# **Review on Forensic Ballistics**

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# **Review on Forensic Ballistics**

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# ABSTRACT

This article aimed to understand the history of ballistics that is how firearms were made, and what modifications were done to them. Also, it includes how ballistic was first used in forensics and how it helped in finding criminals. All the equipment's that were used in the investigation of the ballistic evidence that how they were invented and what all changes must be done to achieve the perfect instrument for analysis.

Keywords: Forensic Ballistics, Criminal Investigations and Firearms.

# INTRODUCTION

Before getting into the history of Forensic ballistics, we should know about Forensic ballistics, the history of firearms, how they were made, and modified and the problems faced in making them. History of these firearms started in 1241 using powder, straight pipe that acts like a barrel of a gun and a fuse for ignition now currently modifications are still there, but some designs are close to being perfect that they can't be changed. Calvin Goddard linked the bullet from the victim to the culprit by examining minute defects, as more firearms were manufactured, it was difficult to narrow down. Eventually, a comparison microscope was made with which marks on bullets were easily examined. If we talk about the history of Forensic ballistics in India, then it was in 1930 that an Arms expert was appointed and a small ballistic laboratory was set up under the Calcutta police for the examination of firearms. The other State CIDs also established small ballistics laboratories to help them in criminal investigations.

# **Forensic Ballistics**

First of all, the word "Ballistics" refers to the study of projectile motion in flight and "Forensic" means "related to or dealing with the application of scientific knowledge to legal problems. So overall forensic ballistics refers to the examination of firearms and ammunition that will help in a court of law. The expert must perform various examinations like –

- Collection of evidence like a bullet, gunshot residue and sometimes firearm too.
- Analysing evidence
- Studying and comparing different types of marks on projectiles.

The identification of the firearm and linking the firearm to the suspect is the primary aim of the Forensic ballistic expert and it is carried out by making sure o the following things –

- Range from where the suspect fired
- Nature of crime
- Number of rounds fired from the firearm
- Crime scene reconstruction
- Identification of the weapon used in committing the crime.

# There are different divisions of Forensic Ballistics –

# 1. Internal Ballistics

It refers to the mechanism of a firearm that how the bullet was fired, its motion inside the barrel of the firearm marks left on the percussion cap by the hammer, marks left by rifling and the calibre of the firearm.

# 2. External Ballistics

It refers to the behaviour of the projectile during flight. There are many factors that can affect the projectile like rifling, resistance, gravity, angle of fire, friction and distance of the target. It also helps in studying the flight as well as the efficiency of the projectile.

# 3. Terminal Ballistics

It deals with the behaviour of the projectile when it hits an object. Factors like friction, resistance, elasticity etc play a vital role in ascertaining the projectile path after hitting the target.

### FIREARM SYSTEM

# Early Hand Cannons

The first type of handgun was cannon of iron, fitted to a frame with metal bands. The weapons were loaded from the muzzle which is at end of the barrel with powder, wad and ball. There was a small hole at the breech end of the barrel that was provided with a pan into which a primer charge of powder was placed. On igniting, the primer with a lighted match, the fire goes to the main powder charge to discharge the weapon.

Weapons used earlier were slow to fire and aim. Also, if it rains so it would hinder the firing process.

The first use of these weapons couldn't be several, but several instances are reported in Spain between 1247 and 1311. The use of hand canons as a cavalry weapon appeared in 1449 in the manuscripts of Marianus Jacobus.

# The Matchlock

This was the first major progress in pistols as it allows the person to fire the gun using only one hand with improved aiming. Its design was the same as hand cannon, but the difference was that a slow-burning cord ignited the priming charge in a curved hook to the frame's side.

#### The Wheel Lock

It consists of a serrated steel wheel, mounted on the side of the weapon at the rear side of the barrel. 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.

It overpowers the matchlock system as it is fast, and rain doesn't affect this system except for heavy rain.

#### The Flintlock

The flintlock system was a major advancement as it is cheap, reliable, and not overly susceptible to damp or rainy conditions. Its mechanism is simple as it involves providing a spark by striking a piece of flint against a steel plate. This weapon could be issued in large numbers to soldiers as it is cheap.

#### The Percussion System

In this system, when compound mercury fulminated, when struck by a hammer, produced a flash strong enough to ignite the main charge of powder in the barrel. With this invention, a self-contained cartridge foundation was laid, and a new field of possibilities was opened. Once this type of ignition was invented it took some time to make it better. In the final version, the percussion cap was claimed by many inventors, it was mainly attributable to Joshua Shaw, which used a small iron cup into which placed a small quantity of mercury fulminate.

#### The Pinfire System

It was introduced to the United Kingdom at the Great Exhibition in London in 1851 by Lefaucheux. The earliest breech-loading weapon was the pinfire weapon using a selfcontained cartridge in which the propellant, missile and primer were all inside in a brass case. In this system, the percussion cup was inside the cartridge case with a pin, that protruded through the side of the cartridge case. Striking the pin with the weapon's hammer took the pin into the priming compound causing it to detonate which results in the ignition of the main propellant charge.

Calibres available in the pinfire revolvers were 5, 7, 9, 12 and 15mm. for shotgun and rifle ammunition in 9mm, 12 bore and various other calibres were also available. The major advantage of this system was not only the self-contained cartridge but the ability of the cartridge to swell and block the escape of gases.

#### The Rimfire System

In this system, the rim is turned into a small quantity of a priming compound. When the rim is crushed with the firing pin, the priming compound explodes, leading to the propellant's ignition. The initiation was done by a Paris gunsmith, Flobert, who had working examples of it as early as 1847. In 1855, Smith and Wesson manufactured the first revolver to fire rimfire cartridges. This was a 0.22" calibre weapon in which the barrel was lifted at an angle using a hinge on top of the frame. This enabled the cylinder to be removed when unloading and loading the weapon.

#### The Centre Fire System

In this system, only the primer cup needed to be soft enough to be crushed by the firing pin. With this, the cartridge case could be made of a more substantial material which would act as a gas seal for much higher pressures that can be done with rimfire ammunition.

#### Rifling

It is defined as the spiral grooves that are made inside the barrel of a gun to improve accuracy and increase the speed of the bullet. It gives the bullet a spin in a point-first direction and lessons any tendency for it to depart from its straight line of flight. German weapons bearing the coat of arms of Emperor Maximilian I and made between 1450 and 1500 have spiral-grooved barrels and are the earliest identifiable rifled guns. Spiral and straight forms of rifling are encountered in early weapons. The number of grooves is normally 12 and it has different shapes/forms like round triangular, square, and even comma shapes. There must be a certain number of grooves to influence 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 the diameter of the bullet was big enough to take up the rifling, then a large mallet was used to push the bullet down the barrel and if its size is small then on firing the gases would escape out resulting in reduced velocity.

Other designs were also tried in which the bullet was pushed down into various projections inside the breech end of the barrel. These designs deformed the bullet resulting in a filled bore.

In 1835, Greener produced the first expansive bullet, the rear of which contained a steel plug. On firing, this was forced into the bullet expanding it uniformly. Lancaster at the same time invented his expanding bullet at the same time when Minnie invented it. This allowed easy loading of the bullet and no mechanism was required to expand the base.

Whitworth patented the first polygonal bore rifling system which solved most of the problems but having no experience in the manufacture of weapons he couldn't produce guns with the consistency required because of this his invention was overtaken by others. The problem of expanding the bullet and filling the bore was eliminated by the invention of the breech-loading weapon. A bullet of the correct diameter could be made and can be inserted into the breech end of the barrel. This type of modification resulted in higher velocities, better accuracy, and improved trajectory.

#### Revolver

It is a type of weapon that has a revolving cylinder which has chambers inside it where bullets are inserted and discharged through a single barrel. The earliest forms of the revolver include a snaphaunce revolver made in the days of King Charles I, which is said to be made before 1650 and during the reign of Henry VIII sometime before 1547 so it was not Samuel Colt who invented the revolver. Colt's patent in 1835, dealt with the revolving of the cylinder by a ratchet and pawl arrangement. The patents of Colt were so tightly worded that no one had any other design that could challenge Colt but when his patents ran out in 1850 the market was open with Dean-Adams in 1851, Beaumont in 1855, and Starr and Savage in 1865 that brought out innovative designs. However, they all had muzzleloading percussion systems. In 1857, Smith and Wesson introduced the first hinged frame 0.22" rimfire revolver.

Bored through chambers and the use of metallic cartridges patents by them gave them the market until 1869. With the passing of their patents, breech-loading arms in calibres from 0.22 to 0.50" were introduced. Colt Single Action Army Model was the first centre-fire Colt revolver to be patented in 1873. In 1880, a 0.476" hinged frame revolver was, but it was soon superseded by the now familiar Webley top latching hinged frame design in 1887. Then it was modified in 1894 and became the standard Webley Mk 1 British Army service revolver. The US government adopted a Colt 0.38" revolver using the now familiar swing-out cylinder system. Different variations on the Smith and Wesson and Colt designs followed, but nothing drastic has changed apart from improved sights, and better metals allowing different grips and higher pressures.

#### Self-loading Pistols

In Birche's History of the Royal Society for 1664 a claim was made by a mechanic that he will be able to make a pistol which could shoot as quickly as possible and then stop at will. There were numerous attempts to make a self-loading pistol as there were patent records of it from 1863. Then the first successful weapon was made which was made by the Austrian Schonberger and made by the company Steyr. It was made for the 8 mm Schonberger, which is a very powerful cartridge.

Hugo Borchardt gave the first successful design but he couldn't finance his design, so he took it to German to manufacture it. Its design was radical containing the first magazine to be held in the grip. It was this design which was modified by Luger to become Germany's first military self-loading pistol. In 1893, Bergman produced a range of pistols, one of which, the 1897 8mm 'Simplex', is of interest as the cartridge became the 0.32'' Automatic Colt Pistol (ACP) cartridge.

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

In 1898, the German factory of DWM (Deutsche Waffen- and Munitionsfabriken Atkien-Gesellschaft, German Weapons and munitions Works) brought 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 the first patent which was introduced as the Model 1900 Colt 0.38" automatic. Webley made a few unsuccessful strike 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. However, Webley design was not successful and never became popular. The most successful pistol ever to be introduced was the Model 1911, Browning designed, Colt Government Model in 0.45" calibre. With small modifications, such as the Model 1911 AI, the weapon was the standard issue military weapon for the United States until the late 1980s. Since then, main innovations have been in the use of lightweight aluminium and plastics for the frame of the weapon, the move towards smaller calibres and higher velocity bullets, the development of magnum handgun ammunition and the use of gas-operated locking systems. There can only be variations on a theme and as with revolver, there is little that can be done to improve on the basic design.

#### The first use of Ballistics in Forensic

Before the mass manufacturing of guns began, bullet molds and barrels were handmade by gunsmiths, so each firearm stands out. It means that the bullets fired always bore some exclusive impressions which were unique to a specific firearm. From their examination the bullet started which could lead to the firearm. This laid the foundation of what is now called forensic fingerprinting – the forensic examination of firearms and other evidence recovered from the crime scene to link them to the specific weapons used in a crime.

The first case of forensic firearm examination to be documented was in 1835. At that time Henry Goddard applied ballistic fingerprinting to link a bullet recovered from the victim to the actual culprit. On inspection, he found that the bullet had a defect on its surface which did not seem to be from the barrel or the result of an impact. It seemed like a defect acquired during its manufacturing. Anticipating that the shooter would have made the bullet himself, he realized that recovering the bullet mold would easily help him confirm the shooter. That same mold was found at the suspect's home matching the marks on the bullet. This proved crucial evidence in convicting the shooter, but he confessed to the crime eventually.

As the mass production of guns and ammunition gained pace, the process of rifling become standardized. It became difficult to match a bullet to a specific firearm made by a specific manufacturer through simple observation, so a new way was adopted which is the magnified observation of bullets.

#### **Development of Comparison Microscope**

Magnification became a crucial part of firearm examinations. Microscope didn't exist back then, it was quite challenging to compare two bullets simultaneously. When examining one bullet under the microscope, the forensic examiner had to retain the mental image of the other bullet for comparison. There was a major flaw involving ballistic fingerprinting that led to the conviction of an innocent Charles F. Stielow in 1915 in the United States. He was convicted and sentenced to death for shooting his employer and employer's housekeeper using a pistol of 0.22 calibre but when investigator Charles E. Waite re-evaluated the evidence with microscopy expert, Dr. Max Poser, he confirmed that the bullets recovered from the crime scene couldn't have been fired from Stielow's gun. Stielow was then acquitted and released.

Feeling embarrassed with his failure, he began cataloguing the manufacturing data on guns and ammunition. He also made sure to include foreign sources upon realizing that most firearms back then were imported. Then Waite along with physicist John Fisher, Major Calvin Goddard, and chemist Philip Gravelle, established the Bureau of Forensic Ballistics in New York City. Philip Gravelle eventually developed the comparison microscope which is two microscopes connected by an optical bridge solving the challenges of simultaneous comparison.

The first application of this microscope was in the investigations of the Saint Valentine's Day Massacre in 1929. By examining the bullets and cartridge cases recovered from the site, he was able to identify the exact weapons used – a 12 – gauge shotgun and two Thompson submachine guns. Furthermore, he was led to the suspect by matching the evidence recovered to the gun retrieved from his home. In 1932, when the FBI laboratory was established, Goddard got to train its first firearm identification professional.

#### Forensic Ballistic History in India

In 1930, an Arms Expert was appointed, and a small ballistic laboratory was set up under the Calcutta Police to deal with the examination of firearms. As the menace of it grew, other State CIDs also established small ballistics laboratories to help them in criminal investigations.

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