1
Firearms

1.1 A Brief History of Firearms

1.1.1 Early hand cannons

The earliest type of handgun was simply a small cannon of wrought iron or bronze, fitted to a frame or stock with metal bands or leather thongs. These weapons were loaded from the muzzle end of the barrel with powder, wad and ball. A small hole at the breech end of the barrel, the *touch hole*, was provided with a pan into which *a priming charge* of powder was placed. On igniting this priming charge, either with a hot iron or lighted match, fire flashed through the touch hole and into the main powder charge to discharge the weapon.

These early weapons could have been little more than psychological deterrents being clumsy, slow to fire and difficult to aim. In addition, rain or damp weather had an adverse effect on the priming charge making it impossible to ignite.

Their first reported use is difficult to ascertain with any degree of certainty, but a number of instances are reported in Spain between 1247 and 1311. In the records for the Belgian city of Ghent, there are confirmed sightings of the use of hand cannons in Germany in 1313. One of the earliest illustrations concerning the use of hand cannons appears in the fifteenth century fresco in the Palazzo Publico, Sienna, Italy.

The first recorded use of the hand cannon as a cavalry weapon appeared in 1449 in the manuscripts of Marianus Jacobus. This shows a mounted soldier with such a weapon resting on a fork attached to the pommel of the saddle. It is interesting to note that the use of the saddle pommel to either carry or aim

Handbook of Firearms and Ballistics: Second Edition Brian J. Heard

Figure 1.1 Early hand cannon.

the hand guns could be the origin of the word 'pistol', the early cavalry word for the pommel of the saddle being 'pistallo'.

Combinations of the battle axe and hand cannon were used in the sixteenth century, and a number of these can be found in the Tower of London. One English development of this consisted of a large mace, the head of which had a number of separate barrels. At the rear of the barrels, a concealed chamber containing priming powder led to all the barrels. When the priming compound was ignited, all the barrels discharged at once.

1.1.2 The matchlock

This was really the first major advance in pistols as it enabled the weapon to be fired in one hand and also gave some opportunity to aim it as well.

The construction of the matchlock was exactly the same as the hand cannon in that it was muzzle loaded and had a touch hole covered with a priming charge. The only difference was that the *match*, a slow-burning piece of cord used to ignite the priming charge, was held in a curved hook screwed to the side of the frame. To fire the gun, the hook was merely pushed forward to drop

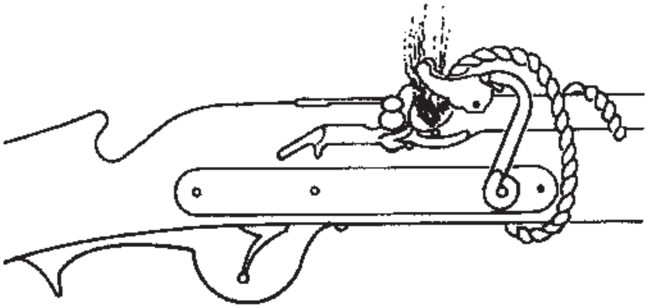


Figure 1.2 Matchlock (by courtesy of the Association of Firearms and Toolmark Examiners).

the burning end of the match into the priming charge. As these weapons became more sophisticated, the curved hook was embellished and took on the form of a snake and became known as the weapon's *serpentine*.

Eventually, the tail of the serpentine was lengthened and became the forerunner of the modern trigger. Further refinements included the use of a spring to hold the head back into a safety position. The final refinement consisted of a system whereby when the tail of the serpentine was pulled, the match rapidly fell into the priming compound under spring pressure. This refinement, a true trigger mechanism, provided better ignition and assisted aiming considerably (Figure 1.2).

It was during the era of the matchlock that reliable English records appeared, and it is recorded that Henry VIII, who reigned from 1509 until 1547, armed many of his cavalry with matchlocks. The first true revolving weapon is also attributed to the period of Henry VIII and is on show in the Tower of London. This weapon consists of a single barrel and four revolving chambers. Each chamber is provided with its own touch hole and priming chamber which has a sliding cover. Although the actual lock is missing from the Tower of London weapon, its construction strongly suggests a single matchlock was used.

The major defect with the matchlock design was that it required a slow-burning 'match' for ignition. As a result, it was of little use for surprise attack or in damp or rainy conditions.

1.1.3 The wheel lock

With the advent of the wheel lock the lighted match used in the matchlock was no longer necessary. This important innovation in the field of firearms design made ambush possible as well as making the firearm a practical weapon for hunting.

When fired from the shoulder, the wheel lock was often referred to as an *arquebus* from the shape of the butt which was often curved to fit the shoulder.

Another name, strictly only for much heavier calibre weapons, was the *hacquebut*, which literally means ‘gun with a hook’. This referred to a hook projecting from the bottom of the barrel. This hook was placed over a wall, or some other object, to help take up the recoil of firing.

In its simplest form, the wheel lock consisted of a serrated steel wheel, mounted on the side of the weapon at the rear of the barrel. The wheel was spring-loaded via a chain round its axle with a small key or spanner similar to a watch drum (Figure 1.3). When the wheel was turned with a spanner, the chain wound round the axle and the spring was tensioned. A simple bar inside the lockwork kept the wheel from unwinding until released with the trigger. Part of the wheel protruded into a small pan, the *flash pan or priming pan*, which contained the priming charge for the touch hole. The serpentine, instead of containing a slow-burning match, had a piece of iron pyrite fixed in its jaws. This was kept in tight contact with the serrated wheel by means of a strong spring. On pressing the trigger, the bar was withdrawn from the grooved wheel which then turned on its axle. Sparks produced from the friction of the pyrite on the serrated wheel ignited the priming charge which in turn ignited the main powder charge and fired the weapon.

The wheel lock was a tremendous advance over the slow and cumbersome matchlock. It could be carried ready to fire and with a small cover over the flash pan, it was relatively impervious to all but the heaviest rain. The mechanism was, however, complicated and expensive, and if the spanner to tension the spring was lost, the gun was useless.

There is some dispute as to who originally invented the wheel lock, but it has been ascribed to Johann Kiefuss of Nuremberg, Germany in 1517.

Whilst the wheel lock reached an advanced stage of development in Germany, France, Belgium and Italy towards the close of the sixteenth century, England showed little interest in this type of weapon.

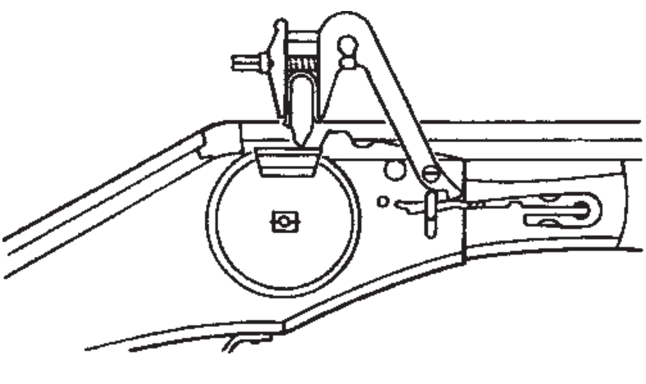


Figure 1.3 Wheel lock (by courtesy of the Association of Firearms and Toolmark Examiners).

Records show that the wheel lock was still being widely manufactured in Europe as late as 1640, but by the turn of the century, it was making way for its successor.

1.1.4 The snaphaunce

The snaphaunce first appeared around 1570, and was really an early form of the flintlock. This mechanism worked by attaching the flint to a spring-loaded arm. When the trigger is pressed, the cover slides off the flash pan, then the arm snaps forward striking the flint against a metal plate over the flash pan producing sparks to ignite the powder.

Whilst this mechanism was much simpler and less expensive than the wheel lock, the German gunsmiths, who tended to ignore the technical advances of other nationalities, continued to produce and improve upon the wheel lock up until the early eighteenth century.

1.1.5 The flintlock

The ignition system which superseded that of the wheel lock was a simple mechanism which provided a spark by striking a piece of flint against a steel plate. The flint was held in the jaws of a small vice on a pivoted arm, called the *cock*. This was where the term to 'cock the hammer' originated.

The steel, which was called the frizzen, was placed on another pivoting arm opposite the cock, and the pan containing the priming compound was placed directly below the frizzen. When the trigger was pulled, a strong spring swung the cock in an arc so that the flint struck the steel a glancing blow. The glancing blow produced a shower of sparks which dropped into the priming pan igniting the priming powder. The flash produced by the ignited priming powder travelled through the touch hole, thus igniting the main charge and discharging the weapon.

The flintlock represented a great advance in weapon design. It was cheap, reliable and not overly susceptible to damp or rainy conditions. Unlike the complicated and expensive wheel lock, this was a weapon which could be issued in large numbers to foot soldiers and cavalry alike.

As is the case with most weapon systems, it is very difficult to pinpoint an exact date for the introduction of the flintlock ignition system. There are indications of it being used in the middle of the sixteenth century, although its first wide use cannot be established with acceptable proof until the beginning of the seventeenth century (Figure 1.4).

Three basic types of flintlock were made:

- *Snaphaunce* – a weapon with the mainspring inside the lock plate and a priming pan cover which had to be manually pushed back before firing.

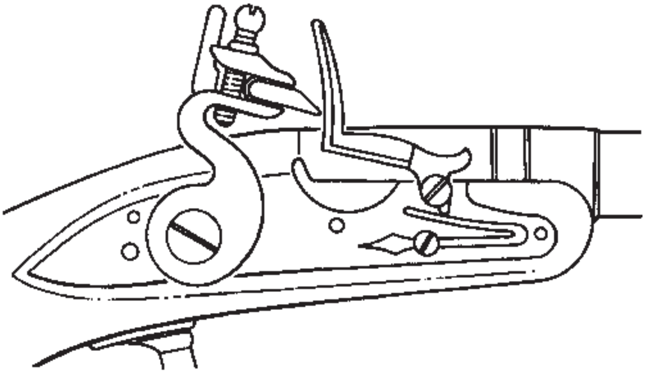


Figure 1.4 Flintlock (by courtesy of the Association of Firearms and Toolmark Examiners).

- *Miquelet* – a weapon with the mainspring outside the lockplate, but with a frizzen and priming pan cover all in one piece. In this lock type, the pan cover was automatically pushed out of the way as the flint struck the frizzen.
- *True flintlock* – a weapon with a mainspring inside the lock plate and with the frizzen and priming pan cover in one piece. This also had a half-cock safety position enabling the weapon to be carried safely with the barrel loaded and the priming pan primed with powder. This system was probably invented by Mann Le Bourgeoys, a gunmaker for Louis XIII of France, in about 1615.

Flintlock pistols, muskets (long-barrelled weapons with a smooth bore) and shotguns were produced with the flintlock mechanism. There was even a patent for flintlock revolvers issued in 1661.

1.1.6 The percussion system

The flintlock continued to be used for almost 200 years and it was not until 1807 that a Scottish minister, Alexander John Forsyth, revolutionized the ignition of gunpowder by using a highly sensitive compound which exploded on being struck. This compound, *mercury fulminate*, when struck by a hammer, produced a flash strong enough to ignite the main charge of powder in the barrel. A separate priming powder and sparking system was now no longer required (Figure 1.5). With this invention, the basis for the self-contained cartridge was laid and a whole new field of possibilities was opened up.

Once this type of ignition, known as *percussion priming*, had been invented, it still took some time to perfect ways of applying it. From 1807 until 1814, a wide range of systems were invented for the application of the percussion

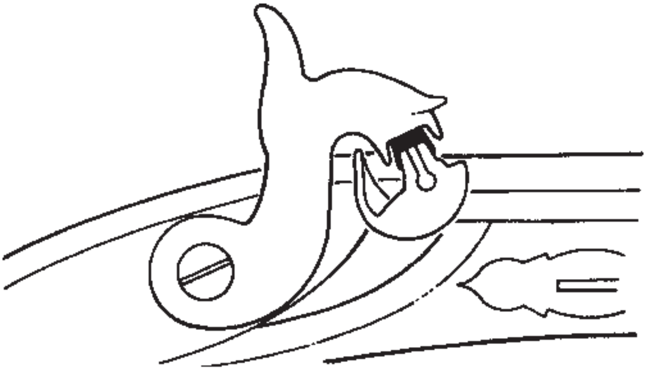


Figure 1.5 Percussion cap system (by courtesy of the Association of Firearms and Toolmark Examiners).

priming system including the Forsyth scent bottle, pill locks, tube locks and the Pauly paper cap.

The final form, the percussion cup, was claimed by a large number of inventors. It is probably attributable to Joshua Shaw, an Anglo-American living in Philadelphia in 1814. Shaw employed a small iron cup into which was placed a small quantity of mercury fulminate. This was placed over a small tube, called *a nipple*, projecting from the rear of the barrel. The hammer striking the mercury fulminate in the cup caused it to detonate and so send a flame down the nipple tube igniting the main charge in the barrel.

1.1.7 The pinfire system

Introduced to the United Kingdom at the Great Exhibition in London in 1851 by Lefaucheux, the pinfire weapon was one of the earliest true breech-loading weapons using a self-contained cartridge in which the propellant, missile and primer were all held together in a brass case.

In this system, the percussion cup was inside the cartridge case whilst a pin, which rested on the percussion cup, protruded through the side of the cartridge case. Striking the pin with the weapon's hammer drove the pin into the priming compound causing it to detonate and so ignite the main propellant charge (Figure 1.6).

The pin, which protruded through the weapon's chamber, not only served to locate the round in its correct position, but also aided extraction of the fired cartridge case.

The pinfire was at its most popular between 1890 and 1910 and was still readily available in Europe until 1940. It had, however, fallen out of favour in England by 1914 and was virtually unobtainable by 1935.

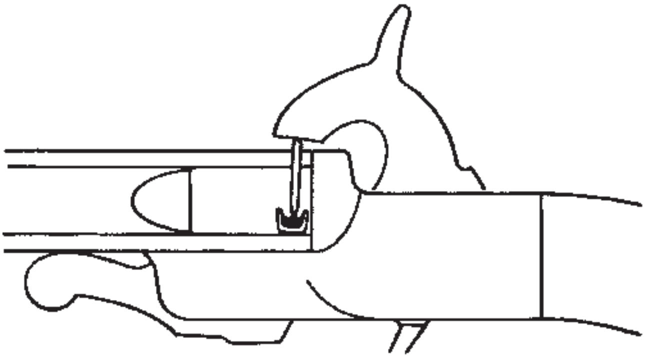


Figure 1.6 Pinfire system (by courtesy of the Association of Firearms and Toolmark Examiners).

Calibres available in the pinfire revolvers were 5, 7, 9, 12 and 15 mm, whilst shotgun and rifle ammunition in 9 mm, 12 bore and various other calibres was also available.

The really great advance of the pinfire system was, however, not just the concept of a self-contained cartridge, but obturation, the ability of the cartridge case under pressure to swell and so seal the chamber preventing the rearward escape of gases.

1.1.8 The rimfire system

Whilst the pinfire system was a significant step forward, it did have a number of drawbacks, not least of which was the propensity of the cartridge to discharge if dropped onto its pin. This problem was all but eliminated by the rimfire which, like the pinfire, was exhibited at the Great Exhibition in 1851.

The rimfire cartridge is a thin-walled cartridge with a hollow flanged rim. Into this rim is spun a small quantity of a priming compound. Crushing the rim with the firing pin causes the priming compound to explode, thus igniting the propellant inside the case.

The initial development of this system was made by a Paris gunsmith, Flobert, who had working examples of it as early as 1847 (Figure 1.7).

It was, however, some time before it gained acceptance, and it was not until 1855 that Smith and Wesson manufactured the first revolver to fire rimfire cartridges. This was a hinged-frame 0.22″ calibre weapon in which the barrel tipped up by means of a hinge on the top of the frame. This enabled the cylinder to be removed when loading and unloading the weapon.

Although a great step forward, the rimfire was only suitable for high-pressure weapons in small calibre. Anything above 0.22″ and the soft rim necessary for the ignition system resulted in cartridge case failures.

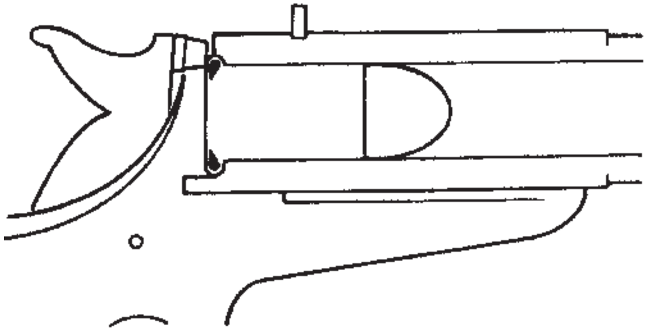


Figure 1.7 Rimfire system.

1.1.9 The Dreyse needle fire rifle

The Dreyse needle gun was a military breech-loading rifle, famous as the main infantry weapon of the Prussians, who adopted it for service in 1848 as the Dreyse Prussian Model 1848.

Its name, the needle gun, comes from its needle-like firing pin, which passed through the cartridge case to impact a percussion cap glued to the base of the bullet.

The Dreyse rifle was the first breech-loading rifle to use the bolt action to open and close the chamber, executed by turning and pulling a bolt handle.

The Dreyse rifle was invented by the gunsmith Johann Nikolaus von Dreyse (1787–1867) and was first produced as a fully working rifle in 1836. From 1848 onwards, the new weapon was gradually introduced into the Prussian service, then later into the military forces of many other German states. The employment of the needle gun radically changed military tactics in the nineteenth century.

The cartridge used with this rifle was a self-contained paper case containing the bullet, priming cap and black powder charge. The bullet, which was glued into the paper case, had the primer attached to its base. The upper end of the paper case was rolled up and tied together. Before the needle could strike the primer, its point had to pass through the powder and hit the primer ahead. The theory behind this placement of the primer is that it would give more complete combustion of the charge. Unfortunately, this led to severe corrosion of the needle which then either stuck in the bolt or broke off rendering the rifle useless. It was, however, a major step forward in the production of the modern rifle (Figure 1.8).

1.1.10 The centre fire system

This was the great milestone in weapon and ammunition development. In centre fire ammunition, only the primer cup needed to be soft enough to be crushed

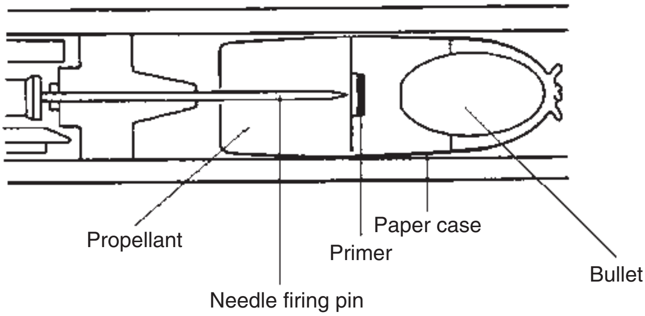


Figure 1.8 Dreyse needle fire system.

by the firing pin. The cartridge case could thus be made of a more substantial material which would act as a gas seal for much higher pressures than could be obtained with rimfire ammunition.

Once again the precise date for the invention of the first centre fire weapon is difficult to ascertain, although there is a patent issued in 1861 for a Daws centre fire system (Figure 1.9).

Probably no invention connected with firearms has had as much effect on the principles of firearms development as the obturating centre fire cartridge case. Although invented around 1860, the principles are still the same and are utilized in every type of weapon from the smallest handgun up to some of the largest artillery pieces.

Rocket-propelled bullets (the Gyrojet), caseless ammunition, hot air ignition and many other esoterica have come and gone. However, for simplicity, reliability and ease of manufacture, the centre fire ignition system in an obturating cartridge case has not been excelled.

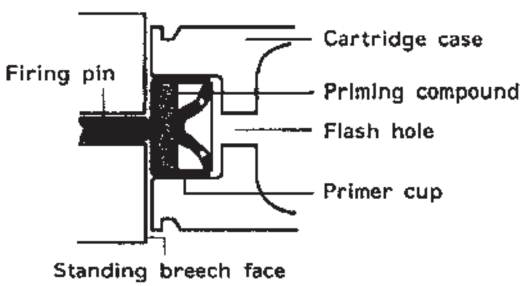


Figure 1.9 Centre fire system.

1.1.11 Rifling

Rifling is the term given to the spiral grooves cut into the bore of a barrel which impart a stabilizing spin to the bullet. This spin keeps the bullet travelling in a point-first direction and lessens any tendency for it to depart from its straight line of flight. As such, this was a very significant event in the evolution of firearms.

Some writers assign the invention of spiral-grooved barrels to Gaspard Kollner, a gunmaker of Vienna, in the fifteenth century. Others fix the date at 1520 and attribute it to Augustus Kotter of Nuremberg.

German weapons bearing the coat of arms of the Emperor Maximilian I and made between 1450 and 1500 have spiral-grooved barrels and are in fact the earliest identifiable rifled guns.

Both straight and spiral forms of rifling are encountered in early weapons, although it is generally accepted that the straight form of rifling was to accommodate the fouling produced in these early black powder weapons.

The number of grooves encountered can be anything from a single deeply cut rifling right up to 12 in number. The form of the groove also varies with square, round, triangular, ratchet and even comma shapes being encountered. The actual number of grooves appears to have little effect on the stabilizing effect of the rifling.

One of the problems encountered with the muzzle-loading rifle was the difficulty experienced in loading the projectile. If it was of sufficient diameter to take up the rifling, a large mallet was required to force it down the bore. If, on the other hand, it was of reduced diameter to assist in its insertion, the gases produced on firing would escape past the bullet leading to reduced velocity. In addition, the bullet took up little of the rifling and thus became unstable in flight. The Brunswick rifle overcame this problem by having a belted bullet and a barrel with two grooves to exactly match the rib on the bullet.

Several other designs were tried in which the bullet was rammed down onto various projections inside the breech end of the barrel. These projections deformed the bullet, thus filling out the bore. Unfortunately, the deformation was irregular and led to erratic behaviour of the bullet.

Greener in 1835 produced the first expansive bullet, the rear of which contained a steel plug. On firing, this was forced up into the bullet expanding it uniformly.

In 1852, Minie, a Frenchman, was awarded a British government contract for the production of an expanding bullet using a steel plug in the base very similar to the Greener design. This resulted in some acrimonious legal action by Mr Greener who was awarded a sum of money recognizing his as the earliest form of expanding bullet.

Lancaster, at about the same time as Minie invented his expanding bullet, produced a rifle with a spiral oval bore. This permitted easy loading of the bullet, did not require any mechanism to expand the base and, as there were no sharp corners to the rifling, it did not suffer the problems with fouling as encountered with conventional rifling.

In 1854, Whitworth patented the first polygonal bore rifling system which overcame most of the problems and was extremely accurate as well. Unfortunately, Whitworth did not have the experience in the practical manufacture of weapons and was unable to produce guns with the consistency required. As a result, his invention was soon overtaken by others.

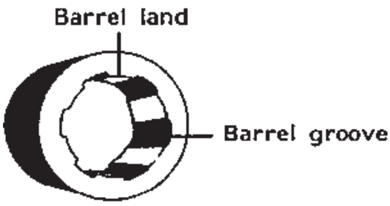


Figure 1.10 Rifling in the bore of a barrel.

The invention of the breech-loading weapon eliminated the problems of having to expand the bullet and fill the bore. The bullet could be made of the correct diameter and could simply be inserted into the rifling at the breech end of the barrel (Figure 1.10). In addition, instead of the deep grooving and a long soft bullet necessary for easy loading and expansion at the breech of a muzzle loader, shallow grooves and hard bullets could be used. This configuration resulted in more uniform bullets, higher velocities, better accuracy and improved trajectory.

1.1.12 Rifling twist rate calculation

One of the first persons to try to develop a formula for calculating the correct rate of twist for firearms was George Greenhill, a mathematics lecturer at Emmanual College in Cambridge, England.

His formula is based on the rule that the twist required in calibres equals 150 divided by the length of the bullet in calibres. This can be simplified to

$$\text{Twist} = 150 \times D^2/L$$

where D = bullet diameter in inches and L = bullet length in inches.

This formula had limitations, but worked well up to and in the vicinity of about 1800 fps. For higher velocities, most ballistic experts suggest substituting 180 for 150 in the formula.

The Greenhill formula is simple and easy to apply and gives a useful approximation to the desired twist. It was based on a bullet with a specific gravity of 10.9, which is approximately correct for a jacketed lead-cored bullet.

In this equation, bullet weight does not directly enter into the equation. For a given calibre, the heavier the bullet, the longer it will be. So bullet weight affects bullet length, which is used in the formula.

For bullets with a specific gravity other than 10.9, then the formula becomes

$$\text{Rifling Twist Rate Required} = CD^2/L \times \sqrt{SG/10.9}$$

If an insufficient twist rate is used, the bullet will begin to yaw and then tumble; this is usually seen as 'keyholing', where bullets leave elongated holes in the target as they strike at an angle.

Once the bullet starts to yaw, any hope of accuracy is lost, as the bullet will begin to veer off in random directions as it processes.

A too-high rate of twist can also cause problems. The excessive twist can cause accelerated barrel wear, and in high-velocity bullets, an excessive twist can cause bullets to literally tear themselves apart under the centrifugal force.

A higher twist than needed can also cause more subtle problems with accuracy. Any inconsistency in the bullet, such as a void that causes an unequal distribution of mass, may be magnified by the spin.

Undersized bullets also have problems, as they may not enter the rifling exactly concentric and coaxial to the bore, and excess twist will exacerbate the accuracy problems this causes.

The twist necessary to stabilize various calibres follows (Table 1.1):

Table 1.1 Rifling twist necessary to stabilize various calibres.

Calibre	Twist rate required
0.22 Short	1 in 24″
0.22 Long rifle	1 in 16″
0.223 Remington	1 in 12″
0.22–250 Remington	1 in 14″
0.243 Winchester	1 in 10″
6 mm Remington	1 in 9″
0.25–0.6 Remington	1 in 10″
0.257 Weatherby Magnum	1 in 10″
6.5 × 55 Swedish Mauser	1 in 7.5″
0.260 Remington	1 in 9″
0.270 Winchester	1 in 10″
7 mm–0.8 Remington	1 in 9.25″
7 mm Remington Magnum	1 in 9.25″
0.30 Carbine	1 in 16″
0.30–30 Winchester	1 in 12″
0.308 Winchester	1 in 12″
0.30–0.6 Springfield	1 in 10″
0.300 Winchester Magnum	1 in 10″
0.303 British	1 in 10″
0.357 Magnum	1 in 16″
0.357 Sig Saner	1 in 16″
0.380 Automatic Colt Pistol	1 in 10″
9 mm Parabellum	1 in 10″
0.40 Smith & Wesson	1 in 15″
0.45 Automatic Colt Pistol	1 in 16″
0.444 Marlin	1 in 38″
0.45–70 Government (US)	1 in 20″

Whilst it is of little circumstance, the question as to the revolutions made per minute by the bullet has been asked on several occasions. The formula for calculating this is as follows:

$$\frac{MV \times 720}{\text{Twist rate in inches}} = RPM$$

For example:

9 mm PB bullet at 1200 fps fired in a barrel with a 1 in 10 twist rate will have a rotational speed of 1200 × 720/10 = 86 400 rpm

0.223″ bullet at 3000 fps fired in a barrel with a 1 in 12 twist rate will have a rotational speed of 3000 × 720/12 = 180 000 rpm

Once again, whilst it has little relevance in everyday case examination, the question as to the rotational speed (revolutions per minute, rpm) and the number of times that a bullet will make a full rotation whilst passing through an object can be asked.

This question was posed in relation to a murder case where one of several bullets which had hit the deceased had cut a trough (often called a ‘gutter wound’) across the victim’s arm. The bullet wound was black and the defence counsel were of the opinion that this was caused ‘by the bullet rotating so fast that it had burnt the flesh to carbon’.

This was extremely easy to refute as the barrel of the weapon concerned had a 1 in 10″ rate of twist, which means that the bullet rotated once in every 10 in. of travel. As the wound on the arm was barely 2 in. in length, the bullet would not have made more than $\frac{1}{5}$ of a rotation during that distance.

The blackening, as can be seen from the following photograph, was simply old congealed blood (Figure 1.11).

Figure 1.11 Gutter wound to forearm.

1.1.13 The revolver

A revolver is a weapon with a revolving cylinder containing a number of firing chambers (basically a revolving magazine) which may be successively lined up and discharged through a single barrel.

In the long history of revolvers, no name stands out more strongly than that of Samuel Colt. But as we have seen earlier, Colt did not, despite his claims to the contrary, invent the revolver.

The earliest forms of the revolver include a snaphaunce revolver made in the days of King Charles I, said to have been made before 1650 and an even earlier weapon made during the reign of Henry VIII some time before 1547.

Those early revolvers were, surprisingly enough, practically identical to the actions covered in Colt's early patents. The actions for those early patents are still in use today in the Colt Single Action Army or Frontier model.

Colt's original patent, dated 1835, dealt with the revolving of the cylinder by a ratchet and pawl arrangement. The original patents belonging to Colt were so tightly worded that no other manufacturer had any real impression on the market until the original patents ran out in 1850. After this the market was open with Dean–Adams in 1851, Beaumont in 1855, and Starr and Savage in 1865, all bringing out innovative designs. These were, however, still all muzzle-loading percussion systems.

It was not until the advent of the rimfire, which was introduced at the Great Exhibition in 1851, that breech-loading revolvers really started. Even then, it was not until 1857 that Smith and Wesson introduced the first hinged-frame 0.22″ rimfire revolver. The patent for bored-through chambers and the use of metallic cartridges gave Smith and Wesson the market until 1869.

With the passing of the Smith and Wesson patents, there was a flood of breech-loading arms in calibres from 0.22 to 0.50″. The day of the rimfire, except for 0.22″ target shooting, was, however, numbered by the introduction of the centre fire (Figure 1.12).

The first centre fire Colt revolver to be patented was the Colt Single Action Army Model 1873. In 1880, Enfield produced a 0.476″ hinged-frame revolver, but it was a design monstrosity and was soon superseded by the now familiar Webley top latching hinged-frame design in 1887. In 1894, it was slightly modified and became the standard Webley Mk 1 British Army service revolver. In 1889, the US government officially adopted a Colt 0.38″ revolver using the now familiar swing-out cylinder system.

A multitude of variations on the Smith and Wesson and Colt designs followed, but little has really changed in the basic design of the revolver mechanism since then, apart from improved sights, better metals allowing higher pressures and different grips. It would seem, however, that little can be done to improve on the efficiency of the basic Smith and Wesson and Colt designs.

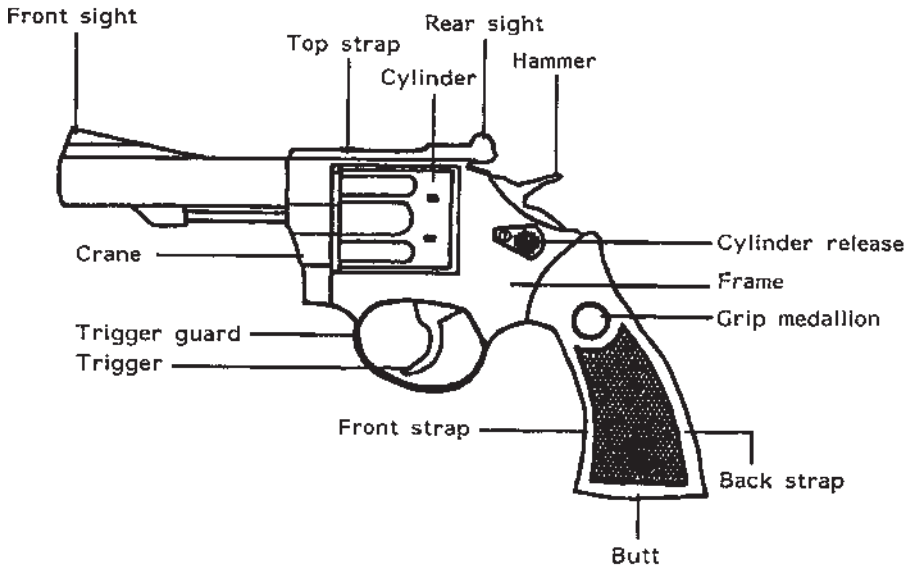


Figure 1.12 Revolver.

1.1.14 Self-loading pistols

The principle of the self-loading pistol was grasped long ago, but without the necessary combination of a self-contained cartridge, smokeless propellant and metallurgical advances, it was not possible to utilize the principles involved.

It is reported in Birche's History of the Royal Society for 1664 that a mechanic had made a claim of being able to make a pistol which could 'shoot as fast as presented and stopped at will'.

Whilst patent records from 1863 show numerous attempts to develop a self-loading pistol, it was not until 1892 that the first successful weapon appeared. This was a weapon patented by the Austrian Schonberger and made by the company Steyr. It was a blowback design and was made for the 8 mm Schonberger, a very powerful cartridge.

The first commercially successful design was by an American, Hugo Borchardt. Unable to finance his design, he took it to Germany to have it manufactured there. This weapon, although clumsy, was of radical design containing the first magazine to be held in the grip and the 'knee joint' toggle locking system. It was this design which was slightly modified by Luger to become Germany's first military self-loading pistol.

In 1893, Bergman produced a whole range of pistols, one of which, the 1897 8 mm 'Simplex', is of particular interest as the cartridge became the 0.32″ Automatic Colt Pistol (ACP) cartridge.

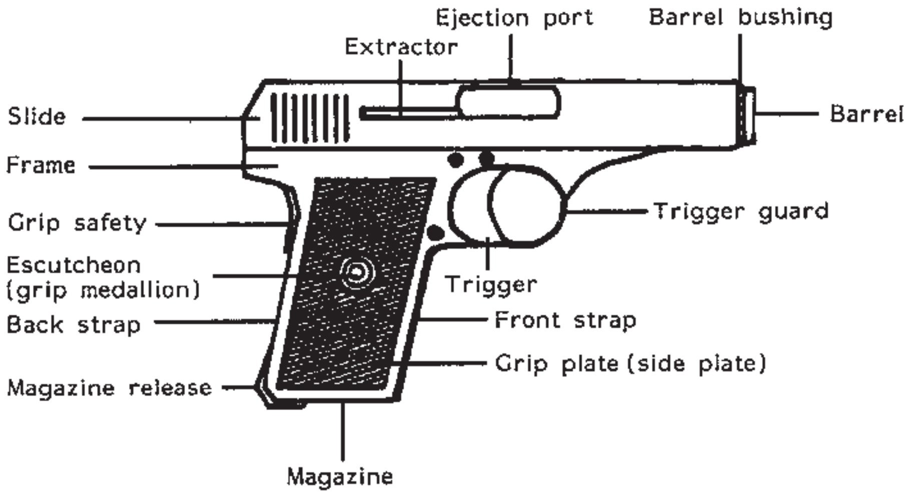


Figure 1.13 Self-loading pistol.

In 1896, the story of the truly successful self-loading pistol really began with the introduction of the 7.63 mm calibre Mauser, the 'broom handle' pistol. This was the pistol made famous by Winston Churchill who purchased one for use during the Sudan campaign of 1898. Winston Churchill credits the weapon with saving his life when he shot his way out of a native trap 'killing several Fuzzy Wuzzies'!

In 1898, the German factory of DWM (Deutsche Waffen- and Munitionsfabriken Atkien-Gesellschaft, German Weapons and Munitions Works) brought out the first model of the famous Luger pistol in 7.65 mm Parabellum calibre. In 1904, the weapon was made available in 9 mm Parabellum, which was the calibre adopted for the German service pistols.

In 1897, John Browning, the greatest of all American small arms designers, produced his first patent. This was finally introduced as the Model 1900 Colt 0.38″ automatic.

Webley made a few unsuccessful forays into the self-loading pistol market with the 0.455″ calibre 1904 model, the 0.45″ 1905 model, the 1910 0.38″ calibre and the 0.455″ navy model 1913. The Webley design was not, however, very successful and never became popular.

Probably the most successful pistol ever to be introduced was the Model 1911, Browning designed, Colt Government Model in 0.45″ calibre. With minor modifications, as the Model 1911 Al, the weapon was the standard issue military weapon for the United States until the late 1980s.

Since then, the main innovations have been in the use of lightweight aluminium and plastics for the weapons frame, the move towards smaller calibres and higher-velocity bullets, the development of magnum handgun ammunition and the use of gas-operated locking systems. These are, however, only variations on a theme and, as with revolvers, it would seem that there is little that can be done to improve on the basic design.

1.1.15 Brief glossary

Breech loader	Weapon in which the ammunition is inserted into the rear of the barrel.
Centre fire	Ammunition with the priming compound held in a cap in the centre of the base of the cartridge case.
Cock (v)	The spring-loaded hammer system which initiates the priming compound.
Cock (n)	The vice-like component of a flintlock mechanism which holds the flint.
Flash hole	Hole connecting the priming compound with the propellant charge; also called the vent or touch hole.
Flash pan	Shallow pan covering the touch hole into which the priming powder is placed.
Mercury fulminate	One of the earliest explosive priming compounds.
Muzzle loader	Weapon in which the propellant and ball are loaded from the muzzle.
Pinfire	Early self-contained cartridge which had a firing pin integral with the cartridge case.
Primer cap	Small cup containing the priming compound.
Priming powder	Finely divided black powder.
Propellant	Solid substance which, when ignited, produces a large quantity of gas to propel a missile down the bore of a weapon.
Revolver	A weapon with a revolving cylinder containing a number of firing chambers (basically a revolving magazine) which may be successively lined up and discharged through a single barrel.
Rifling	Spiral grooves in the barrel to impart spin to the projectile giving it stability in flight.
Rimfire	Self-contained cartridge with the priming compound held in the hollow base flange or rim.
Self-loading	A repeating firearm requiring a separate pull of the trigger for each shot fired. After manually loading the first round from the magazine, the weapon will use the energy of discharge to eject the fired cartridge and load a new cartridge from the magazine into the barrel ready for firing.

1.2 Weapon Types and Their Operation

Terrible confusion exists as to what is *a pistol, revolver, self-loading pistol* and *automatic*. This is very basic firearms nomenclature, but it is often wrongly applied. The use of the correct term is absolutely essential if any credibility is to be maintained.

This chapter attempts no more than to carefully explain the correct usage and, where they exist, alternatives which one might encounter.

1.2.1 Handguns

There are three basic types of handgun: *single shot, revolving* and *self-loading pistols*.

Such exotica as double-barrelled Howdah pistols, self-loading revolvers and self-loading pistols with revolving magazines can be ignored for the purposes of this chapter.

In English nomenclature, all handguns are pistols; some are single-shot pistols; others are revolving pistols, and the rest are self-loading pistols.

The Americans take a slightly more laid-back approach with the terminology using revolvers and pistols. Pistols are also referred to as semi-automatics.

The term automatic is often misused, and when applied to a pistol should be used with great care. Correctly used, the term signifies a weapon in which the action will continue to operate until the finger is removed from the trigger or the magazine is empty – hence 'automatic'.

A true self-loading pistol will, after firing, eject the spent cartridge case then reload a fresh round of ammunition into the chamber. To fire the fresh round, the pressure on the trigger has to be released and then re-applied.

A few true automatic pistols have been commercially manufactured. Examples are the Mauser Schnell-Feuer pistol and the Astra Mod 902. Fully automatic pistols have, however, never been a commercial success due to the near impossibility of controlling such a weapon under full automatic fire. Each shot causes the barrel to rise during recoil, and before the firer has time to reacquire the target within the sights, the next round has fired causing the barrel to rise even further. Even at close range, it is unusual for more than two shots to hit a man-sized target.

Single shot. The vast majority of single-shot pistols are 0.22″ LR (long rifle) calibre and are intended for target use. Generally, the barrel is hinged to the frame with some locking mechanism to keep it in place during firing. On unlocking, the barrel swings down allowing the empty cartridge case to be removed and a fresh one to be inserted. Other types exist in which the barrel is firmly fixed to the frame and some form of breech block which either swings out, pulls back or slides down to expose the breech end of the barrel for loading/unloading.

Revolving pistol. In a revolving pistol, or revolver, the supply of ammunition is held in a cylinder at the rear of the barrel with each round having its own chamber. Cocking the hammer rotates the cylinder via a ratchet mechanism to bring a new round of ammunition in line with the barrel. Pulling the trigger then drops the hammer thus firing the round. This is the most simple type of revolving pistol mechanism and is called the *single-action* mode of operation. The earliest types of revolving pistol employed this type of mechanism. A prime example of a single-action revolver is the Colt Single Action Model of 1873.

The other type of revolving pistol mechanism is called *double action*. In this design, a long continuous pull on the trigger cocks the hammer, rotates the cylinder, then drops the hammer all in one operation. Most modern revolving pistols employ this type of mechanism with virtually all of them having the capability for single-action mode of operation as well.

In the past, very few self-cocking revolving pistols have also been manufactured. These have an action which, after firing a round, automatically rotates the cylinder and re-cocks the hammer. The most successful of this type was the Webley Fosberry. This type of weapon is, however, extremely rare and exists nowadays only as a collector's item.

Revolvers can be subgrouped into *solid frame*, where the frame is made from a single forging, and *hinged frame*, where the frame is hinged to tip either up or down for access to the cylinder. Access to the cylinder for loading or reloading in solid frame revolvers is generally accomplished by having the cylinder mounted on a *crane* which can be swung out from the frame (Figure 1.14). Some weapons also have the cylinder mounted on a removable axis pin which

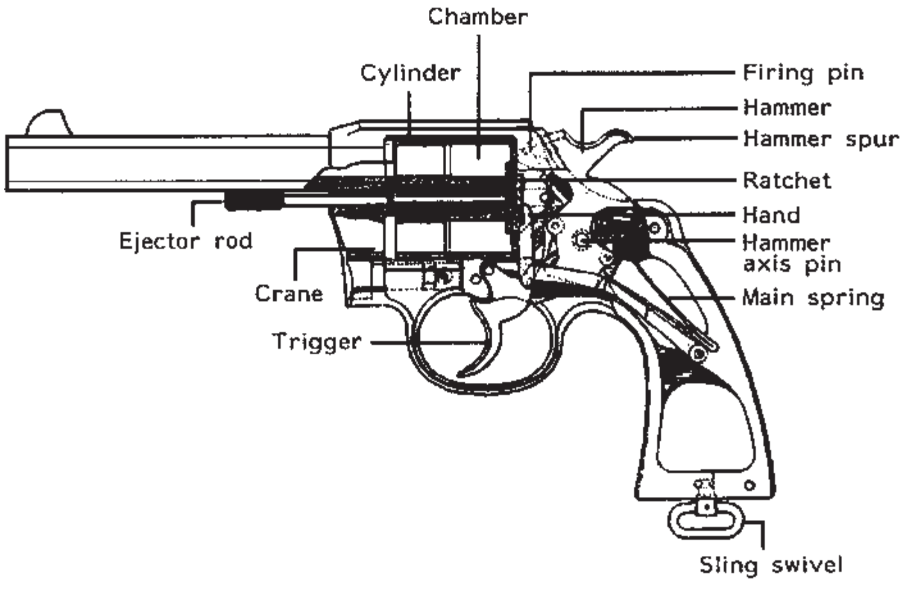


Figure 1.14 Modern revolver mechanism.

when removed allows the cylinder to be completely removed from the frame for loading and unloading. This type of frame is more commonly encountered in cheaper weapons, generally of 0.22″ calibre.

Of the two frame types, the solid frame is the most common, due to its inherent strength and ease of manufacture.

Self-loading pistol (slp). In this type of weapon, the ammunition is contained in a removable spring-loaded magazine housed within the grip frame. The barrel of the weapon is surrounded by a slide with an integral breech block which is kept into battery (i.e. when the face of the breech block is up tight against the breech end of the barrel in a position ready for firing), with the rear of the barrel by a strong spring. Pulling back the slide allows the topmost round of ammunition in the magazine to present itself to the rear of the barrel. On allowing the slide to move forward under spring pressure, the round is pushed from the magazine into the chamber of the barrel by the breech block. This action also cocks the trigger mechanism.

On pulling the trigger, the hammer drops and the round is fired, the bullet being pushed down the barrel by the expanding gases. These gases also exert an equal and opposite force on the cartridge case which forces the slide and breech block to the rear. This ejects the spent cartridge case through a port in the side, or occasionally top, of the slide. At the end of its rearward motion, the spring-loaded slide moves forward stripping a fresh round off the top of the magazine and feeding it into the rear of the barrel ready for firing (Figure 1.15).

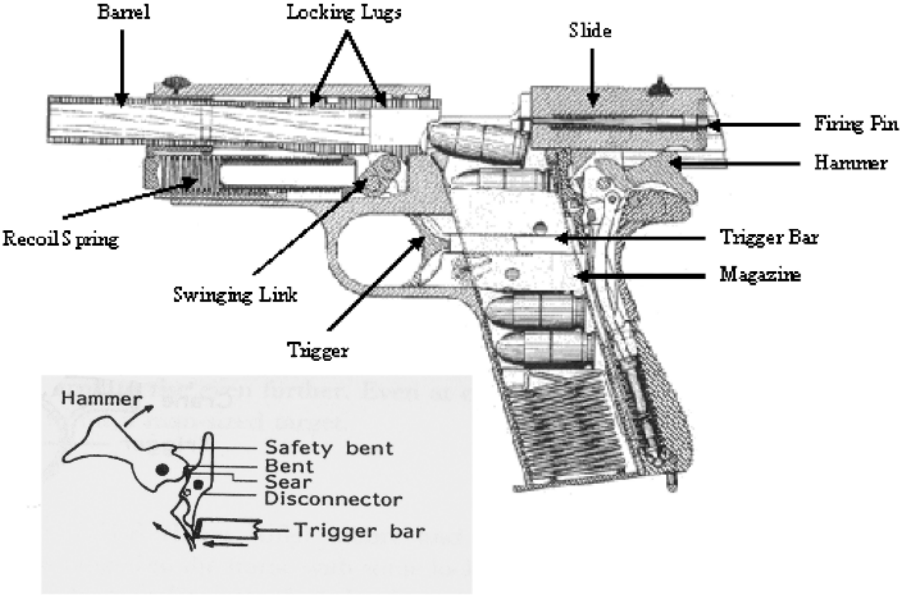


Figure 1.15 Self loading pistol (Colt 1911A1model).

As the action is only self-loading, the pressure on the trigger has to be removed and then re-applied before another round can be fired. To prevent the weapon from firing continuously, a part of the action, called *a disconnecter*, removes the trigger from contact with the rest of the mechanism. Releasing the trigger disengages the disconnecter allowing the trigger to re-engage with the mechanism so that the fresh round can be fired.

An action such as that described, where the slide is kept into battery with the barrel by spring action alone, is the simplest type of self-loading pistol mechanism. It is generally referred to as *a blowback* action and is only of any real use *for* lower-powered cartridges. If a blowback action were used for any of the more powerful calibres, the unsupported cartridge would, on exiting from the barrel, explode due to the tremendous pressures produced during firing. For all practical purposes, the most powerful round which can safely be fired in a blowback action weapon is a 0.380″ ACP (9-mm Short) cartridge. Some blowback action weapons, such as the Astra Model 400 and the Dreys 1910 Military Model, have been designed to fire more powerful cartridges by having massive recoil springs. They are, however, either very difficult to cock due to the strength of the recoil spring and generally require some method of disconnecting the spring during the cocking operation.

Once more powerful ammunition is used, some other mechanism has to be employed to ensure that the pressures produced fall to a safe level before the fired cartridge case exits from the barrel. This is accomplished via a *locked breech* or *delayed blowback mechanism* in which the barrel is locked to the breech block by some mechanical means during the instant of firing.

With this type of action, the rearward thrust of the cartridge case against the breech block causes the barrel and attached breech block to move backwards together. At some point on its rearward travel, designed such that the bullet has exited the barrel and the barrel pressures have fallen to acceptable levels, the barrel is stopped and unlocked from the breech block. The breech block and slide can then continue to the rear and in so doing eject the empty cartridge case. On its return journey into battery with the barrel, a fresh cartridge is loaded into the chamber and the mechanism is cocked ready to fire again.

The variety of locked-breech mechanisms is vast and outside the scope of this book. They range from the very simple Browning 'swinging link' and Luger 'toggle joint' to the more modern systems using high-pressure gas tapped from the barrel either to keep the breech locked or to operate the unlocking mechanism.

1.2.2 Rifles

Rifle actions can be very roughly grouped into single shot, bolt action, self-loading and pump action.

Single shot. In single-shot weapons, the barrel can be hinged to the frame, allowing the barrel to be dropped down for loading and unloading, or can have some form of breech block which either swings out, pulls back or slides down to expose the breech end of the barrel.

Bolt action. In bolt-action weapons, a turning bolt slides in an extension to the barrel, which is basically the same system as in a turn bolt used to lock a door. Pushing the bolt forward brings the bolt face into battery with the breech end of the barrel and cocks the striker (or firing pin). Turning the bolt then locks it into place via bolt lugs engaging with slots in the barrel extension. Other bolt-action weapons cock the striker on the opening of the bolt (Figure 1.16).

Straight-pull bolt actions also exist in which the rotary motion required to turn the bolt locking lugs into their recesses is applied by studs on the bolt which slide in spiral grooves cut into the barrel extension.

Bolt-action weapons are generally magazine fed, either by a tubular magazine under the barrel, through the butt stock or via a box magazine under the bolt.

Self-loading rifles. Self-loading rifles are, with the exception of the lowest power weapons, of the locked-breech type. These are generally very similar to those used in locked-breech pistols, but of a much stronger design to cope with the higher pressures involved (Figure 1.17).

There are basically two types of self-loading rifle action:

- *Short recoil*, in which the bolt and breech block are only locked together for about 0.75″ of rearward travel before unlocking. It then operates as a normal self-loading pistol.
- *Long recoil*, in which the barrel and breech block are locked together for the full distance of the recoil stroke. After reaching the end of its travel, the barrel is then unlocked and pushed forward by spring action ejecting the spent cartridge during its forward motion. When the barrel is fully forward, the breech

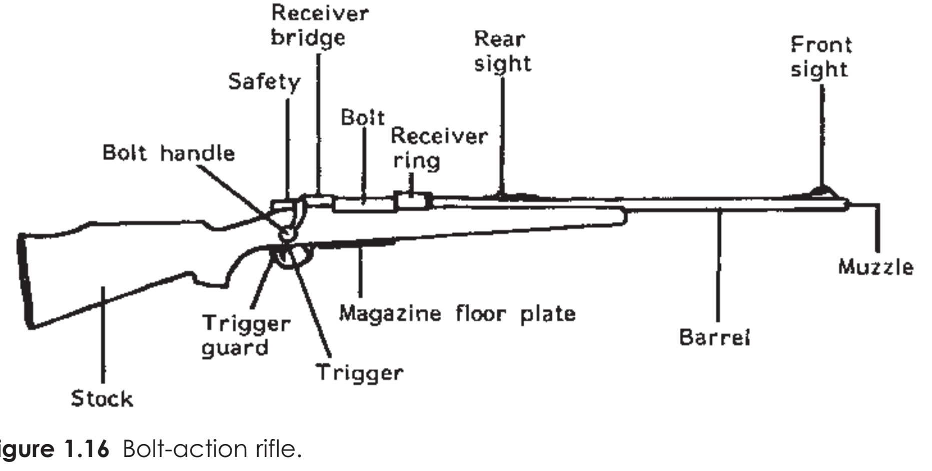


Figure 1.16 Bolt-action rifle.

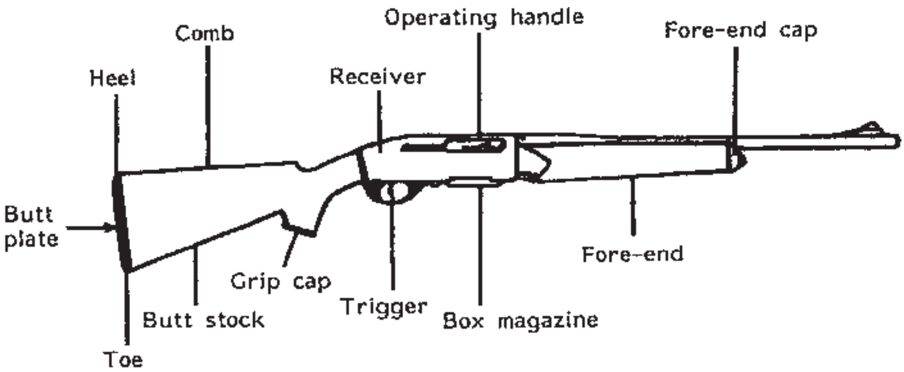


Figure 1.17 Self-loading rifle.

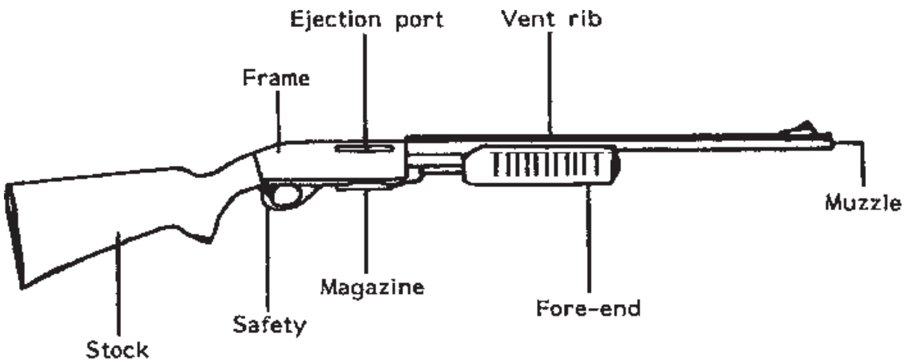


Figure 1.18 Pump-action rifle.

block begins its forward motion reloading a fresh cartridge into the chamber and cocking the action.

Pump action. In pump-action weapons (sometimes also referred to as *slide action*), the breech block is attached, via operating rods, to a moveable fore-end. On pulling back the fore-end, the mechanism locking the breech block to the barrel is released. By pulling the fore-end to the rearmost extent of its travel then pushing it forward, the empty cartridge case is ejected, a fresh round is loaded into the chamber and the action is cocked (Figure 1.18).

1.2.3 Shotguns

Shotgun actions are basically the same as those found in rifles, with single/double-shot weapons with barrels hinged to the frame for loading/unloading, bolt action, self-loading and pump-action. Barrels can be either positioned one on top of the other, over and under or 'superposed' or 'side by side'.

In the smaller calibres, that is, 0.22″, 9-mm and 0.410″, double-barrelled shot pistols are occasionally encountered.

Shotgun/rifle combinations are popular in Europe and can consist of one shotgun barrel and one rifle barrel (*vierling*), two shotgun barrels with one rifle barrel (*drilling*) or two rifle barrels and one shotgun barrel (also called *a drilling*).

1.2.4 Sub-machine guns (smg)

Sub-machine guns are really outside the scope of this book, but a brief description is relevant. These are fully automatic weapons generally chambered for pistol calibre ammunition. The simplest type of action encountered is a simple blowback. To overcome the problems of the cartridge exiting the chamber before the pressures have dropped to safe levels, a very heavy reciprocating bolt and a large spring are employed to delay the cartridge extraction. The classic example of this type of action is the Sten gun used by the British forces in World War II (WWII). Whilst this is an extremely simple, cheap to manufacture and reliable action, it does tend to be rather heavy. More modern weapons are equipped with some form of delayed blowback action of the type used in self-loading pistols and rifle actions, for example, the Uzi. Whilst this does produce a much lighter weapon, it is much more expensive to manufacture and, being more complicated, more prone to malfunction.

1.2.5 Machine guns and heavy machine guns

These are well outside of the scope of this book, but basically, a machine gun is a long-barrelled automatic weapon firing rifle calibre ammunition. A heavy machine gun is very similar to a machine gun, but it is much more sturdily built, often with a water jacket round the barrel to prevent overheating and a consequential rapid rate of wear. Being much heavier, it is generally mounted on a sturdy tripod and is designed for sustained high rates of fire.

1.2.6 Headspace

Headspace is not a subject that comes up in the everyday examination of firearms cases. It is, however, a subject that one should be aware of and be able to answer questions upon if asked.

In firearms terms, the headspace is the distance measured from the part of the chamber that stops forward motion of the cartridge (the datum line) to the face of the bolt.

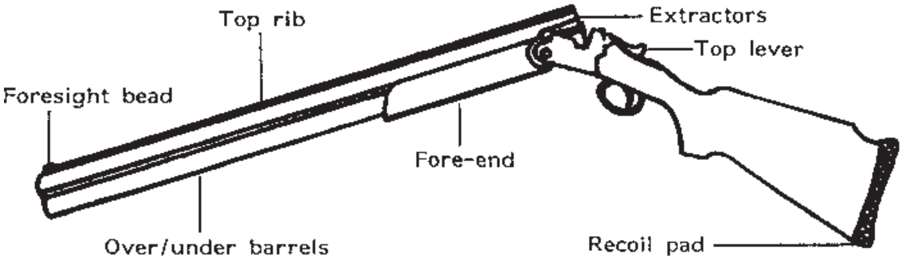


Figure 1.19 Over and under shotgun.

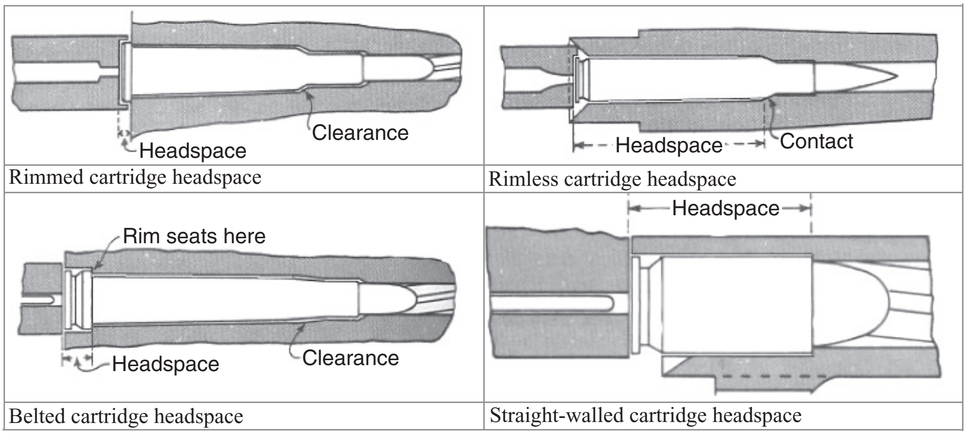


Figure 1.20 Headspace measurement for various cartridge types.

With cartridges having a rim, the headspace is measured from the back face of the barrel to the face of the breech.

With rimless cases, it is measured from either the mouth of the case (if a straight-walled case) or from a datum point on the shoulder of the case (Figure 1.20).

Headspace is measured using a precision gauge cut to the dimensions required.

Headspace gauges generally come in three sizes: a ‘go’ gauge on which the action will close and lock up, a ‘no-go’ gauge on which the action can only be partially closed or closed only with some effort and a ‘field’ gauge on which the action should not be able to be closed on (Figure 1.21).

Excessive headspace allows movement of the case during firing which can cause case stretching, case separation (ruptured case) and gas leakage.

When the powder is ignited, the base of the cartridge can move back whilst the sides of the case stick to the walls of the chamber. As a result, the case can

Figure 1.21 Rimless cartridge headspace gauge.

separate and rupture. If the bolt and receiver are not strong enough to contain and vent the blast, serious damage can be caused to both the firer and the firearm itself.

Some military firearms are designed to handle a problem like case rupture. The ported holes on the side of Mauser bolts are an example of a design to vent off gases that may be inadvertently sent through the bolt to the rear of the firearm.

Insufficient headspace prevents the closing of the bolt and possibly the complete chambering of the cartridge. If the bolt is forced closed, this can cause the bullet to be compressed further into the neck of the cartridge's case. This will lead to over-pressure conditions when the cartridge is fired and may cause very similar results to that caused by excessive headspace; the case may rupture sending very hot, high-pressure gases through the rear of the receiver.

1.2.7 Muzzle attachments

Rifles, pistols and revolvers can be found with six types of muzzle attachment. These are:

1. sound suppressors (often wrongly called silencers);
2. recoil reducers, also referred to as compensators;
3. flash hiders;
4. muzzle counter weights (mainly for target weapons);
5. grenade dischargers;
6. recoil boosters.

Shotguns can also be fitted with all of the above, although they are most likely to be found with either fixed or adjustable chokes or a recoil reducer.

1.2.8 Sound suppressors

There are four distinct components that together make up the noise we perceive as a gunshot. In order of loudness, these are:

Figure 1.22 Typical silencer construction.

1. pressure wave from rapidly expanding propellant gases;
2. supersonic crack of bullet as it passes through the sound barrier;
3. mechanical action noise;
4. flight noise.

The pressure wave. This is produced by the rapidly expanding propellant gases and is, generally, the only noise component that a suppressor can reduce.

Exceptions include those weapons where the silencer is integral to the barrel and is designed to bleed off gases before the bullet reaches supersonic speed. Examples would include the H&K MP5SD and High Standard Model HD.

As the expanding gases exit the barrel of an unsuppressed barrel, they rapidly expand causing a loud bang which is basically due to the gases exceeding the speed of sound (approximately 1100 ft/s). The suppressor reduces this noise by the slow release, through expansion and turbulence, of high-pressure propellant gases to the point where they no longer exceed this velocity.

The basic design of a sound suppressor consists of an expansion chamber (in Figure 1.22 this wraps back around the barrel to decrease the length of the suppressor) and a series of baffles to further reduce the speed of the emerging gases.

Suppressors can either be an integral part of the weapon or a muzzle attachment to be screwed on, attached via a bayonet type fitment or with grub screws.

Integral suppressors can be designed that the gases are bled off (ported) into the expansion chamber before the bullet reaches supersonic speeds. Example of weapons with an integral suppressor would include the High Standard HD 0.22″ slp and the H&K MP5SD 9 mm PB smg. In these weapons, bleeding the gases off early reduces the final velocity of the bullet to below that of sound thus allowing standard ammunition to be used rather than a reduced loading.

Most suppressors for supersonic cartridges can realistically be expected to reduce the noise of firing by 18–32 dB depending on the design.

Supersonic crack. This can only be removed by either utilizing subsonic ammunition or via a ported barrel to bleed off propellant gas and thus reduce the velocity of the bullet.

Bullet flight noise. Bullet flight noise is not loud enough to be sensed by the shooter, although they can be distinctly heard if they pass close by a person.

This noise resembles a distinctive high-pitched whirring sound as the bullet flies through the air. Flight noise is too quiet to be heard above the sonic crack.

Mechanical noise. This is caused by the weapon's hammer, firing pin, locking mechanism and so on. This can, to a certain extent, be reduced by the use of single-shot weapons with a cushioned firing pin. The WWII Special Forces Welrod is an example of such a weapon. It was made in 9 mm PB, 0.380 ACP and 0.32 ACP calibres, and was virtually silent in operation.

Sound suppressors also function as flash suppressors and, to a certain extent, recoil reducers.

1.2.9 Recoil reducers

Muzzle brakes and recoil compensators are devices that are fitted to the muzzle of a firearm to redirect propellant gases with the effect of countering both recoil of the gun and unwanted rising of the barrel during rapid fire.

Generally speaking, a muzzle brake is external to the barrel of the firearm, whilst a recoil compensator is typically part of the structure of the barrel proper.

A properly designed muzzle brake can significantly reduce recoil. The actual effectiveness depends to an extent on the cartridge for which the rifle is chambered with claims of up to 60% being made.

Recoil compensators are generally less efficient than muzzle brakes.

Muzzle brakes/compensators are designed to reduce what is called the 'free recoil velocity' of the weapon. The free recoil velocity is how fast the gun comes back at the shooter. The faster a gun comes back, the more painful it is for the firer as the body has less time to absorb the recoil.

Weapons firing fast small-calibre bullets generally have a smaller recoil velocity than larger-calibre slow-moving bullets.

The following examples of recoil energy and velocity are all measured in 8 lb rifles (Table 1.2).

Table 1.2 Recoil energy and velocity for various rifle calibres.

Calibre	Bullet weight (g)	Muzzle velocity (ft/s)	Recoil energy (ft lbs)	Recoil velocity (ft/s)
6 mm Rem	100	3100	10.0	9.0
270 Win	140	3000	17.1	11.7
0.30–06	180	2700	20.3	12.8
0.35 Whelen	250	2400	26.1	14.5
0.450 Marlin	350	2100	35.7	17.0
0.458 Win Mag	500	2050	68.9	23.5

There are numerous types of recoil reducer from the simplest, a short length of tube attached at 90° to the end of the barrel to divert the gases sideways, to laser-cut slots in the muzzle end of the barrel (Magna Porting).

In conventional designs, combustion gases depart the brake at an angle to the bore and in a slightly rearwards direction. This counteracts the rearward movement of the barrel due to recoil as well as the upward rise of the muzzle. The effect can be compared to reverse thrust systems on aircraft jet engines. The mass and velocity of the gases can be significant enough to move the firearm in the opposite direction of recoil.

On the AKM assault rifle, the brake is angled slightly to the right to counteract the sideways movement of the gun under recoil.

A major disadvantage of recoil reducers is, however, the large increase in noise levels and the gas blast which directs back towards the firer.

One other problem with high-powered rifles such as the Barrett 0.50 Browning is the violent disruption of debris from the ground which can expose the firer's position. This is only a significant factor in military or law enforcement tactical situations.

1.2.10 Flash hiders

When a gun fires, only about 30% of the chemical energy released from the propellant is converted into the useful kinetic energy of actually moving the projectile down the barrel. Much of the remaining energy is primarily contained in the propellant gas–particle mixture which escapes from the muzzle of the gun in the few milliseconds before and after the bullet leaves the barrel.

This extremely hot mixture of incandescent gases and partially burnt propellant ignites on contact with the air causing an intense 'muzzle flash'. This can be disconcerting for the firer and a distinct disadvantage under night-time military or law enforcement tactical situations. Not only does it temporarily destroy the firer's night vision, but it also pinpoints his position for the enemy.

Flash hiders either physically hide the flash by way of a cone-shaped device on the end of the barrel (e.g. Lee Enfield No.5 Jungle Carbine) or by dispersing the flash upwards or sideways via a series of fingers or a tube containing longitudinal cuts (M16 rifle).

These attachments are often dual-purpose items designed to suppress the flash of firing and also to reduce recoil.

1.2.11 Muzzle counter weights

These are only used on highly specialized target weapons and are designed to add stability in sighting as well as to reduce the recoil-induced upward motion of the barrel.

1.2.12 Grenade discharger

In its simplest form, this is cup attached to the end of a rifle barrel into which a grenade can be launched via a blank cartridge. Utilizing this device, grenades can be propelled to much greater distances than by throwing alone.

More modern devices can be used with bulleted rounds and contain aluminium or mild steel baffles to capture the bullet.

1.2.13 Recoil booster

Very few of these have been manufactured, the most notable being the muzzle attachment to the German WWII MG 34 machine gun. This attachment was intended to increase the rate of fire in this short recoiling weapon.

Some recoil-operated semi-automatic pistols also have to be fitted with a recoil booster to compensate for the additional weight of the suppressor. Without a booster, short recoil pistols will not function in the self-loading mode of operation.

1.2.14 Brief glossary

Automatic or fully automatic	Correct terminology for a weapon which continues to fire until the trigger is released.
Blowback action	Simple form of self-loading pistol in which a spring retards the opening of the action after firing.
Bolt action	A method of closing the breech, generally involving a turning bolt.
Disconnecter	A mechanism in self-loading weapons which requires the trigger to be released and re-pulled between each shot, thus preventing the weapon from firing automatically.
Double action	Revolver mechanism where one long pull on the trigger rotates a fresh chamber in front of the firing pin, cocks then drops the hammer, all in one operation.
Drilling	German name for a three-barrelled long arm with a combination of smooth and rifled barrels.
Headspace	The distance measured from the part of the chamber that stops the forward movement of the cartridge and the face of the bolt.
Locked breech or delayed blowback	A weapon in which a mechanical delay is incorporated to ensure that the breech block cannot move back until the pressures in the barrel have subsided to a safe level.

Machine gun	Fully automatic weapon which will keep firing until the pressure is released from the trigger; normally designed to fire rifle calibre ammunition.
Pistol	In English terminology, all handguns are pistols; some are revolving, some single shot and some self-loading. In American terminology, refers to a self-loading handgun.
Revolver	Handgun in which the magazine is a revolving cylinder behind the barrel.
Rifle	Long-barrelled weapon with a rifled barrel.
Semi-automatic or self-loading	Weapon which uses a portion of the energy of discharge to eject the empty cartridge case, reload a fresh round into the chamber and cock the action ready for firing.
Shotgun	Smooth-bore shoulder firearm designed to fire cartridges containing numerous pellets or a single slug; can be of any calibre from 0.22″ upwards.
Single-action	Revolver mechanism where the hammer has to be manually cocked to rotate the cylinder.
Sub-machine gun	Automatic weapon, firing pistol ammunition, generally 9 mm PB, of a size in between a pistol and a rifle.
Vierling	German nomenclature for a long arm with two barrels, one of which is for shotgun ammunition and the other for rifle ammunition.

1.3 Proof Marks

Proof marks are stamps applied to various parts of a weapon during and after manufacture to show that the weapon is safe for use with the ammunition for which it was designed.

In England, the London and Birmingham proof houses were established (in 1637 and 1813, respectively) by Royal Charter to protect the public from the sale of unsafe weapons. A number of other countries have also established their own proof houses and by agreement at consular level, reciprocal arrangements have been made for their proof marks to be mutually accepted. At present, these include Austria, Belgium, Chile, Czechoslovakia, Finland, France, Germany, Hungary, Italy, Republic of Ireland, Spain and the United Kingdom.

A number of other countries have their own forms of proof, either in-house or centrally run. For various reasons, these have not been acceptable to the European commercial proof houses, and the weapons have to be fully proofed before they are legally saleable in those countries.

There are also a number of countries which have a separate military proofing system for service weapons. These, once again, are not accepted by the

European commercial proof houses. Weapons bearing military proof marks have thus to be commercially proofed before they can be legally sold in those countries.

There are basically three types of proof: *provisional proof, definitive proof* and *reproof*.

- *Provisional proof is* only for shotgun barrels in the early stages of manufacture. This type of proof is designed to prevent the manufacturer from continuing work on barrel blanks which may have hidden defects.
- *Definitive proof* applies to all weapons and shows that the weapon has been tested with an overcharge of propellant and missile. Generally, this calls for between 30 and 50% increase in pressure over the standard round of ammunition.
- *Reproof* is an additional test which may be applied after a weapon has been repaired or altered in some way.

1.3.1 Proof marks and the examiner

Proof marks can be a very valuable aid to the forensic firearms investigator as they can give information as to the age, history and country of origin of a weapon.

Many countries have specific exemption from their firearms legislation for weapons which are ‘antique’. At one time, the situation was simple, with an antique being considered to be anything over 100 years old. This, however, no longer holds true as many weapons, for example, the Colt Single Action Army Model of 1873, are well over this age and can fire modern centre fire ammunition.

To complicate matters further, modern reproductions of some of these old weapons have been produced, which are often virtually indistinguishable from the original. In these cases, the proof mark could prove to be the only method of accurately dating a weapon.

This is, however, a very complex subject and requires much research and experience in the interpretation of the marks before accurate information can be obtained.

Many papers and books have been written on this subject, but probably the most authoritative is ‘The Standard Directory of Proof Marks’ by Wirnsberger, distributed by Blacksmith Co., Southport, Connecticut 06490 (Figures 1.23–1.36).

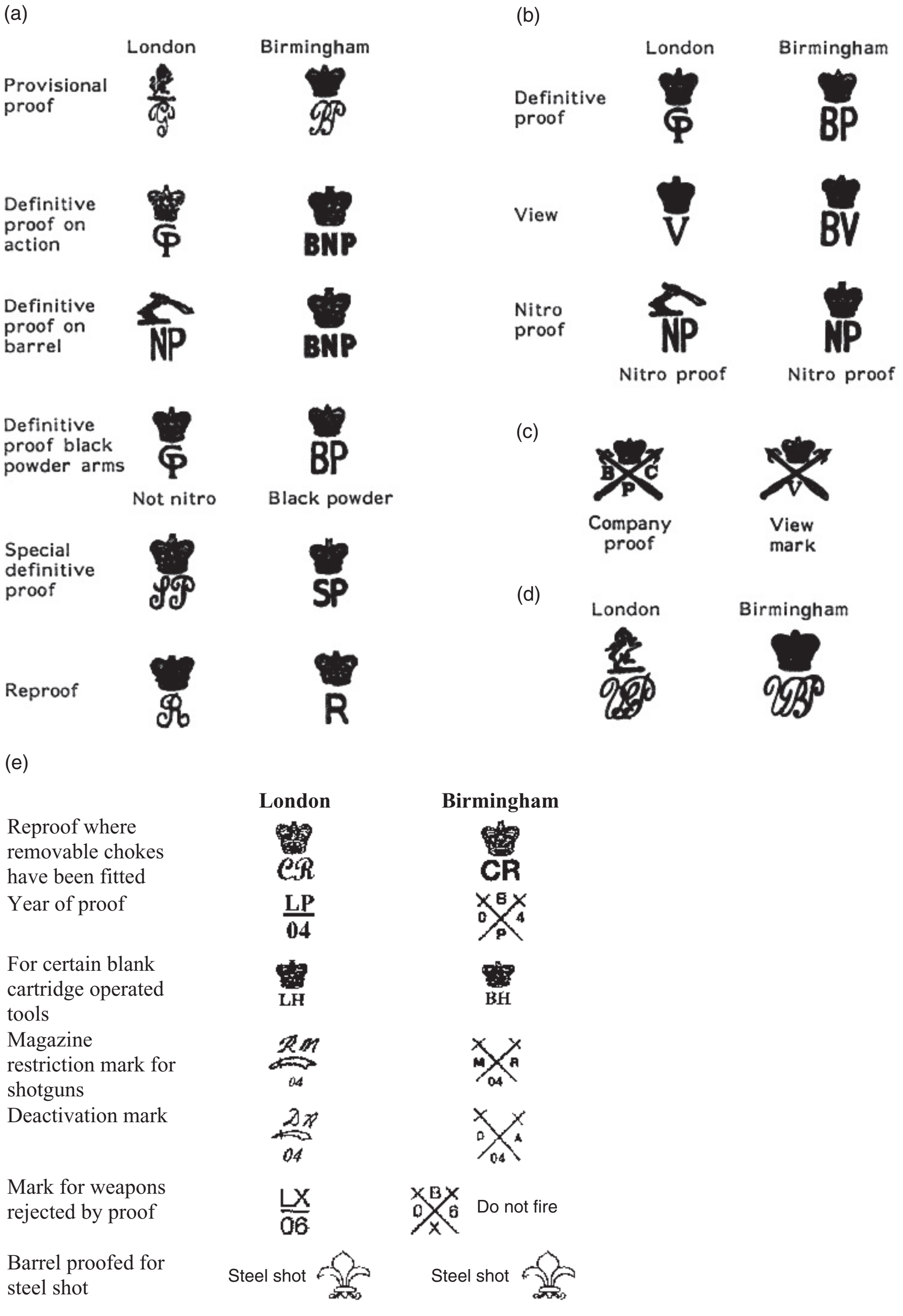


Figure 1.23 British proof marks. (a) Under 1954 rules of proof; (b) under 1925 rules of proof; (c) Birmingham proof marks – 1813–1904; (d) proof marks used between 1887 and 1925; (e) under 1988 rules of proof.

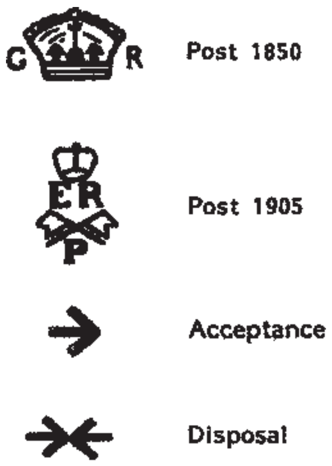


Figure 1.24 British military proof marks.

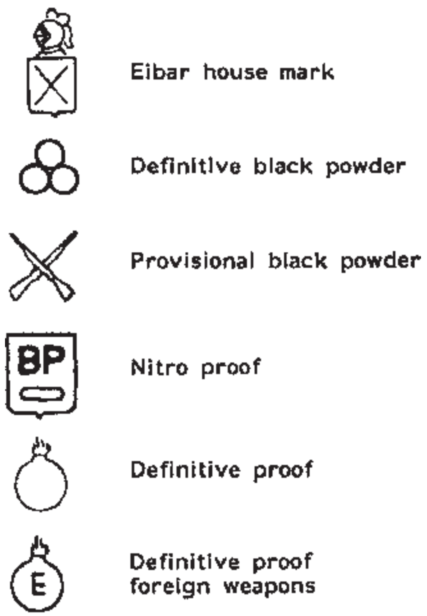


Figure 1.25 Spanish proof marks.

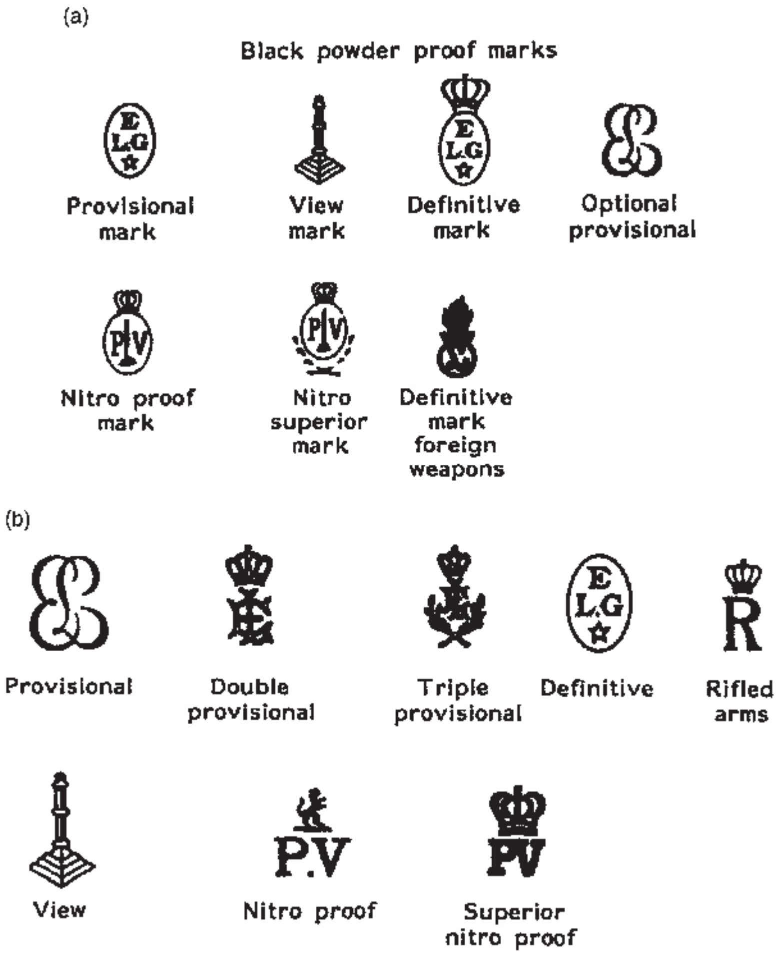


Figure 1.26 (a) Belgian proof marks – since 1968; (b) Belgian proof marks – before 1968.

Figure 1.27 Czechoslovakian proof marks.

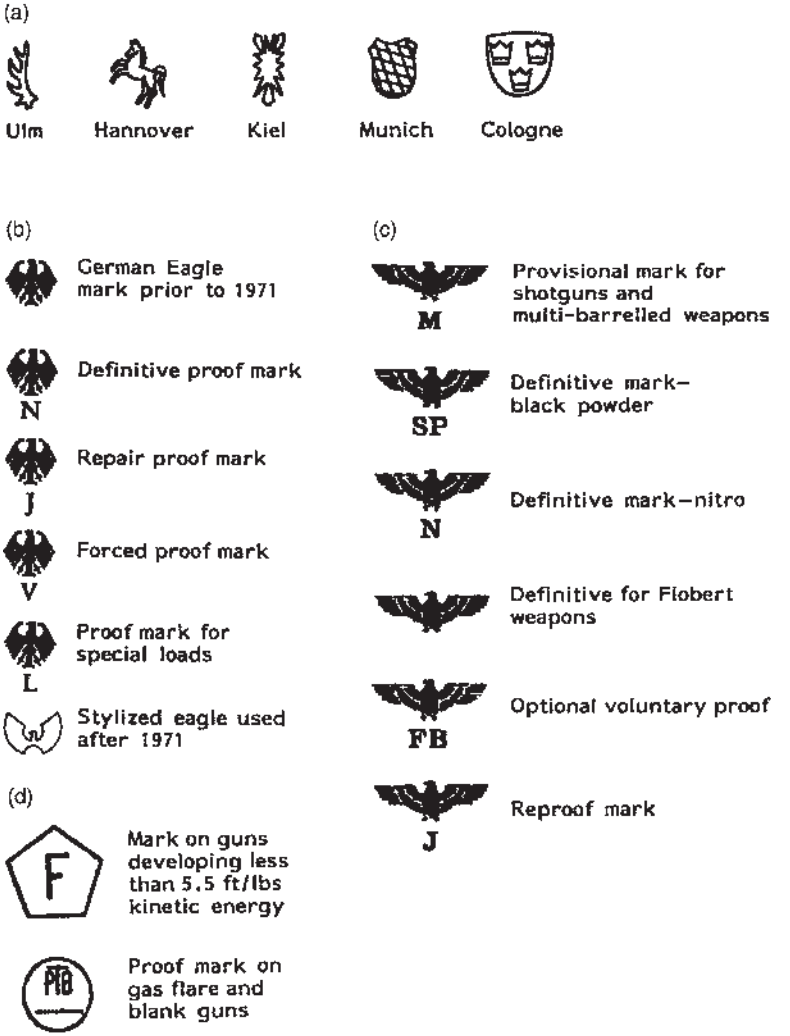
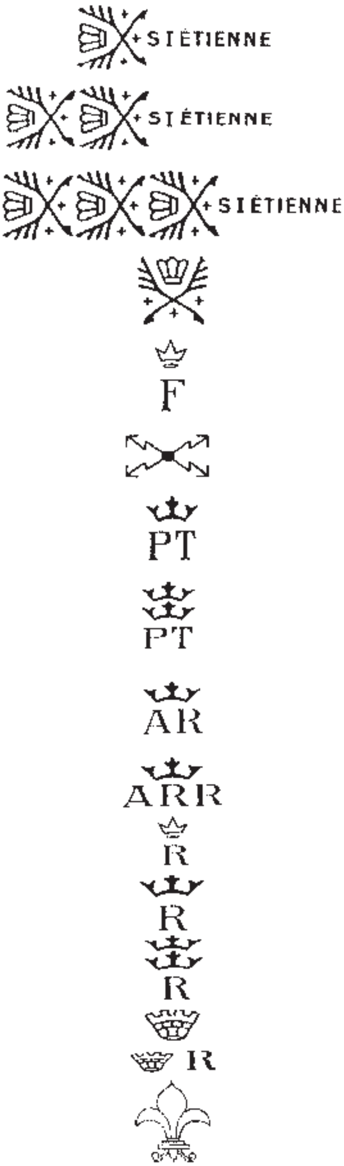


Figure 1.28 (a) German proof house marks since 1955; (b) West German proof marks after 1945; (c) German proof marks 1939–1945; (d) other German proof marks.

Figure 1.29 Republic of Ireland proof mark.

Figure 1.30 American military proof mark.



Voluntary proof: barrels in the finished state : ordinary proof

Voluntary proof: barrels in their finished state : double proof

Voluntary proof: barrels in their finished state triple proof

Compulsory proof: sample or model proof

Compulsory proof: guns in their finished state, ordinary black powder proof

Compulsory proof: proofed arm ready for sale (supplementary mark)

Compulsory proof: ordinary nitro proof of finished guns

Compulsory proof: superior nitro proof

Compulsory proof: long-barrelled firearms

Reproof of long barrelled firearms

Ordinary black powder reproof

Ordinary nitro reproof

Superior nitro reproof

Proof of short-barrelled firearms

Reproof of shot-barrelled firearms

Steel shot proof for smooth bored guns.
Note: This mark is now used on all EU proofed firearms

Figure 1.31 French proof marks post 1960.

Voluntary provisional proof

Definitive proof of arms in ‘white’ condition

Reproof

Superior proof

Suitable for steel shot

Figure 1.32 Hungarian proof marks.

Distinctive proof mark of the Gardone V.T. Proof house impressed on all firearms

Definitive black powder proof

Definitive smokeless powder proof

Voluntary superior smokeless powder proof

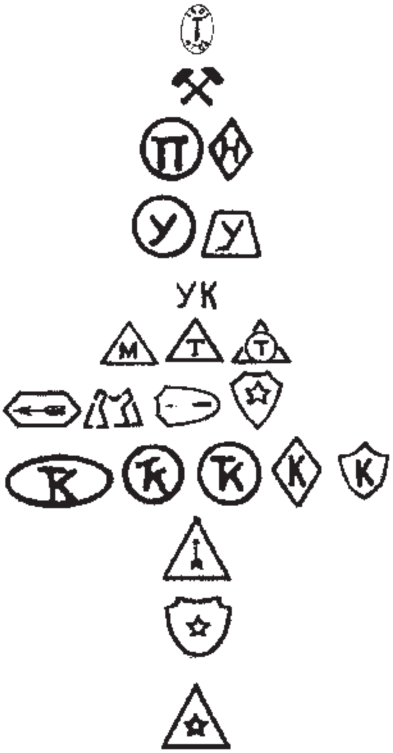
Supplementary mark for arms delivery condition

Suitable for steel shot

Figure 1.33 Italian proof marks.

Symbol	Arsenal/subcontractor	Period of operation
	Koishikawa arsenal (Tokyo) on rifles	1870–1935
	Kokura arsenal on rifles	1935–1945
	Nagoya arsenal on rifles	1923–1945
	Jinsen arsenal (Korea) on rifles	1923–1945
	Mukden arsenal (Manchuria) on rifles	1931–1945
	Toyo Kogyo on rifles	1939–1945
	Tokyo Juki Kogyo on rifles	1940–1945
	Tokyo Juki Kogyo on rifles	1940–1945
	Howa Jyuko on rifles	1940–1945
	Izawa Jyuko on rifles	1940–1945
	Toyokawa arsenal on handguns	1940–1945
	Sasebo arsenal on handguns	1940–1945
	Yokosura arsenal on handguns	1940–1945
	Kure arsenal on handguns	1940–1945
	Maisuru arsenal on handguns	1940–45
	Current proof mark	

Figure 1.34 Japanese arsenal/proof marks.



Tula proof mark prior to 1917

Tula proof mark prior to 1971

Tula and Izhevsk arsenal provisional black powder proof marks after 1950

Tula and Izhevsk arsenal final black powder proof after 1950

Final proof

Tula proof house marks

Izhevsk proof house marks

Quality control marks

Proof mark of Izmash on AK(S)-47, AKM(S) and AK(S)-74

Proof mark for Vyatskie Polyany Arsenal (Molot) Machine-Building Plant OAO on RPK and RPK-74

Proof mark for Tula Arms Plant (Tulsky oruzheiny zavod) on AKS and AK74

Figure 1.35 Russian proof marks.

Izhevsk Proof House
Arms proof and inspection for ammunition

Klimovsk Proof House
Arms proof and inspection for ammunition

Krasnozavodsk Proof House
Arms proof and inspection for ammunition

Steel shot proof for shotguns

Figure 1.36 Russian federation proof marks.

Further Reading

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