Machine gun

A .50 caliber M2 machine gun surrounded by spent shell casings: John Browning's design has been one of the longest serving and successful machine gun designs

An illustration of later model 19th century Gatling gun. It was a multi-barreled rotary machine gun fired via a manual crank, which mechanically loaded and primed cartridges from the hopper above the gun

A modern image of an 1895 tripod-mounted, .303 caliber Maxim machine gun. The original Maxim of the 1880s was the first fully automatic machine gun, as well as using a belt of linked ammunition rather than a hopper

For other uses of the phrase, see Machine gun (disambiguation).

A **machine gun** is a fully-automatic mounted or portable firearm, usually designed to fire rifle cartridges in quick succession from an ammunition belt or large-capacity magazine, typically at a rate of several hundred rounds per minute. The first machine guns were manually operated, for example, by turning a hand crank.

In United States law, *machine gun* is a term of art for any fully-automatic firearm, and also for any component or part that will modify an existing firearm into a fully-automatic firearm.[1]

Operating Principles

There have been two main machine gun eras: the era of manual machine guns and the era of automatic machine guns. The technical development itself is marked by a series of developments of

specific automatic features, as well as technical developments (such as linked ammunition). The era of manual multi-shot devices extends back hundreds of years (such as manual volley guns), but the development of manual and automatic machine guns takes place almost entirely in the latter half of the 1800s. Manual machine guns are manually-powered, e.g., a crank must be turned to power reloading and firing, as opposed to simply holding down a trigger, as with automatic machine guns. There are many other notable features, but this is one of the most significant to allowing higher rates of fire common to machine guns.

Manual machine guns, as well as manual volley guns, saw their first major use in the American Civil War. The Gatling gun and "coffee gun" both used manually-powered automatic loading, fed via a hopper filled with cartridges. The Gatling gun would be the major type of the late 19th century, though there were many other manual designs with varying degrees of use (e.g. the Nordenfelt machine gun). The first automatic machine gun was the recoil-operated Maxim gun, which used linked (belt) ammunition, as well as a single barrel and automatic loading. This concept of using bullet energy would also drive the development of nearly all other semi and fully automatic firearms of 20th century.

The two major operation systems of modern automatic machine guns are gas operation and recoil operation. As the name implies, the gas operated system uses the gas generated from the burning powder to cycle the action, whereas the recoil operated uses the recoil generated from the ejecting bullet. The first gas-operated machine gun was the Colt-Browning M1895.[2]

Another (minor) type is the externally-powered machine gun. Rather than human manual power or energy generated by the cartridge, an external source such as an electric motor is used. These types are now called by more specific names such as Minigun and Chaingun. They are common on fighting aircraft and ground vehicles, where the externally powered mechanism allows for automatic clearing of many failure conditions that would otherwise disable the firearm.

Caliber Overview

Machine guns are generally categorized machine guns and autocannons. The separation takes place by caliber at about 20mm, with the larger-caliber guns being referred to as autocannons.

Another factor is whether the gun fires conventional rounds or explosive rounds. Guns firing large-caliber explosive rounds are generally either autocannons or automatic grenade launchers ("grenade machine guns"). Machine guns tend to share a very high ratio of barrel length to caliber (a long barrel for a small caliber).

Overview of modern automatic machine guns

Jędrusie Polish underground group firing a belt-fed water-cooled automatic machine gun- a Browning M1917 clone


The Gatling gun of a USAF A-10 ground attack aircraft.

Unlike semi-automatic firearms, which require one trigger pull per bullet fired, a **machine gun** is designed to fire bullets as long as the trigger is held down and ammunition is fed into the weapon. Although the term "machine gun" is often used by civilians to describe all fully automatic weapons, in military usage the term is restricted to relatively heavy weapons fired from some sort of support rather than hand-held, able to provide continuous or frequent bursts of automatic fire for as long as ammunition lasts. Machine guns are normally used against unprotected or lightly-protected personnel, or to provide suppressive fire.

Some machine guns have in practice maintained suppressive fire almost continuously for hours; other automatic weapons overheat after less than a minute of use. Because they become very hot, practically all machine guns fire from an open bolt, to permit air cooling from the breech between bursts. They also have either a barrel cooling system, or removable barrels which allow a hot barrel to be replaced.

Although subdivided into "light", "medium", "heavy" or "general purpose", even the lightest machine guns tend to be substantially larger and heavier than other automatic weapons. Squad automatic weapons (SAWs) are a variation of light machine gun and only require one operator (sometimes with an assistant to carry ammunition). Medium and heavy machine guns are either mounted on a tripod or on a vehicle; when carried on foot, the machine gun and associated equipment (tripod, ammunition, spare barrels) require additional crew members.

The majority of machine guns are belt-fed, although some light machine guns are fed from drum or box magazines, and some vehicle-mounted machine guns are hopper-fed.

Other automatic weapons are subdivided into several categories based on the size of the bullet used, and whether the cartridge is fired from a positively locked closed bolt, or a non-positively locked open bolt. Fully automatic firearms using pistol-caliber ammunition are called machine pistols or submachine guns largely on the basis of size. Selective fire rifles firing a full-power rifle cartridge from a closed bolt are called automatic rifles, while those using a reduced-power rifle cartridge are called assault rifles.

Assault rifles are a compromise between the pistol-caliber submachine gun and a traditional rifle firing a full-power cartridge, allowing semi-automatic, burst and full-automatic fire options (selective fire). The modern legal definition of "assault rifle" is of significance in states like California, where according to state law, certain short, small-caliber, semi-automatic weapons are categorized as "assault weapons", which were also made illegal by civilians to acquire or own. Supporters of gun rights generally consider the use of the phrase "assault weapon" to be pejorative when used to describe these civilian firearms, and this term is seldom used outside of the United States in this context.

The machine gun's primary role in modern ground combat is to provide suppressive fire on an opposing force's position, forcing the enemy to take cover and reducing the effectiveness of his fire [citation needed]. This either halts an enemy attack or allows friendly forces to attack enemy positions with less risk.

Light machine guns usually have simple iron sights. A common aiming system is to alternate solid ("ball") rounds and tracer ammunition rounds (usually one tracer round for every four ball rounds), so shooters can see the trajectory and "walk" the fire into the target, and direct the fire of other soldiers.

Many heavy machine guns, such as the Browning M2 .50 caliber machine gun, are accurate enough to engage targets at great distances. During the Vietnam War, Carlos Hathcock set the record for a long-distance shot at 7382 ft (2250 m) with a .50 caliber heavy machine gun he had equipped with a telescopic sight [citation needed]. This led to the introduction of .50 caliber anti-material sniper rifles, such as the Barrett M82.

Components

All machine guns require the following components:

1. A feed system to load the chamber. Cartridges can be fed into the chamber by a variety of methods, the most common being magazines or ammunition belts.
2. A trigger mechanism to fire the round. This includes the actual trigger, a trigger sear to catch the bolt, a bolt and a firing pin, as well as other components. Typically, the act of pulling the trigger causes something to strike the primer on the round in the chamber and disengages the sears. This allows continual cycling of the bolt until the trigger is released. A sear then grabs the bolt or firing pins. This stops the machine gun at some point in its cycle.
3. An extractor system to eject the spent or misfired cartridge. Usually this is fairly simple. A pin on the side of the bolt catches a ridge on the cartridge and flicks it out an ejection port.

These components form a mechanism which must be powered. If powered by absorbing the recoil of a cartridge, it is called recoil-operated. If powered by the expanding gases of a fired cartridge, it is called gas actuated. If powered by an external force, such as a motor, it is usually called a chain gun.

Operation

An M60 machine gun aboard a Navy patrol craft. The USS Constellation (CV-64) in the distance; July 2002

All machine guns follow a cycle:

- Removing the spent cartridge through an ejection port.
- Cocking the trigger mechanism so the weapon can be fired again.

- Loading the next round into the firing chamber. Usually spring tension or a cam forces the new round and bolt back into the firing chamber.

A mechanism makes the firing pin fire the cartridge, activating the ejection and reloading steps. The cycle repeats. This full cycle takes a fraction of a second and can thus occur many times per second. The operation is basically the same, regardless of the means of activating these mechanisms. Some examples:

- Machine pistols and submachine guns (like the World War II "grease gun," MAC-10 or the Uzi) are usually blowback operated.

- Most assault rifles and squad automatic weapons are gas actuated. Some weapons, such as the AR-15/M16, integrate the piston with the bolt. Others, such as the AR18 and AK patterns, attach the piston to a bolt carrier that unlocks and operates the bolt.

- A recoil actuated machine gun uses the recoil to first unlock and then operate the action. Heavy machine guns, such as the M2 .50 and Browning .50, are of this type. These can be recognized by a large cocking lever needed to feed the first round.

- An externally actuated machine gun uses an external power source, such as an electric motor or even a hand crank to move its mechanism through the firing sequence. Most modern weapons of this type are called chain guns in reference to their driving mechanism. Gatling guns and revolver cannon have several barrels or chambers on a rotating carousel and a system of cams that load, cock, and fire each mechanism progressively as it rotates through the sequence. The continuous nature of the rotary action allows for an incredibly high cyclic rate of fire, often several thousand rounds per minute. Not all chain guns use multiple barrels or chambers, though. Chain guns are less prone to jamming than a gun operated by gas or recoil, as the external power source will eject misfired rounds with no further trouble. This is not possible if the force needed to eject the round comes from the round itself. Chain guns are generally used with large shells, 20 mm in diameter or more, though some, such as the M134 minigun, fire smaller cartridges. They offer benefits of reliability and firepower, though the weight and size of the power source and driving mechanism makes them impractical for use outside of a vehicle or aircraft mount.

Heavy machine guns are often water cooled or have interchangeable barrels, which must be changed periodically to avoid overheating. The higher the rate of fire, the more often barrels must be changed and allowed to cool. To minimize this, most air-cooled guns are fired only in short bursts or at a reduced rate of fire.

Not all machine guns strike the primer in the same way. In blowback machine guns, the act of seating the round also fires the round. In gas operated and recoil-operated guns, a separate step in the firing sequence is needed to strike the round. In a progressive-fire gun, the firing pin is cycled by cams. In some automatic cannon, the primer is fired electrically.


U.S. Marines and their M240G at Camp Hansen, Okinawa

In weapons where the round seats and fires at the same time, mechanical timing is essential for operator safety, to prevent the round from firing before it is seated properly. This is especially important in weapons like the 40 mm grenade launcher, where high explosives are present in the rounds being fired.

Machine guns are controlled by one or more mechanical sears. When a sear is in place, it effectively stops the bolt at some point in its range of motion. Some sears stop the bolt when it is locked to the rear. Other sears stop the firing pin from going forward after the round is locked into the chamber.

Almost all weapons have a "safety" sear, which simply keeps the trigger from engaging.

History

The Chinese had some success with creating a repeating crossbow; the most common model, the Zhuge Nu, better known in the West as the Chu-ko-nu, is typically attributed to 2nd and 3rd century strategist Zhuge Liang[*citation needed*], who developed it for the Kingdom of Shu during the Three Kingdoms period. However, a buried library in the ancient state of Chu indicates that some sort of repeating crossbow had at the very least been designed in the 3rd century BC.Multi-shot weapons have a long development, going as far back to the 1st century, with plans for a multi-shot arrow gun by Greek engineer Hero of Alexandria [*citation needed*]. Leonardo Da Vinci devised plans for one in the 1400s, and stretching back to some of the earliest firearms and attempts at higher rates of fire, and some machine-gun-like traits happened as early as the 1700s. However, it would not be until the mid-1800s that successful machine-gun designs came into existence. The key characteristic of modern machine guns, their relatively high rate of fire and more importantly machine (automatic) loading, came with the Model 1862 Gatling gun, which was adopted by the United States Navy. These weapons were still powered by hand; however, this changed with Hiram Maxim's idea of harnessing recoil energy to power reloading in his Maxim machine gun. Dr. Gatling also experimented with electric-motor-powered models; this externally powered machine reloading has seen use in modern weapons as well. The Vandenburg and Miltrailleuse volley (organ) gun concepts have been revived partially in the early 21st century in the form of electronically controlled, multibarreled volley guns. It is important to note that what exactly constitutes a machine gun, and whether volley guns are a type of machine gun, and to what extent some earlier types of devices are considered to be like machine guns, is a matter of debate in many cases and can vary depending which language and exact definition is used.

Early rapid-firing weapons

Among first known ancestor of multi-shot weapons was created by James Puckle, a London lawyer, who patented what he called "The Puckle Gun" on May 15, 1718. It was a design for a 1 in. (25.4 mm) caliber, flintlock revolver cannon able to fire 9 rounds before reloading, intended for use on ships [*citation needed*]. According to Puckle, it was able to fire round bullets at Christians and square bullets at Turks.[*citation needed*] While ahead of its time, foreshadowing the designs of revolvers, it was not adopted or produced.

In the early and mid-19th century, a number of rapid-firing weapons appeared which offered multi-shot fire, and a number of semi-automatic weapons as well as volley guns. Volley guns (such as the Mitrailleuse) and double barreled pistols relied on duplicating all parts of the gun. Pepperbox pistols did away with needing multiple hammers but used multiple barrels. Revolvers further reduced this to only needing a pre-prepared magazine using the same barrel and ignitions. However, like the Puckle gun, they were still only semiautomatic.

The coffee-mill gun of the Civil War featured both automatic loading and single barrel, only separated functionally from the modern machine gun by being hand-powered rather than using cartridges.

The Gatling gun, patented in 1861 by Richard Jordan Gatling, was the first to offer controlled, sequential automatic fire with automatic loading. The design's key features were machine loading of prepared cartridges and a hand-operated crank for sequential high-speed firing. It first saw very limited action in the American Civil War and was subsequently improved. Many were sold to other armies in the late 1800s and continued to be used into the early 1900s, until they were gradually supplanted by Maxim guns. The Gatlings were the first widely used rapid-fire guns and, due to their multiple barrels, could offer more sustained fire than the first generation of air-cooled, recoil-operated machine guns. The weight, complexity, and resulting cost of the multibarrel design meant recoil-operated weapons, which could be made lighter and cheaper, would supplant them. It would be another 50 years before the concept was again used to allow extremely high rates of fire, such as in miniguns, and automatic aircraft cannons.

Maxim gun

A Vickers machine gun with crew wearing gas masks during WWI

A model of a typical entrenched German machine gunner in World War I. He is operating an MG08, wearing a Stahlhelm and cuirass to protect him from shrapnel, and protected by rows of barbed wire and sandbags.

The first true machine gun was invented in 1881 by Hiram Maxim. The "Maxim gun" used the recoil power of the previously fired bullet to reload rather than being hand powered, enabling a much higher rate of fire than was possible using earlier designs. Maxim's other great innovation was the use of water cooling (via a water jacket around the barrel) to reduce overheating. Maxim's gun was widely adopted and derivative designs were used on all sides during the First World War. The design required less crew, was lighter, and more usable than earlier Gatling guns.

Heavy guns based on the Maxim such as the Vickers machine gun were joined by many other machine weapons, which mostly had their start in the early 20th century. Submachine guns (e.g., the German MP18) as well as lighter machine guns (the Chauchat, for example) saw their first major use in World War I, along with heavy use of large-caliber machine guns. The biggest single cause of casualties in World War I was actually artillery, but combined with wire entanglements, machine guns earned a fearsome reputation. The automatic mechanisms of machine guns were applied to handguns, giving rise to automatic pistols (and eventually machine pistols) such as the Borchardt (1890s) and later submachine guns (such as the Beretta 1918). Machine guns were mounted in aircraft for the first time in World War I. Firing through a moving propeller was solved in a variety of ways, including the interrupter gear, metal reinforcement of the propeller, or simply avoiding the problem with wing-mounted guns or having a pusher propeller.

Interwar era and World War II

During the interwar years, many new designs were developed, such as the Browning M2 .50 caliber (12.7 mm) in 1933, which, along with others, were used in World War II. The trend toward automatic rifles, lighter machine guns, and more powerful submachine guns resulted in a wide variety of firearms that combined characteristics of ordinary rifles and machine guns. The Cei-Rigotti (1900s), Fedorov Avtomat (1910s), AVS-36 Simonov (1930s), MP44, M2 Carbine, AK-47, and AR-15 have come to be known as assault rifles (after the German term *sturmgewehr*). Many aircraft were equipped with machine cannons, and similar cannon (nicknamed "Pom-pom guns") were used as antiaircraft weapons. The designs of Bofors of Sweden were widely used by both sides and have greatly influenced similar weapons developed since then.

Germany developed during the interwar years the first widely-used and successful general-purpose machine gun, the Maschinengewehr 34, which inspired many modern machine gun developments. The later Maschinengewehr 42 was feared during WWII by Allied forces as it was capable of firing at a rate of 1200-1800 RPM with pauses of only a few seconds to replace the quick-change barrel when

operated by experienced soldiers [citation needed]. The successor of the MG42, the MG3, is still today in use in the German army. Many modern machine guns are derived from the MG42.

Modern era

The Cold War era saw mostly a refinement of weapon types in the form of lower weight and higher reliability. The semi-automatic rifles of World War II vintage were almost totally replaced by lighter assault rifles such as the M16 and Soviet AK-47. Infantry adopted general-purpose machine guns like the American M60 for squad use, using air cooling for lighter weight. Heavy machine guns were retained for ground vehicles and fortifications. For aircraft use, even heavy machine guns proved to lack killing power in the air-to-air role, and by the late 1950s fighter aircraft armament had almost totally switched to automatic cannons. Machine guns, with lower recoil, remained popular for helicopters and for ground attack aircraft, supplemented by new Gatling-style, electric multibarrel weapons like the American Minigun. In police, special operations, and other paramilitary roles, smaller automatic weapons, including light submachine guns and machine pistols, proliferated, many relying on ubiquitous pistol rounds.

The last major use of a manual machine gun, was a manual grenade machine gun during the 1970s used on river boats in the Vietnam Conflict. The manual type, the Mk 18 Mod 0 was replaced by fully automatic ones such as the Mk 19 grenade launcher.

Future

A 7.62 mm GAU-17 gatling gun of the U.S. Navy. It is an externally powered automatic machine gun. The electric motor that powers its loading, priming, and firing mechanics is on top. Also, note the spade grips and pintle mount.

Conventional machine-gun development has been slowed by the fact that existing machine-gun designs are adequate for most purposes, although significant developments are taking place with regard to antiarmor and antimissile weapons.

Electronically controlled machine guns with ultrahigh rates of fire, like Metal Storm's weapons may see use in some applications, although current small-caliber weapons of this type have found little use: they are too light for anti-vehicle use, but too heavy (especially with the need to carry a tactically useful amount of ammunition) for individual soldiers. The trend towards higher reliability and lower mass for a given power will likely continue. Another example is the six barreled, 4000 round per minute, XM214 minigun "six pack" developed by General Electric has complex machinery, weighs 85 pounds, and has very little penetration power to show for it.

Human Interface

The most common interface on machine guns is a pistol grip and trigger. On earlier manual machine guns, the most common type was a hand crank. On externally powered machine guns, such as

miniguns, an electronic button or trigger on a joystick is commonly used. Lighter machine guns, such as light and medium machine guns often have a butt stock attached, while mounted and tripod mounted machine guns usually have spade grips. In the late 20th century, scopes and other complex optics became more common as opposed to just iron sights.

Loading systems in early manual machine guns were often from a hopper of loose (un-linked) cartridges. Manual volley guns usually had to be reloaded manually all at once (each barrel reloaded by hand). With hoppers, the rounds could often be added while the weapon was firing. This gradually changed to belt-fed types. Belts were either held in the open by the person, or in a bag or box. Some modern vehicle machine guns used linkless feed systems however.

Closeup of M2- This machine gun is part complex armament subsystem;it is aimed and fired from the aircraft rather than directly

Modern machine guns are usually mounted in one of four ways. The first is a bipod- often these are integrated with the weapon. This is common on light machine guns and also medium machine guns. Another major way is with a larger tripod, where the person holding it does not form a 'leg' of support. Medium and heavy usually use tripods. On ships and aircraft machine guns are usually mounted on a pintle mount- basically a steel post that is connected to the frame. Tripod and pintle mounts are usually used with spade grips. The last major way is disconnected from humans, as part of an armament system, such as a tank coaxial or part of aircraft. These are usually electrically fired and have complex sighting systems. (For examples see US Helicopter Armament Subsystems).

It is also heavily used in video gaming such as shoot-em-ups and other fighting games

Notes

1. ^ In United States law, a Machine Gun is defined (in part) by The National Firearms Act of 1934, 26 U.S.C. § 5845 as "*... any weapon which shoots ... automatically more than one shot, without manual reloading, by a single function of the trigger.*"
2. ^ Famous Historical Gun Manufacturers

See also

- Category:Machine guns
- Light machine gun
- Medium machine gun
- Heavy machine gun
- Sub machine gun
- Firearm action
- Meroka gun
- Metal Storm
- Squad automatic weapon
- Breda (machine gun)

- Weapon
- General-purpose machine gun
- List of firearms
- Mitrailleuse - The French word for machine gun, but also a type of manual volley gun.
- Submachine Gun

External links

- subguns.com - US site with discussion on the topic and controlling US laws, and many machine guns for sale under US regulations
- MachineGun.com - Machineguns available for law enforcement, military and civilian sales.
- How Stuff Works - Very well written article with animated diagrams
- Gun history
- U.S. Patent 15,315 -- A patent for an early automatic cannon
- Vickers Machine gun site
- The REME Museum of Technology - machine guns