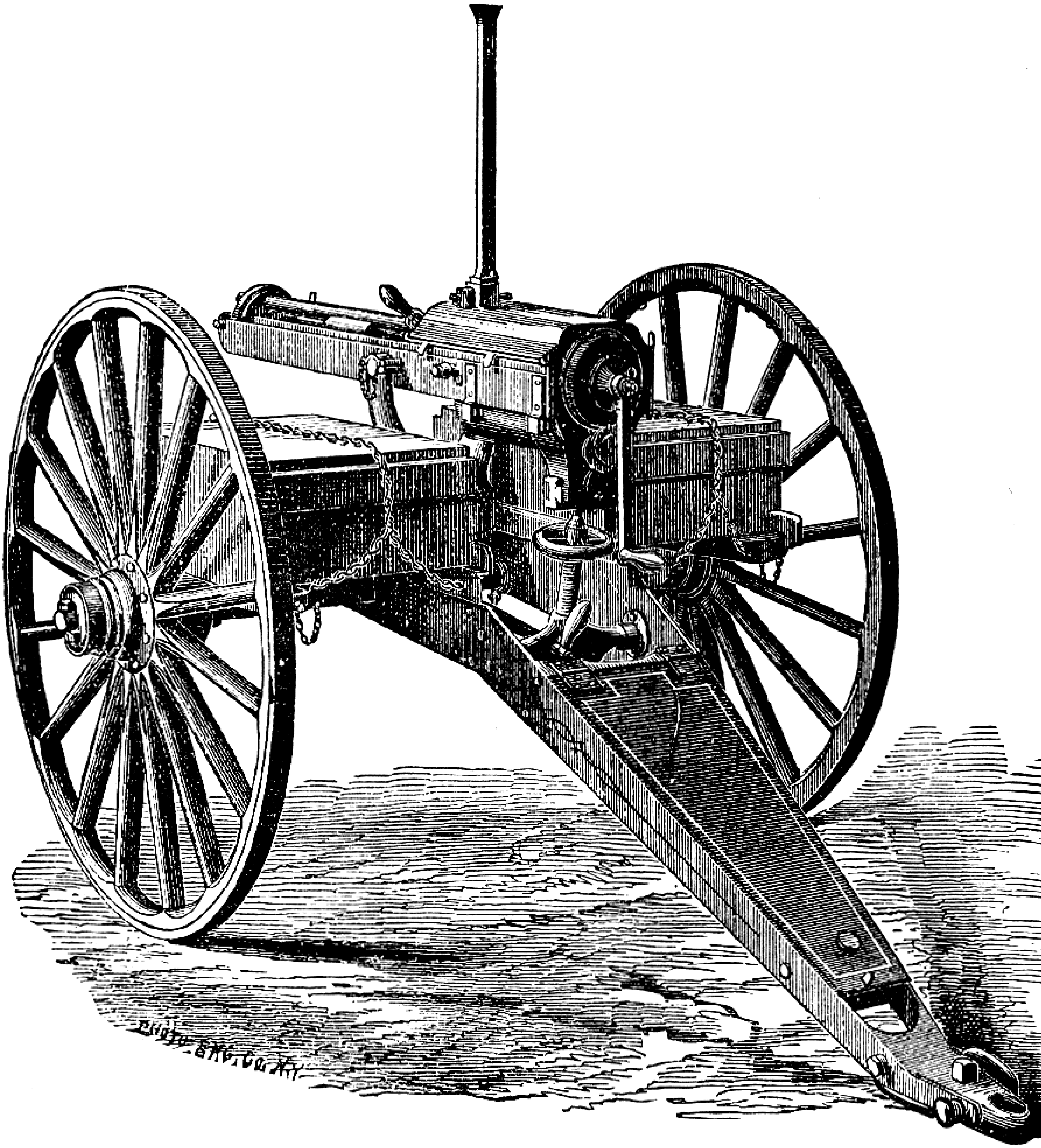
The working parts are exceedingly simple, and of rugged construction. It requires only a matter of seconds to inspect or remove them. The two extractors have a unique feature in that they do not depend upon springs, but operate by a positioning cam, forming a solid **T** slot until the empty case is well loosened from the chamber.

The principal parts of the breech mechanism are the crankshaft and worm for rotating the feed or carrier rolls. There is also the lock which encases the firing pin and spring, and serves as a support for the double extractors. All of this mechanism with the two carrier rolls and shaft is housed in a brass casing, the upper left half of which is hinged. Immediate access to the operating parts is permitted by pressing down on a spring-loaded latch, and then raising the whole side. With the barrels tilted and the housing raised, the entire operating mechanism is exposed for inspection, maintenance, or replacement.

The cam used to force the plunger, or lock, home is so designed that after the lock is in battery, and the round has been fired, it continues to back up the member while the crank rotates. This features allows a time lag to take care of hang-fires which are such a dangerous possibility in the manually operated type of machine gun where rounds are fed in and out of a chamber with great rapidity.

The operating crank of the Lowell gun is located directly to the rear, and made so that it can be turned without interfering with the gunner's vision. Because only the barrel located in the center of the gun fires at a given time, there is no tendency for the recoil to throw off the operator's aim.

The feeder consists of a square iron tube, inserted in a recess directly over the carrier rolls. Extending its whole length on the forward side is a **T** slot milled slightly in excess of the diameter of the cartridge and its rim. The feeder holds 30 cartridges, and can be removed, if necessary, by loosening a set screw located at its bottom end. The top of the feeder is open and



Lowell Machine Gun on Carriage Mount.

flared to facilitate the introduction of the cartridges into their proper position.

When the rims of loaded rounds are dropped into the grooves, they fall by gravity to the bottom. The original horizontal position is maintained throughout the whole descent. They pass out of the feed case at the bottom, and enter the recess in the carrier rolls in proper position to be chambered by the advancing lock plunger.

In the socket which holds the feeder is an ammunition stop that consists of a spring-loaded pawl. It allows the operator to interrupt the feeding at will merely by pushing the release button in and turning it slightly to the left. The stop plunger snaps forward under the incoming round, and holds it above the recess of the carrier rolls.

The Lowell gun uses the service caliber .50 infantry cartridge with a ball of 450 grains and 70 grains of powder, as developed by General Benét. This ammunition is packed in paper containers so that the rims protrude enough to allow easy insertion in the trumpet-shaped mouth of the feeder.

When the feeder is loaded, the weapon may be put in action by changing the selector from *safe* to *fire* and rotating the crank clockwise. As each round is expended, a fresh one drops from the feed guide into the fluted carrier roll. It is moved downward by further rotation of the crank until indexed into position for the plunger lock to shove it forward and chamber the cartridge. As the loading plunger starts toward battery, the firing pin lug is held in contact with the cocking plate, slowly compressing the spring. Upon reaching the locked position, the firing pin rides off the cocking plate cam, causing it to snap forward under spring tension, striking the primer and firing the cartridge.

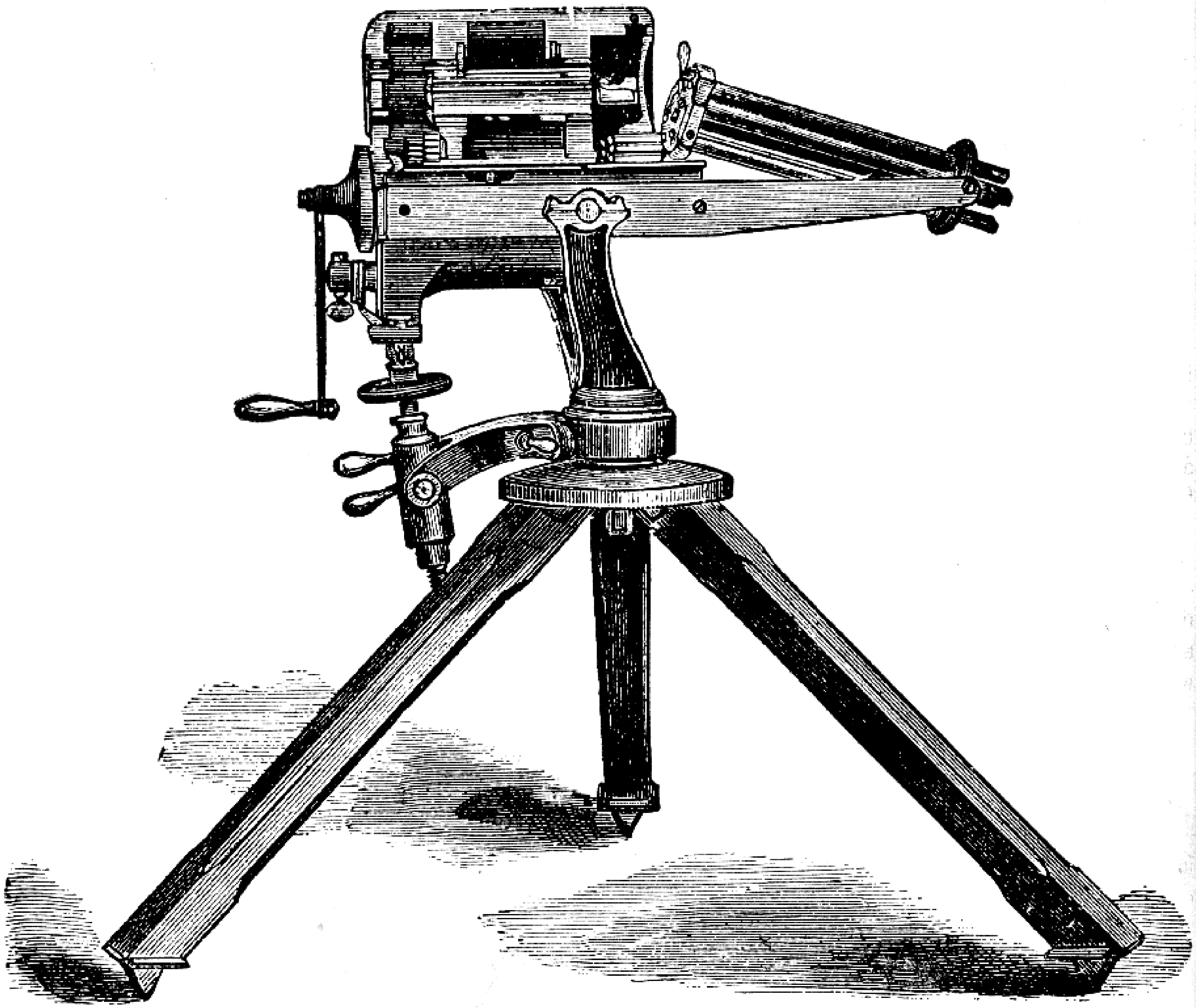
The continued motion of the propelling cam, after a short dwell to allow for hang fires, starts the plunger lock rearward. During the first fraction of an inch of this travel, the double hooks of the extractors are positively positioned around the rim of the cartridge case forming a solid T slot until the case is fully loosened. Then the extractor claws come out from under the influence of the cam and are left in a position where they offer no resistance while the carrier roll rotates the empty case through the opening in the housing. It would be very difficult to originate a more positive system to extract and eject an empty cartridge case than is found on this weapon.

At the request of the Lowell Manufacturing Co., Commodore William W. Jeffers, Chief of the Bureau of Ordnance, on 30 September 1876, ordered a board to witness an official test of the 1876 model weapon. At 10 a. m. on 3 October 1876, at the Experimental Battery at Annapolis, Md., the board met. Lt. Comdr. A. S. Crowninshield, the officer in charge of the trials, introduced Farrington, who described the weapon in detail, explaining the function of each working part while demonstrating the ease of assembly and disassembly.

To prove the Lowell's simplicity and substantiate the very important claim that trained operating personnel was unnecessary, Farrington asked that someone not engaged in ordnance work fire the Lowell during the entire test. This request was granted. Two unskilled laborers who had never seen the gun before its arrival at Annapolis were selected. They alternated as operator and loader throughout the test. After being shown once how to remove the lock and two carrier rolls, the only parts considered susceptible to derangement or fouling, they were able successfully to assemble and disassemble the weapon when necessary during the trial.

The muzzles were depressed 35° to subject the feed to the maximum vertical angle thought necessary for shipboard use. In this position a burst of 2,100 rounds was fired. The feed system and all other mechanisms worked perfectly. The only delays in this burst were for rotating a cool barrel into position. These changes were deemed necessary approximately every 400 rounds, and averaged 5 seconds each. The 2,100 shots were fired in 8 minutes 30 seconds, including all delays in shifting barrels.

A total of 9,870 rounds were fired during the day, with the laborers manning the weapon. Practically all firing was in bursts averaging 400 rounds. It was noted by the firing officer that when such a burst was fired the barrels were hot enough to char paper, but not to light it. When 600 rounds were fired without stopping, the paper would light upon contact, but the barrels



Lowell Machine Gun with Cover Open and Barrels Depressed for Inspection.

could still be rotated easily with the shifting lever.

Farrington had had trouble in doing this in a previous unofficial test. Therefore, a clearance of $\frac{1}{64}$ inch had been made between the breech end of the barrels and their fastenings in the main body of the receiver to compensate for expansion from heating.

Near the end of the day, Farrington asked to be allowed to use a new method of detonating the primer in lieu of the conventional spring-loaded firing pin. He called it a system of firing by pressure. The tip of the firing pin was forced into the primer by a cam arrangement striking a lug on the assembly at the instant the weapon was securely locked. Farrington claimed the lurching forward of this heavy piece crushing the primer would bring about ignition as effectively as the quick snap effect heretofore administered by the spring-loaded firing pin.

An attempt to fire 550 rounds was made using the new method. All but 15 of the primers ignited. Farrington explained to the officers present that the novel principle was really undeveloped. Its discovery had been the result of observation from an unofficial test, when he found he could fire the weapon with the firing pin spring removed.

The Naval board was much impressed by this system of detonating the primer and went so far as to make drawings of modifications that, in its opinion, would make it more reliable. This bit of observation on Farrington's part, and the helpful suggestions made by Lt. Comdr. Crowninshield and Lt. Edward Very, were the origin of what is known today as inertia firing. It has been basic in machine-gun design ever since.

Several 300-round bursts were checked for rate of fire. The two best rates recorded were one in 50 and the other in 53 seconds. Since the cycle of operation was governed by the operator's strength in rotating the crank, this rate could be increased or decreased at will.

The firing records show only four malfunctions in the total number of rounds expended during the day's firing. Of these, only two hang fires were considered serious by the firing officer. No damage was done in either case to the firing mechanism. One of the hang fires exploded, driving the bullet into the barrel. After an examination showed the weapon could continue firing, the plugged barrel was rotated out of the way with the idea of driving out the bullet at the end of the burst. At the end of firing, however, the barrel was found to have been so hot that the bullet had melted, making removal very difficult.

Inventors of this era were quick to capitalize on even the smallest things. Farrington, therefore, pointed out that no other weapon could so quickly resume firing when a barrel had been hopelessly plugged by the worst malfunction imaginable—a shell going off when the weapon was unlocked, leaving a bullet in the barrel. The total time involved after the accident until firing was resumed was recorded by the observers as being 40 seconds.

The rate of fire of the Lowell was well over the minimum previously agreed upon as a practical rate for manually operated machine guns. The board recommended that more consideration be given to simplicity of mechanism, possibility of getting out of order, feed and extraction methods, durability, and accessibility of parts. It further stated that of all the machine guns known to them, the Lowell mechanism had been brought closest to perfection.

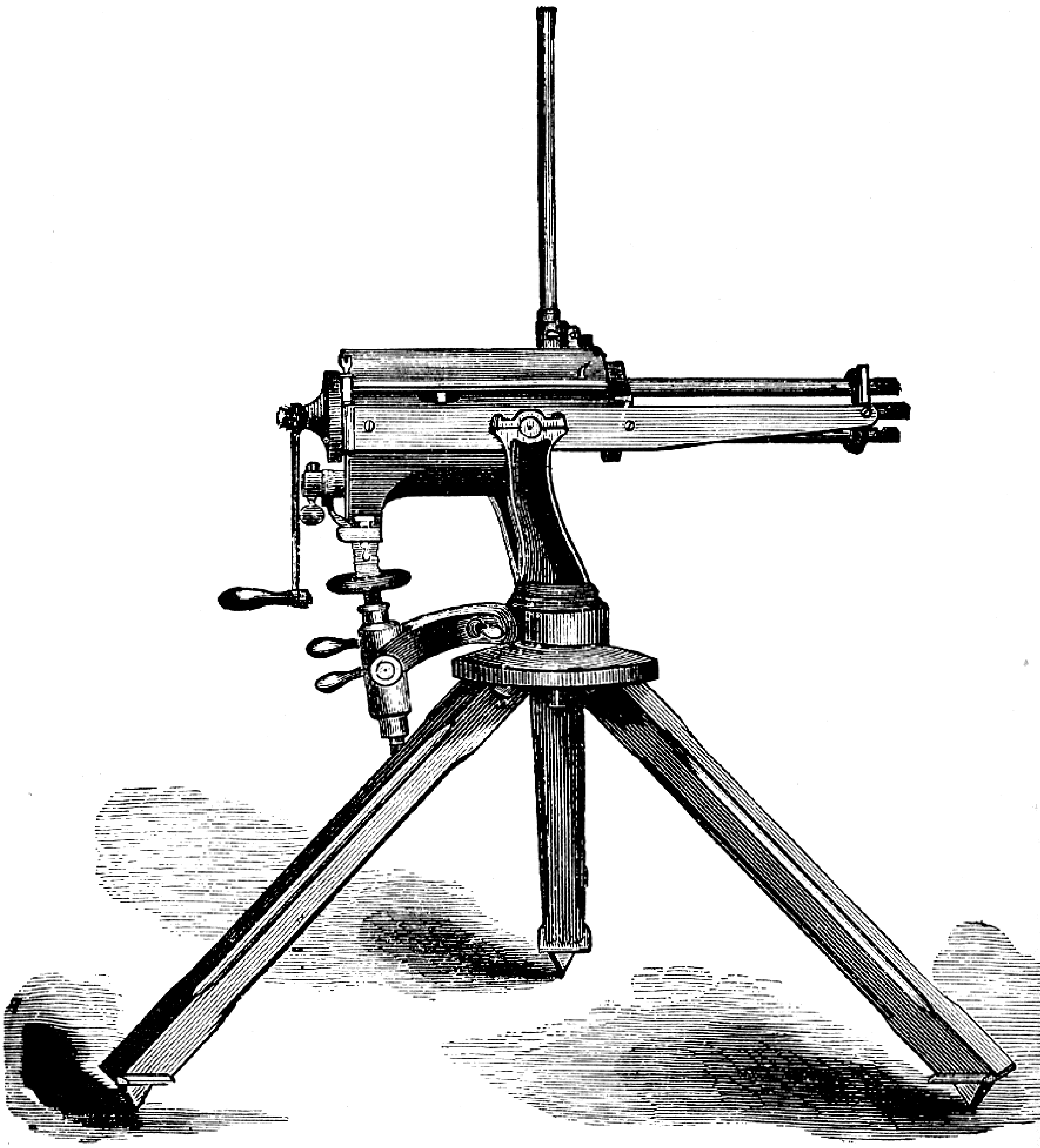
Following its creditable performance at Annapolis, the weapon was sent back to the factory. There all the modifications suggested by the board, plus many features Farrington believed would constitute improvements, were built into the gun. Finally, when it was thought ready for the grueling bursts of fire demanded by the Navy during this period of machine-gun development, it was returned for another test. The records of this performance show the stamina of the improved weapon.

The whole program was carried out with unusual speed. Commodore Jeffers issued the order authorizing the trial on 12 July 1877. The weapon arrived at Annapolis at 8 a.m. on the 13th. By the next afternoon, 50,000 rounds had been fired through the weapon. And on 16 July 1877, the full report, including all firing data, recommendations, and conclusions, was in the hands of Commodore Jeffers who, with high officials, had witnessed the trial in its entirety.

The report is far too bulky to give more than the high lights. The most outstanding is the statement of the firing officer, Commander R. S. McCormick, concerning the weapon's over-all performance.

"There were two stoppages only during the prolonged test of the gun. The first which occasioned a delay of 68 minutes was caused by the crank and internal gear which are connected together, binding upon the crankstud for want of lubrication. The second which consumed seven minutes was due to the shanks of the extractors having been probably sprung by the explosion of a cartridge left intentionally partly inserted in the barrels, to try the effect of their heat on it, aided perhaps by the action of a serious hang-fire that had occurred in the rolls. It was necessary to shift lock once, the firing pin having become jammed by the back fire of a cartridge which had been pierced through the cap. The old lock was repaired and made ready for use by simply hammering back the firing pin and then pouring alcohol into its cylinder [firing pin recess]. The trial showed the great advantage of being able to throw out of use altogether and without delay a barrel which from any cause had become choked. At the end of the trial the gun was taken apart and carefully inspected. No wear or signs of failing were discovered about any of its parts."

In view of the fact that the United States was not at war, and there was not even the slightest indication of trouble in the near future, the



Lowell Machine Gun with Tripod Mount.

rapid development of machine guns by the American Navy at this time was indeed out of the ordinary. The early tests of the Lowell gun were remarkable for a prototype weapon, as there seemed to be no limit to the ingenuity of DeWitt Farrington in adding improvements to an already reliable mechanism. This was especially unusual since he had no Government contracts to encourage him financially. However, the Navy did give the weapon every consideration possible in the way of testing facilities and advice. The firing officers even went so far as to make suggestions and prepare drawings on features that they thought would be beneficial to its operation.

One of the improvements requested was the simplification of the bulky design of the rear housing containing the two feed rolls. With this in mind, Farrington worked out a modification which retained all the good qualities of positive extracting and ejecting. Only one roll is used in conjunction with a cam-operated feed arm that positively places a cartridge in position for the plunger to chamber and fire. In this change the cartridges are fed, not directly into the flutes of the rolls as before, but upon an inclined surface. They are placed into the recess by a spring-loaded finger that is held back until the proper moment by a roller cam functioning only when the roll is at rest. The round is positively held in the flute of the roll, until it is revolved into the prolongation of the axis of the barrel. There it is chambered by the plunger lock. The design is thus improved by permitting a more streamlined housing.

The single feeder roll is locked by the fluted plate on the roll shaft whose flutes are concentric with, and ride upon, the disc on the main shaft. This action prevents any motion of the rolls until the recess in the disc is opposed to, and frees the corner of, one of the flutes. The stud on the disc then comes into action and engages a tooth of the carrier allowing it to turn only one flute and stop. The feed finger is now cammed forward, positioning the round.

It was recognized that the second cartridge which exploded in the feed rolls during the early test might have been the result of the firing pin prematurely searing off, while the lock plunger was chambering the round—instead of a too hasty unlocking of a hang fire as was first stated in the firing records. In order to make certain that the modified weapon could not be seared off accidentally (as had been possible with the first gun), the main cam, or the lock plunger driving cam, was fastened to the main shaft. It was so designed that the firing pin was retracted and cocked during the forward motion of the lock plunger. The cocking lug was removed as an obstruction only when the weapon was securely locked. This eliminated the possibility of accidental discharge in the act of chambering.

A handle for shifting the barrels was placed on the front side of the rear barrel disc in order to make the lever stronger. It permitted the extension of the carrier roll so that the flute served as a guide to within a sixteenth of an inch of the chamber entrance.

There were a few other modifications, such as placing a plate in front of the breech ring to hold the barrels more firmly and a change in the way the weapon was connected to the traverse mechanism and elevating screw. The latter proved to be undesirable. Firing was interrupted on an average of once every thousand rounds because the brass separated and left a portion in the chamber to jam the incoming round.

The demonstrators were successful in getting off a 2,000-round burst, on which the rate of fire was recorded as being 452 rounds a minute. This was a marked increase over the first Lowell model. When a second man on the crank was added, the gun later reached a rate of 600 shots a minute.

After 4 hours 57 minutes of firing, the board of officers stopped the test. They felt at this point it should be established whether the weapon or the ammunition was at fault, with regard to the consistent splitting of cartridge cases. Out of 19,-200 rounds fired throughout the day, 1,803 had split the brass down the side. A few had ruptured, leaving a portion of the empty case in the chamber.

A Remington infantry rifle with perfect head spacing was brought to the range, and 500 rounds of the ammunition were fired. Upon examination of the empty cases, 105 were found to be split in the same manner as were the ones fired in the Lowell gun. To be more certain that the gun was not at fault, a sulphur cast was made of each chamber. When gauged, they were found to be of correct dimensions.

As no other ammunition was available, the board deemed that a continuance of the trial would only expend labor and material without furnishing any information as to the real quality of the gun after its alteration. Testing was postponed therefore.

A comparison of the Lowell gun with its rivals detracted nothing from the performance. It used only one lock, and was able to change quickly from an overheated or disabled barrel to a cool and serviceable one, maintaining in this manner a continuous fire. It was most certainly a wonderful example of the skill and ingenuity of gun designers of this period, who thrived on competition and welcomed opportunities to pit inventive skill against all problems.

After the unsuccessful attempt resulting from the bad lot of ammunition, no further test was made of the weapon until 7 May 1879. The gun was then returned to the Experimental Battery, accompanied by 25,000 rounds of ammunition, furnished by the Lowell Co., and made expressly for the test by the United States Cartridge Co., also of Lowell.

It seemed to have been an ironclad policy of the Navy to take under consideration practically anything offered. Before a weapon could be sent to the proving ground, all claims made for it must be verified at the Experimental Battery of Annapolis. This Battery superintended all prototype firing and offered to the inventor any help or suggestions that would better the performance of his firing mechanism. It permitted the inventor, or company representative, the privilege of actively operating the weapon himself, or of designating some particular individual, if it was felt his knowledge and experience would help it pass the severe trials for endurance and speed.

It will be noted that once a test got under way, a delay for any reason whatsoever was counted against the rate of fire. In taking a specific rate of fire, a 5-, 10-, or 15-minute burst was shot, followed by counting the empty brass on the ground.

The results of this 1879 trial are hard to believe when compared to our present-day conception of machine guns. Therefore, the report of the day's firing is given in its entirety. A more complete picture may, thus, be obtained of the requirements demanded.

The following tabulation outlines the test chronologically:

	Times H.M.S.	Cartridges fired	Remarks
Commenced firing:			
No. 1 barrel	11.45.00	500	The gun has considerable vertical vibration.
No. 2 barrel	46.42	1,000	
No. 3 barrel	48.34	1,500	
No. 4 barrel	50.17	2,000	
No. 1 barrel	51.50	2,500	All parts of the gun working well.
Changed man at crank	52.10		
No. 2 barrel	53.50	3,000	No delays over 2s. in shifting the barrels or the men at the crank.
Changed man at crank	54.31		
No. 3 barrel	55.33	3,500	
No. 4 barrel	57.20	4,000	
No. 1 barrel	58.53	4,500	A slight breeze blew the smoke directly to the rear causing much annoyance to the men serving the gun.
Changed man at crank	59.00		
No. 2 barrel	12.00.38	5,000	
Ceased firing	02.06		
Commenced firing:			
No. 3 barrel	12.18.00	5,500	5,000 cartridges were fired in 17m. 06s. which is at the rate of 292 per minute.
No. 4 barrel	19.35		
No. 1 barrel	21.13		

	Times H.M.S.	Cartridges fired	Remarks
No. 2 barrel	22.50		
No. 3 barrel	24.05		
No. 4 barrel	26.12		
Stopped	27.13		Delay of 18s. caused by the splitting off of a piece of brass lining which was soldered in head of feeder.
No. 1 barrel	28.00		
No. 2 barrel	29.40		
No. 3 barrel	31.20		Changed feeder.
Stopped	33.10		A cartridge shell failed to extract. Delay of 20s.
No. 4 barrel	33.50		
Ceased firing	35.25	10,000	
Commenced firing	1.03.15		
Changed barrel	3.50		At 1h. 03m. 50s. a shell failed to extract, delay of 10s.
Ceased firing	6.56	12,000	The bearing of the [finger pivot] was found to be loose, and the points of the extractor hooks appeared to be much worn. (Afterwards cleaned and found to be broken off.) Changed lock and screwed up bearing of the finger pivot.
Commenced firing for maximum speed	2.04.56		
Ceased firing	2.06.56	12,740	740 cartridges were fired in 2m., which is at the rate of 370 per minute.
Commenced firing for maximum speed	2.10.00		240 cartridges were fired in 35s., which is at the rate of 411 per minute.
Stopped firing	2.10.35	12,980	
Resumed firing for maximum speed	2.15.00		
Stopped and changed barrel	2.16.00		At 2h. 16m. 00s. a shell failed to extract: delay of 12s.
Resumed firing	2.16.12		
Stopped	2.17.35	13,950	At 2h. 17m. 35s. there was a jam caused by one of the leaves of the carrier roll being split at its rear end and turned into its flute, preventing the entrance of the lock. Cause unknown. The leaf was pushed back into line and at 2h. 20m. 00s. resumed firing at a slow speed.
Commenced firing	2.20.00		
Ceased firing	2.20.20	13,980	Gun worked well.
Commenced firing for maximum speed	2.25.00		No. 4 barrel alone was used, and it became very hot, inflaming paper and pine splinters.
Ceased firing	2.27.37	14,980	
Commenced firing for maximum speed	2.33.00		No. 1 barrel alone was used, with same results as above.
Ceased firing	2.35.30	15,980	
Commenced firing	3.03.30		The gun mounted on its field carriage and depressed 34° was fired without traverse from the sea wall into the water.

	Times H.M.S.	Cartridges fired	Remarks
Jam	5.05		At 3h. 05m. 05s. a shell was torn near the ball in loading and caused a jam. Delay of 40s.
Resumed firing	5.45		
Changed barrel	7.30		
Jam	10.20		At 3h. 10m. 20s. jam same as above, delay of 10s.
Resumed firing	10.30		
Changed barrel	11.45		
Jam	12.13		At 3h. 12m. 13s. jam same as above, delay 5s.
Resumed firing	12.25		
Changed barrel	15.14		Examination of the cartridges shows that in many of them the shells are not properly crimped around the balls, which is probably the cause of their tearing in loading.
Failed to extract			
Changed barrel	18.15		
Failed to extract			
Changed barrel	19.10		Gun seemed to work less easily. A screw pin of one extractor works out.
Ceased firing	20.50	19,980	
Commenced firing	3.32.00		Gun mounted as before and depressed 34° was fired with full traverse.
Changed barrel	33.30		
Jam	3.34.20		At 3.34.20 jam from torn shell as before, delay of 25s.
Ceased firing	35.36	20,980	
Commenced firing	3.48.25		
Ceased firing	52.13	21,980	Gun mounted on its rail pivot and fired from sea wall into the water. Depressed (about 25°) and trained by means of the training bar. The man turning the crank attended to the training bar until 600 cartridges were fired, after which the training was done by another man. Examination of the lock showed that one of the extractor hooks was broken at the point—changed lock.
Commenced firing	4.01.12		Gun mounted on its field carriage—depressed 34°, was fired from the sea wall into the water. At 4h. 04m. 20s. a shell was torn in loading as before—delay of 10s.
Jam	4.20		
Failed to extract	4.07.10		At 4h. 07m. 10s. a shell failed to extract—delay of 10s.
Ceased firing	4.11.26	23,960	The gun was examined and found to be in serviceable condition with the exception of the broken extractor hooks.
Cartridges fired in preliminary shots during trial		40	
Total		24,000	

Résumé

Total number of cartridges fed to the gun	24,000
Greatest number per minute (at 2h. 16m. 12s.)	407
Misfires (bad primers)	39
Shells torn in loading	10

A similar test was also conducted by the Army at the Sandy Hook Proving Ground with practically the same results as the Navy had obtained.

While the most skeptical individual was forced to marvel at the reliability of the weapon, the fact remained that this country had no immediate need for the gun. The limited encouragement given by Naval adoption of the gun was not sufficient in a financial way to keep the Lowell Firearms Manufacturing Co. solvent. A few were delivered to the American Navy, 20 were sold to the Russian Navy, 3 went to the State of California for its prisons, and 1 to the police department of the city of Cincinnati. After these sales, the Lowell Co. collapsed, but not before DeWitt Farrington had contributed certain basic principles of design that have been used to the present day.

Chapter 11

WILDER MACHINE GUN

The phenomenal success of the Gatling and Gardner guns led many inventors in this country to design weapons that, in their opinion, were superior. In doing so, they hoped to sell their products to the Government, but if no interest was forthcoming, then to any foreign power that would adopt them for service use. One of the most outstanding examples of an attempt to better machine-gun design by sheer engineering ability was the gun invented by Elihu Wilder of Hillsborough, N. H. In 1876 he made a prototype weapon capable of being demonstrated.

The Wilder gun was made with five barrels in a semicircle, fastened rigidly fore and aft. The barrels did not revolve, which, Wilder claimed, allowed him a great advantage in loading. With revolving barrels the ammunition had to feed through one port and be chambered as each barrel followed the other in the cycle of rotation. With his system each barrel had its own cartridge inlet which enabled one to load considerably faster, and to use, at will, any or all of the five barrels.

Wilder pointed out that other machine guns using stationary barrels side by side, or in stacks, necessitated an equal number of locks. As firing capacity and the number of locks are increased, so do the chances of their getting out of order, to say nothing of the additional cost, weight, and bulk. However, with the five barrels placed in a half circle, as Wilder had done, the weapon was not only much more compact, using only two locks; but one cam could operate all the bolts, fore and aft. This was especially important, since the action of the bolts was independent of either the striker or the hammer, thereby eliminating the wear and friction that most weapons of this type would naturally have. Wilder positioned his two locks opposite each other. This enabled him to discharge all the barrels with a half turn of the crank; in other words, each barrel was fired twice during one revolution of the crank, giving a rate of fire double that of similar weapons.

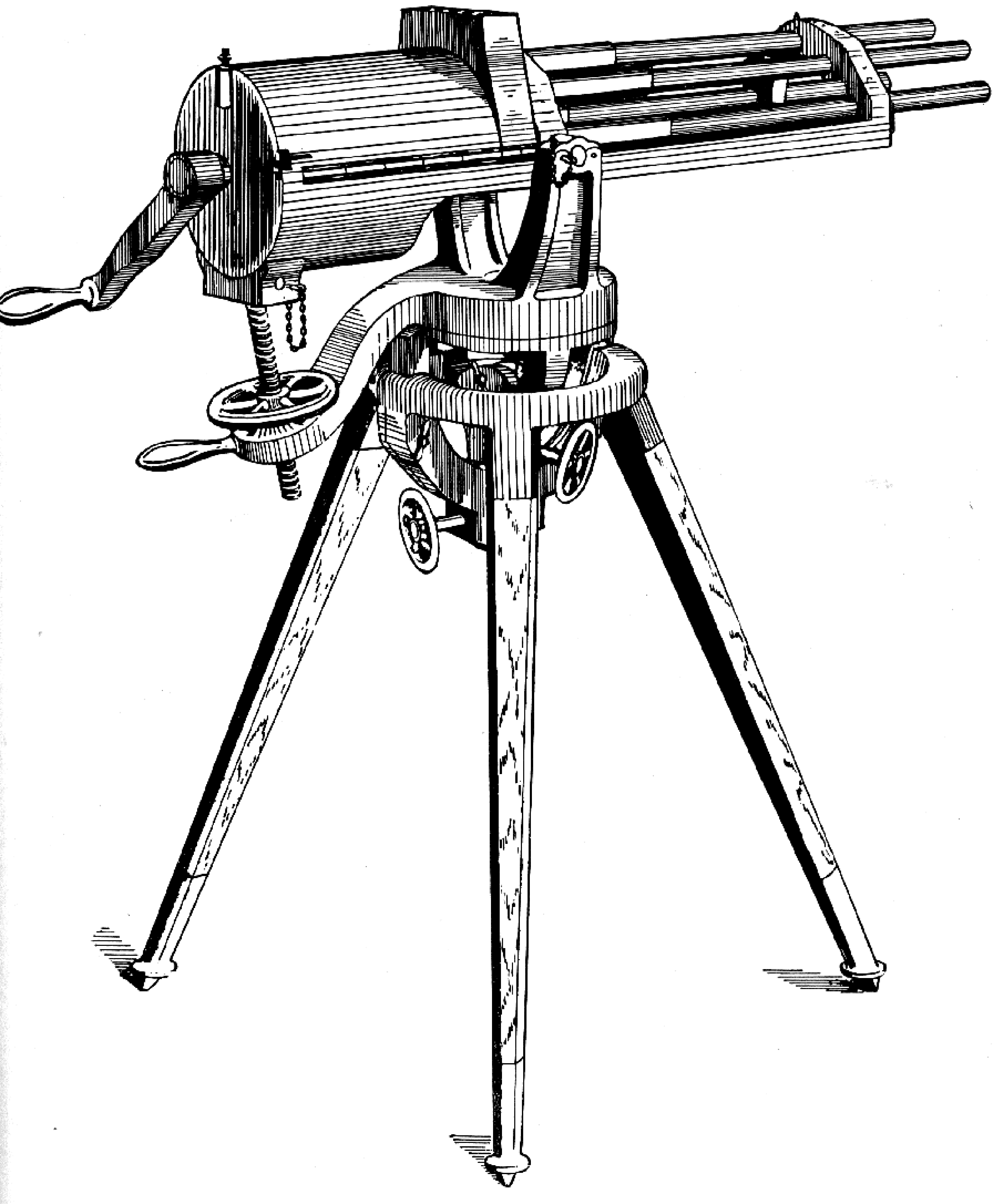
His extractors were the double-jawed kind that cammed over the rim of the cartridge when the bolt was in battery with the cartridge in the chamber. This presented a solid **T** slot until initial extraction had been accomplished.

The original weapon used the caliber .45–70 service cartridge and first was designed for tripod firing, although provision was made whereby it could be mounted on the standard howitzer limber.

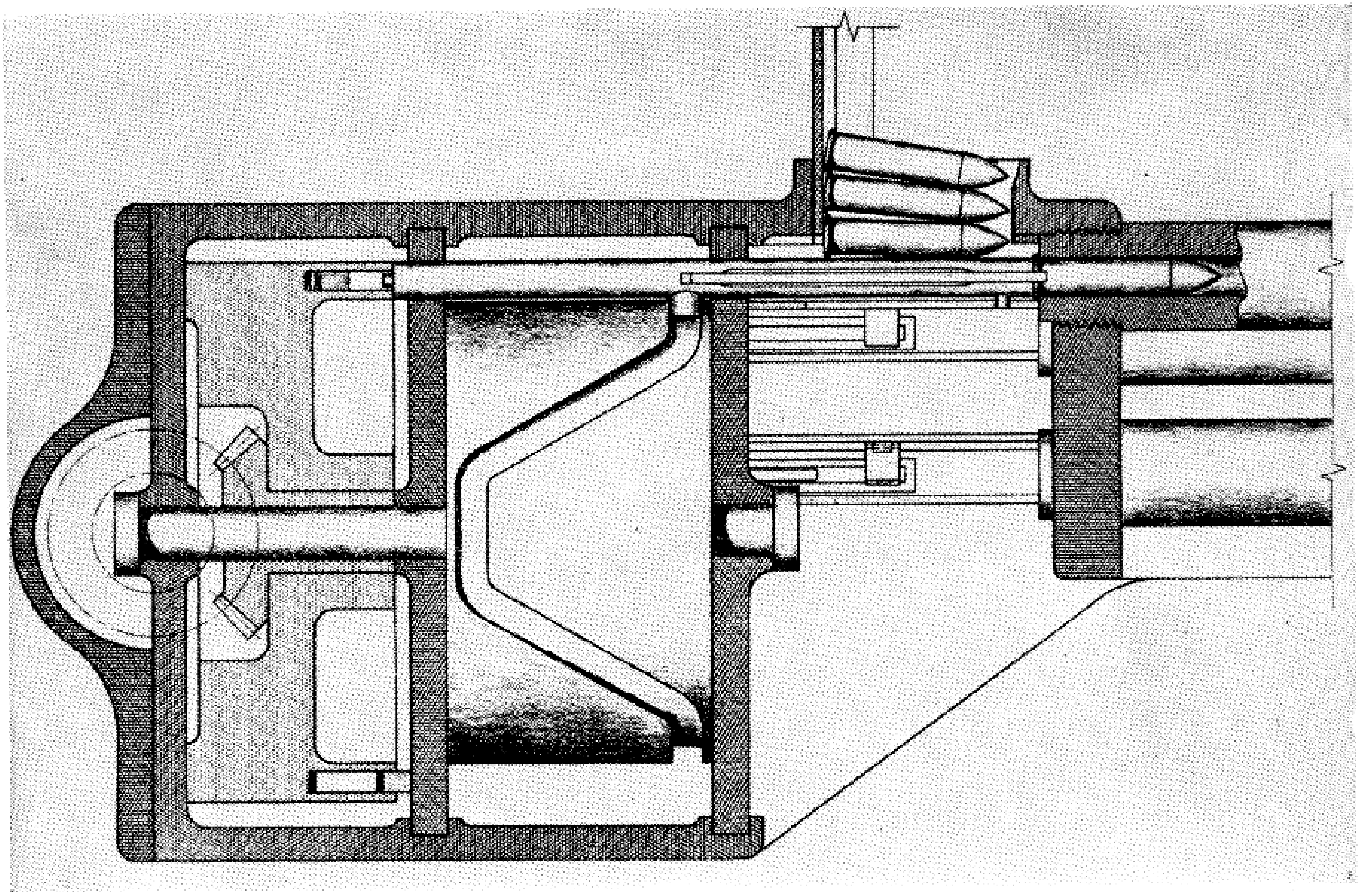
After the five feed guides are filled to a capacity of 50 rounds each, the feed stop pawls are placed on *open* and the weapon is ready for action. As the rotation of the operating handle begins, a cartridge is dropped into the top recess and brought immediately in line with its intended barrel. The forward travel of the bolt forces the round into its chamber by the engagement of the lug that rides in the cam. At the same time the hammer is cocked by a ratchet-type cam, compressing its spring. It sears off at the high point, and the hammer snaps forward, driving the firing pin against the primer with great force and firing the cartridge. Located diametrically opposite each other are two such hammers for the five barrels—a very simple system that would save much maintenance.

The weapon having been fired at the conclusion of an intended time lag, a helical cam with a steep slope jacks the bolt rearward with great speed, carrying with it the empty cartridge case. At a distance slightly greater than that of the empty case the extractors relax all hold on the rim of the case, and a section of the star-wheel guide revolves the empty case free of the working mechanism, where it is released to drop out of the gun by gravity.

This method of completely releasing the brass by the extractors before ejection functioned perfectly when firing horizontally. For shipboard



Wilder Machine Gun on Tripod Mount.



Section Drawing of Wilder Machine Gun.

use, however, where firing was sometimes straight down, the cartridge would drop back in the chamber before the star wheel rotated it to strike the ejector fingers. To overcome this fault, five levers were used (one for each barrel). Actuated by cams, they would swing in between the spent cartridge and the chamber, until ejection was completed, and then return to their normal position, leaving the barrel open to receive the next round.

The ejectors, called by the inventor "abutment fingers," forced the empty cases out of the star wheel and insured that they could not fall or bound back into the mechanism. In the bottom of the receiver a deflection plate helped to control the flight of the brass and kept spent cartridges from piling up in the housing when firing at a high rate.

The Wilder gun was optionally equipped with a water jacket and a device giving the muzzles a lateral motion to and fro during firing. There was also a three-barrel version of the weapon intended for mounting on horseback. This smaller arm weighed only 70 pounds, and was rated as being capable of firing at a speed of 1,000 rounds a minute. This fire power was doubled in the five-barrel version. Brig. Gen. Charles Benjamin Norton, former United States Commissioner to the Paris Exposition, referring in 1882 to one of the guns which had been displayed there, stated, "It is claimed this arm is capable of being fired at a rate of 2,000 shots a minute, this being based on results of a late trial where 200 shots were fired in 6 seconds."

There is no doubt that the Wilder gun would have furnished serious competition to contemporary weapons if the inventor had not died shortly after his first models were produced. Little was done with it until nearly 20 years later when his widow sold her interest to a Boston concern which, no doubt, planned production of the weapon.

By this time manually operated guns were doomed, regardless of cleverness of design or rate of fire, as the fully automatic machine gun had become a reliable weapon.

The Wilder gun in reality embodied the Ripley principle made to employ a feed system capable of producing sustained fire. In doing this, Wilder used Gatling's mode of feeding practically in its entirety. It seems ironical that this weapon could very easily have furnished stiff competition to the Gatling, which was likewise very similar to the Ripley mechanism.

A large caliber weapon was under design by the inventor before his death. It was to use the 37-mm round of the Hotchkiss revolving cannon and had a high rate of fire resulting from the fact that only the firing mechanism revolved in place of the heavy barrels of similar guns. Its easy cycle of operation, combined with the devastating explosive effect of the projectile, would have made a naval weapon of great destructive possibilities against torpedo boats and other lightly armored vessels. It was later estimated that its rapidity of fire would have been four times that of the Hotchkiss. However, there was no immediate need for the gun, and without stimulus the 37-mm version was never carried beyond the blueprint stage.

J. H. McLEAN'S "PEACE MAKERS"

For some reason the profession of gun design and development seems to have been infested with more phonies than any other known vocation. It would be a great injustice to the true craftsmen of the manually operated machine-gun era not to mention in contrast the alleged inventions of Dr. J. H. McLean and his assistant, Myron Coloney. These men invented more mythical weapons, had more publicity, and accomplished less than anyone since Puckle.

McLean was born in Scotland in 1829, and a few months later his father emigrated to Nova Scotia. At the age of 13 the boy left home and followed the frontier west as far as St. Louis, where he attended a medical college. He decided, at this time, to concoct a preparation known as a "strengthening cordial" which, according to advertisements, would cure just about anything from pink eye to paralysis. The returns from his patent-medicine sales, which were practically all profit, soon made McLean immensely wealthy. At this point he entered the gun-development field. This sudden change in professions was no doubt due to a chance meeting with Myron Coloney of New Haven, Conn., a self-confessed inventor of great reknown.

Dr. James H. McLean.

This pair set out upon a mission, the scope and ambition of which the world has never known; they patented impregnable forts, unsinkable ships, repeating cannon, gun-launched torpedoes, repeating pistols, rifles, and machine guns of all descriptions. The best insight into the aims of McLean and Coloney can be obtained by quoting from a 200-page brochure advertising their world-shaking ordnance designs and extolling the inventors. The pamphlet, entitled *Imperial Edict,* was written by the promoters themselves, but was phrased stiltedly in the third person.

"Dr. J. H. McLean's Strengthening Cordial and Blood Purifier, with his other prepared medicines, can now be found in drug stores in nearly every village, hamlet and home in the Western and Southern States—in fact, in many places in Europe as well as the United States—accessible to the poor as well as the rich. That humane mission fully accomplished, that great life work carried out, one might think would be sufficient; but the Doctor's great heart burned to go on—go on to do more for his fellow men. Hearing of the killing and slaughter of the brave soldiers in Europe and Asia at the will of their rulers, he resolved to develop such terribly destructive weapons of war, arms, torpedoes, and fortresses, and such perfect defenses, as would compel all nations to keep peace towards each other.

" 'Save the Lives of the People' is his motto.

"In pursuing his professional career unaided and alone, he amassed a large fortune. The people of the Mississippi Valley know well Dr. J. H. McLean's Grand Tower Block and his vast Laboratory. With him to will is to do and to have done, having all the means necessary at his command, and the brain and vital force to carry out his enterprises. He has succeeded in developing, and now presents to the world, the most terribly destructive weapons of war, from a 48-shot pistol and 128-shot rifle (self-loading) up to cannons of all grades; Battery (machine) Guns capable of firing from 600 shots a minute up to 2,000 shots a minute, and sweeping an area of six miles; Infantry and Rifle Protection Forms; Floating and Permanent, *absolutely impregnable* Fortresses; swift-sailing vessels, which cannot be sunk by perforation. . . .

"When the world has fully realized the grand success of the crowning act of the life of Doctor James Henry McLean . . . we think all will acknowledge that he *is* truly a Man of Destiny, a great *reformer* in the highest sense of the word, and a savior of the tyrannized and down-trodden human race. 'So mote it be.' "

Myron Coloney.

It will be noted that McLean could not resist the temptation to list the wonderfully curative powers of his patent medicine at the same time he described the awesome engines of war he and Coloney invented. It is hard to believe any man could write about his own accomplishments in such glowing terms without stretching his ego to the exploding point.

Myron Coloney, in writing about himself in the same pamphlet, left no indication that he was suffering from an inferiority complex and admitted that he even startled himself, at times, with his various gun inventions. A short quotation is given from the many pages he wrote about himself.

"Myron Coloney was born in St. Lawrence County, N. Y., on the 24th of April 1832, and when still quite young, exhibited great constructive skill and mechanical ability in building boyish sawmills, apple-paring machines, animal traps & etc., of curious and novel workmanship. Amongst those rich traits of character with which he was endowed, there was also a deep love for literature. This desire grew almost into a passion, and determined the young lad to enter a printing office, rather than follow his father's more successful trade. . . .

"Among the most important creators of wealth, in any nation, are the inventors. They are the pioneers in merchandising, in mechanics, and in the arts of sciences. One class of ingenious men invents a new forcible and impressive method of making known their business and of selling their wares, and thereby secure wealth for themselves and afford a means of livelihood to their employees. Other inventive minds, of a mechanical turn, perceive defects in mechanism, and thereupon, originate new devices which cheapen cost and increase production. Both of these classes, in their way, are creators of the wealth of a nation.

"There are others, and great inventors, who, with one master stroke of genius, wipe out all past works of a class and create instead better and more useful forms, which in their application, give employment to the many, and contribute to the general prosperity of the nation. The effort of their genius may be directed toward improvements in the tools employed in husbandry, or towards the perfection of machinery for the manufacture of textile fabrics, or in an effort to create more powerful engines of war. Whatever may be the bent of their effort, the achievement is the same. The world is astonished at the result, and then commences to make use of the improvements, and carries them forward to ultimate perfection, employing the labor and the skill of thousands.

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"To this class, we think, belongs Myron Coloney, one of the inventors of the Dr. James H. McLean Peace Makers. . . . Myron Coloney engaged at once with Dr. McLean, and removed to New Haven, Connecticut, where he could obtain the best skill and most able and intelligent mechanics, to superintend and develop these terrible engines of destruction, which are intended to strike terror to the heart of every enemy. Not only those devices . . . but other great inventions, which his fruitful inventive brain suggested and which he has since perfected, have been called into being, and which will create an enthusiasm and a sense of security in every nation on this globe, handing down to posterity the name of Myron Coloney, in connection with Dr. J. H. McLean's Peace Makers, with the great honor and credit."

These two self-acknowledged geniuses continued on for more than 200 pages on a subject they both loved, namely, J. H. McLean and Myron Coloney. They stopped only to illustrate the terrible engines of war conjured up in their frequent outbursts of brilliant design.

Their machine guns were given such colorful names as the "Annihilator," "Pulverizer," "Broom," and "Vixen." But like all strong men, the doctor had his weaker moments and named the most deadly of all his machine guns the "Lady McLean." The paramount motive behind the exorbitant claims of these "Men of Destiny" is to be found after reading 171 pages of sensational copy. At this point the author states:

"Fortunes to be Made Everywhere

"The important fact that companies formed in each nation for the manufacture of Dr. J. H. McLean's Peace Makers can contract with their governments to convert all sound old-fashioned guns into these formidable repeaters at a great saving to the government must be steadily remembered. In this business alone companies can make fortunes in each nation. Address Dr. J. H. McLean, 314 Chestnut Street, St. Louis, Mo."

It is interesting to find, in studying the drawings of McLean's "improved" machine guns, that one rapid-firing cannon has a tubular feed on each side. In order to place the ammunition in this type of feed, the designer drew the cartridges without rims and with a cannelure exactly like the present-day rimless ammunition. While there is no record to show that McLean's great masterpiece ever fired a shot, there is strong likelihood that this drawing was seen later by some wide-awake inventor and developed into the rimless cartridge. It is hoped that this was the case, as it would be a shame that such self-admitted talent did not contribute anything to the field of machine gun development except a large stack of meaningless drawings and ridiculous claims.

Dr. McLean's project was the first attempt of a European to develop a machine gun in America. And should anyone be interested in looking further into his inventions, it will be noted that he remained close to the European demand for volley fire, whereby a number of stacked barrels were to be discharged simultaneously. This ordnance venture, however, proved that unlimited money and publicity cannot make a poorly designed weapon work if the inventor does not have the necessary skill. These self-appointed "geniuses," therefore, were unable to compete with the master mechanics of this era, who did have the happy faculty of knowing what they were doing.

Chapter 13

BAILEY MACHINE GUN

Another interesting machine gun tested by the Navy was designed in 1874 by Fortune L. Bailey of Indianapolis, Ind. One year later the Winchester Arms Co. had manufactured a working model, which seemed reliable enough to warrant a request for Navy consideration for purposes of adoption.

After an interview with company representatives, Commodore T. H. Patterson of the Navy Yard, Washington, D. C., on 31 January 1876, ordered a trial to be held on the Navy Yard Range. At the appointed time, 11 February 1876, the board convened. Commander Montgomery Sicard, Inspector of Ordnance, was the officer in charge.

The weapon shown was small in comparison with similar mechanisms, being made to use a caliber .32 rifle cartridge. The reason for this, according to Bailey, was that the gun being tested was built merely as a working model. Its performance had proved so phenomenal in private tests, however, that its producers had been convinced it was capable of being demonstrated.

The inventor called attention to the fact that until now all machine guns fired either from hoppers or drums. These were limited in their capacity of rounds. His weapon, however, had no such restrictions. It fired from a belt which could be made any length desired. He also made the astounding claim that the round would be fired without being withdrawn from the belt.

After the formal discussion, a close inspection was made of the weapon. Many unusual features were noted that had not been known in other machine guns.

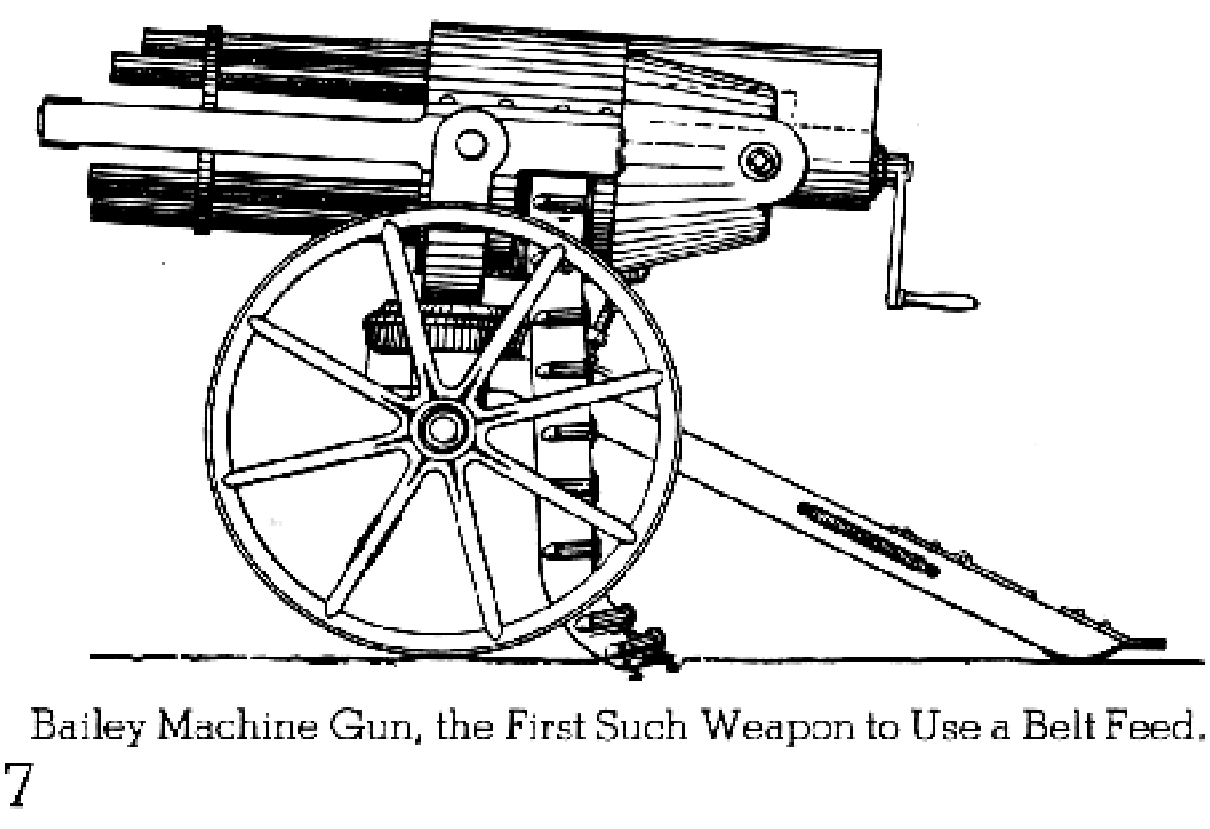
In appearance the Bailey resembles the Gatling, with its barrels grouped around a central shaft and held securely by central discs fastened to the frame. But at this point all resemblance ends. The systems of feeding and firing are radically different from earlier types.

When the crank on the right side is turned, the barrels revolve. Concurrent with this they have a reciprocating motion caused by successive engagement of an inclined flange, or cam. Sufficient play is, of course, allowed in the bearings to permit such fore and aft motion, and to compensate for the increased diameter of the metal due to heating from sustained bursts.

The firing is done from the top barrel. While this is taking place, the empty cartridge, still in the belt, is cleared.

A plate revolving with the barrels houses the firing pins and springs. As a barrel arrives at battery position, its firing pin is struck by one of the two plungers, or strikers, that alternate in firing. The dual plunger assembly consists of two flat pieces of steel with shanks on the rear end that serve as guides to the striker springs. These springs drive the plungers forward when the studs are alternately released from contact with the flanges of the cocking cam, located on the lock flange cylinder.

The cylinder is a simple, well constructed tube, firmly secured to the center shaft. About its circumference are two separate helical cams of rapid pitch. As the cams are rotated by the clockwise movement of the crank, they are brought into engagement with the studs on the reciprocating plungers. Each set of flanges manipulates its own plunger. As the cylinder con-



Bailey Machine Gun, the First Such Weapon to Use a Belt Feed.

tinues to turn, the cam that is engaged with a stud forces it back until the end is reached. At this point it sears off, actuated by the compression of the spring, and strikes against the floating firing pin.

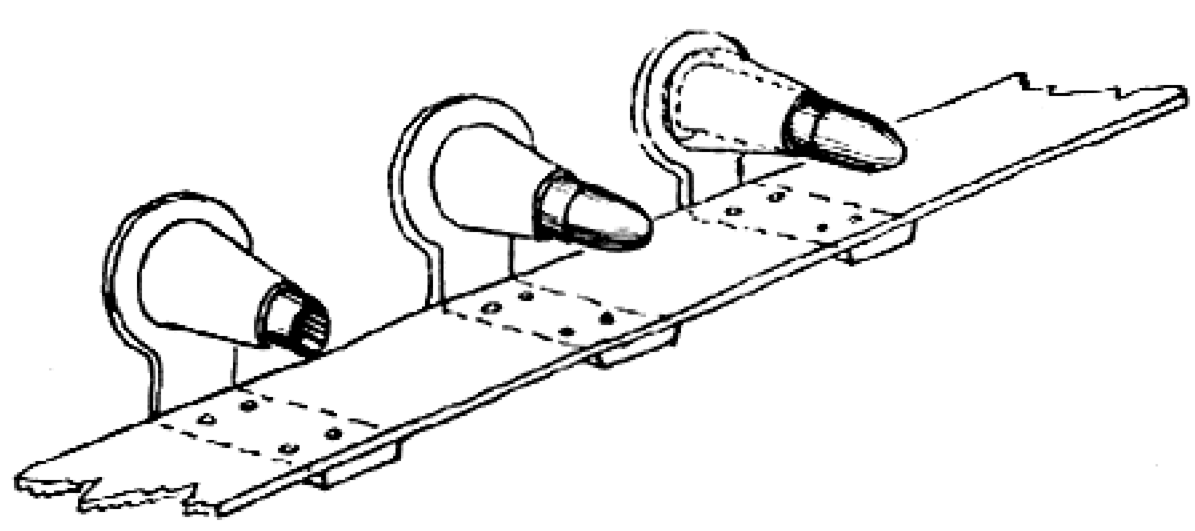
As each barrel is fired, the continued rotation of the crank brings up the next one, with its firing pin in position to be struck by the alternate plunger. The weapon cannot possibly be fired until alined with the striker. Accidental firing before being in battery is impossible, as the weapon is secured for firing by the novel method of locking the barrel and not the bolt.

The plan for feeding and extracting is indeed extraordinary. A cylinder of wrought iron is fastened on the center shaft, just forward of the firing pin plate and inside the circle formed by the rear end of the barrels. Its surface is indented by recesses, the general direction of which is parallel to the axis of the center shaft.

These identations mate with flat pieces of brass similarly shaped, which are riveted to the underside of the feed belt. This makes the cartridge belt a kind of flexible feed rack, running over the wrought iron drum.

The cartridge containers of the Bailey gun are conical-shaped brass sockets fastened at right angles to the flat side of the belt. They receive the loaded rounds when the ammunition is belted before firing. The distance between the rounds in the belt when mated with the recesses in the drum exactly equals that between the center lines of the chambers.

The cartridge containers are conical in exterior design, but are bored internally to receive the round. When the ammunition is pushed into this device from the rear, the rim is seated in the slight recess made for it, while the entire bullet and the neck of the metallic case protrude through the forward end of the cartridge container.



Belt with Sockets, + Cartridge

Bailey Machine Gun Cartridge Belt. A Sketch Made by the Officer Who Tested the Weapon at the Washington Navy Yard, 1876.

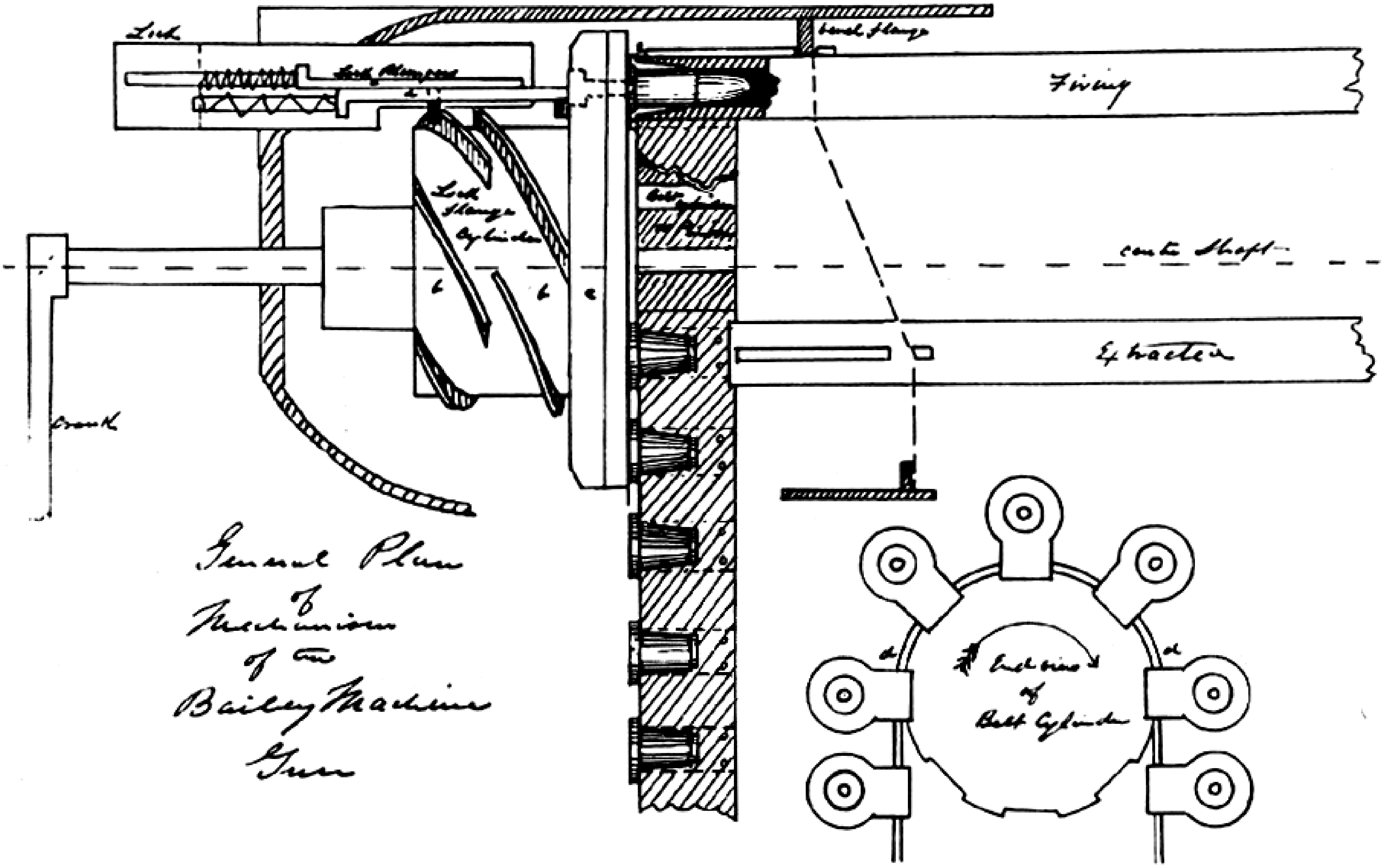
When the belt is inserted in the left side of the Bailey gun, the cartridge holders are then positioned in a prolongation of the axis of the barrels and directly to the rear of them. The chambers of the barrels of the weapon are bored conically to receive and fit snugly over the cartridge-carrying belt sockets.

As the center shaft is revolved by the crank, the belt and cartridge containers are drawn over the alining cylinder. The cartridges in succession come opposite the rear openings of the barrels, and the reciprocating cam causes the barrels on the left, or loading, side of the piece to move rearward. While they revolve, each successive chamber covers more and more of its assigned cartridge container. By the time the firing position is reached, the whole container is covered, and the firing barrel is securely locked, the butt of the cartridge being backed up by the firing pin plate. With everything now in place, one of the plungers is released by running off the high point on the cocking cam, and the weapon is fired.

As the rotation continues, the discharged barrel starts to cam forward, pulling the chamber off the cartridge holder. By the time one quarter of a revolution is made on the crank, the belt section with the cartridge container and empty case is free to go out the right side of the gun, dropping vertically to the ground.

The Navy board found that Bailey had not brought a sufficient number of belts to warrant an opinion on reliability and endurance in a firing test. Therefore, it refused to take the weapon under consideration, but offered to allow him to fire any amount he wished in an unofficial demonstration.

Because the belts supplied by Bailey held only 100 rounds, and the reputed speed of the weapon precluded attaching additional ones after a burst had started, the sustained fire periods were of relatively short duration compared to Navy requirements. However, he was permitted to prove one point of this claim—rapidity of fire. One of these 100-round bursts was officially recorded as



The Mechanism of the Bailey Machine Gun. Sketched During the 1876 Trials.

being fired in 6 seconds, or at a rate of 1,000 rounds per minute. This rate of fire impressed the officer in charge. Commander Sicard stated in describing the unusual performance: "The test that was made for rapidity of fire was, however, truly astonishing. One hundred rounds being fired in about 6 seconds, the gun appearing to be almost in a continual blaze, the whole number ran off smoothly."

Thus ended the first successful attempt to fire a machine gun fed by a belt, in lieu of drum or hoppers. Like many others in his field, Fortune Bailey did not gain financially, but he admirably overcame the bottleneck in machine-gun feeding. The novel mechanism he originated not only fed the weapon from a belt, but fired the round without ever removing it from the conveyor as it passed through the machine.

Chapter 14

NORDENFELT MACHINE GUN

At the same time that American inventors were bending every effort to produce a reliable fast-shooting gun, employing only one barrel at a time, European engineers were still trying to improve volley fire. This they considered to be the acme of perfection in relation to delivering a concentrated small arms fire.

The best attempt at perfecting a system of volley fire was done by Heldge Palmcrantz, a Swedish engineer. He originated a mechanism, very similar to the Claxton, that permitted the operator to keep up sustained fire, or discharge the barrels one at a time if desired. Locking and firing were accomplished by the operation fore and aft of a single lever; a separate gravity feed was installed over each barrel. The cartridge cases fell through openings in the frame, after they had been extracted beyond the length of the empty brass.

As was the case with most inventors, Palmcrantz was without funds to produce his weapon and had to appeal to a Swedish broker named Thorsten Nordenfelt, who at the time was conducting a banking business in London. The latter agreed to finance its manufacture, but not until the name was changed to the Nordenfelt machine gun.

The broker proved himself one of the world's greatest salesmen, as, by sheer merchandising ability, he promoted successfully a multibarrel weapon inferior to half a dozen other guns available at the time. Nordenfelt was a shrewd businessman who made every effort to meet the whims of influential people who could help him in disposing of his products. He constructed from 1- to 12-barrel versions in any caliber from rifle cartridge to artillery.

Realizing that England never took a weapon of this type under consideration unless it was actually built on English soil, his first move was to construct a manufacturing plant in the British Isles, with offices in London. His salesmen, and in most instances Nordenfelt himself, never let an exhibition go by without the display of his product. If possible, a long demonstration was arranged to bring out the simplicity and reliability of the "Nordenfelt system," as it was now universally called.

The English Government's Small Bore Machine Gun Committee in 1880 laid down three basic conditions that must be met before a machine gun could qualify as being worthy of consideration:

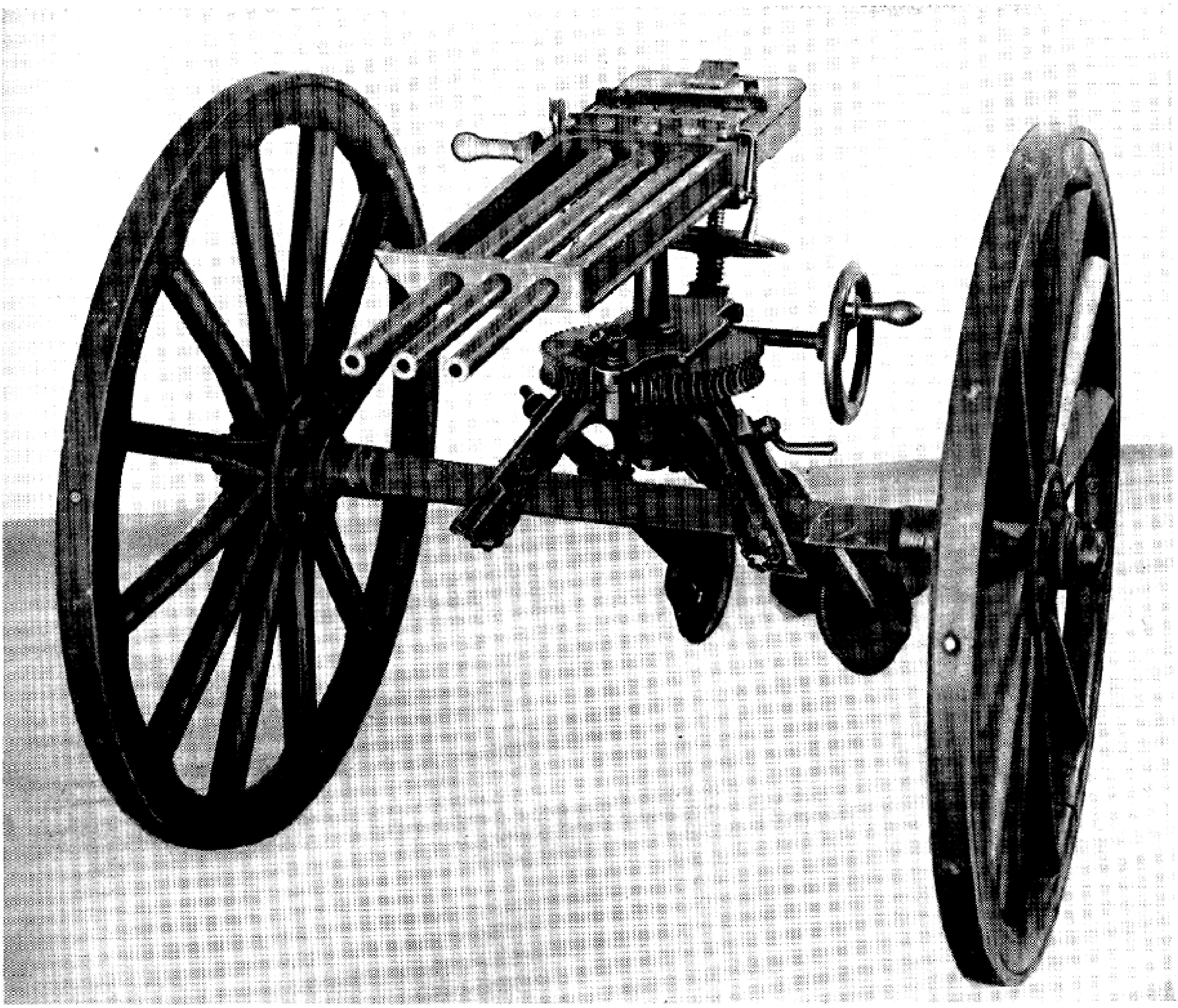
"It must be capable of firing 400 rounds a minute.

"The breech of the barrel being fired to remain securely closed one third of a second, or ample time in the opinion of the experimental committee to insure safety from a delayed explosion of a cartridge (hang fire).

"To fire rapidly 1,000 continuous rounds at a speed satisfactory to the committee. That must not cause undue heating of the barrels."

These specifications favored the Palmcrantz system. This fact was exploited by Nordenfelt, as most of his trials were conducted with the 12-barrel rifle caliber gun. With this he could easily shoot 400 rounds a minute, or less than 50 rounds per barrel. A 1,000-round burst figures out roughly only 83 shots per barrel, so the problem of overheating the barrels did not exist.

Time has proved that the weapon, as far as design was concerned, was hopelessly obsolete while still in the blueprint stage. However, with respect to reliability, workmanship, and endurance, its performance in some cases was nothing short of phenomenal. For instance, at a test of the 10-barrel rifle caliber model, held at Portsmouth, England, in July 1882, the weapon fired 3,000 rounds of ammunition in 3 minutes 3 seconds, without a parts failure or stoppage. In other words, it maintained a rate of fire of 1,000 rounds a minute for three consecutive minutes.



Nordenfelt Machine Gun, Cal. .45, with Gun Carriage Convertible to Tripod Mount.

This model had a rated speed of 1,200 shots per minute with shorter bursts.

A description of one of the Nordenfelt multi-barrel mechanisms will describe all 18 models. They differed only in size, number of barrels and caliber. The operating parts remained basically the same.

All the Nordenfelt weapons can be classified easily by placing them in groups as follows:

(1) Rifle-caliber machine guns.

(a) Light machine guns including those of less than 150 pounds in weight that can be carried by the individual soldier, or on horse or mule back.

(b) Heavy machine guns. Those of 150 pounds upward, that could not be transported other than by limbers or shipboard mountings.

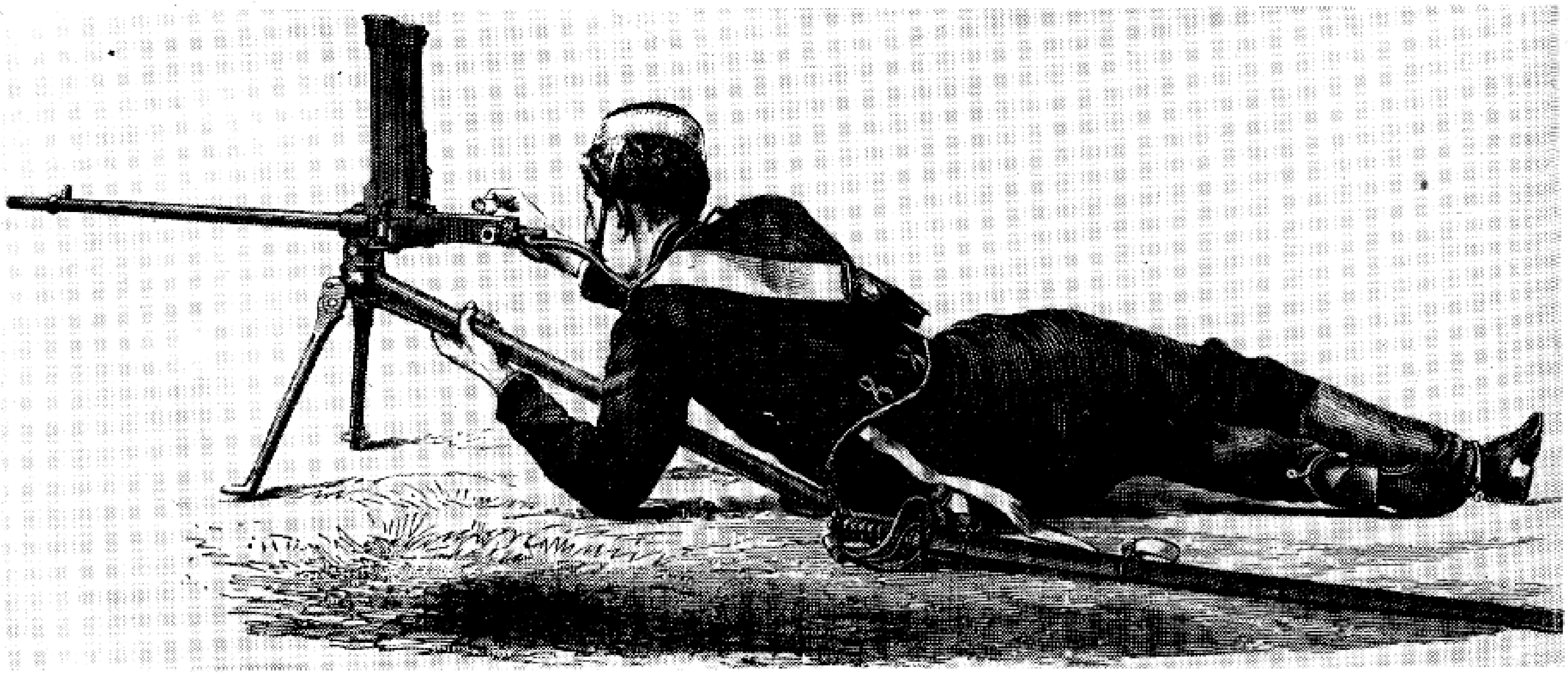
(2) One-inch caliber machine guns. The gun, especially designed for torpedo-boat defense, was made with four barrels only.

(3) Rapid-loading shell guns.

(a) Light guns including 1½ inch, 37-mm and under.

(b) Heavy guns. Those upwards of 1½ inches, 37-mm.

One inch was the largest caliber gun using the lever toggle joint locking system of Palmcrantz, for which Nordenfelt was famed. The larger shell guns were simply manually operated drop-lock mechanisms, that permitted rapid loading



Nordenfelt Single-Barrel Machine Gun.

and extracting. They should in no way be confused with the other weapons, regardless of the fact that the company advertised the heavy guns as "Shell Machine Guns."

The Nordenfelt Co.'s most interesting product was a light single-barrel machine gun designed for the infantryman. It was lever operated and used toggle joint locking. The principal parts of this rifle caliber weapon were: (a) Hand lever with cam plate combined, (b) plunger, (c) action slide piece, and (d) breech cover.

Energy for the horizontal motion necessary for firing is obtained by means of a lever pivoted on the left side, extending under the breech to be manipulated by the right hand.

The plunger contains the firing pin, spring, and extractor. The latter is claw shaped, the upper part seizing the rim of the cartridge above. The lower portion grasps it on the right side. In the center of the plunger, on the under side, is machined a broad slot, and on the rear, two recoil or locking projections. The firing pin is housed in the plunger, and has on its end a T-shaped projection for cocking.

The action slide has a friction roller, as well as a cam piece of the same shape as the slot in the plunger. The roller runs in the hand lever cam slot, with the cam piece working in the plunger slot. Forward travel of the plunger causes rotation of this piece to engage with projections in the receiver, securely locking the piece.

The breech cover has an ejector, fastened underneath at the forward end, which throws the empty cases through the opening and clear of the gun. In the breech of each barrel, on the inside, one above the other, are cut two longitudinal grooves. In the lower one is fixed a flat spring, with a projection on it for the purpose of compressing the firing pin springs.

To fire the single-barrel Nordenfelt, the operating lever is pulled back evenly. This rotates the plunger, bringing its locking projections clear, at the same time alining the cocking piece with the lower grooves. If the weapon has just been fired, the empty cartridge case is drawn to the rear with the plunger, carrying the T-projection cocking piece over and behind the flat spring.

As the operating lever reaches its furthermost travel rearward and the empty case is ejected, the cocking lug is held back under spring compression. The lever is then shoved forward and the bolt strips a loaded round from the feeder and chambers it. When the lugs rotate down into locking position, the obstruction is removed from the T of the cocking lug, and the firing pin is seared off, discharging the weapon. A driver permits the operator to use the piece as a reciprocating rifle if he so desires.

It is especially to be noted that the Nordenfelt employs the rotating bolt head that unlocks by a straight pull rearwards. The system has since been copied throughout the machine-gun world.

By shoving the operating handle forward, the firing pin spring is compressed and the lock plunger chambers a loaded round. The final movement forward rotates the locking projection on the plunger. At the instant the act of locking is completed, the T-shaped cocking piece is turned clear of the flat spring projection, releasing the firing pin to strike the primer and fire the piece.

The mechanism is very simple, there being only 23 parts in all. It can be removed in a matter of seconds by unscrewing the rear screw by hand and drawing out the parts. The operating lever is so designed that, when removed, it can be used as a spanner wrench to disassemble the remainder of the weapon.

This gun weighed only 13 pounds, and could be fired by the average soldier at a rate of 180 shots a minute. It was made by the Nordenfelt Co. to show that a machine gun could be made, with a weight only four pounds more than that of the average service rifle.

European military authorities were prejudiced against the single-barrel machine gun at this time. Farrow's Military Encyclopedia expressed the opinion of practically all Europe by stating: "A general would probably not submit to the expenses and inconveniences of machine gun equipment, and services of men and mules for gun and ammunition, when the efficiency of the gun is entirely dependent on one single rifle barrel."

The multibarrel models of the Nordenfelt (Palmcrantz) system (it was internationally known by this name) have a magazine located directly over the carrier block holding 250 rounds of rifle caliber ammunition with an entrance slot behind each chamber in which the rounds drop by gravity.

Power for operating the weapon is furnished when the gunner moves a bent lever using a fore and aft movement of his right hand.

The frame has three cross pieces, and the barrels are inserted from the front (from 1 to 12), all lying in the same plane and parallel to each other. The breech ends of the barrels are secured into the metal crosspiece, while the muzzles rest on a solid part of the frame.

The principal parts are: (a) Hand lever, (b) action lever, (c) action block, (d) breech piece, (e) trigger comb, (f) carrier block, and (g) cover.

The hand lever is pivoted to the axis pin, and when actuated manually, sets the whole mechanism in motion. The action lever is fixed to the action pin, and has a stud on which a friction roller works. In the rear, a projection riding in a slot, gives a transverse motion to the action block, which is located at the back of the breech framework.

The action block contains slots for the plungers to pass through. In the solid portion between the slots, chambers are bored to house the firing pin springs and hammers, the hammers being each a T-shaped projection. Through the middle part of the action block, a channel passes from right to left for the reception of the trigger comb.

The breech piece consists of a plate with a plunger for each barrel, each plunger housing the firing pin and extractor. Beneath this plate is fixed the director cam slot in which the action lever friction roller works. This affords the breech piece longitudinal movement only. On the upper part are fastened studs which engage the T projection on the hammers, forcing them back and compressing the firing pin springs.

A lug on each side of the breech piece acts against a corresponding lug on the carrier block, thus forcing it to the right or left as the operating handle is moved forward and back. The trigger comb has a small spring to bring it to the right, and to retain the hammers after they have passed the teeth on its lower surface. The comb which projects to the right of the action block is forced against the right side of the framework on the action block, moving to the right. The comb is thus pushed to the left, releasing the hammers.

The carrier block, or cartridge receiver, is given its lateral movement by lugs on the breech piece, allowing the cartridges to drop by gravity into position for chambering.

The cover is hinged to the center crosspiece, and secured in its place by a spring lock on the rear member. The cover is opened towards the muzzle and access to the mechanism is obtained without moving the feeder.

To fire the multibarrel Nordenfelt, the operator moves the handle to the rear, and the aft projection of the action lever carries the action block to the left. The openings in the action block for the plungers being in line with the action lever roller in the breech plate cam slot, the breech piece and plungers are carried rearward. If a volley has been previously fired, the empty cartridge cases at this point are extracted and ejected to drop through openings in the bottom of the housing.

By the time the handle has reached its extreme rearward position, the studs on the upper surface of the breech plate catch the lower part of the hammers' **T** projections. This forces them back against the beveled edges of the trigger comb teeth. The comb is then moved against its spring to the left until the hammers are clear. When the spring carries the trigger comb to its original position with the teeth in the jaws of the hammers, the firing pin springs are compressed and the carrier block brought to the left.

As the handle is pushed forward to battery position, the carrier block is moved to the right, placing loaded rounds in position for chambering. Then the breech piece with its plungers is carried forward, chambering the cartridges in their respective barrels.

After the rounds are driven home, the action block then moves to the right and the hammers are alined behind their firing pins. At the same instant the projecting part of the trigger comb is carried against the framework of the gun, causing the trigger comb to be pushed to the left, freeing each hammer in turn, to be driven forward to strike the firing pin and thus fire the cartridge.

The method of feeding all the barrels from one hopper is unique. The hopper consists of an upper and a lower part. It is constructed of steel plates, with the exception of the rear face and guides, which are of gun metal. The lower hopper, often termed the distributor, is placed on the gun at the top of the breech cover over the carrier block, and secured into position by a spring lock where it remains during firing.

The distributor has a separate compartment for each barrel. On the rear face of each compartment is a guide for holding the cartridges by their rims. The ammunition lies in an inclined position, with the bullet slightly raised and touching the front inner face of the distributor.

The upper part of the hopper also has separate compartments. It is loaded from the top, a hinged cover being provided for that purpose. The cartridges are kept in place by means of a catch at the rear running the whole width of the hopper. This catch can be thrown in and out of action by a handle on the left outer side of the hopper. A similar catch is used on the distributor.

To operate, the empty lower distributor is first fixed in its place. An upper filled hopper is then positioned. The catch handle is pushed down, dropping the cartridges into the lower hopper where they then fall into their respective compartments in the distributor. When the catch on the distributor is released, a cartridge for each barrel falls into position on the carrier block. The others continue to take their places as soon as a vacancy occurs.

By means of the catch, the distributor and upper hopper could be taken off separately at any time without the cartridges falling out. This method of feeding proved quite adequate and was very simple and positive. The cartridges being contained in a closed case, any chance of the gun being fouled by dust and grime on the cartridges was obviated. While the system served this type of weapon well, it suffered by comparison with other feeds developed for the rapid-firing mechanisms of single-barrel guns.

On the models that had five barrels and over one of the most unusual devices ever put on a machine gun was found. This feature was called the Nordenfelt automatic scattering gear. By this, the shots composing a volley were separated from each other by a space of 3 feet between each bullet. Thus volley fire of 10 shots would cover respectively 5 to 10 men in formation. This spread of bullets can be given for any distance up to 500 yards by adjusting a thumbscrew placed on the left rear of the gun. Beyond that range it was thought the natural dispersion of the gun would insure a sufficient spread. When firing volleys at bodies of troops, the lateral direction on the gun could be slightly altered after each discharge so that no two volleys would fall in the same target area.

Another accessory, called a drill stop, was provided with the 1-inch four- and five-barrel guns. By this the operating lever was prevented from fully completing its back stroke, so that the hammers could not be retracted far enough rearward

Nordenfelt Machine Gun, Cal. .45, Five-Barrel Model. Mounted in Top of a Fighting Ship to Sweep the Decks of the Enemy.

to pass into the trigger comb. With this device the gun could never be full cocked, as the firing springs were not compressed when the action block moved forward. The stop, as the name implies, was for drill purposes only; it allowed the gunner to train gun crews using live ammunition with absolute safety.

The Nordenfelt multibarrel guns as a whole were clumsy contraptions when compared with American-designed weapons of this era. However, the firm did one thing that justified its existence by introducing the rifle caliber armor-piercing bullet years ahead of its time. In fact, it was so revolutionary that it was rediscovered nearly 40 years later. Nordenfelt left no doubt that he had the modern-day AP round in mind when he described his projectile as follows: "The bullet of this kind of cartridge is formed of hardening cast steel with a sharp pointed head. Over this projectile, for the purpose of a gas check and for rotating the bullet, is placed an envelope of brass, which is choked into a cannelure around its base. Also on the base are several radial cuts, into which the envelope is set on firing. In place of a brass envelope a coating of copper may be deposited on the projectile by the electro-galvanic process, and thus any possibility of altered flight due to the stripping of the brass envelope is rendered impossible."

This high-velocity armor-piercing projectile that had a speed in excess of 2,000 feet a second and penetrated 2 inches of solid iron plate at 300 yards was a distinct contribution to the field of ordnance. It is ironical that Nordenfelt was either far ahead of his time or hopelessly behind it.

But the most outstanding achievement of his long and colorful career was a machine gun that weighed only 13 pounds, capable of easy operation by the individual soldier, and with a rate of fire of 180 rounds a minute. Any army in Europe would have had a great advantage with this fire power and mobility.

Military authorities in Europe still looked upon the machine gun as an auxiliary or supporting arm to artillery in order to protect the latter from being rushed by foot soldiers or cavalry charges. They continued to insist that volley fire was the best way to break up a charge, and it was practically impossible to sell them on any weapon that would not discharge a hail of bullets at one time.

The British Navy, however, did not share this opinion. Like the American Navy, it did much to encourage and develop a lighter weapon capable of sustained fire that could be put ashore or fired from the rigging of the ships. The Admiralty already had what it considered the best manually operated weapon ever designed (the Gardner). It took no particular note of the single-barrel Nordenfelt gun, and as the army simply ignored it, the weapon went out of existence. However, Nordenfelt did produce and place in the hands of the British Army the first lightweight rifle-caliber machine gun for carriage and operation by the individual soldier.

Chapter 15

TAYLOR MACHINE GUN

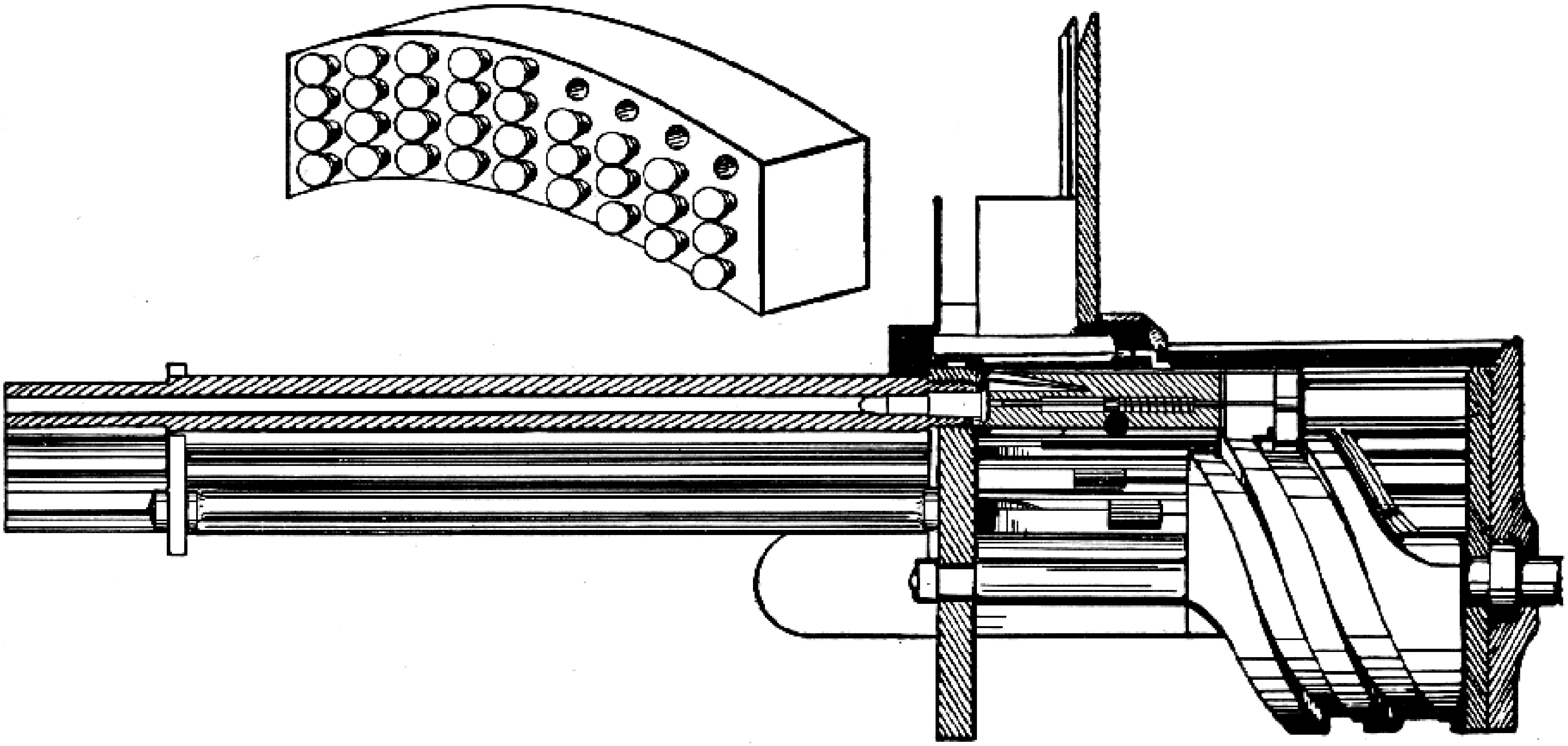
Because of inertia and lack of encouragement, there was little incentive actually to produce a weapon capable of standing the rigorous tests demanded by the proving grounds. Of the more than 80 patents issued in the United States on machine guns between 4 November 1862 and 26 June 1883, only one other was completed sufficiently to justify trial. This weapon was the Taylor machine gun. The inventor, James Patton Taylor of Carter County, Tenn., made a gun very similar in appearance to the Wilder.

Nine rifle-caliber barrels are permanently fastened in a half circle. The bolts work in conjunction with a revolving cam cylinder which is constructed with two grooves or flanges. One is for imparting a longitudinal movement to a series of reciprocating bolts, one for each barrel. The other flange is for retracting the striker and spring, and for searing off the firing mechanism when the bolt is securely locked. The flange that operates the bolts is formed with an opening at the extreme rear of its stroke to facilitate the removal of a bolt when necessary.

The feeders are of unusual design. A semicircular housing containing nine separate columns allows the cartridges to drop in line with the corresponding slot behind each chamber.

To fire the weapon, the feeder is loaded and tended by one man, while the gunner turns the crank and aims the piece. As a loaded round drops into position behind its respective barrel, the cam that actuates its bolt causes it to go forward and chamber the round. At the same time the engagement of the cocking lug on the striker with the breech cam on the revolving cylinder compresses the striker spring. When a bolt arrives at its extreme forward travel, the lug reaches the end of the cam. It then sears off, allowing the striker to be driven into the primer and fire the weapon.

As the actuating cylinder continues to turn, the cam that controls the bolt starts jacking it rearward. On its first movement in this direc-



Taylor Machine Gun.

tion, the double jaw type extractors pull the empty case from the chamber. After a travel of 1 inch, a physical interference forces the jaws to release their hold on the rim. When a distance slightly greater than the over-all length of the cartridge is reached, an ejector butts down in its path; striking it a smart blow on the base, it pivots and drives it through an opening in the housing, clear of all operating parts. Continued turning of the crank repeats the cycle. With every complete revolution of the handle the weapon fires nine times.

Of the three machine guns that Taylor patented, the one described is the only one that got far enough along to stand trial (in 1878). At the time, because of its feed, it failed to meet the demands of the Army board. The only comment was: "The Taylor gun is an ingenious and promising machine gun, but with the present arrangement of feeding the cartridge, it does not compete favorably with the other, better perfected machine guns that have been offered for test before this board. It is probable that a better feed can be effected for the service of this gun by the inventor; until this is accomplished however the board cannot recommend the procurement by the United States of any of these guns for service."

Chapter 16

END OF THE MANUALLY OPERATED PERIOD

From Gatling's original patent on 4 November 1862 to 26 June 1883, American supremacy in machine-gun design went unchallenged. It is of particular importance to note that from the adoption of the Gatling gun by our Army until the conclusion of this era, there was no threat of war to our country. This disproves the pacifist's claim that once any nation has fully developed a superior weapon, war is inevitable to prove its effectiveness.

In this peaceful era, the Navy demanded perfection from the weapons tried. Some of the requirements placed upon these guns seem impossible when compared with our present-day system of testing.

It should be especially noted that at this time a Naval Acceptance Board functioned. This body of officers had the responsibility of seeing that any gun inventor could bring his invention to trial for purposes of adoption, and of extending to him all assistance possible to make his weapon reliable and effective. In fact, some of the suggestions offered helped in no small way the phenomenal success the guns later enjoyed.

The intense and wholehearted cooperation of these officers not only contributed to the mechanical accomplishments of the weapon under test, but undoubtedly furnished the inventor an incentive, since he knew that these officers would give him all the help in their power. That this procedure paid big dividends can best be judged by comparing these 21 years of progress with any other period in the continuous effort to produce weapons.

The establishment by the Navy in 1872 of the Experimental Battery at Annapolis, Md., showed the farsightedness of the officers responsible for weapon development. This facility handled all the firing of prototype weapons. And certain defects, inevitably present during initial firing tests, were required to be remedied before the weapon was allowed to go before the board for final trial at the Navy Yard, Washington, D.C. The unbelievable performances of machine guns tested there was due to their having previously been fired under the expert supervision of Naval officers at the Experimental Battery. Many of the defects were eliminated that would otherwise have caused the weapon to fail during the rigorous acceptance trials demanded by the Navy.

Some of the official records from these two firing ranges of the Navy reveal performances that no modern fiction writer would dare to credit to the present-day machine gun; yet they were actual accomplishments of this era.

Incidentally the Experimental Battery at Annapolis was the pioneer Naval Proving Ground. In 1890 it was moved to a new tract overlooking the Potomac River at Indian Head, Md., and in 1921 the present Naval Proving Ground was opened at Dahlgren, Va.

Though these tests helped gun design, they did not enrich the designer. One fact, standing out above all others, is that during this era a successful machine gun inventor was compelled to go abroad to market his weapon, although in every instance it was first offered to his Government.

While the United States had no need, and no immediate prospect, of using these superb weapons, foreign governments not only recognized their superiority, but made every possible overture to induce the inventors to leave home and market their discoveries abroad. With no incentive in this country to warrant any other choice, a steady trek of gun geniuses left America for Europe to establish factories—not only taking with them the "know-how" and top talent of the gun profession, but, in most instances, staffing their foreign factories with the highest skilled Yankee machinists they were able to hire. Their services were thus lost forever to their own country. And the factories they established abroad have been there so long that today they are thought to be of foreign origin, when in reality they were started by skilled American citizens, building a product unwanted at home. Necessity alone placed them on foreign soil to design and perfect the deadliest known instrument of war—the machine gun.

The weapons of this quarter century were all manually operated. Since it was always necessary for a gunner to aim the piece, there seemed no reason why he should not also furnish the power to feed and fire the gun. Mechanical advantage was utilized to enable the individual soldier to maintain sustained fire with a minimum effort.

During the latter part of this era, the weapons reached such a high degree of efficiency it was predicted there was nothing left to be improved. They were accepted as "invincible reapers of death."

As has been the case throughout weapon history, when perfection in the *n*th degree seems accomplished, an "impossible" principle is suddenly made to work. Past ideas, years of heartbreaking effort, and standards of perfection are outmoded overnight; yesterday's invincible weapon is today's obsolete scrap.

PART III

FULL AUTOMATIC MACHINE GUN DEVELOPMENT

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Chapter 1

MAXIM MACHINE GUNS

Maxim's Early Years

For many years nothing surpassed the American gunmaker's ingenuity. Even refinement of existing firing mechanisms was considered a task challenging the utmost skill of any designer. However, the world did not reckon with a young man from America, Hiram Stevens Maxim, who was for the first time to combine the words "automatic" and "machine gun." He accomplished this by using the power of the recoil forces generated from the explosion of the powder charge in the cartridge to produce the entire cycle of operation. The only human energy now required was for releasing the sear. The internal forces of the gun performed the loading, firing, extracting, ejecting, and cocking of the piece.

Maxim had not previously been a gun designer. His meager schooling had deprived him of the engineering misconceptions preached in his day. He did not believe a better machine gun design was impossible. The simple mechanism he originated as a first attempt worked so successfully that for the last 64 years the famous Maxim automatic machine guns have been basically unchanged.

A summation of his life is given in an attempt to portray the background of this quick-witted American, whose keen observation, native intelligence, and amazing energy have greatly influenced world history.

The Maxim family was of French Huguenot descent. Driven out of France, the ancestors of Hiram Maxim fled to Canterbury, England; then emigrated to Plymouth County, Mass. Here, according to Maxim, "they could worship God according to the dictates of their own conscience, and prevent others from doing the same."

Maxim's great-grandfather lived first at Wareham, Mass., where his grandfather was born. The latter married an unusually large and strong woman, Eliza Rider, also a descendant of early English settlers. This couple emigrated to the district of Maine, not yet a State, and took possession of a tract of land on the shores of Androscoggin Lake, in sight of the White Mountains.

Maxim's grandfather had seven children. The youngest, Isaac Weston Maxim, was the inventor's father. The middle child in the family was Eliza, a very intellectual young woman and a physical giantess like her mother. Throughout the family history there was in each generation one person of unusual physical proportions. The inventor himself claimed he was the strong member of his own generation and cited the fact that in each place he worked he had made it a point to whip every barroom bully. His father was only average in size, being 5 feet 8 inches in height and weighing 180 pounds.

As a young man, Maxim's father assisted on the grandfather's farm. Later he moved to Massa-

Hiram Maxim at the Age of Seventeen.

chusetts, only to return to Maine, and marry Harriet Boston Stevens. They went to Sangersville, Maine, cleared a farm, erected buildings, and started farming. At this place Hiram Stevens Maxim was born on 5 February 1840.

When Hiram was six, the father gave up his farm, and started a wood turning establishment at French's Mill in the same township as Sangersville, where Maxim began his education at the local school.

The boy was a great hunter and natural outdoorsman. He and his brother, Leander, killed many bears, then so numerous in the Maine woods.

A self-educated man, he took advantage of every opportunity offered. An outstanding example was his contact when 12 years of age with a sea captain, who taught him to read longitude and latitude. At this time his inventive genius first became noticeable. Lacking money to buy a chronometer, he made one that worked perfectly. Since he showed quite an interest in this field, his father obtained for him a book on astronomy, as well as Comstock's *Natural Philosophy*. Both were eagerly read by Maxim.

At the age of 14 he was apprenticed to Daniel Sweat, a carriage maker at East Corinth Village. The recommendations stated that Maxim had built an excellent boat, was a natural mechanic, and, though young, was very handy with machinery. Sweat paid the boy $4 a month, although not in cash.

It was summer. Sweat and his crew began work at 5 o'clock in the morning, breakfasting at 7. Work was resumed at 7:30 and continued until the dinner hour, 12 to 1. In the afternoon they labored until a 5 o'clock supper, followed by more duties until sunset.

Years later in New York, men striking for an 8-hour day were told by Maxim, "The 8-hour day is nothing new to me. I used to work 8 hours in the morning, and 8 in the afternoon."

After several months with Sweat, Maxim decided to leave and go back to his father, who had moved to Sangersville Village. On the way he stopped for several days with his uncle, Capt. Samuel Maxim, who suggested that a firm in Sangersville making rakes for farmers might have a place for a young man with his aptitude. Hiram worked with this company until school commenced. While attending school at Sangersville, he supplemented his income by trapping animals.

In Abbot Lower Village, Daniel Flint owned a fine carriage shop equipped with many machines driven by water power. When school was finished that spring, Hiram's father recommended him highly to Mr. Flint, and mentioned the boy's large size, saying that he could do a man's job and do it well. Flint put him to work immediately. The use of power driven machinery made the work easier; the hours, however, were the same as at Sweat's. While with Flint, Maxim started applying his gift of drawing to designing parts, sketching things he thought would be improvements in the carriage business.

After 4 years with Flint, Maxim set up and operated his own grist mill at Abbot Main. Like all grist mills it was infested with mice. While working at the carriage shop Maxim had constructed a few box traps during his off time. The difficulty with these was that after a mouse had been caught, another could not be trapped until the first had been taken out. He therefore decided to make an automatic trap, one that would wind up like a clock and set itself a great number of times. The trap was to be actuated by a coil spring, somewhat like a clock. On the morning after the first one was set, he found it contained five mice. It was the first of the many successful original devices he produced. He made no attempt to patent the trap and years later saw its widespread sale by someone else who had copied it in detail.

Business at the mill involved very little cash, as most of the payments for grinding were taken out in grain, which was hard to sell. So Maxim was again forced to work for Daniel Flint to earn enough to purchase a suit of clothes, as he said, "to get out of Abbot," and obtain more money for his work. Being under age, it was necessary that he have published in the *Piscataquis Observer* what was known as a "freedom notice." In this his father had to state that he relinquished all claim to the young man's earnings.

In Dexter, Maine, he saw Mr. Ed Fifield, who, Maxim understood, needed a decorative painter. Fifield told him the vacancy had been filled but he needed a good wood turner. Maxim applied for this job. Upon learning Maxim had several years' experience as a wood turner, Fifield gave him the position which he held when the Civil War broke out.

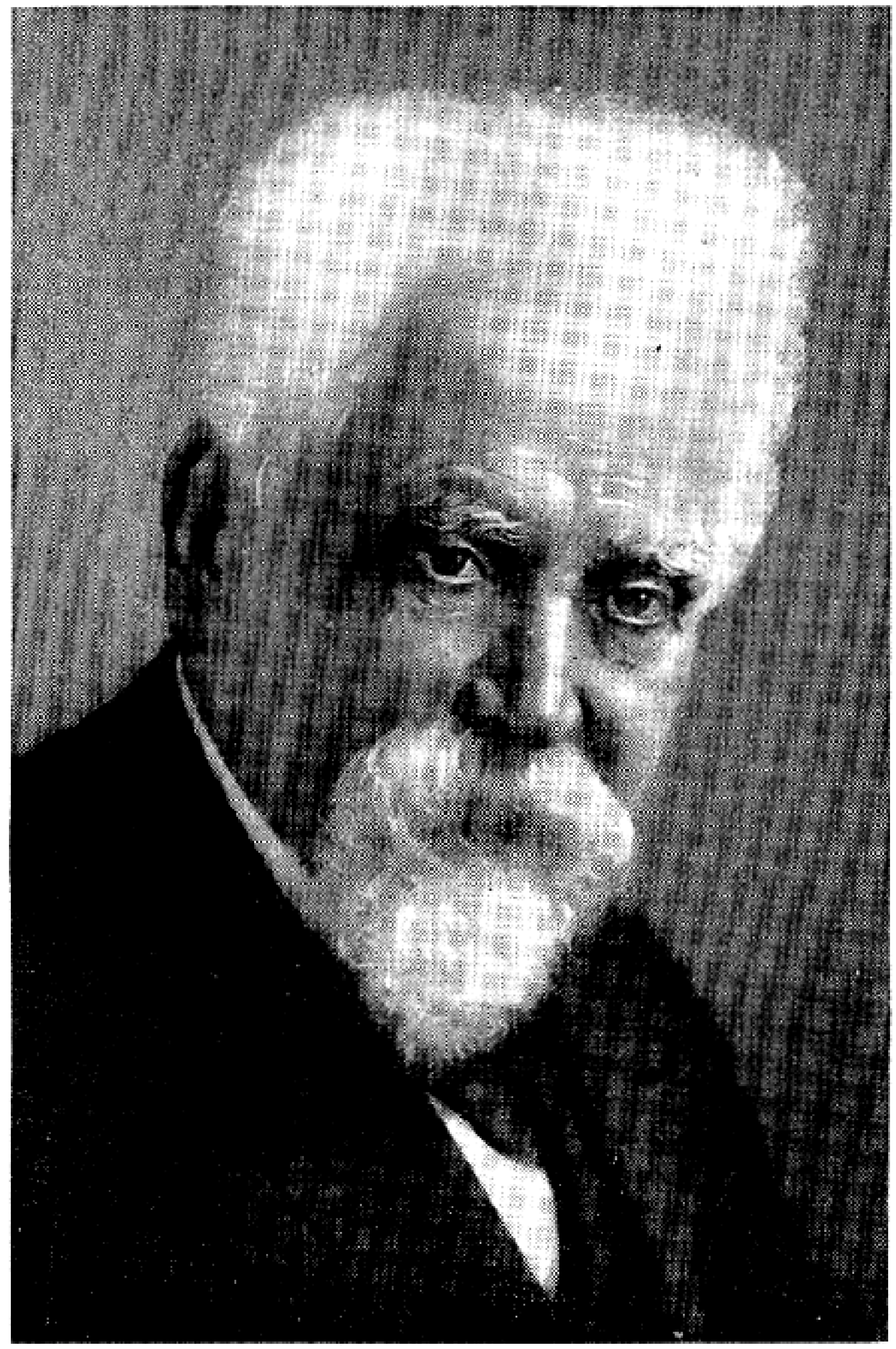
The younger men at Dexter formed a home guard company, with the local shoemaker as captain. They used broomsticks for their drilling in lieu of rifles. Maxim soon tired of what he called "playing soldier." He left the organization and gave his entire time to Fifield's shop. The home guard officers bitterly denounced him for not continuing with the local company.

Their attitude worried Maxim. He sought the advice of an old friend, Dr. Springall, who advised that he was entirely too promising a young man to go off to war and it was hardly worth while, anyway, as every one conceded the war would not last more than 3 or 4 months. And he would have to be seeking another job when it was all over.

Although he was of age, and eligible for military service at the time, he never made another attempt to join the service. A short time after this Maxim left Dexter and went to Huntingdon, Canada. This fact caused people to believe the story circulated by rival concerns at a later date that he deliberately dodged the Civil War draft in the United States by taking up residence in Canada.

While in Huntingdon he was employed in decorating sewing machines, and painting signs for local taverns. He even did some contracting and bartending. Once he had a contract to paint several thousand wooden chairs, for which he received the price of 6 cents each.

While in Canada he tried almost every job imaginable to make a living. One resulted in an unusual achievement. He constructed an entirely new type of blackboard for a schoolhouse at St. Jean Chrisostome, by originating a paint that allowed the chalk to work successfully on plain plaster walls. This would save the school board many hundreds of dollars. He was bitterly disappointed that his work was not accepted with enthusiasm, and had been cut down, as he said, to the price of an every-day laborer. He never forgave the board for this, as it turned out later to be a very valuable invention, and one from which he did not realize a single cent. This influenced him greatly in leaving Canada, which he shortly did. The argument of the school board in refusing to pay him, was that while it would save them hundreds of dollars, he only used 40 or 50 cents worth of materials, and that the $6 he asked was entirely too high.



Hiram Maxim. Picture Taken Shortly Before His Death in 1915.

By this time Maxim's two brothers, Leander and Henry, were in the Army and since it was a policy of the draft board never to take more than two members from one family, he was never called.

Ever seeking to improve his education, Maxim found Ure's *Dictionary of Arts, Mines and Manufactures.* He spent the entire winter reading this book. Later he said it was the background for most of his education. According to him, it amused the girls in the village very much to ridicule him for reading a dictionary. The teasing did not stop his reading. But, he said, it did end his interest in silly young women.

Maxim was soon looking for another job, first in one community, then another. In Boston, he met a young lady whom, after a courtship of a few months, he married. Even this did not settle him. He continued roaming—in the South, in the Far West, and back again in the North—specifically, to Fitchburg, Mass., where he was employed in the engineering shop of his uncle, Levi Stevens. This family connection meant little. The uncle put him to work, like any other novice, cleaning brass off the new castings.

One day some white metal castings were to be made into patterns. The head foundryman gave the job to Maxim, stating, "You are too good a man to work at cleaning castings. The way to get out of your present job is to make a good showing on these patterns that I am giving you."

Maxim followed his advice and did an unusually good job. The foreman showed them to Stevens, who promoted Hiram to a big lathe on rough cast iron work, and he was soon turning out as much work as the average journeyman.

Soon his uncle contracted to make a number of automatic illuminating gas machines for the Drake Co. of Boston, Mass. Maxim was asked to dismantle the prototype machine that had been furnished, and make mechanical drawings. He got together the necessary wrenches for dismantling the working model, put up a draftsman's table, collected the mediocre drawing instruments the office afforded, and started to work the next morning. His uncle complimented him very highly on his skill, and suggested that he never let this particular talent drop.

Maxim explained that he had studied every book he could find on the subject. To encourage this gift, his uncle obtained better drawing instruments and provided him with a regular draftsman's office.

The Drake machines had not been made for many months before Maxim's uncle felt that he, himself, could construct a much better one. He drew up the working details, and then had one made. It was a dismal failure. He then asked Hiram if he would like to try designing one. The machine Maxim planned worked satisfactorily. His uncle ordered patterns made of the latter machine, a New York firm having agreed to sell all that he could deliver.

As Maxim studied the question, he found that by changing the design again, he could greatly simplify the machine and reduce the cost of production. Also by interposing a very powerful box spring between the drive gear and the pump, the pump could be made to continue running for a few minutes while the machine was being wound.

The shop had already commenced to produce the original model, and, as the new design would require tooling up all over again, Maxim's uncle was furious. He seemed to think the improved design should have been drawn first. The disagreement led to Maxim's being fired and again he was out of work. This turned out to be a fortunate event for Maxim. He was employed in Boston by Oliver P. Drake, an instrument maker by trade, who understood his business thoroughly. Maxim was working for him when the Civil War came to an end in 1865.

Gas machines in those days consisted of a wet meter wheel used as a pump, and driven by a falling weight, after the manner of a clock. The air forced into the carburetor came into contact with gasoline. When the machine was at the temperature of the surrounding air, and freshly charged, the gas was very rich and would smoke if used in a common burner. After the machine had been running for about an hour, the refrigeration due to evaporation reduced the density of the gas so that it was just right for the burner. Unfortunately, it did not stop at this density. If many burners were used at the same time the evaporators would become too cold and, as the gas diminished in density, the flame soon became weak.

Maxim suggested to Drake that a density regulator would diminish the richness of the first gas made, and add to the gas made at the end of the evening.

Drake replied, "Yes, that would be splendid, if it could be done. But I think it impossible."

Maxim found by experiments that the air expanded only in the degree that it was carbureted. He also discovered that by putting two meter wheels on the same shaft, one slightly larger than the other, the smaller one pumped air into the carburetor while the larger one pumped gas out. Pressure would be formed in the carburetor if the gas were too rich. This, working on a diaphragm, would open a valve and allow the passage of air from the pump directly into the gas pipe where it would mix with the gas, thus reducing the density.

The first model worked and the principle attained widespread use. He did not get it patented because of the cost. Maxim was led by this experience to try to sell patentable ideas of his to various concerns.

While in Boston a large furniture factory burned for the third time. Maxim was asked to design something to prevent this. He invented and installed the first automatic sprinkler that would be started by the fire itself. It would sprinkle only the place that was burning, at the same time ringing an alarm at the fire house giving the exact location of the outbreak. He installed it in the factory, but met with little success in trying to sell it elsewhere. When the patent expired, however, it was adopted almost universally.

His next place of employment was the Novelty Iron Works of Boston, Mass., where he acted as foreman and draftsman. For this he was paid $5 a day, a considerable sum at that time. Later he received $7.50 a day for working in the company's New York establishment on the East River.

Maxim next went into business for himself and formed the Maxim Gas Machine Co. with offices at 264 Broadway, New York City. This venture was very successful. Mr. A. T. Stewart, one of the wealthiest men in America, gave him a lucrative contract to light his mills and a large hotel in New York City.

People were beginning to talk about electric lamps. Regardless of how clever they might be, designs using alternate means of lighting were doomed. Seeing the trend, Maxim did not try to combat it with an improved version of a gasoline lamp. Instead, he met it by producing a fairly successful electric bulb using carbon. It is recorded that the first electric lights used in New York City were installed by Maxim's company in the Equitable Insurance Co. Building at 120 Broadway, in its day considered to be the most modern in the world.

When electric lighting first came into use in America, everyone wanted to examine the machines which produced the current. Many of these sightseers had highpriced watches which became magnetized and stopped.

Maxim developed a simple machine that could demagnetize a watch in a matter of minutes. At first he charged a dollar each for demagnetizing watches. The flow of business took much of his time. After patenting the machine, he made it available to any watchmaker or jeweler. The demagnetizers were used until the introduction of alternating current, at which time anyone could demagnetize a watch in a matter of seconds.

The instrument was made with a very powerful electric bar magnet rotated on a vertical axis, presenting the north and south poles in rapid succession. The magnetized watch was placed near the magnet, and rotated on a wheel and horizontal axis at the same time. As the crank turned, the carriage holding the watch was slowly withdrawn from the magnet by the action of a screw. By the time it reached the limit of its travel, no trace of magnetism was left on the watch.

Few oceanic crossings by an individual have affected the history of mankind more than Maxim's embarking for Europe on the S. S. *Germanic* on 14 August 1881. This voyage was made after he had held jobs in practically every section of the United States. His current employer had come to the conclusion that it would be to the firm's advantage for Maxim to visit the Electrical Exhibition then being held at Paris, France. During this interval he was engaged by the United States Electric Lighting Co. at a salary of $5,000 a year. By this time Maxim had bestowed upon himself the title of "engineer."

Immediately after his European arrival he received orders from his home office to examine carefully every exhibit of an electrical nature, and describe it in his own words, and to collect and study all circulars and pamphlets on the subject.

He did such a thorough job that he was asked to describe each patent on electric lighting in the French patent office, from the very first one entered to the latest on file. For this job he was assisted by two secretaries and two draftsmen. The important ones were copied verbatim in French, and he wrote his own ideas of their worth to the home office.

At the completion of this project, Maxim examined Belgian patents in the same manner as he had those in France. This work later proved very valuable to his company, as it helped the firm to defend itself against a considerable number of lawsuits for infringement of previous American patents.

The First Automatic Machine Gun

When his home office sent Maxim to London to reorganize the British subsidiary, the Maxim-Weston Co., he noticed that every inventor in Europe, regardless of qualifications, was attempting to perfect some sort of machine gun. While in Vienna on business, it was suggested to him that he also try to originate a machine gun. The person advising this was an American friend, also in Europe on electrical business. Disgusted with the delay and red tape encountered in this field, he stated to Maxim, "Hang your chemistry and electricity! If you want to make a pile of money, invent something that will enable these Europeans to cut each other's throats with greater facility."

Maxim later stated that the idea of his machine gun came to him during some target practice with the Springfield caliber .45–70–405 service rifle, which, when fired, left his shoulder black and blue. With his alert mind he naturally asked himself, "Cannot this great force, at present merely an inconvenience, be harnessed to a useful purpose?"

He instantly saw the uselessness of a machine gun constructed like the Montigny mitrailleuse with its terrific weight and meager firepower. Maxim's idea was to produce a single-barrel weapon that, if possible, would fire full automatic.

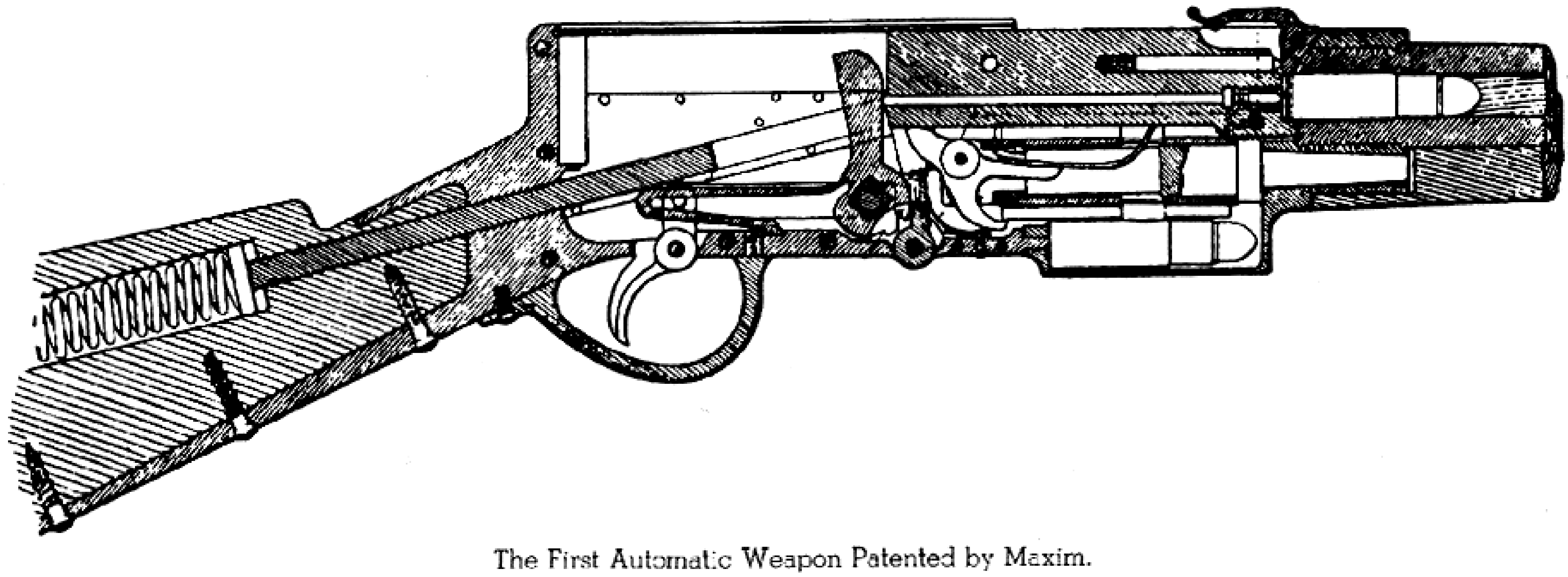
Maxim attempted first to develop an automatic rifle to be fired from the shoulder. It was designed to utilize the kick that he had observed as a young man.

His original drawings in 1883 were for a loose spring-supported heel plate fitted to a standard Winchester rifle, with a series of jointed levers, arranged so that the recoil of the piece against the shoulder operated the loading lever. When the recoil force ceased, the action of the spring-loaded butt stock pressed the rifle away from the shoulder and locked the action in battery ready for firing again. The specifications on another early drawing showed a blowback fully automatic rifle fed by a revolving magazine of the Roper type.

At this time a London broker, in an attempt to sell shares, made the exaggerated announcement in English newspapers that "Hiram Maxim, greatest electrician in the world, has been engaged to come to London to reorganize the Maxim-Weston Co. at Bankside."

This publicity was the occasion for much ridicule directed at the American. It influenced him greatly in breaking away from the electrical end of the business and devoting his time solely to the development of the machine gun.

Inspecting his newly reorganized factory, he observed a Brown and Sharpe milling machine. Maxim asked that the machine be assigned to him, and it was upon this American-made product, which in background and origin itself came from the early gun industry, that Maxim made



The First Automatic Weapon Patented by Maxim.

the first working model of a fully automatic machine gun.

He set up a small workshop at 57 Hatton Gardens, corner of Clerkenwell Road. Bringing with him the milling machine used at Bankside, he purchased additional American lathes, planers, drill presses, and other tools necessary for the work. He did not attempt to make the barrel for his machine gun, but purchased suitable ones from the London office of the Henry Rifle Barrel Co. These barrels, used in Maxim's first experiments, were the product of the outstanding American gun designer, Tyler Henry, then president of the Winchester Arms Co.

When Mr. Purvis, superintendent of the Henry Rifle Barrel Co. of London, heard that Maxim planned to construct a fully automatic machine gun, he said, "Don't do it. Thousands of men for many years have been working on guns. There are many hundred failures every year. Engineers and clever men imagine that they can make a gun do as you have described. But they have never succeeded. They are all failures. So, you had better drop it and not spend a single penny on it. You don't stand a ghost of a chance in competition with regular gun makers. You are not a gun man. Stick to electricity."

Maxim replied, "I am a totally different mechanic from any you have ever seen before, a different breed."

The barrels were delivered, chambered for the .45 caliber British Gatling gun cartridge of that day, having an 80 grain black powder charge and a 485 grain bullet.

Maxim took his drawings to a local pattern maker. However, the first brass castings delivered for the prototype were not satisfactory because of faulty patterns.

In describing the work on his first model, Maxim states that, as tools were required for the various machines, he forged and tempered them himself. His helpers thought it exceptional for a man in his position to do a blacksmith's and toolmaker's work.

There was no precedent for Maxim to follow. No one before had ever carried experimentation to this point, as it was generally believed that recoil forces would not be adequate to operate machine guns successfully. Maxim ignored these dogmas and continued with his original idea. By fabricating the components and fitting them together by hand, he saw his experiments evolve into a mechanism that showed promise of success.

It was still necessary for him to conduct a series of tests before he could make final mechanical drawings. He constructed an apparatus by which he could determine the force and character of the recoil and find the distance that the barrel should be allowed to retract, in order for the projectile to clear the bore and let the gun be safely unlocked. All the hand-made working parts were easily assembled. After adjusting them to produce what he thought would be successful results, he placed six cartridges in the feedway and pulled the trigger. They all fired in what was later estimated to be half a second.

Maxim saw certain success ahead, and worked day and night on his drawings until they were finished. Then in his machine shop he proceeded to build a gun rugged enough to meet required demands.

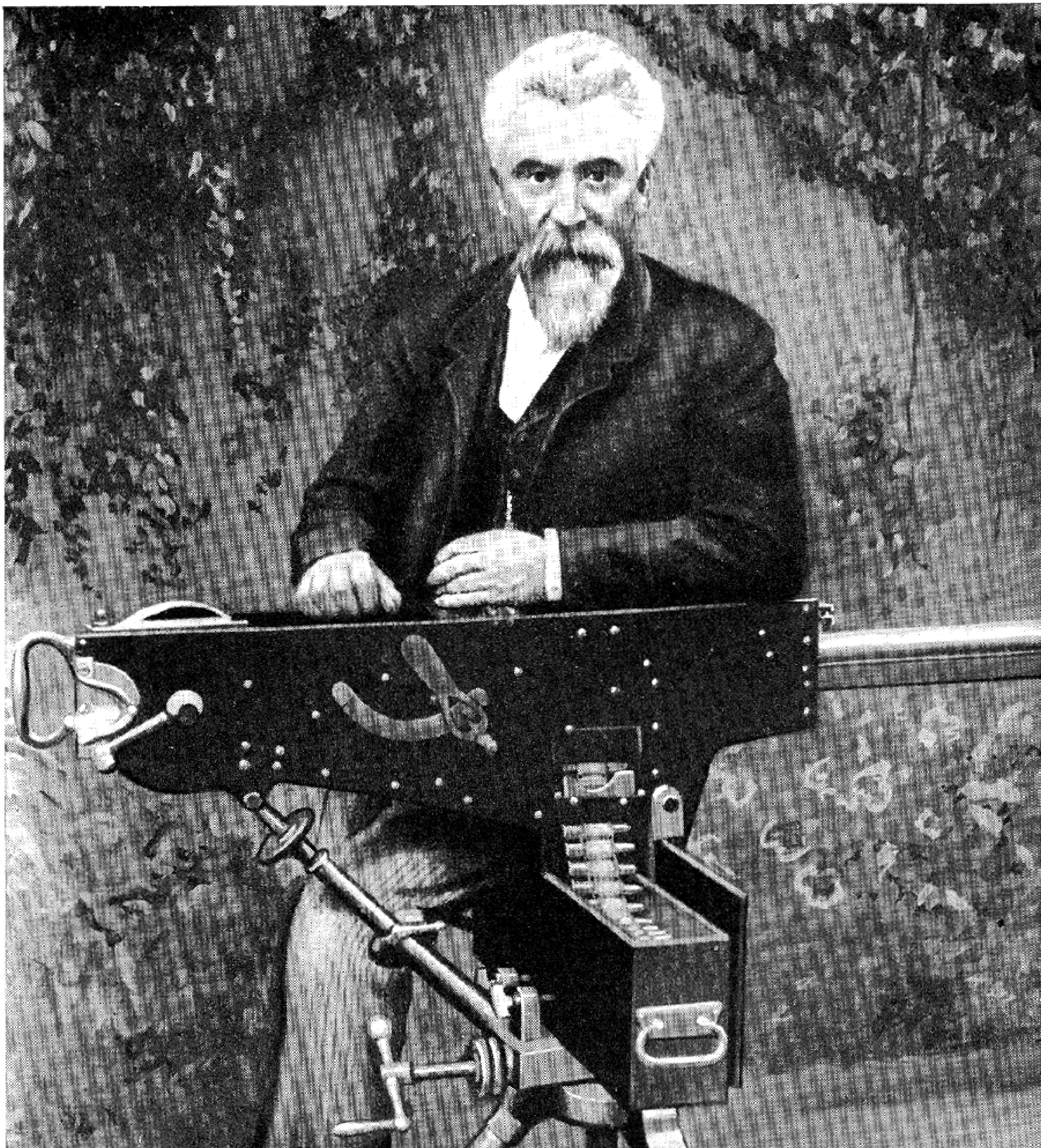
In the spring of 1884 he had progressed to a point where his experiments resulted in a finished product. His original model is now at the South Kensington Museum in London, and is labeled, "This apparatus loads and fires itself by the forces of its own recoil, and is the first apparatus ever made in the world in which energy from the burning powder is employed for loading and firing the arm."

If the single-barrel Gardner is closely compared with Maxim's prototype, it is evident that the action of the former was taken under study by Maxim as the most logical weapon then in existence with which to apply the theory of automatic fire.

Faced with the problem of constantly increasing momentum if the bell crank be allowed continuous rotation, Maxim restricted its motion to three-quarters of its circumference in bringing the bolt back to battery. Firing at this point reversed the rotation.

This not only prevented increased inertia, but likewise eliminated the danger from hangfires, as the mechanism had no means of operating until energy for commencing the next cycle was generated by the fired round.

It is believed that Maxim's earliest experiment resulting in his first successful automatic fire was



The First Model Maxim Automatic Gun.

one with the conventional post type vertical feed. Realizing that his success would not be complete until he had devised a way to make the weapon continuously feed cartridges from its own energy, he next designed two systems of feed, both operated from surplus barrel recoil energy, first the flat type drum and finally the belt. He perfected the latter, having concluded that it was the only practical system for sustained fire.

He produced several hand-made guns before he let it be known to the press that "Hiram Maxim, the well-known American electrician in Hatton Gardens, has made an automatic machine gun with a single barrel, using the standard caliber .45 rifle cartridge, that will load and fire itself by energy derived from the recoil at a rate of over 600 rounds a minute."

Everyone thought this was somewhat like the advertisement for the "world's greatest electrician" and a bit of Yankee brag. But this time he was waiting with the finished product to squelch any scepticism.

The first person of any prominence to see the new weapon was Sir Donald Currie. A day or so later, Mr. Matthey, a dealer in precious metals in Hatton Gardens, brought His Royal Highness, the Duke of Cambridge. The Duke was delighted and congratulated Maxim on a great achievement. This seemed to be the signal for everybody in London interested in such matters to visit Hatton Gardens to see the phenomenon.

The first cartridges he fired were manufactured by the British Small Arms Co. Many proved faulty. He applied to the government for better ammunition and was sold the latest lot number available, which proved satisfactory.

In demonstrating his weapon, Maxim personally fired over 200,000 rounds. Government authorities became interested in his gun. Lord Wolseley, accompanied by a large number of high ranking officers of the War Office, made an appointment with Maxim. At the designated hour Maxim fired thousands of rounds of ammunition for them. Afterwards, Lord Wolseley said to Maxim, "It is really wonderful, you Yankees beat all creation. There seems to be no limit to what you are able to do."

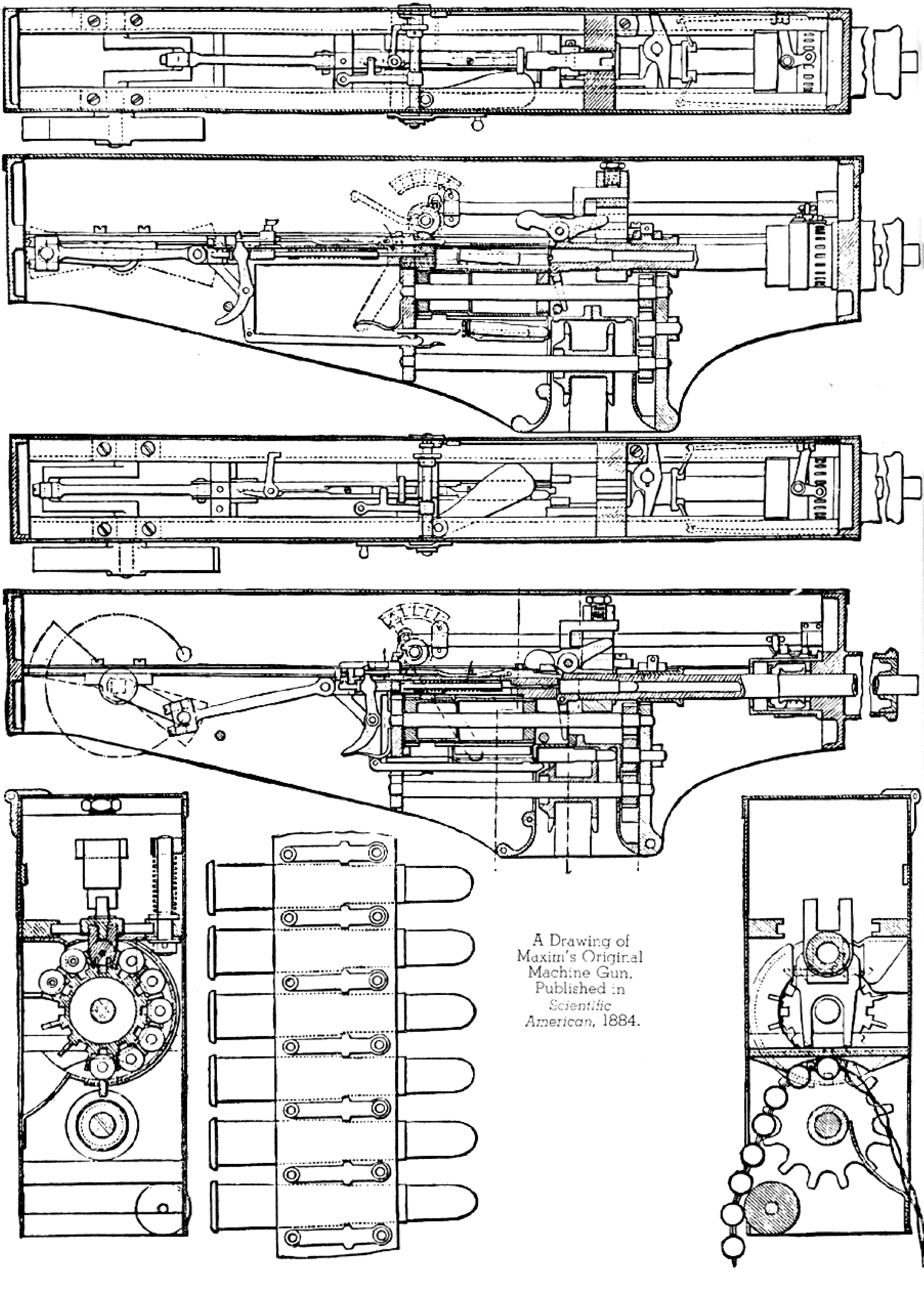
One of the officers in Lord Wolseley's party was Lt. Gen. Sir Andrew Clarke, inspector general of fortifications. He advised the inventor to simplify the gun as much as possible and said, "Do not be satisfied until it can be disassembled, examined, and cleaned with no other instrument than the hands."

Taking his advice, Maxim immediately redesigned the feed system, and simplified the working mechanism, so that, if anything injured it, the components could be taken out and replaced in 6 seconds.

The only change from the prototype in what is known as the first model had been a refinement for the purpose of making a presentable gun for demonstration. Having proved the weapon, he now felt it advisable to lighten the gun as a whole and add the features suggested by General Clarke, until its high rate of fire, combined with its light weight and simplicity, would be a selling point. Basically it remained the same with the single barrel supported in a jacket by front and rear bearings.

At the moment of firing the recoil drives the barrel rearward for practically three-quarters of an inch. It is this movement of the barrel alone that unlocks the bolt and actuates the mechanism of the gun, producing continuous fire. The cartridges are placed in a canvas belt, similar to those worn by the sportsmen of that day. Each belt is seven yards long holding 333 cartridges with a clip device on the end for attaching another loaded belt. An external firing and rate control arrangement consisting of a lever placed against a graduated quadrant at the side of the gun determines the rapidity of firing. If the lever, or selector, is pulled toward the gunner until the pointer indicates the figure "1" on the quadrant scale, the gun will fire at the rate of one round per minute. By pulling the selector farther to the rear the rate of fire is gradually increased in proportion to the rearward travel of the lever, until the end of the scale is reached. Then the fire is maintained at the rate of 600 rounds per minute.

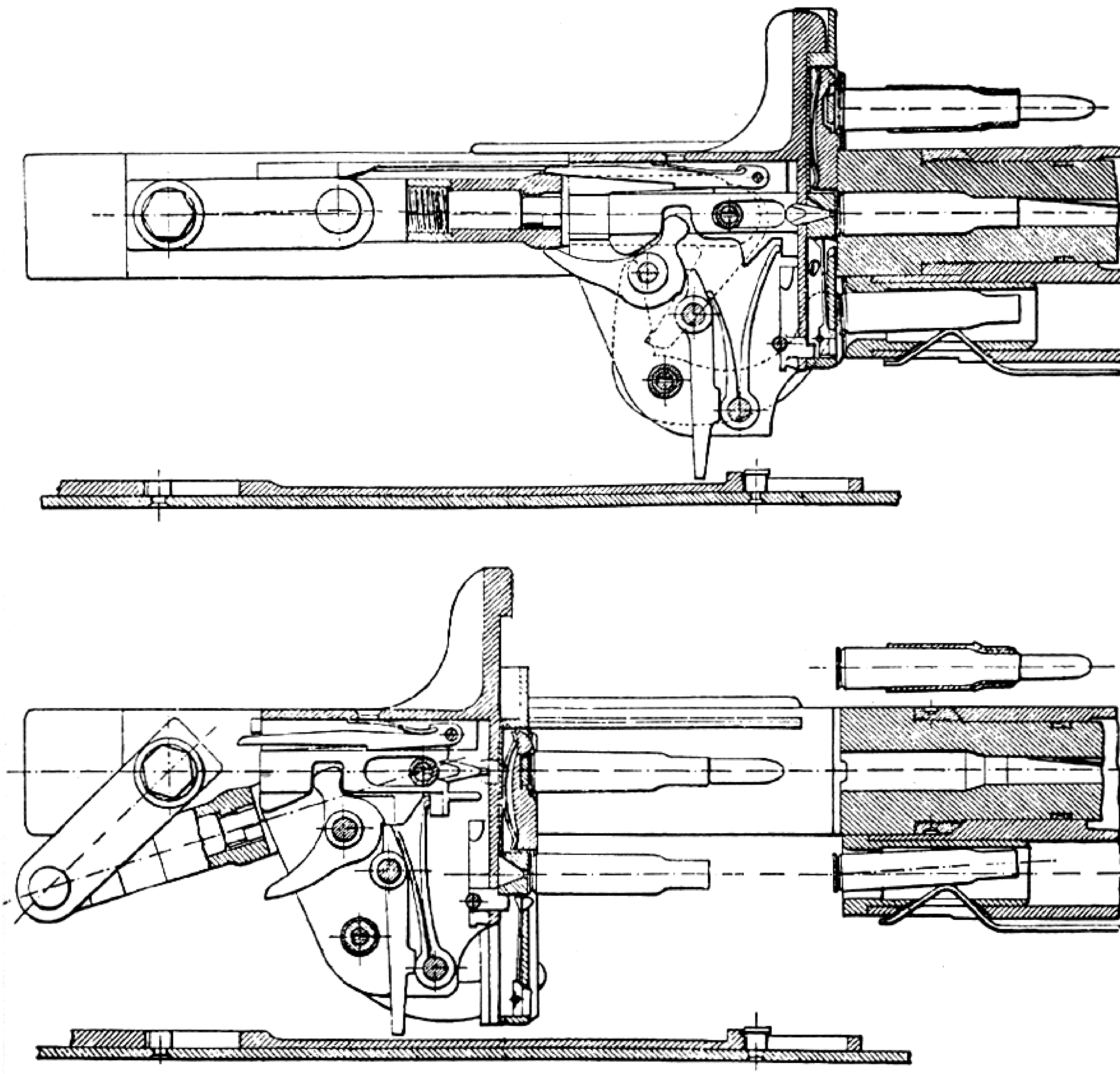
It was possible to fire a single shot, bursts of 10, 20, or 100 per minute and to maintain a continuous fire, fast or slow. When a rate had been selected, the gun would fire at that speed, independent of human agency, until all the cartridges had been discharged. Should the man working the gun be killed, the gun would still continue to fire.



A Drawing of Maxim's Original Machine Gun. Published in *Scientific American*, 1884.

The rate-of-fire regulator found only on the very first model Maxims employed a simple hydraulic oil buffer arrangement. It controlled the speed of counter recoil by which the weapon returned to battery by varying the size of the orifice in the buffer tube through which the oil flowed. The weapon would complete the recoil movement without restriction but the return movement was checked by the oil and piston method. If the weapon's regulator was set for "Open," the operating parts returned to battery unrestricted and a rate of fire of 600 shots per minute was maintained. If the orifice was closed, however, the return speed of the battery was slowed to any length of time desired, including a creeping action of a minute or more. While this device was very impressive, it was of small military value and was soon dropped.

Besides the system of feeding from a belt, Mr. Maxim devised another plan in which 96 cartridges are placed in a flat brass drum on top of the gun. The movement of the bolt rotating the drum, withdraws the cartridge and forces it into the feedway to be positioned in the chamber.



Breech Mechanism of the Improved Maxim Gun.

When the empty drum is removed, another can be substituted without stopping the operation of the gun, as an auxiliary magazine holds enough cartridges to maintain continuous fire.

Gen. Sir Gene Graham (Royal Engineers) preferred the belt feed to the drum feed and suggested that Maxim bend all his efforts to producing a gun that fed in this manner.

The machine gun belt feed was also used with Maxim's automatic rifle fired from the shoulder. In one instance, he altered a Winchester rifle so that the recoil extracted the empty cartridge case, ejected it, cocked the hammer, closed the breech, and performed all necessary functions except pulling the trigger. The inventor also made another gun in which all these operations were performed by means of a slight elongation of the cartridge case at the moment of firing, the case being corrugated to afford the required extension. The last-described system scarcely seems practical.

French Army officials, upon hearing of Maxim's automatic machine gun, invited him to demonstrate it before them. One of their first questions was whether it would be possible to produce one with a controlled rate of fire; they did not know the weapon already had this feature. Their idea was a gun firing automatically, but with a prolonged delay between shots, to be securely locked in position covering a breech in enemy fortifications. The intermittent shots, sighted in during daylight hours, would prevent men from working after dark in the target area.

For answer, Maxim fired the initial round, adjusting the regulator for one shot per minute, and left the gun by itself. While waiting for the second shot to explode, a young lieutenant approached, requesting to see the gun in action. Upon being told by Maxim that the gun was firing, he refused to believe it.

In a few seconds the gun went off by itself. The young lieutenant then waited with watch in hand. One minute later the gun went off again. He threw the remains of his cigarette on the ground, and walked off, exclaiming that while he had seen it, he still did not believe it.

To the French officers, Maxim described the weapon as an engine: the gunpowder in the cartridge being analogous to the steam; the breech block, the piston; and the trigger, the valve gear. These basic characteristics have remained in every machine gun from that day to this.

Maxim's early successes led him to experiment in earnest on automatic guns from 1883 until 1885. During this time, insofar as it was possible, he patented every conceivable method by which automatic fire could be obtained.

The principle he decided to be the most practical was what is known today as the short recoil system. To this he added the ingenious features of initial extraction, adjustable headspace, an accelerator that transferred energy from the recoiling barrel to the bolt assembly, the **T**-slot extractor, and "wipe" ejector. These methods have not been improved on.

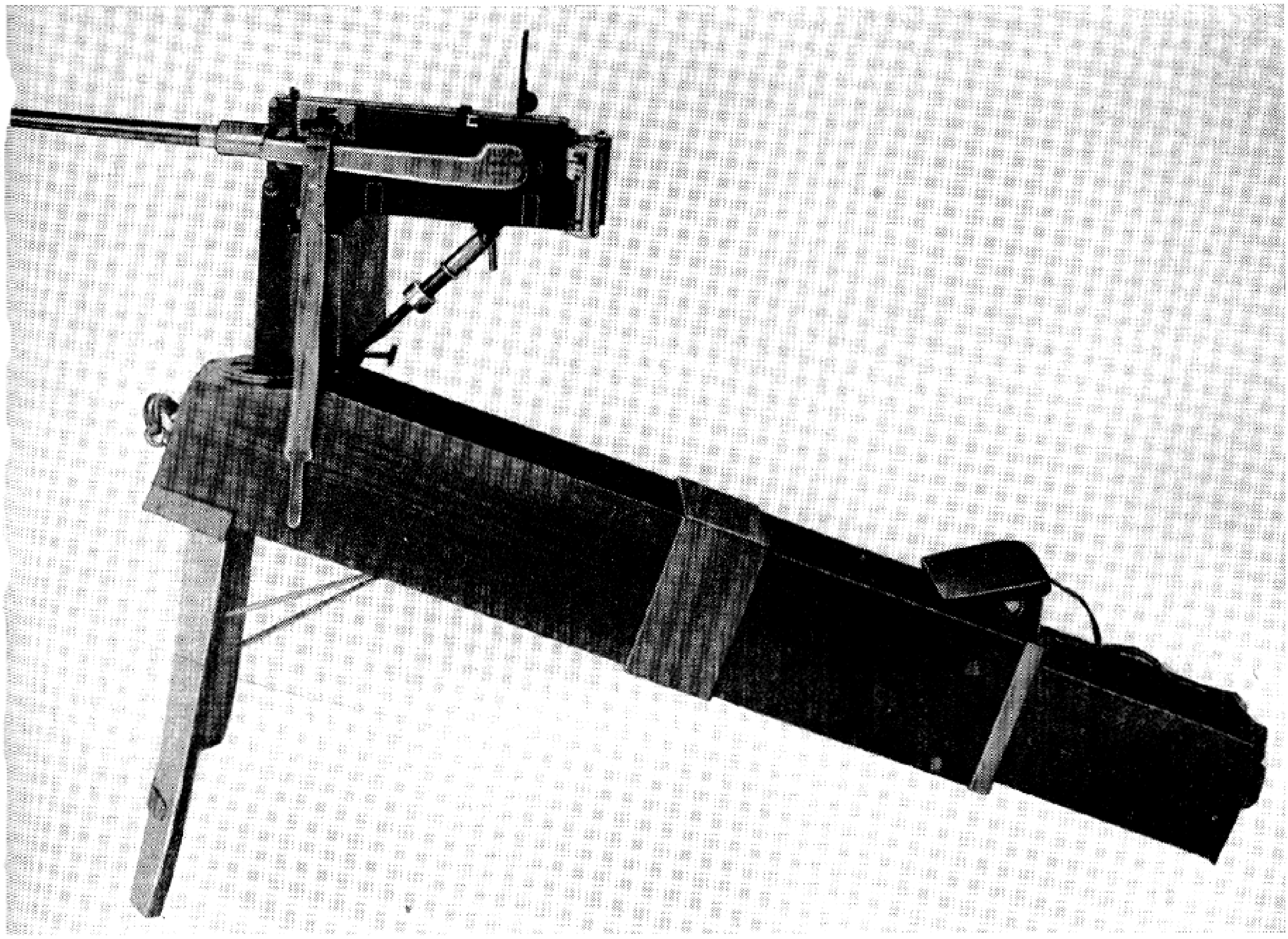
During the summer of 1885 the general public was shown the Maxim gun at the Inventions Exhibition in South Kensington, a small contract having been let to Albert Vickers, the steel producer of Crayford in Kent, for the manufacture of the gun. At the Inventions Exhibition the gun was fired daily for the crowds.

To operate the weapon, the gunner inserts the loaded ammunition belt in the right side of the gun and raises the safety catch. This permits the thumb piece to be pushed forward, actuating the trigger bar and sear and releasing the firing pin. As the powder charge in the cartridge is ignited, pressure is built up, and the projectile starts through the bore. During this time the barrel and bolt are securely locked.

After recoiling three-quarters of an inch, the bolt is unlocked. The crank engages the unlocking cam, breaking the toggle joint and freeing the bolt. The recoiling forces are now able to accelerate the bolt assembly to the rear and rotate the crank. This winds the actuating chain, loading the extension-type driving spring while the recoiling mechanism completes its rearward stroke.

The initial rotation of the crank pivots the cocking lever, forcing the firing pin back against its spring, until the sear engages the sear notch of the lever.

At the first movement of recoil after unlocking, the sliding boltface (**T** slot) begins simultaneous extraction of the empty case from the chamber and withdrawal of a loaded round from the belt. Continued rearward movement engages cams in the receiver to force the sliding boltfac



A Demonstration Gun and Mount Used by Maxim. The Wooden Case Was Used as a Tripod When Firing and to Contain the Gun and Ammunition During Transportation.

downward, bringing the loaded round in alignment with the chamber, and the empty case in position for the ejection tube. The loaded cartridge is held securely in place by a latch arrangement located in the face of the **T** slot.

During recoil a cam lever action moves the entire feed block slide to the right. The top feed-pawls move over to engage the incoming round in the belt (being held in position by the bottom belt-holding pawl), at the same time compressing the barrel return spring. After completing its full recoil stroke, the forward action of the barrel and barrel extension returns the feed block slide to the left, bringing the next live round in the ammunition belt into position against the cartridge stops for engagement by the sliding **T** slot.

The complete force of recoil having expended itself, the extended driving spring starts the movement of counter recoil. As the bolt moves forward, the cartridge to be fired is positioned for chambering. When this is accomplished, the **T** slot rises, "wipes" itself clear of the spent case and slips over the rim of the incoming round in the belt.

When the bolt has reached its extreme travel forward, the toggle joint is forced slightly below the horizontal by the connecting rod. At this securely locked position the sear is depressed and disengaged from the firing pin, removing the safety feature, so that continued pressure on the trigger piece permits automatic fire.

The above cycle represents the basic operating principle on which were constructed all future Maxim and Maxim-Vickers guns (later internationally called the "Vickers"). There were from time to time a few modifications such as muzzle boosters to accelerate recoil, changing the direction of throw of the toggle joint, various attempts to aid unlocking, and numerous miscellaneous refinements, but nothing that ever affected the original principles of the gun. Although Maxim chambered the weapon to shoot practically every form of cartridge in existence, ranging from black to smokeless powder and from rifle caliber to artillery ammunition, the mechanism remained the same except for weight, rate of fire, systems of cooling, and mounting.

First Trials of the Maxim Gun

When the light version was finally satisfactory to Maxim, he displayed it at Hatton Gardens. Here Mr. Pratt, of the Pratt and Whitney firm, viewed the weapon. One of the finest machinists in the world, this old friend of Maxim's voiced his amazement, "If any one had told me that it would be possible to make a gun . . . do all these things in the tenth part of a second, I would not have believed it . . . But now I have seen it with my own eyes."

Maxim was wined and dined by London society and met many distinguished personages. On one occasion His Royal Highness, the Duke of Cambridge, took him by the arm, saying, "Come with me, Maxim, and I will introduce you to everyone here who is worth knowing." There were several members of the royal family present. Maxim capitalized on these contacts.

A short time later he received an invitation from the then Duke of Sutherland to spend a week end at Trentham, where he met the Duke of Manchester, Sir Reginald McDonald, and a Mr. Henry Stanley, later famous as the African explorer who found Dr. Livingston. Maxim and Stanley became fast friends. And Maxim humorously mentioned later how they hid out many times to keep from going to church, an act expected of all the guests.

Maxim always leaned strongly toward what he termed "book learning." Whenever he took up anything new, he read everything that could be found on the subject. As he had commenced to make guns, he purchased and read gun books, military documents, and the like.

One day a bookseller obtained for Maxim a very large volume supposedly published for the exclusive use of army and navy officers. In it, Maxim saw at once a fallacy of reasoning. The designer was calculating a "one-shot" weapon. Repeated shooting would destroy it if constructed on such erroneous calculations. Maxim felt that, if international authorities dispensed such false doctrine, the profession needed practical experience in gun design.

Mr. Pratt, before leaving London, again visited his old friend, and stated he had never made successfully a certain type of gun actuating spring last more than a few rounds. Maxim told him a secret process for constructing springs which an old gun maker had taught him. Pratt, after returning to the United States, wrote how successful this method had been. The springs made following Maxim's instructions had all been tried thousands of times on a testing machine devised by Pratt without any indication of breaking.

The British Government's first order for a Maxim gun specified that it must weigh less than 100 pounds, and be able to fire 400 shots in 1 minute, 600 shots in 2 minutes, and a thousand in 4 minutes. Three guns were supplied to the British Government for trial in March 1887. They easily passed the test. The last fire delivered a thousand rounds in a minute and a half, having previously passed the sand and rust test. The three guns were then purchased by the government. Yet the machine gun was not adopted as a weapon in the regular British Army at this time, although the territorials and militia acquired and used several on their own initiative.

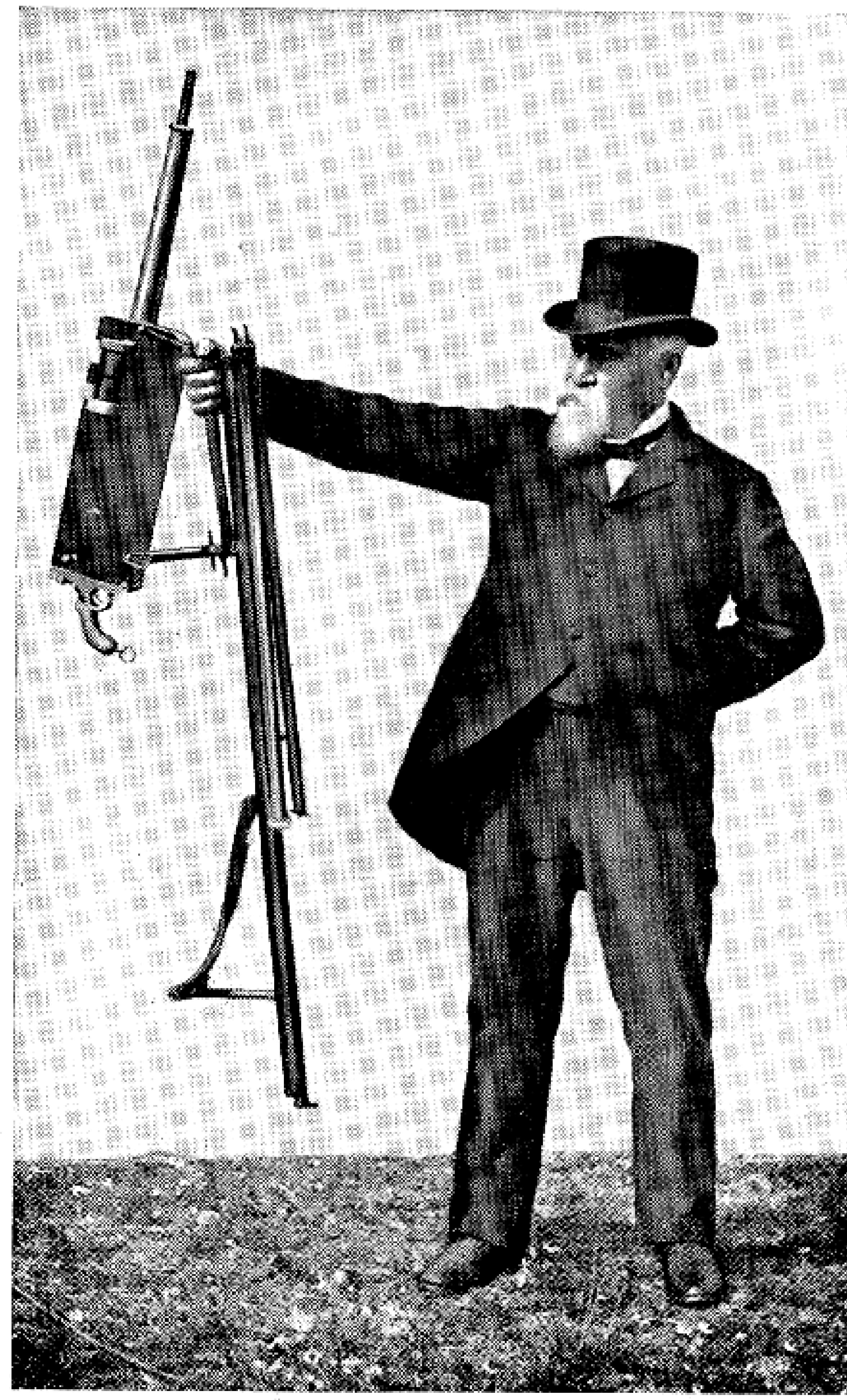
Maxim had unlimited confidence in his gun. When he received an invitation to fire at Enfield for an official trial, he was delighted. After having passed every test easily, he placed the gun on an ordinary tripod, put in a double cartridge belt that contained 666 rounds, and fired them all in 1 minute. As an added attraction, he provided himself with a very large ammunition box and a belt containing 3,000 cartridges. The gun was placed on a naval cone, such as used for machine guns on battleships. The bottom of the cone was filled with water and compressed air. Upon pulling the trigger, a valve was opened allowing the water to circulate inside the water jacket. This provided a cool gun. Maxim introduced the belt and pulled the trigger. The cartridges ran through the gun at the rate of 670 a minute. Many of the bystanders had to leave before the belt was emptied because the constant firing hurt their ears.

In 1887 Maxim also took one of his automatic machine guns to Switzerland for trial in competition with the Gatling, the Gardner, and the Nordenfelt. The two-barrel Gardner had already beaten the field and large orders were expected. Maxim wrote to the authorities telling them what his gun could do and asking them if they would allow him to fire it in Switzerland in competition with the Gardner. On this occasion he was accompanied by Mr. Albert Vickers, who was now deeply interested in the business. Their gun had been chambered to use a certain German-made cartridge which was not quite so large and powerful as the English. When testing it against the Gardner, they found the latter was using a new cartridge of smaller bore and longer range. To compete with the improved Gardner cartridge, Maxim dipped his projectiles in hot beeswax and tallow to prevent barrel fouling and lubricate the bore. Vickers did the firing and showed great skill as a machine gun marksman, as he outshot the Gardner in spite of its improved ammunition.

The next trials were in Italy at Spezzia, in competition with the Nordenfelt gun, which had already been thoroughly tested and the performance of which was definitely known.

The Maxim gun was lighter and by trial proved much faster and more accurate. Fewer men were required to work it. Next, the Italian officer in charge of the test requested Maxim to submerge the gun in the sea, and allow it to remain there for 3 days. At the end of the period, without cleaning, the gun performed as well as it did before subjection to this unusual demand.

After Italy, the next demonstration was held in Vienna, where thousands of rounds were fired before high ranking army officers, who expressed their amazement that a little gun could fire so fast, and that the crank handle should turn without anyone touching it. Among the high officials who came out from Vienna was His Royal Highness, Archduke William, the Field Marshal of the Austrian Army. He greeted Maxim warmly, and looked with great curiosity at the gun. Maxim showed him the working mechanism and explained all the parts in detail to him. He was then asked to fire it at various ranges. Vickers



Hiram S. Maxim Holding the Light Maxim Gun and Mounting.

and Maxim alternated in operating the weapon and fired practically the entire day. After the test, the archduke approached the party and congratulated them on the performance of the weapon. When asked by Maxim if it fired fast enough to suit him, he answered, "Indeed, too fast. It is the most dreadful instrument that I have ever seen, or imagined."

During this Austrian test, Maxim used British-made cartridges. While the officers were well pleased with the gun, they insisted on having one that used their own rifle cartridge, which Maxim agreed to make on his return to England. Unfortunately it was illegal for anyone to take one of the Austrian service cartridges out of the country. He had to content himself with a mechanical drawing and a piece of unprimed brass. Upon his

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return to England, he ordered a lot of cartridges made according to the specifications. But it appeared that the manufacturer, the Birmingham Small Arms Co., did not understand continental weights and measures. The shape and size of the completed round was correct, but the powder charge was considerably lighter than that of the Austrian cartridge. Maxim attempted to fire the ammunition and found that it would work successfully if the springs were lightened to compensate for the weak charge.

On 7 July 1888 the Austrian committee on the Maxim ordered a preliminary trial with two rifle caliber guns (one 11-mm). They were satisfied as to rapidity of fire, simplicity and ease of manipulation. At 200 meters, 30 shots, all hits, were made in 3 seconds. At 400 meters the same story was repeated. At 600 meters there were 40 rounds in 4$\frac{3}{10}$ seconds, all hits. At 1,000 meters, 40 shots in 4 seconds produced 36 hits. At 1,200 meters 25 shots in 2$\frac{5}{10}$ seconds gave 24 hits. Again at the same range, 40 shots in 4 seconds gave 29 hits. At 1,400 meters 60 shots fired in 6$\frac{1}{10}$ seconds gave 46 hits. And at 1,575 meters, 60 shots in 6 seconds gave 45 hits.

For a reliability and endurance test, 13,504 shots were fired without serious mishap. The cartridges were supplied in belts each containing 333 rounds and averaged 10 rounds per second during the entire test. The original mainspring was of insufficient strength, and gave way after 7,281 rounds. A striker broke after 10,223 rounds and a buffer failed after 11,418 rounds. But these were easily replaced on the scene in a few seconds, and the firing continued. The committee reported strongly in favor of the Maxim. After 6,356 rounds the accuracy was found to be excellent.

The official report stated, "Wet does not impair the mechanism; dust diminishes the speed of firing, but the mechanism, especially the feeding apparatus, is very susceptible to wet and dust combined. If certain reserve parts are supplied, and the buffer spring made stronger, the efficiency of this machine gun is guaranteed under all circumstances."

The committee concluded with this significant summation: "From the foregoing results it is evident that the original favorable judgment formed after the preliminary trials was justified. It can therefore be asserted that of all systems of machine guns hitherto tried, the Maxim is the best adapted to the purpose for which it is intended."

The next test was in Germany. Although the gun worked perfectly, no decisions were made for a long time. Thousands of rounds were fired, but still no orders were received. While things were in this state, His Royal Highness, Albert Edward, Prince of Wales, visited the Kaiser. When the conversation turned to arms, the Prince asked the Kaiser if he had yet seen the Maxim gun. He said he had not, but had heard a lot about it. The Prince told him that it was really a wonderful weapon, loading and firing itself 600 times a minute. As the gun was at Spandau, only a short distance from Berlin, the Prince suggested they see it. A day or so later, the Kaiser and the Prince visited Spandau where elaborate preparations had been made to show all forms of machine guns. A total of 333 rounds were to be fired from each gun under test at a large target located 200 meters distant. The Gatling gun, worked by four men, fired the cartridges in less than a minute. The same number of men fired the same number of rounds from the Gardner gun in a little over a minute. The Nordenfelt also was fired in approximately the same time. Then Maxim advanced, took his seat on the trail of his automatic gun, pressed the trigger, and 333 cartridges were fired in less than half a minute. The Kaiser, much impressed, walked over to the gun; placing his hand upon it, he said, "That is the gun—There is no other."

Had Maxim tried to market his invention a short time earlier, there is ample reason to believe that he would have found his task more difficult. Several powers were alert for an improved gun when his was introduced. Had he found all war departments completely stocked with hand-operated weapons, he would have had no purchasers. Italy already owned many Gardner hand-operated machine guns. She ignored the new, expensive automatic, as did the United States. The hand-cranked Gatling was relied upon in this country 10 years after the British service had purchased the Maxim full automatic.

In 1887 Maxim took his gun to St. Petersburg, Russia. Here he used the well-made English cartridges on which he could rely. It appeared to Maxim that the Russian officers were very impatient, and looked with contempt upon his little gun. One young officer went up to it, took hold of the crank, turned it backwards and forwards, and said in French, "It is absolutely ridiculous for anyone to pretend that this gun can be fired 600 rounds in a minute. No man living can turn this crank handle backwards and forwards more than 200 times in a minute."

The Russian even offered to bet any reasonable amount that the gun could not be fired as fast as 200 times a minute. Maxim chose to answer him by placing a belt of cartridges in the gun and fired 333 shots without stopping. The handle that the officer was talking about worked so fast by itself that it was impossible to see it. The officers present had not the least conception of what an automatic gun really was. Any gun in Russia was said to be automatic when one turned a handle to fire it. Newspapers described it as "a gun that would load and fire itself simply by turning a crank handle."

The Russians, seeing the handle working by itself and the center of the bulls-eye shot away, were wildly enthusiastic. But Maxim encountered much red tape in Russia. He had not been in St. Petersburg 2 weeks when he was informed he must either leave the country or go to police headquarters and give an account of himself. A friend, Mr. de Kabath, went with him.

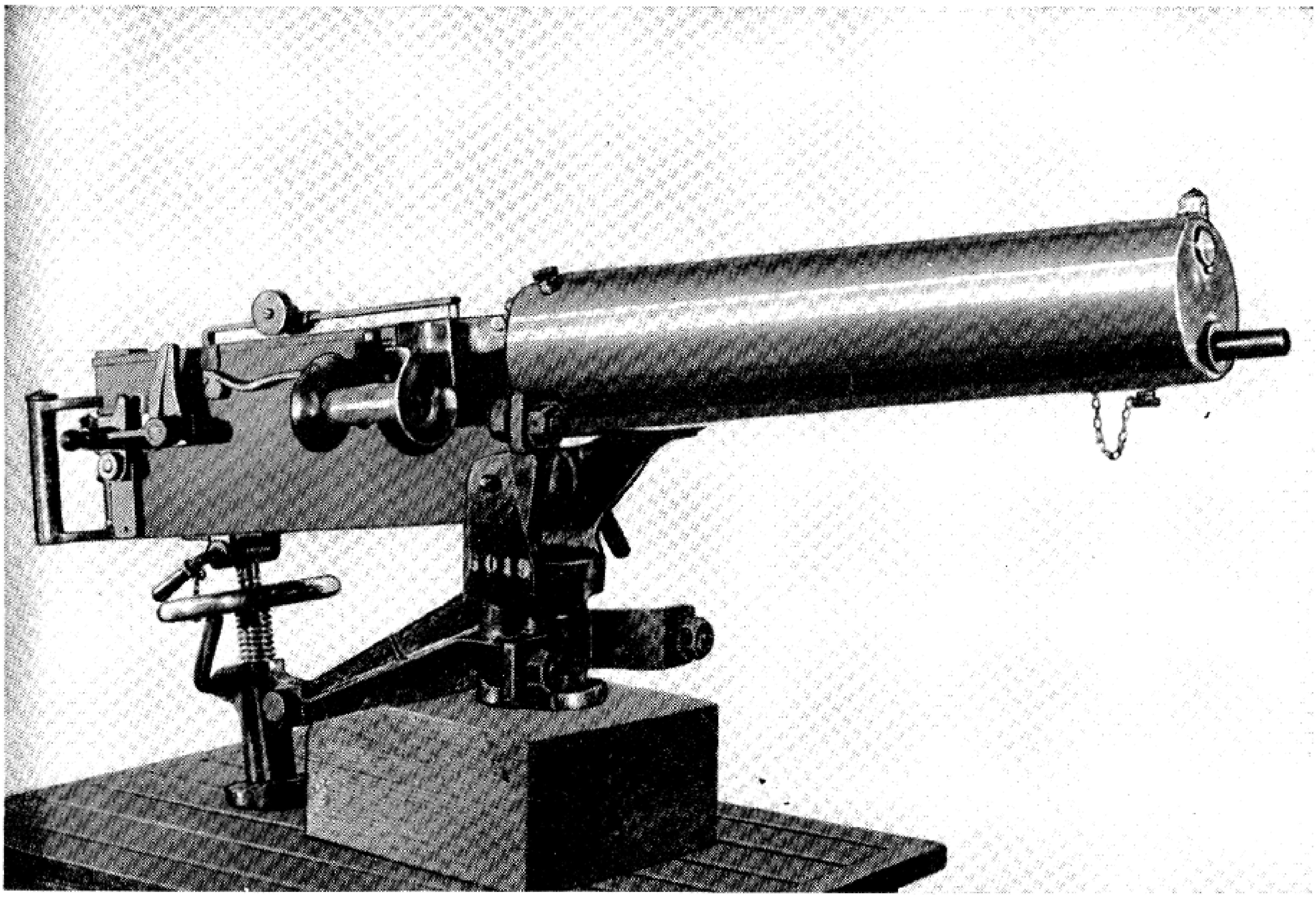
The official spoke English perfectly, and commenced by asking Maxim how old he was and where he was born. Maxim told him.

"What religion have you?"

"None whatever, never had any."

He was told no one could remain in Russia unless he had a religion. He replied in that case he would most certainly have to find one—what particular brand did the officer recommend?

Mr. de Kabath suggested that it was more popular to be a Protestant.



Maxim Machine Gun, Model 1893, Cal. .45.

Maxim asked if a Protestant was not one who protested against something? The Russian admitted that such was the case.

Maxim then said to the official, "Put me down as a Protestant. I am a Protestant among Protestants. I protest against this whole thing." In that way, Maxim said, he became a member of the Protestant church.

Although the Russians moved slowly, they finally purchased vast numbers of Maxim guns. Later, observers reported that over half the Japanese casualties in the Russo-Japanese War were inflicted with the Maxim gun.

On 23 April 1892, Maxim published an article in *Engineering,* from which the following is quoted:

"Of late there has been going the rounds of the press, especially in America, an account of an automatic machine gun made by the Winchesters, which is said to fire a thousand rounds a minute, and to beat the Maxim, because the Maxim only fires 750 a minute. In connection with this it might be interesting to the public to know just how fast it is possible to fire a single-barreled automatic gun, and what sort of cartridges can be fired with the greatest rapidity.

"The first automatic Maxim gun which was submitted to an official test at Enfield was claimed to fire 600 rounds a minute, using the Royal Laboratory machine gun cartridge. At the trials 1,000 cartridges, all in one belt, were fired in 1½ minutes. This would give a speed of 666 rounds per minute. The Royal Woolwich cartridges, considered from all points, are perhaps the most perfect cartridges to be met with today. Of over 200,000 rounds which I myself have fired, I have only found one faulty cartridge, and this missed fire on account of not having any fulminating powder in the primer.

"At the official trials in Switzerland, where the German Mauser cartridge was used, the official speed was 612 per minute. At the Italian trials, which took place with the same cartridge at Spezzia, the rate of fire was found to be 620 per minute. The French Gras cartridges, which had been made for 7 or 8 years, were found to fire at the rate of about 500 per minute; those which were only 2 or 3 years old, at the rate of 600 a minute; while with those that had only been made up a few weeks, the rate of fire amounted to nearly 700 rounds a minute.

"At the Austrian trials with the old Mannlicher cartridges the rate of fire was 620 rounds per minute. With the new Austrian cartridge with compressed powder a speed as high as 770 per minute was attained. With the Russian Berdan cartridge, made on the old fashioned plan, having a hollow rim, 1,000 rounds were fired out of a single belt in 2¼ minutes. This was the slowest of all European cartridges except those made in Italy for the old Vetterli rifle, which were found to be imperfect, and the rate of fire in some cases did not exceed 300 per minute. In Spain, cartridges were found which were so bad that they could not be fired at all with an automatic gun. In Germany, the rate of fire varies according to the kind of cartridges which are employed and ranges from 600 to 700 per minute.

"Of all the black powder cartridges the American service cartridge has been found to attain the highest speed. This arises from the fact that the cartridge is small and short, the powder compressed, and the primers very large. At trials which took place in England with this cartridge the rate of fire was 742 per minute. At trials which took place in the United States, in which new cartridges made by the Union Metallic Cartridge Co. were employed, the rate of fire was 775 per minute. This was the highest rate of fire ever attained by an automatic gun deriving all of its energy from the recoil.

"After the Maxim gun had been formally adopted into Her Majesty's service it was found necessary to provide some means of operating them with blank cartridges, as these of course did not give sufficient recoil to operate the mechanism. Attachments were then put on to guns which were required for the maneuvers, in which the escaping gases at the muzzle of the gun produced an action upon the barrel similar to that of recoil. The first of these guns was made for the Easter maneuvers some 5 years ago, and the first cartridges experimented with were loaded with 60 grains of black powder, the rest of the case being filled with tallow, but the rate of fire was so enormously high that the powder charge was reduced to 42 grains, and with this the rate fell to about 600 per minute.

"About 2 years ago, while we were experimenting with the French Lebel cartridge in Paris, I had a gun constructed to utilize the force of the escaping gases at the muzzle for operating the mechanism. The number of cartridges which the officer brought to the trial was only 200; consequently only small belts were used. Upon placing a belt of 20 cartridges in the gun and pulling the trigger, I remarked, 'The gun has stopped, it does not work,' whereupon my French assistant pulled the belt out and said, 'It is quite empty.' My ear had been accustomed to a fire of about 600 per minute, and the usual belts that we first try a gun with hold only 10 cartridges. These 20 Lebel cartridges had gone off in just about the time that 10 English cartridges would have been fired. The speed was found to be somewhere between 1,100 and 1,200 rounds per minute, and the officer in charge decided that the rate of fire was altogether too high, expressing the wish that we should seek to reduce the rate of fire rather than to increase it.

"It is a curious fact that the German and the French committees, acting quite independently of each other, expressed their opinion that the most desirable rate of fire would be 250 per minute, and guns were, in fact, made for these two nations provided with regulators, but it was found that the mechanism necessary to reduce and regulate the speed of a gun was quite equal to all the rest of the mechanism in the gun. The first one-pounder Maxim guns fired at the rate of 400 shots per minute. The speed was afterwards reduced to 300 per minute.

"The effect of very rapid firing upon the chamber and rifling of the gun is most marked. In Austria, when a gun was fired at the rate of about 600 per minute with steel-covered [jacketed] bullets, and the fire was often stopped to replace the ammunition boxes, it was found that the gun made as good a target after 20,000 rounds had been fired as it did upon starting, while with a speed of 670 per minute with practically no stoppages, the bore was considerably injured after 10,000 rounds had been fired. During all the Austrian trials with the Maxim gun, 200,000 rounds of ammunition were used, the greatest number fired at one time from a single gun being 35,000.

"As regards the speed that it might be possible to attain with a single-barreled gun, I would say that probably if both the gun and cartridge were made expressly for producing the highest possible rate of fire, and if the recoil energy, together with the escaping forces of the gases, were both utilized, 1,500 to 1,600 rounds a minute might be fired, but at this speed the barrel would be very highly heated, even if inclosed in a water casing.

"Machine guns which are operated by hand are as a rule provided with more than one barrel, and perhaps the greatest absolute speed that ever has been attained was with a 12-barrel Nordenfelt gun, in which each barrel was fired 100 rounds per minute, but this fact can only be accomplished by a very powerful and trained athlete. The Gatling 10-barrel gun did not, I believe, fire over 400 rounds a minute at the Shoeburyness trials, but it is said now to fire at the rate of 100 rounds per barrel per minute. The greatest speed ever attained by a single barrel hand-operated machine gun was when Gardner himself fired 250 rounds per minute. The Nordenfelt five-barrel gun, such as is used in the British Navy, may be fired with three trained operators about 400 to 500 rounds per minute. At the Swiss trials the two-barrel Gardner gun, with four men to operate it, fired 333 rounds in a minute."

While the whole world marveled at the machine guns of American origin, a French chemist, Paul Vieille, was quietly trying to develop for his government a smokeless powder that would not reveal the infantryman's position or obscure his aim. In 1885 he discovered a successful propellant that gave off practically no smoke. Mixing cellulose with gelatinized nitroglycerine not only eliminated smoke, but produced a progressive burning powder that left little or no residue. While seeking a musket propellant, he had unknowingly invented the perfect fuel for the automatic machine gun.

Black powder generates all its force at the moment of ignition, then the chamber pressure decreases quickly. Smokeless powder, on the other hand, continues to burn after maximum pressure, giving a prolonged thrust, leaving a high residual pressure in the bore. This allowed machine gun inventors to design mechanisms taking full advantage of this prolonged power-impulse, and to utilize the force of expanding gases in the barrel after the projectile is gone, to accelerate further the recoiling parts.

That the engine came before the fuel cannot be questioned. Maxim was already firing his automatic gun over the continent of Europe, using almost any black-powder cartridge of current design. But peak efficiency was not reached until he used the French Lebel service cartridge. The prodigious rate of fire mentioned in his article in *Engineering* was produced by the first military cartridge in the world having smokeless powder as a propellant charge.

The Maxim gun was first used by the British colonial forces in the Matabele War of 1893. In this campaign of 1893–94 against the Matabele of the Northern Transvaal, a detachment of 50 infantrymen with four Maxim machine guns defended themselves against 5,000 warriors who charged them five times in an hour and a half. All of these fanatical charges were conducted with great bravery and were invariably stopped each time about a hundred paces in front of the English firing lines by the lethal fire of the Maxim guns. It was recorded that the enemy after the charges left 3,000 dead in front of the English position. The troops engaged against the Matabeles were the armed police of the Rhodesian Charter Co. They were greatly outnumbered by the enemy which attacked with the reckless courage of the Zulu tribes. The Rhodesians, realizing the deadly power of the machine guns, provoked the Matabeles to charge. A handful of men fortified themselves with Maxim guns. And against these determined rushes of thousands of fierce fighting savages, the streams of bullets from the Maxim guns tore lanes of dead through the enemy masses and always broke the attack.

In the Chitral campaign in 1895 on the Afghan frontier, the English again used their Maxim guns against the fanatical mountaineers of the Hindu Kush, the fire proving so effective that the British colonial troops who charged the position found only the dead bodies of the enemy to oppose them.

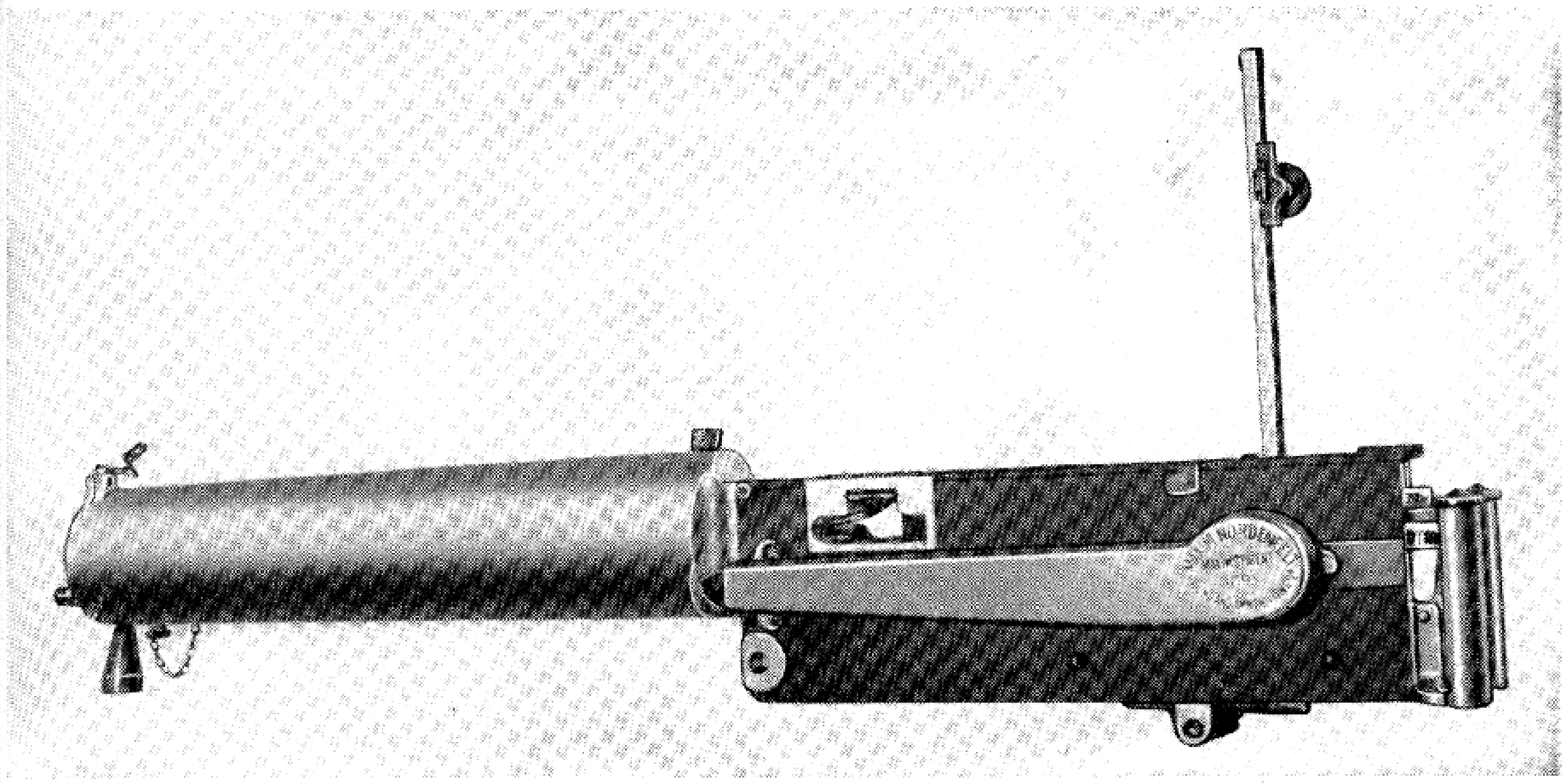
Later on, in some of the fights of the 1898 campaign in the Sudan these guns were extremely successful. It is stated that General Kitchener could not have held out had it not been for them. A battalion had two machine gun sections, each organized as a battery of four Maxims mounted on wheeled carriages. A special precaution was taken to prevent the mechanisms from becoming fouled by the desert sands which formed almost a fog on windy days in the Sudan. Each gun had a silk cover in which it was kept wrapped until brought into action.

At Ferkeh, on 7 June 1896, the four guns were only in action for a few minutes, but in this time they broke up the dervishes' only attempt to charge. Perhaps the battle of Omdurman was the most classical example of the deadliness of the weapon. No less than 20,000 dervishes were slaughtered and three-fourths were officially credited to the Maxim machine gunners at this battle. A German military attaché, Major von Tiedemann, told how he watched the effect of the Maxim gun battery on the right front. "The gunners did not get the range at once. But as they soon found it, the enemy went down in heaps and it was evident that the Maxim guns were doing a large share of the work in repelling the dervish rush."

For a moment it seemed as if the dervishes might overwhelm the Sirdar's forces. In dense array they moved forward, but their ranks were torn by the murderous machine gun fire. It is interesting to add here that Winston Churchill went into action with the cavalry charge, almost the last on record in British history. He was attached to the Twenty-First Lancers. British casualties amounted to less than 2 percent, while the enemy was practically annihilated (all due to the deadly Maxims).

Hoping to reach American markets, Maxim wrote to all prominent gun and pistol producers in the United States, telling them that his automatic system could easily be applied to all sizes of pocket pistols or rifles, and advising them to use his mechanisms under license. From these gunmakers he failed to receive one favorable reply. In fact, he stated, most of the answers were scurrulous. In spite of professional jealousy his market grew. Soon the little factory in Hatton Gardens became too small to fill all the orders for his automatic machine guns.

Maxim amalgamated for a short while with Nordenfelt, the financier, and formed the Maxim Nordenfelt Guns & Ammunition Co. In this way he was able to take advantage of the manufactur-



Maxim Machine Gun, Model 1895, Cal. .303.

ing facilities of the Nordenfelt plants to fill his backlog of orders. While they produced many models of rapid-firing naval guns, the only automatic weapons manufactured were the 37-mm pom-pom and the rifle caliber gun, known as the Maxim-Nordenfelt. All were based on his earlier patents.

Other Maxim Weapons

The success of the rifle-caliber gun led the British Admiralty to ask Maxim to design a special-objectives weapon for use against torpedo boats, specifying that the projectile must be large enough to penetrate light armor, and the rate of fire as high as thought practical.

Lord Wolseley asked Maxim also to produce, if possible, a projectile that could be used effectively against armor at a great range when used as solid shot, but at the gunner's will the same projectile could be converted to fragments having the effect of a shot gun with buckshot when used against personnel at close range.

These demands resulted in 1898 in the long range caliber .75 machine gun with the disintegrating bullet. This projectile was of peculiar construction, being made up of several segments, arranged around a central steel core and held together by rings of lead, hardened by adding tin. A cutting device on the muzzle allowed the gunner either to fire a solid armor-piercing bullet at great range, or to spray fragments over an area at close quarters. The cutter having severed the bands, the projectile disintegrated from centrifugal force. When not cut, it stayed together and the hardened core easily penetrated light armor.

The next development was the pom-pom, an automatic 37-mm shell gun. The name was given it by African savages trying to describe its unusual report during automatic fire. The operating mechanism was basically the same as the rifle caliber gun. Originally rated at 400 rounds a minute, Maxim concluded this was too fast for peak performance, and slowed the action to 300 a minute, where it remained.

It is ironic that the pom-pom, developed at the request of the English Government, was ignored by the major powers until it proved its deadliness in use against the British soldier. The weapon, when introduced, was scorned by English artillery experts. They contended it was too large for use against personnel, too small for employment against fortifications, and any field battery could put it out of commission in a relatively short engagement.

The War in South Africa disproved their evaluation. The Boers obtained a few of these automatic shell guns and, in engagement after engagement, a single pom-pom manned by a crew of four secreted behind rocks and dense foliage would quickly put out of action a whole battery of British artillery. The cartridges were loaded with smokeless powder. The Boers got on a target with single shots, and then covered the area with a full automatic burst, usually fatal to the British artillery unit. The English gunners, though skillful, were unable to take aim at the sound. And, before they could locate their adversary, their battery would be destroyed.

The Boers were aided by their exploding projectiles as the smoke and dust from the detonation showed the pom-pom gunner how far he was off in sighting. Then, making the correction, which rarely took more than three or four spotting shots, he fired approximately half his 25-round belt full automatic into the target.

Neutral newspapers all over the world gave page after page of publicity to the plucky Boers in annihilating the British field artillery units.

Maxim pointed out that the error was not his, as he had made the weapon at the suggestion of the English Government, only to have it turned down by the army. The Boers had purchased their guns from the French, who had bought a considerable number, ostensibly for their own use.

Maxim later was approached by a Chinese Government representative in London, who stated, in behalf of his country, that he would like to see the firing of the 37-mm and rifle-caliber Maxim guns. On the day fixed, the Chinese staff met with a large number of prominent Londoners to watch the demonstration. After a 1,000-round burst by three Maxim rifle-caliber guns, the pom-pom was brought into position. The Chinese representative questioned its advertised rate of 400 rounds per minute. The gun fired, and the projectiles, being filled with explosives, went off upon striking the target. When the firing had ceased, he observed the bursts from the exploding shells continued to flash at the target. When this had stopped, he still heard the reports of the exploding shells from the distance. He at once came to the conclusion that there was some trick, that some machine located behind the target was producing the flash and report, having failed to cut off when the gun was stopped.

It was then explained to him, as had been previously done for other incredulous observers, that, with the target a thousand yards away, a number of projectiles were still in the air when the gun ceased firing. After the last projectile had struck the target and exploded, the reports in the air were still echoing. The Chinese was satisfied, and, as he had timed the gun with his own watch, said it fired faster than 400 rounds a minute. He examined a cartridge and, on being told the price was 6 shillings 6 pence, he said, "This gun fires altogether too fast for China."

The King of Denmark, likewise, wished to see the pom-pom fired. When told the cost per round he stated, "That gun would bankrupt my kingdom in about 2 hours."

The English press also took up the cry "Economy," pointing out that at 6 shillings for each shell fired, these guns would require the expenditure of 90 pounds per minute in cost of ammunition. The quantity of ammunition for this one gun alone in a war, even if victory were assured, would make the cost prohibitive.

The British Government, still smarting from the lesson handed it by the Boers, who were not so economy minded, answered these paper theorists by adopting the weapon and ordering millions of rounds of ammunition.

Vickers-Maxim Machine Gun

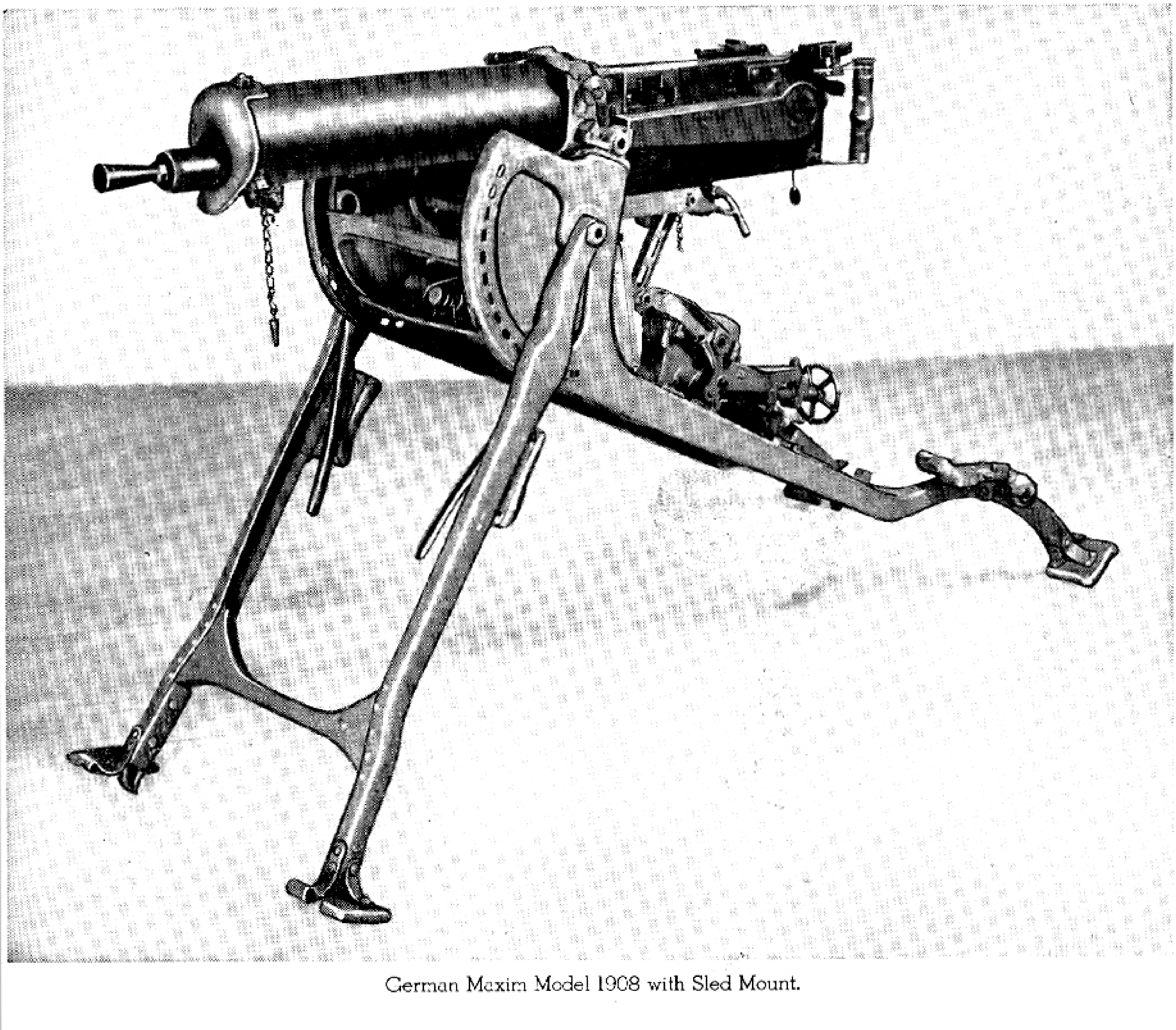
Though the short-lived Nordenfelt association produced the pom-pom, Maxim's best known and lasting affiliation was with Vickers. Vickers Sons and Maxim Ltd. was formed on 20 July 1888. In this company Hiram Maxim remained an active participator until his seventy-first birthday. The Vickers-Maxim rifle caliber gun is only a refinement of the original Maxim invented in 1884. Its point of difference from the first gun lies in the toggle-joint action, which is inverted, and the weight, which is reduced approximately one-third. This was accomplished by the substitution of superior steel and aluminum in lieu of heavier metals. The 1904 model was reduced to 40.5 pounds, whereas the previous weapon had weighed 60 pounds. Though Maxim had been associated with Messrs. Vickers and

Sons of London for 16 years, it was the first gun to bear the name "Vickers" along with "Maxim."

The South African War between the British and the Boer Armies was the first war in which regular armies composed of white troops both used Maxim guns. The Russo-Japanese war in Manchuria in 1904–5 is also of special significance—it being the first major war between regular armies in which automatic machine guns were employed in large numbers on each side, and with full fire effect. The Russians, converted to a belief in machine guns by the Gorloff (Gatling), used Maxim caliber .312 manufactured by Vickers Sons and Maxim. The Japanese began the war without automatic weapons except for a few in the cavalry. In November 1904, they issued to the infantry large numbers of another type of automatic machine gun having a caliber .253 of French design, but manufactured at Tokyo.

The Russian Maxims were recoil operated and water cooled, while the Japanese weapons were gas operated and air cooled. The Russians and Japanese organized their machine guns alike in batteries of six or eight and treated them as a special arm. The Maxims were mounted first on artillery carriages with high wheels. Due to the exceptionally heavy losses sustained by the Russian batteries at the Yalu River, a low tripod with a shield was substituted.

Field reports spoke in glowing terms of the Maxim guns, saying that in some cases even bet-



German Maxim Model 1908 with Sled Mount.

ter results were obtained with them than with artillery. One of the best examples of Russian employment of this type of weapon was during the battle of Mukden when 16 Maxims, half of them used at a time, repelled seven fierce Japanese attacks. The eight guns, not firing, were serviced and held in reserve. The guns fired altogether 200,000 rounds of ammunition that day, and every gun remained in excellent condition.

A German observer with the Russian Army sent the following report, which was reprinted in the official Journal of the German Army and Navy. "On January 28, 1905, near Lin-Chin-Pu the Japanese attacked a Russian redoubt that was armed with two Maxim guns. The Japanese company about 200 strong was thrown forward in skirmishing order. The Russians held their fire until the range was only 300 yards. The two machine guns were then brought into action. In less than 2 minutes they fired about 1,000 rounds and the Japanese detachment was literally swept away."

During the Russo-Japanese War military observers for the first time began to look upon the machine gun not as a piece of inferior artillery, but as a superior military rifle.

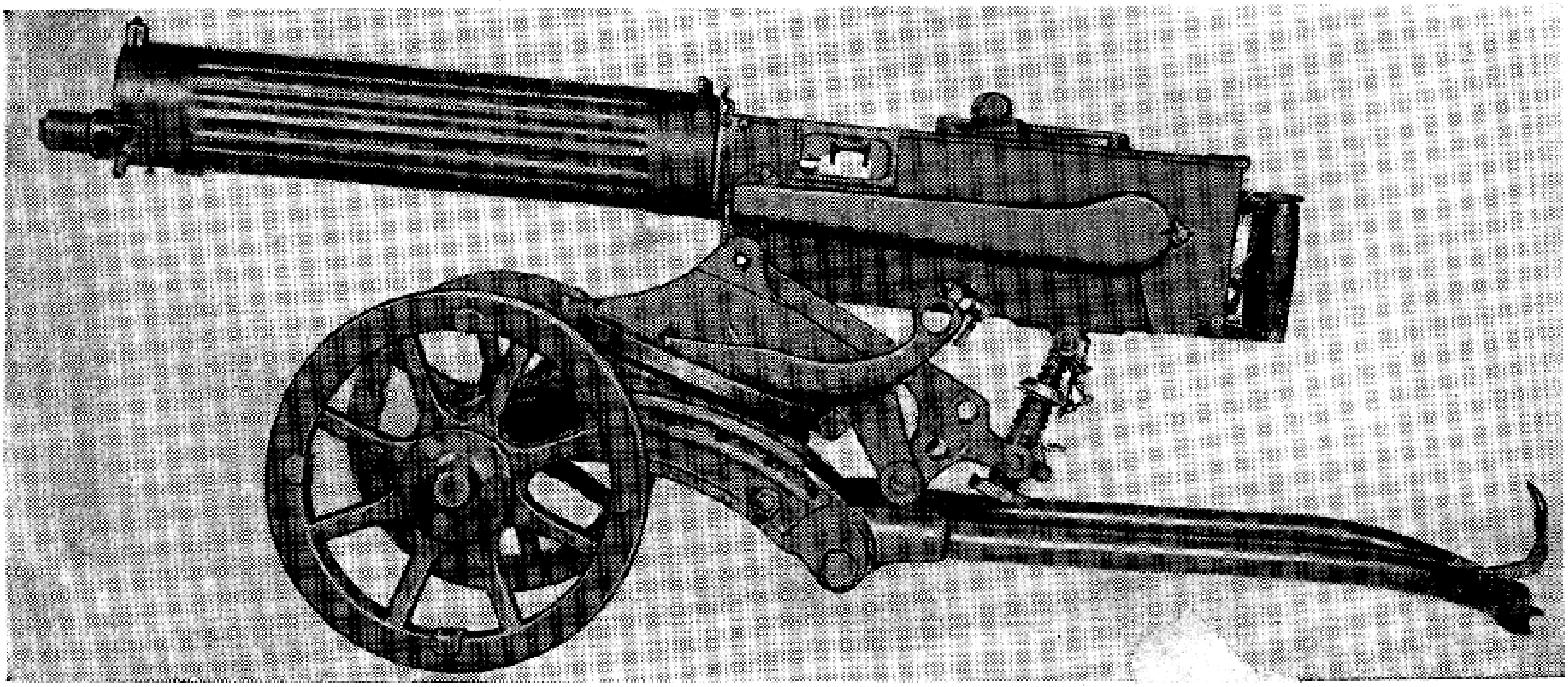
In the Philippine insurrection, the American Army had not yet adopted an automatic gun. It is interesting to note that Maxim full automatic machine guns caliber .303, manufactured in 1895, were captured from the natives by our forces.

One of the first countries to capitalize on the potential lethal effect of the automatic machine gun was Germany, which adopted the Maxim gun in the year 1899, and issued it experimentally for some years to various units of the German Army.

After observation by German officers of the deadly employment of these weapons in the Russo-Japanese war, Germany determined to equip herself with large quantities. A heavy Maxim gun designated Model 1908 was developed at the Government armory at Spandau. With a metal sled-like mounting, it weighed around a hundred pounds. A later mount made at Erfurt reduced the total to 85 pounds. The weapon was chambered for the German service cartridge caliber 7.92-mm Mauser, supplied in 250-round belts.

Russia continued to be a big purchaser of the Maxim gun, but now employed an unusual mounting, called the Sokolov, which consisted of two small wheels supporting the traversing mount and a heavy steel shield setup in front of the action of the gun to protect the operator. The Russian gun was chambered for the 7.62-mm infantry rifle cartridges, and the model is listed the M–1910.

Though Englishmen armed the world with an American inventor's weapon, the British pacifist



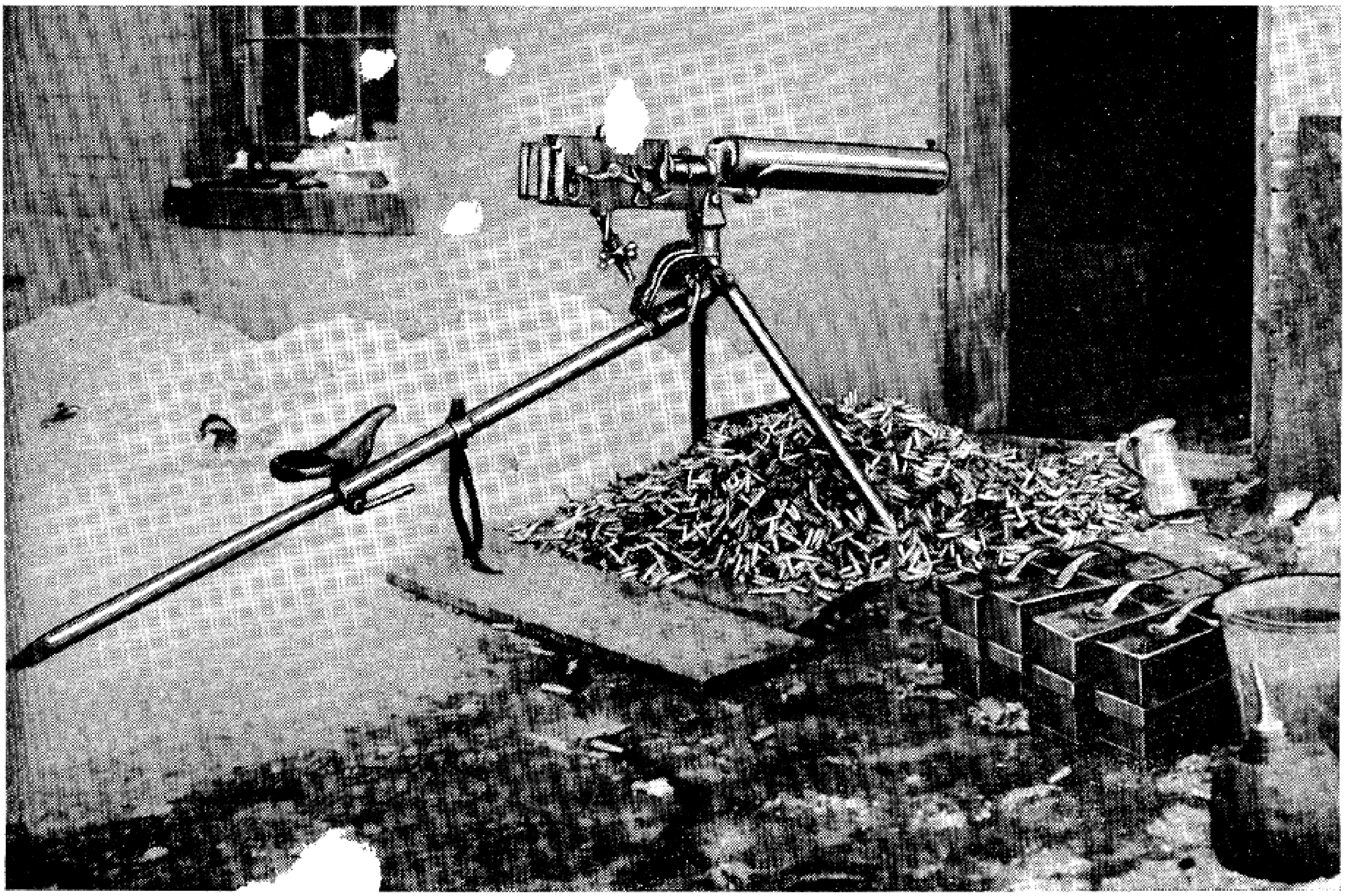
Russian Maxim Model 1910 on "Sokolov" Wheeled Carriage.

element saw to it that England profited less than any other European power. True, there was always an intense and intelligent interest in the machine gun by a minority group of the army. One or two pioneers even suggested the formation of a machine gun corps, but it was not carried out.

In 1908 the rule of Turkey in the Far East was seriously shaken. A reform group calling themselves "The Young Turks" deposed Abdul Hamid in favor of his brother. In the resulting confusion Bulgaria declared its independence, and the provinces of Bosnia and Herzegovenia were annexed by Austria. The Balkan League was then formed by Greece, Serbia, Rumania, and Bulgaria. In 1912 the League waged war against Turkey and conquered all of its European possessions, except Constantinople. The principal infantry arm of practically every nation involved was the Maxim machine gun, chambered to fit each country's rifle caliber ammunition. A few employed the 37-mm pom-pom. And a Greek report stated that Greece received as booty from the Balkan War a quantity of the 7.95-mm Maxim.

The first recorded trial of Maxim guns by the United States was in 1888. Although the gun performed well, nothing came of it. From the test Maxim admits he got the highest rate of fire ever obtained with black powder. The Navy continued Maxim trials up to the Spanish-American War. It decided against the rifle caliber in favor of an American-developed automatic machine gun, following its policy of favoring American products. But it did adopt the pom-pom, since nothing comparable was being produced in this country.

During the peaceful first decade of the twentieth century the American Government, especially the Navy, ran constant trials as new automatic weapons were introduced by their inventors. But there was no prospective need for automatic machine guns. Finally the United States realized she was unarmed compared with



Automatic Gun After Firing 15,000 Rounds at an American Trial in 1899.

the rest of the world, and tests were frantically resumed.

In the 1913 competitive tests, the outstanding automatic machine gun was the Vickers, built by Colt's Patent Fire Arms Co. of Hartford, Conn. This was basically the 1904 Vickers-Maxim, which in turn had the same operating mechanism as the original Maxim model that was featured in the 1888 trials. However, when this weapon was adopted by the United States Army, it became known as the 1915 Model Vickers.

The United States Army Board unanimously declared that the Vickers tested on 15 September 1913 was superior to any of the other seven guns submitted. (The weapon showed it was still capable of the excellent performance this mechanism had demonstrated in the 1888 trial.) Not a single part was broken or replaced, nor was there a jam worthy of the name during the entire series of tests. A better performance could not be desired.

The Board also reported that, with the exception of the Vickers, none of the others submitted showed enough superior qualities to warrant consideration for adoption.

Another test of the Vickers in 1914 was summarized by the Machine Gun Board: "This gun fired 40,000 rounds in a satisfactory manner. While there were a number of malfunctions, they were mostly due to a failure to completely seat the cartridge in the chamber, and the jam was removed by giving the side lever a sharp blow. Four main springs, one gib, and one muzzle gland were broken. The latter was caused by the loosening of the muzzle attachment, causing a bullet to strike the edge of the orifice. While the firing was sometimes irregular, the time of firing including time for cooling, cleaning, and repacking the barrel was 1 hour, 38 minutes, and 55 seconds consumed for the first 20,000 shots; and 1 hour, 6 minutes, and 9 seconds for the next 20,000 rounds."


British Sergeant Instructing American Troops in France.

The Board stated that the Colt-made Vickers gun was a very efficient weapon, and recommended immediate procurement of 4,600 guns. But nothing was done. Finally, 2 days after the United States declared war, General Crozier, Chief, Ordnance Department, authorized the purchase of 4,000 Vickers, since there was not a single machine gun in the country suitable for use on the European front.

The high command in the Army insisted that an American-developed gun was superior, and cited an early 1917 test as conclusive. Better or not, production on the new gun was almost a year away; consequently, the Vickers was the only gun to fall back on, since Colt was tooled up to make it. Cables from the A. E. F. indicated its efficiency and requested immediate continuance of production.

The first deliveries from Colt were in July 1917. By 12 September 1918, 12,125 Vickers Model 1915 had been made, but few saw action, since the war ended 2 months later.

The French high command, in the fall of 1917, urgently requested a thousand American-made Vickers for a special objective. They offered their machine guns in exchange. This request was granted. Subsequent production was used to equip mobile army troops until the American-developed gun could be available. When this new gun was finally issued, there was such a serious shortage of spare parts it had to be replaced by the Vickers gun.

Every major power in the world, at one time or another between 1900 and World War I, had adopted the Vickers-Maxim gun, either in rifle caliber, the pom-pom, or both. The German high command apparently were the first to realize the deadliness of the weapon and made thorough preparations for the coming war, having more than 50,000 Maxim-type guns ordered or on hand at the outbreak of World War I. True to the German military tradition, they sought to build tomorrow's weapons today. In contrast, it has always been our custom to build yesterday's weapons soon.

Chapter 2

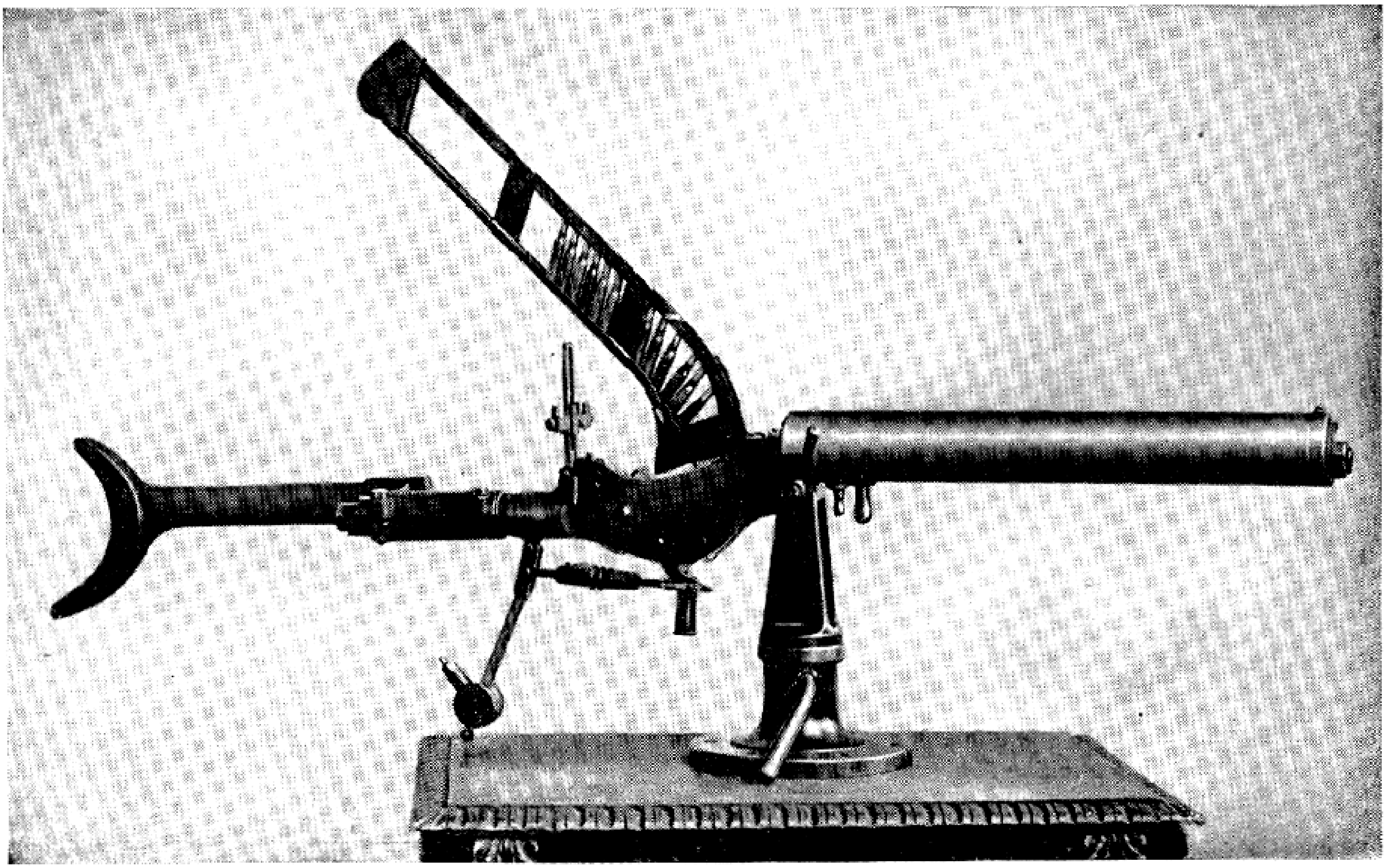
SKODA MACHINE GUN

A very peculiarly designed weapon, popularly known as the Skoda automatic machine gun, made its appearance on the Continent shortly after the Maxim gun. Invented by Grand Duke Karl Salvator and Colonel von Dormus of Austria, it was patented in 1888. Patent rights were purchased and the gun produced by the famous Skoda Works of Pilsen, Austria-Hungary. This company was established in 1859 by the Count of Waldstein and came under the ownership of M. de Skoda in 1869. It was one of the outstanding armament manufacturing plants in Europe.

The odd-looking Skoda gun operated from retarded blow-back and was made in rifle calibers ranging from 6.5 to 11 millimeters. Austria-Hungary adopted it and gave it the designation Model 1893. It was, however, relegated to fortifications and naval use. There is no record that the army ever officially used it as a first-line machine gun. But an Austro-Hungarian naval detachment, equipped with the Skoda, was sent to the defense of the Legation at Pekin during the Boxer rebellion in 1900. Its use in this engagement was very limited.

The military authorities of Austria-Hungary looked upon the weapon as suitable only for the defense of fixed positions and recommended that it be installed in turrets behind heavy armor.

A lengthy article in a military publication, *Review of Artillery,* volume 43, 1893, noted the reliability of the gun when it was subjected to a rugged proving ground test in Austria-Hungary.



Skoda Machine Gun, Model 1893.

The weapon fired a considerable number of bursts of 3 minutes' duration and, on one occasion operated continuously for 9 minutes before a stoppage occurred to put it out of action. It also passed the dust and mud test and was fired successfully in temperatures ranging from 32° Fahrenheit to 20° below zero.

The gun was optionally provided with a water jacket and, when so used, the barrel life was found to be of unusual length. In fact, a single barrel was required to fire 20,000 rounds and still have a certain degree of accuracy in order to pass an official endurance trial.

The Skoda machine gun, Model 1893, was presented to the United States Army in 1895 for consideration and adoption. The following description and cycle of operation are derived from official Army records and give the conclusions drawn from the test by the Ordnance Board:

The weapon is a single-barreled arm, which operates automatically by a system known as retarded blow-back. Its 25-pound weight puts it in the lightweight gun classification. The rate of fire can be regulated at will. It uses an Austrian cartridge with a weight of 244 grains, and a smokeless powder charge of 42 grains.

The principal parts are the barrel, the receiver, the breech mechanism, and the driving spring.

The barrel, made of Bessemer medium carbon steel, is enveloped by a bronze sleeve, in which circulates a continuous current of cold water. This sleeve is pressed against the shoulder by a nut, screwed on the muzzle. Leather washers make the connection watertight. A screw locks the sleeves in proper position.

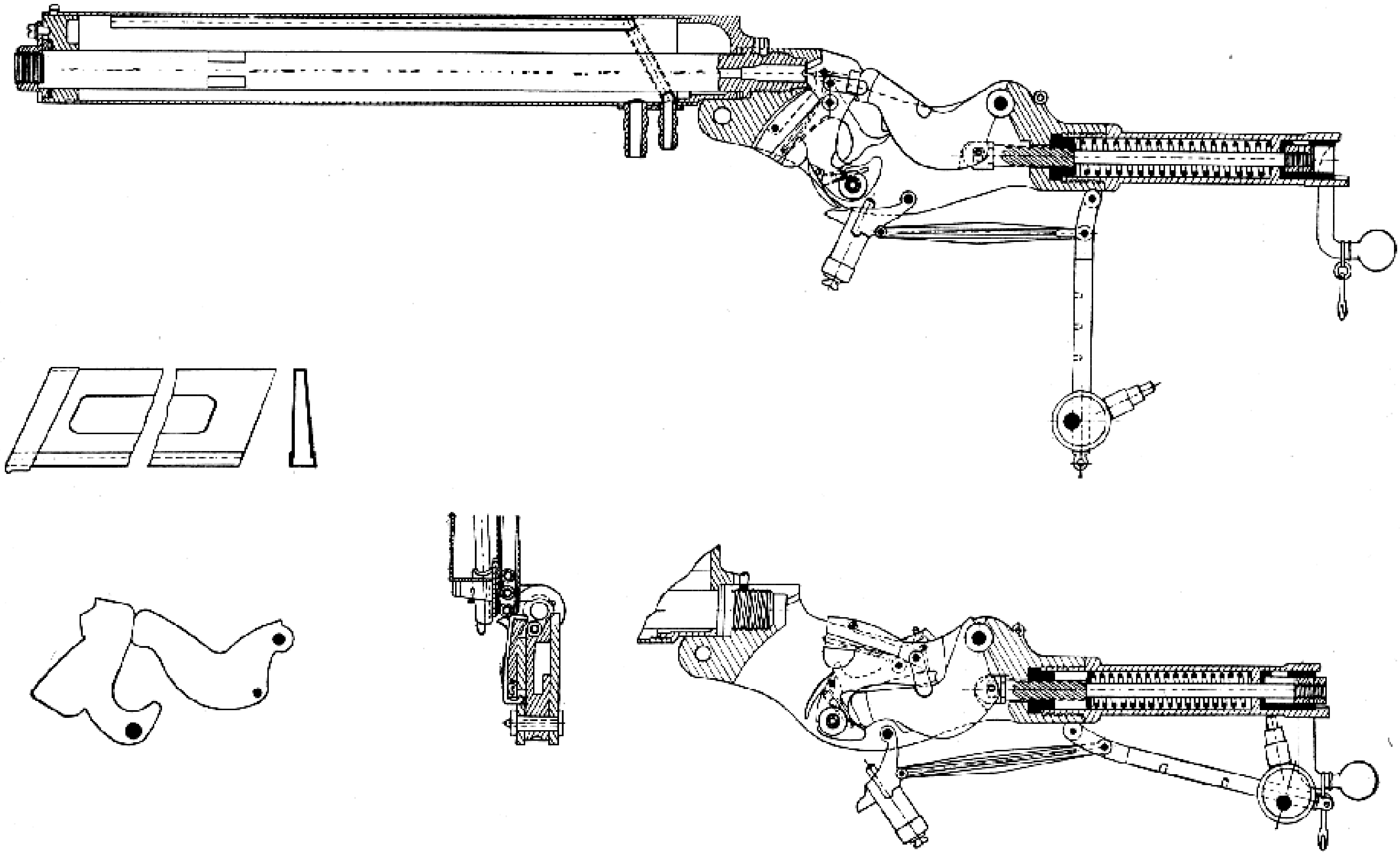
An inlet and an outlet are provided in this part, through which cold water can be led in by rubber tubes. The water is forced in by a small pump and finds its way from front to rear through a metal tube placed under the upper element of the sleeve to the outlet. In this way the barrel is constantly covered with cold water.

The pivoted breechblock, mounted between the parallel sides of the casing, is recessed to contain the firing mechanism and, when closed, is held in position by the block support. This pivoted support is continually under the pressure of the accumulator spring through a spindle and exercises a pressure on the block. When the piece is fired, the shock of recoil, exerted against the face of the block at the instant the bullet leaves the bore, forces it to the rear. This in turn drives back the support against the spring, causing the forward end of the support to revolve downward. A quick screw thread is cut on the forward end of the spindle, which works through a closely fitted cylindrical nut. Its shoulder serves to relieve the spring of part of the energy of recoil. The friction of revolving also diminishes the speed with which the breech is opened and closed.

As soon as the energy of recoil is expended, during which time the empty cartridge case is ejected and a new cartridge supplied from the feed, both being accomplished automatically, the spring forces the support forward, closing the block and pushing the cartridge into the barrel. The rear end of the spindle screws into the nut joining the spindle to the sleeve. Attached to the latter is a crank. The rear of the spring cylinder is cut in the form of a helicoidal ramp, against which the crank rests. To load the first cartridge, the crank is turned to the left. Being forced to the rear by the ramp, it draws the spindle and the support with it, allowing the block to fall and open the breech.

The steel receiver is composed of two parallel frames, screwed on to the rear end of the barrel. On the left frame is fixed a distributor, in front and in rear of which are supports to receive the feed. The distributor consists of a swinging lever pivoted at a point flush with the mouth of the feed. On the outer side of the distributor is a spring, the lower end of which, shaped like a hook, projects through an opening into the receiver.

The feed is a sheet-iron frame, through which the cartridges pass to the distributor, their rims sliding in a groove. When the machine gun is mounted in a turret, the feed is made in two parts, the lower part fixed, and the upper part movable. The lower part rests in the support; the upper part is joined to the lower by a hinge and is held in place by a spring, a tenon of which catches in one of the four holes of the lower part. By this arrangement the movable part can be raised or lowered slightly to allow the necessary space for filling the feed under different angles of fire.



Section Drawing of Skoda Model 1893.

Under the receiver is hung the pendulum, a swinging arm, on which is the adjustable weight that regulates the rapidity of fire. In the weight is a mortise containing the rear stop plunger placed over a heavy spring. At the top is the pendulum stop buffer, also mounted over a spring. These springs are intended to increase the impulses which make the pendulum oscillate. The pendulum arm and the trigger gear are connected by a bar. This bar consists of two parts threaded on the adjoining ends and joined together by a nut. By turning the nut, the rate of fire can be varied at will.

On the receiver is a sight that can be raised or lowered and a deflection plate which throws to one side the empty cartridge cases as they are extracted from the breech.

The breech mechanism comprises the block and the support. The block is recessed to contain the firing pin, the hammer, the firing pin spring, the tumbler, and the tumbler spring. The lower part of the front of the block forms a loading shelf, the location of which assures the proper positioning of the cartridge. The upper part of the front of the block carries the extractor. In the left face are two openings for the distributor, the forward and rear openings. At the rear of the block is the cylindrical bearing surface.

When the breech is closed, the bearing surfaces of the block and support should be in complete contact. The plane surface closes the rear opening of the barrel and the loading shelf is in front of and below this surface.

When the support revolves to the rear opening of the breech, its finger presses against the tail of the hammer until the nose of the tumbler falls into the notch of the hammer. The piece is thus cocked. While revolving, the support rests on the arm of the block, sending the latter to the rear. When the breech is thus completely open, the block, with the loading shelf above it, rests on the support.

To close the breech, the crank is turned in the opposite direction from that which opens the breech. The spring extends, revolving the support and the block and closing the breech.

In order to fire the weapon, the pendulum is drawn to the rear until stopped by the bolt striking against the cylinder and then let go. The trigger sear then releases the tail of the tumbler, freeing the nose from the notch of the hammer. The striker spring throws the hammer against the firing pin and discharges the piece. If the breech is not completely closed, the tail of the hammer will strike against the support. The firing pin being thus protected, premature discharge cannot take place.

When the piece is discharged, the recoil throws the breechblock and the support to the rear, the breech opens, the hammer is cocked, the empty case is extracted, and the next cartridge is placed on the loading shelf. Then the driving spring starts closing the breech, shoving the cartridge on the shelf into the chamber, while the lowest cartridge in the feed falls on the distributor tray. The swing of the pendulum causes the trigger assembly to strike the tumbler and the piece is again discharged.

To fill the feed, a charger is placed over its upper end. It is reinforced at one end by the sabot, on the outside of which is a spring. The nose of this spring projects through an opening in the charger and supports the cartridges. At the upper part of the feed, there is also a sabot, with a lug directed toward the interior. When a charger is placed over the feed, this lug pushes outward the wedge-shaped nose and, consequently, the spring. As the cartridges are no longer supported, they drop one by one into the feed.

When the breech opens, the block pushes toward the outside the arm of the distributor spring; the latter throws the distributor in the opposite direction, and the cartridge is rapidly projected on the loading shelf. The tray of the distributor positions the cartridge and directs it into the chamber.

At the closing of the breech, the cartridge is pushed into the chamber by the front face of the breechblock. At the same time the block acts on the extraction arm of the distributor and pushes it to the outside. The next cartridge, which has been resting against the head of the distributor during the loading of its predecessor into the chamber, now falls on the distributor tray, ready to be inserted when the breech opens again.

The rapidity of fire can be regulated in two ways: First, by lengthening or shortening the connecting bar by turning the nut; second, by varying the position of the weight on the pendulum arm, thus changing the time of oscillation.

This gun was tested on 5 June 1894 in the presence and under the direction of the Ordnance Board. The firings were conducted and the gun manipulated by a representative of the company, who was present for the purpose. Owing to the limited amount of ammunition available, the firings were restricted to those necessary to determine the ease and certainty of action of the mechanism when set for different speeds; also for rapidity during comparatively long and short periods of time. Six hundred rounds in all were fired, as follows:

	Rounds
Single shots to test action of mechanism . .	25
At the rate of 175 rounds per minute	25
At the rate of 300 rounds per minute	25
At the rate of 500 rounds per minute	25
In 1 minute 5½ seconds	400
In 13 seconds	100

The following conclusions are quoted from the Board's report:

"No tests could be made of the action of the mechanism when subjected to the dust or rust tests, defective cartridges, or excessive pressure. A positive opinion of the merits of the system under these circumstances cannot therefore be formed. It would seem, however, that the mechanism is somewhat delicate and would be liable to get out of order when subjected to the severe conditions of field service, although it was claimed by the representative of the gun that two of them had been tested with 40,000 shots each (with smokeless powder) in hot and cold weather and when covered with dust and rain, and that it has successfully withstood uninterrupted firing for nine minutes. For permanent fortifications or other positions where the gun could be cared for and kept in good condition, it might be a useful arm in repelling storming parties or other work of like nature. Its fitness for adoption in the service as compared with other arms of a similar character can be deter-

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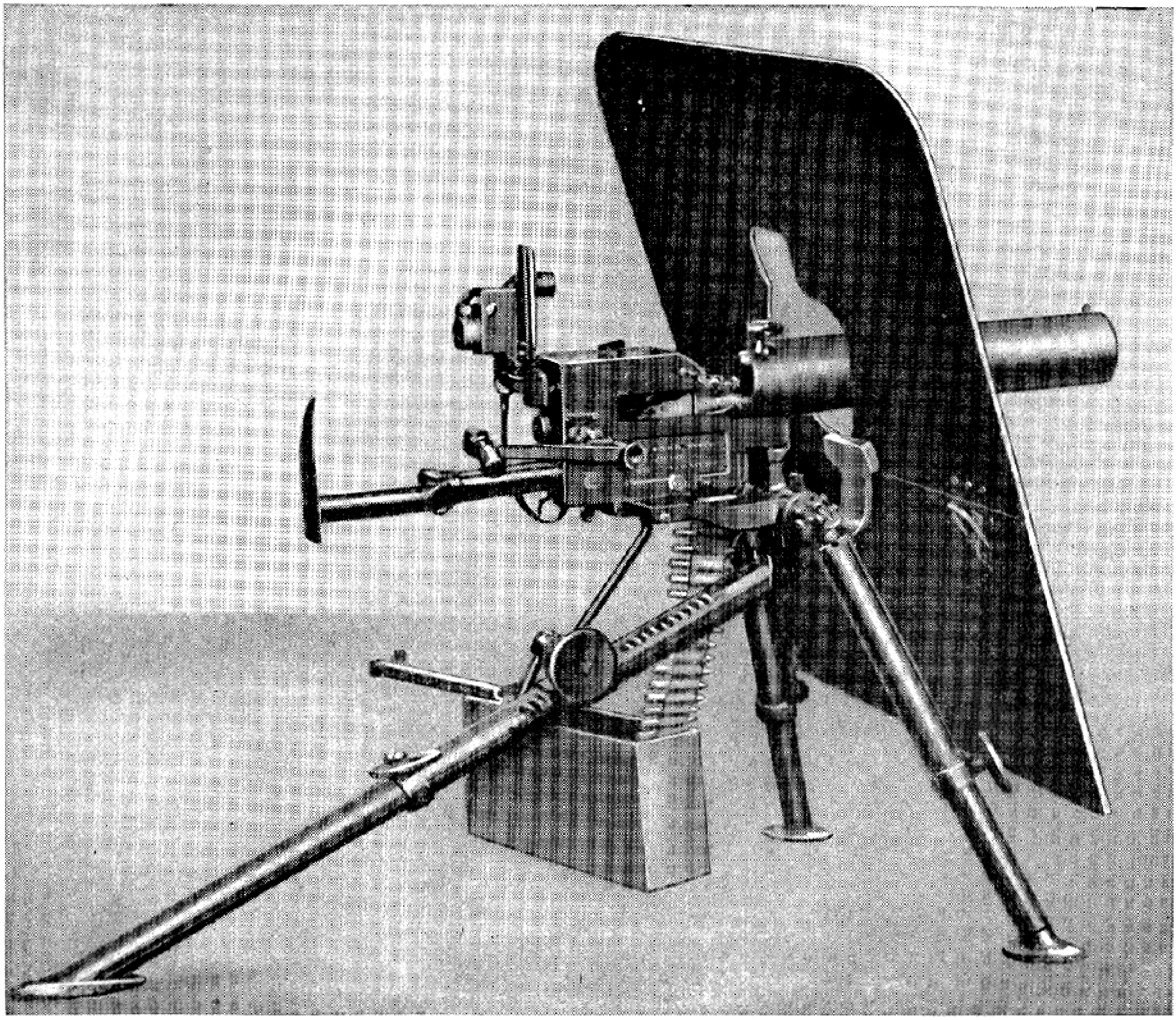

Skoda Machine Gun, Model 1909.

mined only by a much more exhaustive trial than was practicable during the test above referred to."

The Board consisted of the following officers: Frank H. Phipps, Major, Ordnance Department, U. S. A., president; Frank Heath, Captain, Ordnance Department, U. S. A.; and William Crozier, Captain, Ordnance Department, U. S. A.

The Skoda was later completely redesigned and appeared as the Model 1909. The engineers responsible for this modification deserve great credit, as they incorporated many features that were obviously improvements. The bulky ill-designed hopper-type feeder was done away with and the feed system was altered to use the conventional fabric belt employed by most machine guns of the era.

The swinging pendulum rate-of-fire regulator was replaced by a compact buffer arrangement and a simple cyclic rate control that not only did not interfere with the gunner's aim during firing but allowed the arm to be streamlined.

In the complete working over of this weapon, the designers made great efforts to lessen weight and succeeded to the extent that the finished product was one of the lightest full-automatic belt-fed machine guns of its day. Had this very much improved model with its many true refinements made its appearance in place of the crude 1893 Skoda, it would have furnished serious competition to the other automatic machine guns of that time.

There is no record of this later weapon getting beyond a few insignificant trials and its only contribution to machine gun study is as a rare museum piece.