Ballistics –Firearm, Cartridge, Bullets, Range of Fire & Explosive

- Ballistics - It is the study of the motion Of projectile and derived from Latin word Ballista.
- Ballista - Crossbow like device for throwing stones with twisted ropes.

TYPES OF BALLISTICS

- **Internal Ballistics** - Motion of projectile from the moment the trigger mechanism is activated till it leaves muzzle end of barrel, rate & manner of burning of propellant, development of gas pressure on the gun, barrel & breech etc.
- **External Ballistics** - Motion of projectile during its trajectory through the air, stability, wind deflection & gravitational pull etc.
- **Terminal Ballistics** - Impact of projectile upon the target, it includes wound Ballistics.

External ballistics :

Discharge Of Gunshots

Trajectory is the path of the projectile in air, from the moment it leaves the gun until it hits a target. Bullets do not typically follow a straight line to the target . Controlled bullet flight is possible because of its ballistic coefficient and the spin imparted to it by the rifling (**gyroscopic effect**).



Bullets of different shapes, weights, and calibers do not behave alike in passing through the air. Round-nosed bullets are retarded more rapidly in air and tissues than sharp points and consequently they penetrate less well. Bullet jacket offers increasing resistance to expansion as well as disintegration.

Bullets travel in a trajectory that becomes more and more curved as range increases and velocity drops off.

- Romans first used gun powder to propel projectiles as a sport without any intent to cause harm this lead to manufacture of muzzle loading guns & later breech loading guns in which cartridge is loaded through the breech end of the barrel.



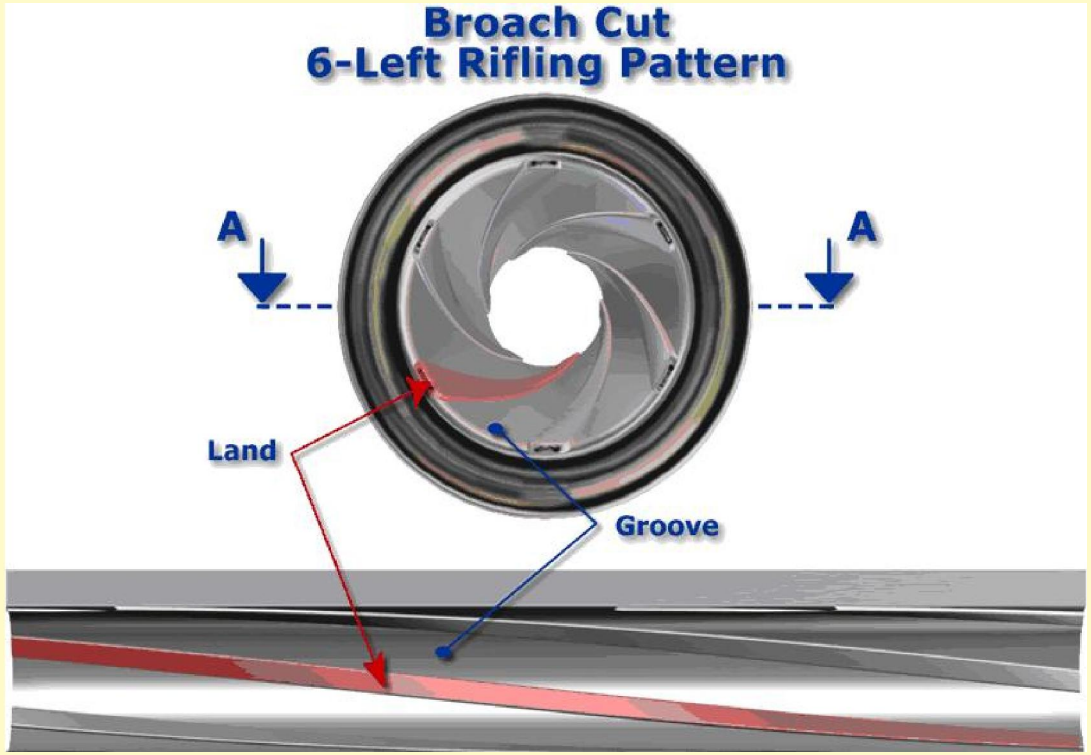
Firearm

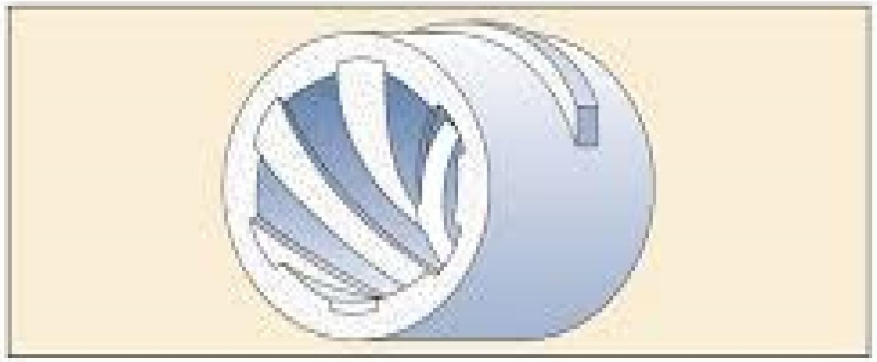
- It is a device which sets of projectile to a considerable distance with high velocity, the force comes from the propellant burning produces high pressure.

- Firearm is so called because flame is generated & the flame generated &it is flame responsible for propelling the projectile.

Bore & Caliber

- Bore - It is associated with smooth bore firearm, it is number indicating the size of internal diameter of barrel & represents the number of spherical balls of pure lead each fitting inside the bore which together make a pond.
- 12 Bore the internal diameter is equal to the diameter of spherical ball of pure lead of 1/12of pound (.729 inch).
- Caliber - It is associated with rifled firearm, the distance measured across corresponding lands.
- Rifling - the grooves are cut inside the barrel bore , the raised portions are called lands.

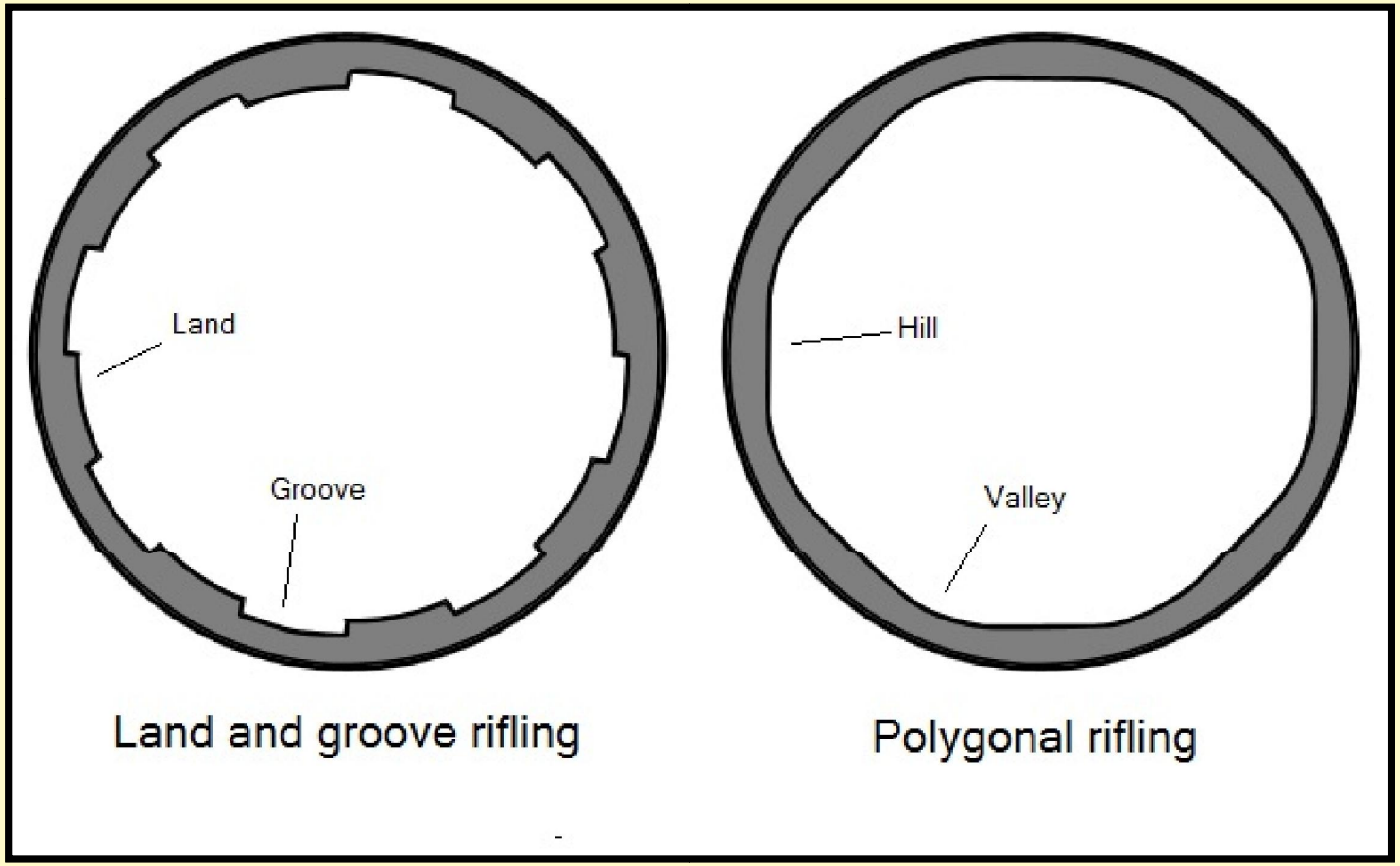




Interior view of a gun barrel, showing the presence of lands and grooves.

Importance of Rifling

- Gives gyratory motion.
- Which stabilizes the bullet flight & keeps it on nose on position due to which bullet spins round its longitudinal axis.
- The gyratory motion decreases air resistance.
- Effective velocities are maintained for longer range.
- The trajectory obtained are flatter thus better aim at longer ranges


Land
Groove
Land and groove rifling
Hill
Valley
Polygonal rifling

Classification Of Small Arms.

- Firearms which can be handled, moved & operated by a single person & propel projectiles of diameter less then 1inch.

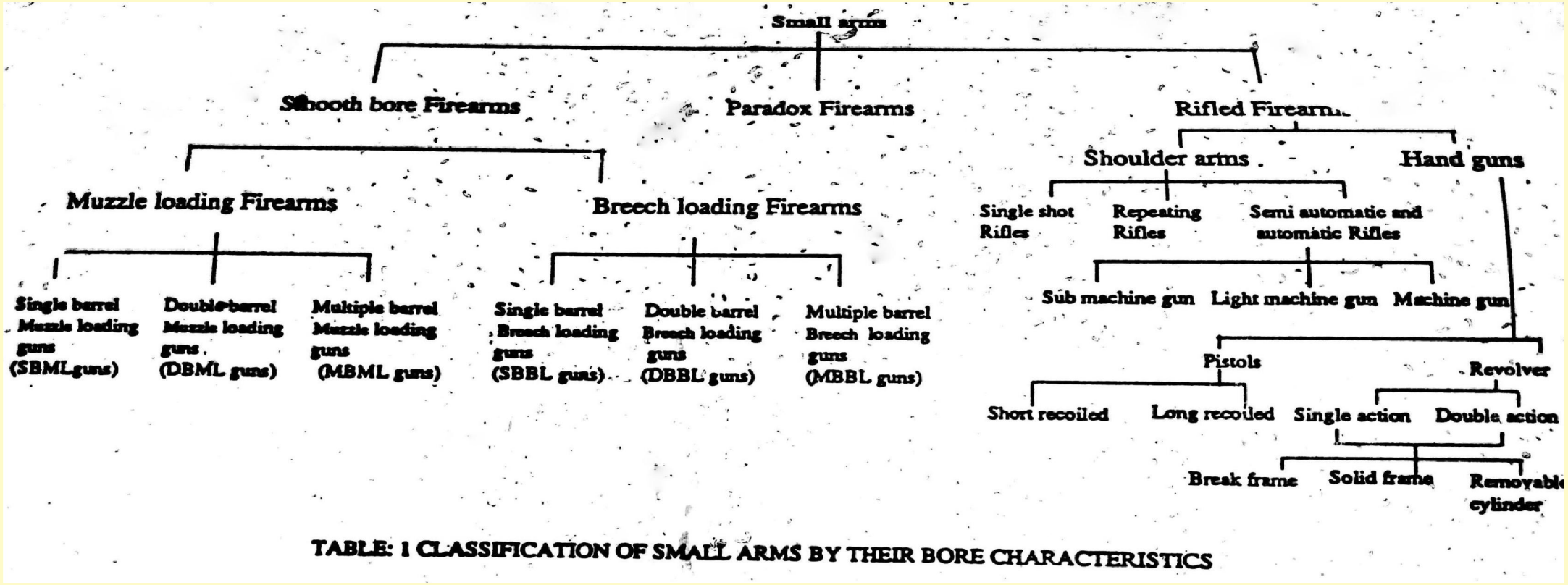


TABLE: 1 CLASSIFICATION OF SMALL ARMS BY THEIR BORE CHARACTERISTICS

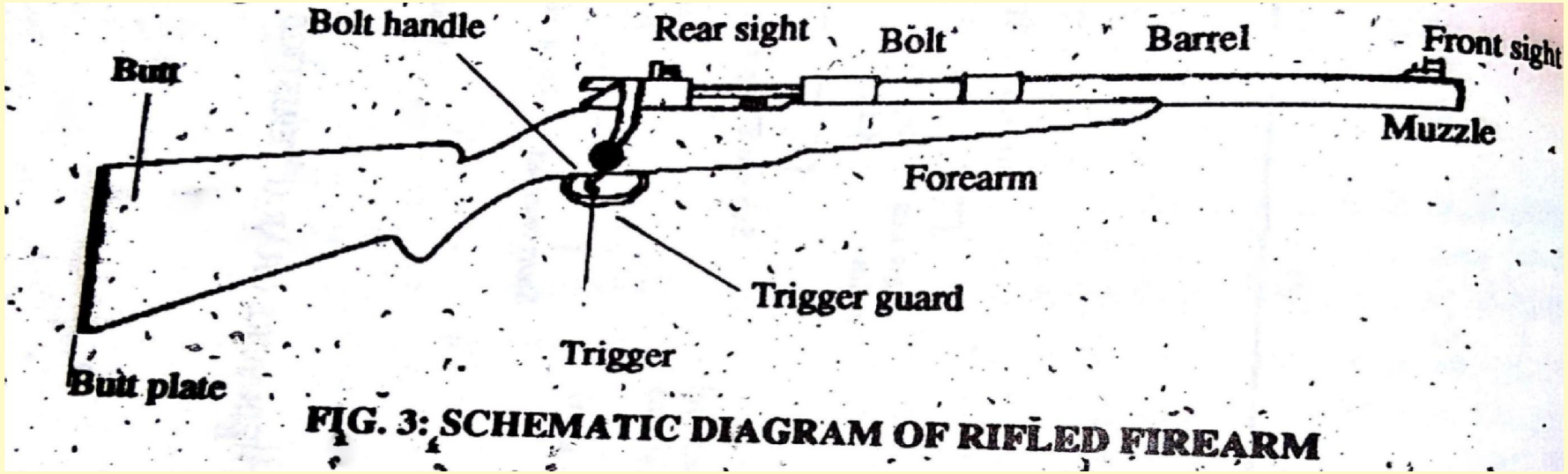
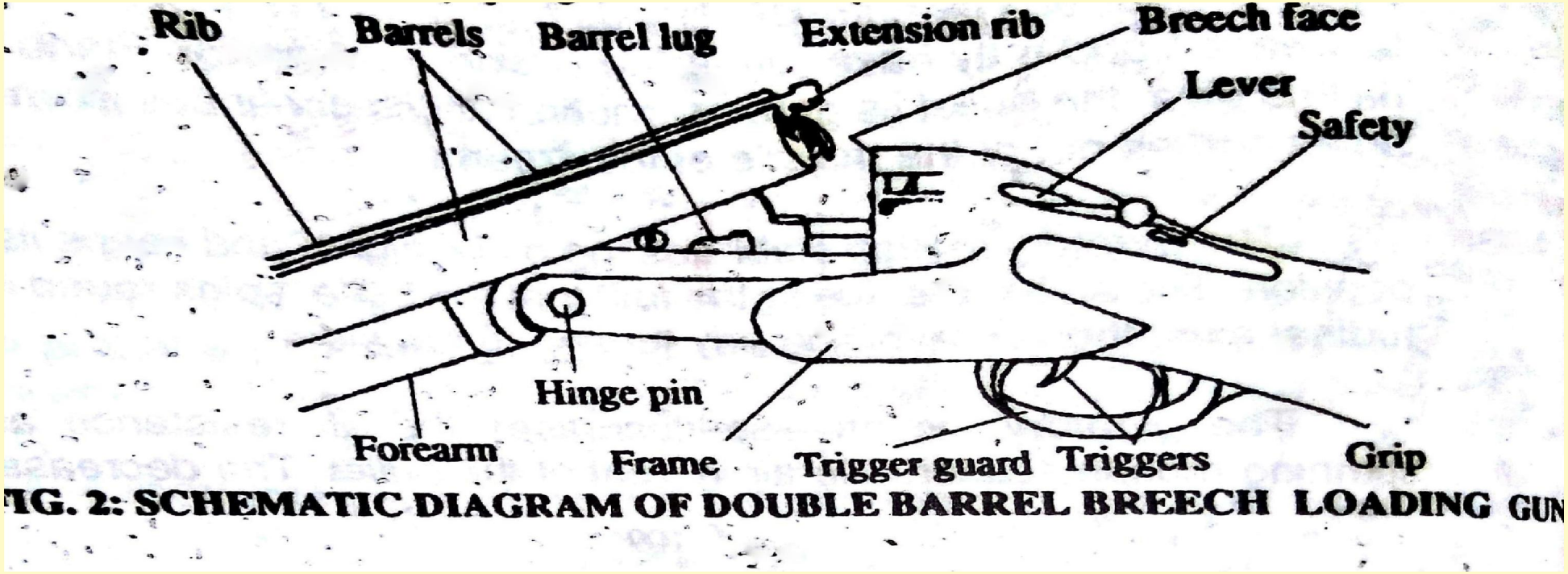


FIG. 3: SCHEMATIC DIAGRAM OF RIFLED FIREARM



IG. 2: SCHEMATIC DIAGRAM OF DOUBLE BARREL BREECH LOADING GUN

Smooth bore Firearm

- These are also Known as Shotguns designed to fire spherical projectiles.
- Muzzle Loaders - propellant, the wad, the shots or shot charge are loose & inserted from the Muzzle end.
- A ramming rod is provided with this gun to position various components properly. At the breech end of barrel is a nipple which is struck with hammer aflame is generated which burns the propellant & gaseous pressure is developed & projectiles are discharged.
- They are single barrel, double barrel & multiple barrel.

Breech Loaders.

- The cartridge are loaded from the Breech end of the barrel.

- They are Single barrel, double barrel & multiple barrel.


SHOTGUNS

Paradox Firearms

- These are shotguns with an effective range of 200 yards.

- A small portion at the muzzle end of their barrels are Rifled.

Rifled firearm

- Rifled firearm have rifled barrels & used metallic cartridges containing bullets.
- Such firearms are further divided into shoulder arms & hand guns.
- Shoulder Arms - Are arms which can be operated with both hands with butt resting on the shoulder.
- These are long barreled firearms.



Single Shot Firearms

- In these firearms a single cartridge is loaded for firing.
- To fire another the empty cartridge case has to be manually extracted & ejected then fresh cartridge loaded.




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Repeating Firearms.

- These have magazines to accommodate number of cartridges.
- When bolt is pushed forward it picks up uppermost cartridge from the magazine &loads into Chamber .
- After firing the bolt is drawn backward to eject the fired case .
- The operation is repeated for every shot till the magazine is empty.



Automatic and Semiautomatic Firearms.

- In these firearms the first cartridge is manually loaded & fired.
- Mechanism automatically extracts & ejects the fired cartridge case & loads another cartridge from the magazines into the chamber. This cocks the firearm instantly.

- In the case of semi automatic firearms the trigger must be released & then pulled for each & every shot.
- Automatic firearm are those which continue to fire as long as trigger is kept pressed till the cartridges are finished.

- **Sub Machine Guns or carbines=These are automatic guns with alternative semi automatic arrangement, low power cartridges are fired through these.**



- **Light Machine Gun –These are automatic firearms to fire high power rifle cartridges & the effective range is 600 – 1000 yards.**



- Machine Guns =Automatic firearms, high power cartridges are fired through these firearms. The effective range is more then 2500 yards.



- Pistols–These are hand guns having short barrels which are usually not more then 10 inches long.
- The pistol has a grip by which it can be held & fired with one hand.
- Its effective range is 100 yards and muzzle velocity is 1200 ft./sec.



- **Revolver –They have cylindrical magazine arranged behind the breech end of barrel which accommodates usually six cartridges.**



BRAKEFRAME

- For every trigger operation the mechanism rotates the cylinder in such a way that the next chamber becomes aligned with the barrel of the revolver.



SOLIDFRAME

- The length of barrel is about 7 inches &\effective range is about 100 yards.



REMOVABLE CYLINDER

- Single action revolver - The hammer must be cocked by hand after each shot & then to fire trigger is pressed.

- In Double Action the hammer can be cocked by hand but it can also be cocked & fired by prolonged pull on the trigger.

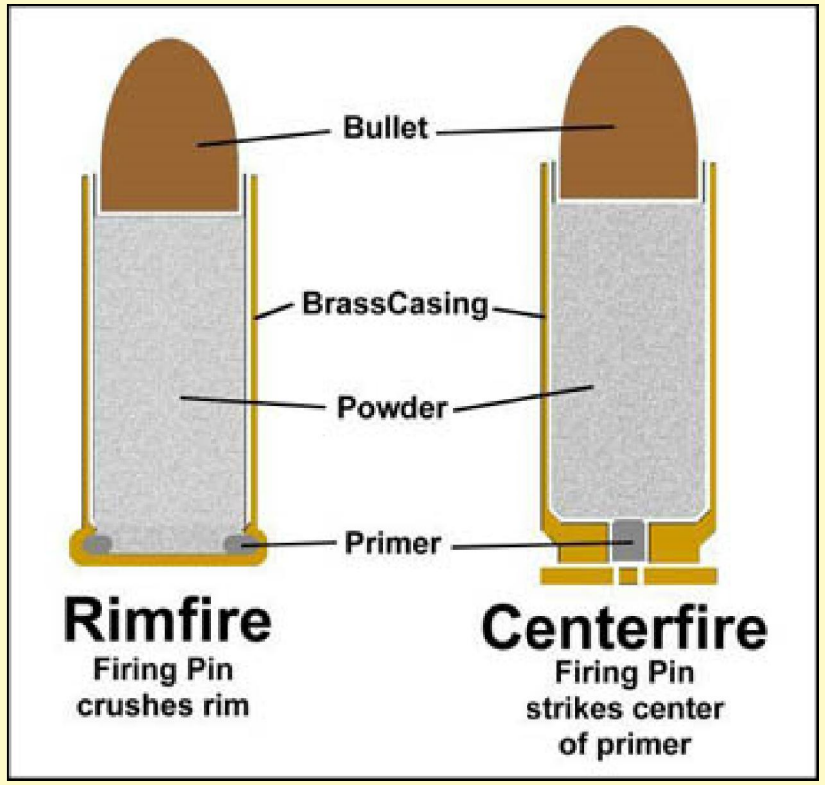
Miscellaneous Firearm.

- Improvised Firearm or country made firearms --- These are homemade Firearms usually manufactured by blacksmiths from cheap quality of iron or steel.
- Company made Ammunition is fired from them.
- They do not possess any specifications as to the standard weapons.
- Their barrel are rough & irregular.

- Toy firearm –These firearm look like factory made standard firearm but they can not fire any cartridge , they only fire blanks.
- Freak Firearm –These firearm do not seem to be such they do fire the standard ammunition.
- They have usually appearance of innocent articles e.g. pen, walking stick, umbrella, etc. the effective range is about 25 yards.

Ammunition

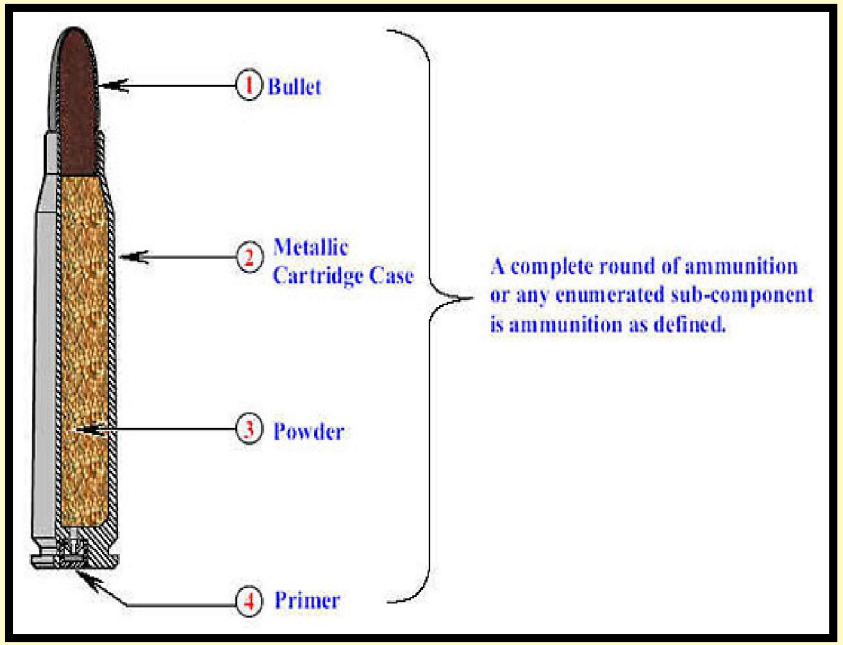
- Small arms ammunition is of two types
- Metallic ammunition.
- Shot Gun Ammunition.
- Cartridge –It is an assembly which creates power in any Firearm.
- Pin Fire.
- Rim Fire.
- Centre Fire.



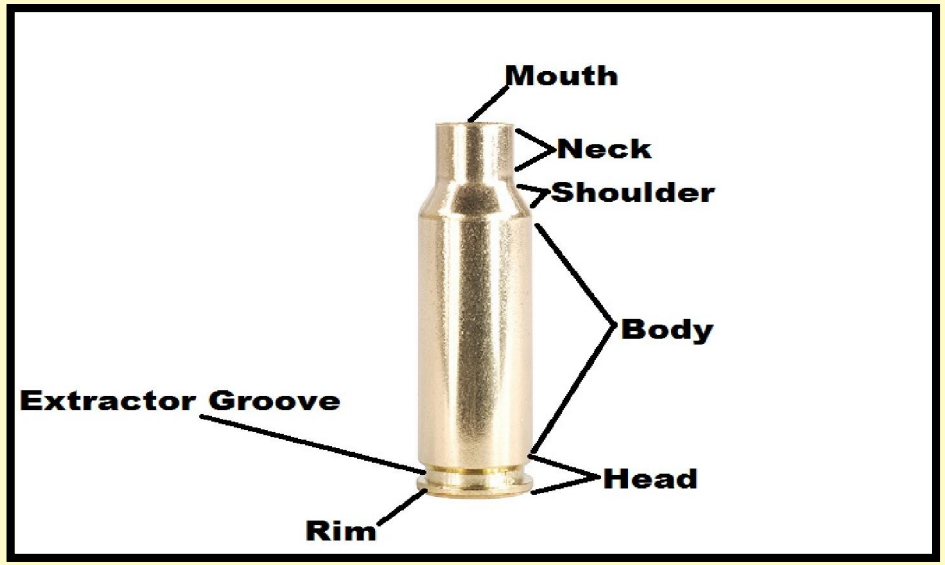


Components of Metallic Cartridges

- Metallic Cartridge Case or Shell Or Empty.
- It serves as a container for primer, propellant & projectile.
- It serves as a unit which can be loaded in the chamber of Firearm.
- It serves as a gas seal and prevents escape of propellant gases.

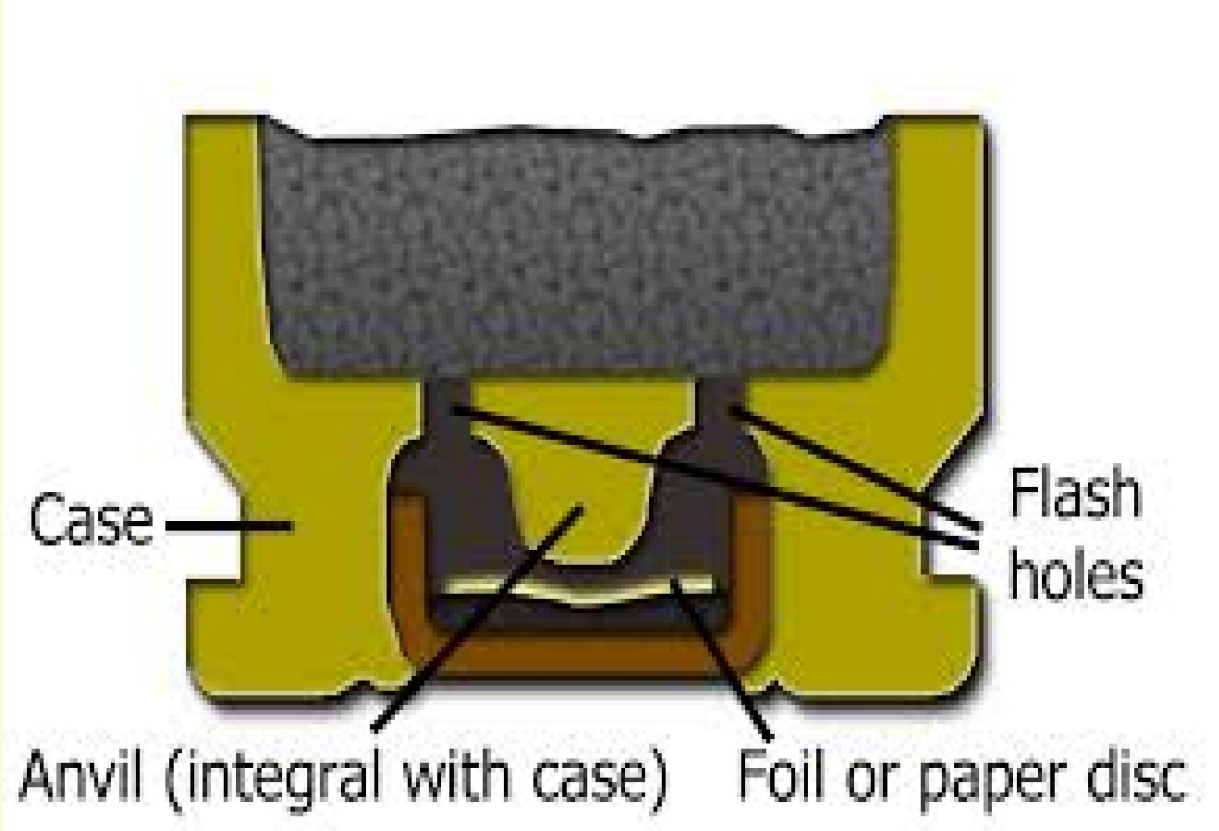


- Cartridge cases are broadly divided into two types according to shape of head.
- Rimmed cartridge cases.
- Rimless cartridge case.
- They may be straight, tapered or bottle necked.

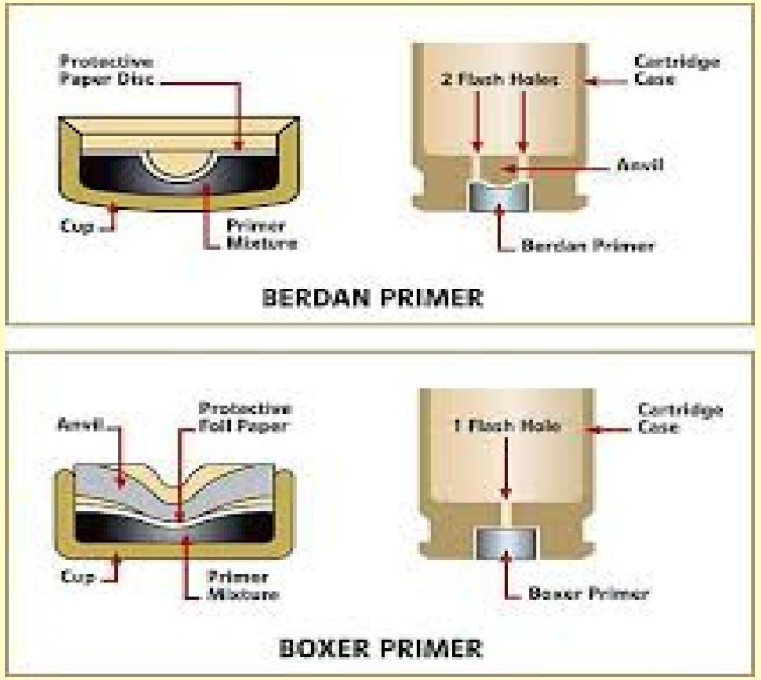


Primer

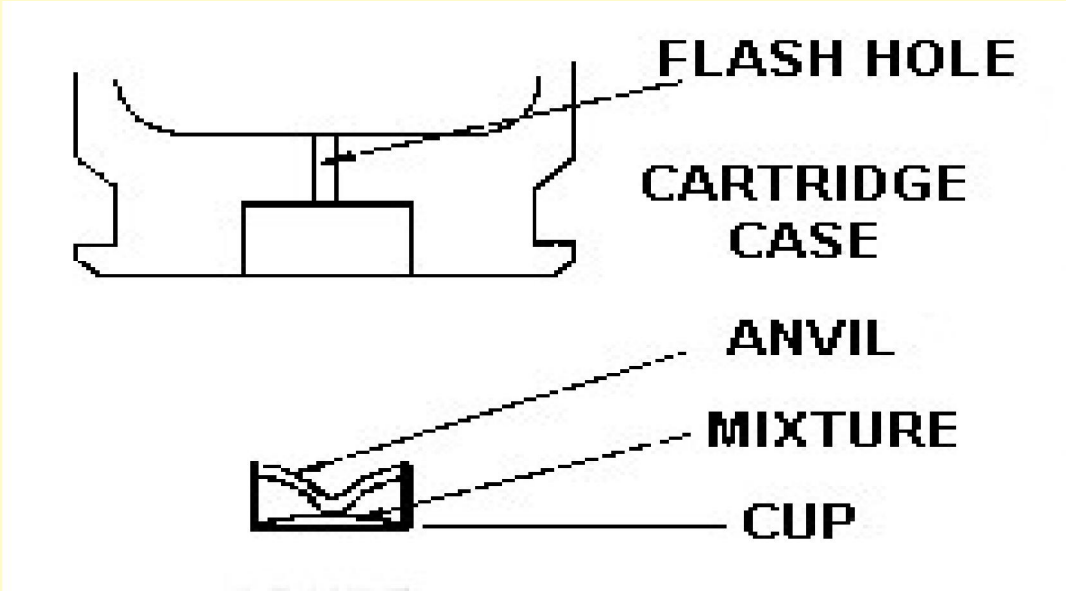
- The primer is a strong explosive .
- The priming mixture is composed of mercury fulminate, stibnite (Antimony Sulphide 80% & Antimony oxide 20%) & potassium Chlorate.



- Priming mixture is kept in small cups made of Copper, Brass, cupro nickel alloys & Anvil is placed over it.



- When firing pin strikes percussion cap mixture is crushed between the Anvil & primer cup & flame is generated.



Propellant

- It is low explosive on burning it converts into gaseous pressure which propels the projectile.
- Gun Powder –Potassium Nitrate (75%),Charcoal (15%) & Sulphar (10%) .
- It was replaced by Smokeless Powder.
- It consist of either Nitrocellulose or Nitroglycerine or both.
- Semi Smokeless powder-Mixture of Black Powder & nitrocellulose in the ratio of 80:20.

Projectile

- It is apart of ammunition that is propelled from the firearm to the target.
- Spherical shaped projectiles are called Pellets or shots they are made of lead & are used in shot guns.

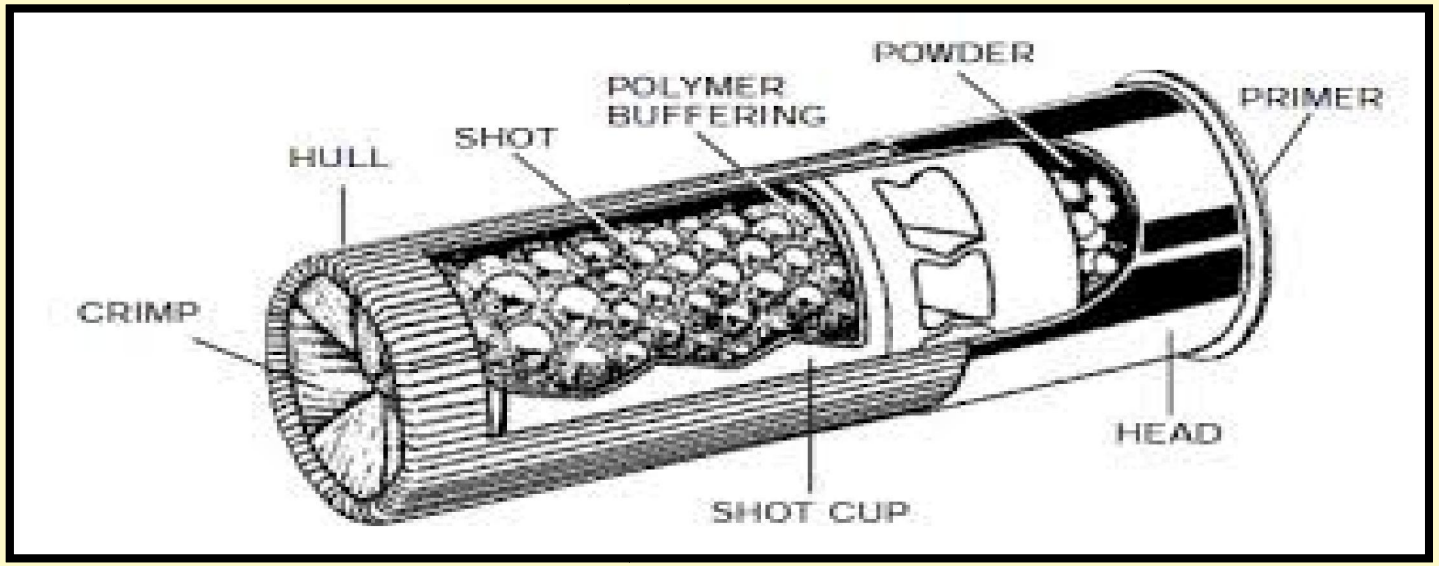


- A shot gun loaded with a single projectile is known as Ball ammunition.
- Elongated projectiles are called Bullets which are either jacketed or unjacketed.



Shot Gun Cartridges have following Components.

- Paper Cartridge Case or Shell Or Empty.
- Percussion Cap or Primer.
- Propellant Or Gun Powder.
- Spherical Balls or Pellets.
- Over Shot Wad, Under Shot Wad, Air cushion Wad & Over Powder wad.



Estimation of Range

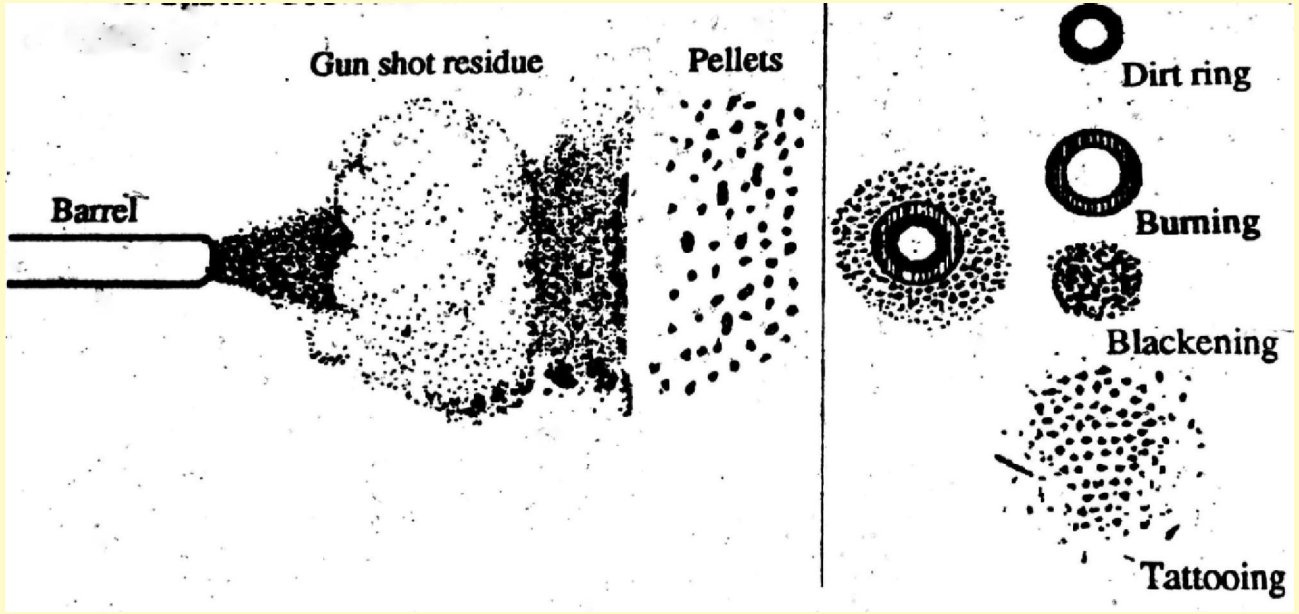
- When firearm is fired lot of gases are formed due to burning of propellant & there is flame.
- Propellant gases consisting of carbon particles.
- Ejecta in the form of gun shot residues in the form unburnt & partially burnt propellant.
- Barium, lead, Antimony, Mercury, Etc. from priming mixture.
- In shotguns the pellets, wads.
- These ejecta travel to different distances.
- This is the basics of Range Estimation.

Burning

Co+H2 of the propellant gases when react with atmospheric oxygen flame is produced which extend to few inches.

Service Rifles /Shotguns - a distance of 6 inch.

Handguns - 2 to 3 inch.



Blackening

- The propellant gases consisting of carbon particles are deposited around the wound producing Blackening.

- Service guns /Shotguns ----12 inch.

- Handguns ----6 inch.

Tattooing

- Depositing of unburnt & partially burnt propellant around projectile is called Tattooing / peppering .
- Service Rifles / Shotguns --- Up to 4feet.
- Handguns ---- Up to 1feet

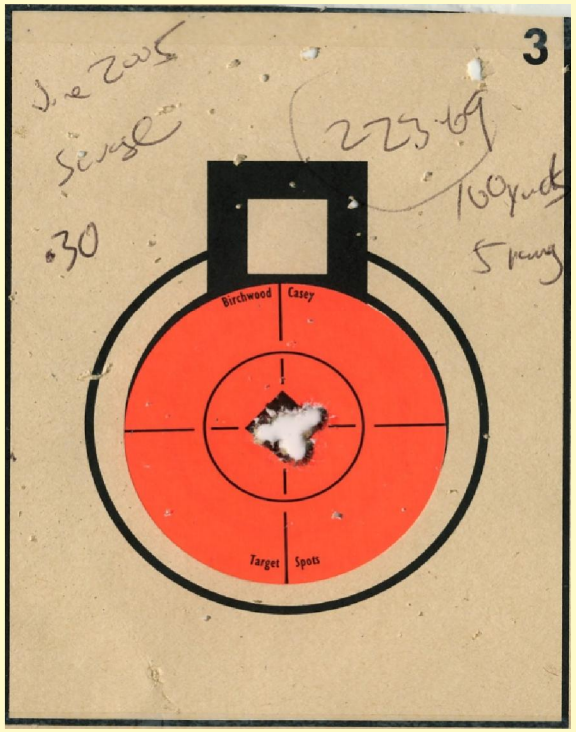


Beyond the range of Tattooing.

- Attempts are made to determine range by the presence of elements lead, copper particles by suitable chemical test.
- Beyond which metallic particles are present the it determination of range is carried out by elements like Barium, lead, Antimony, Mercury etc.
- These come from the priming mixture it is believed that vapour's travel beyond the Bullet.
- Lead by Atomic absorption Spectrometry.
- Antimony, Barium, Mercury by Neutron Activation analysis.

Dispersion of Pellets.

- Single Hole up to –2Meters.
- At 30cm Diameter of Hole is 2cms.
- At 1Meter Diameter of Hole is 3Cms.
- At 2Meater the Diameter of Hole is 4Cms.



Separation of Pellets

- Rat Hole - Central hole surrounded by several holes at distance of 2 to 5 Meters & diameter of central hole is 2 to 6 Cms



Shotgun Distant wound

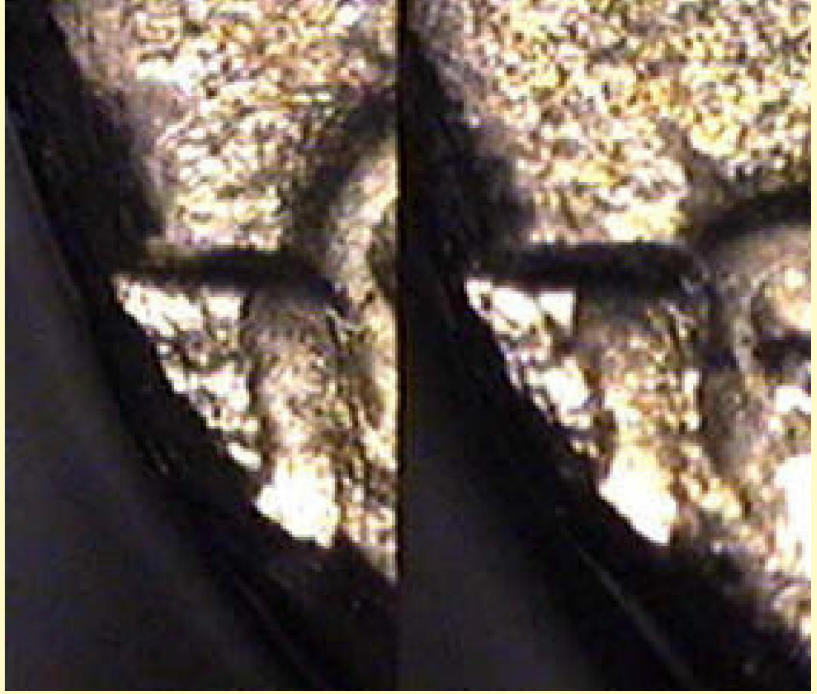
Wad Distribution

- Enter target up to 3 Meters.
- They scatter from 5Meters to long distance .
- If the distance between victim & wad is known range of Fire can be determined.
- Air cushion wads travels average of 40 Meters.

Identification of Firearm.

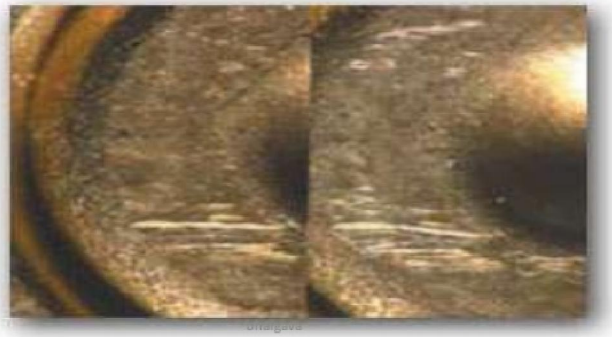
- Shooting cases fired empty cases, spent bullets, pellets, wads are found at the spot.
- In order to link the weapon recovered from the suspect with the cartridge cases & Bullets recovered at the spot & link the suspect with the crime.
- When hard object acts on a soft object it leaves its own class & individual characteristics on the soft object.
- Object acquires some peculiar characteristics due to usage, wear & tear, maintenance, user peculiarities & so on no two firearm leave identical individual characteristics.

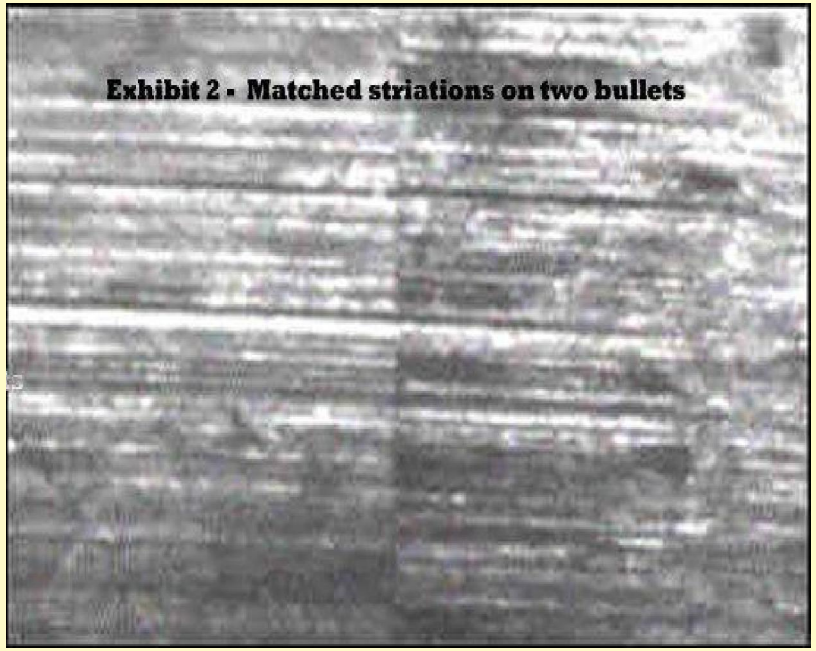




Bullet markings Photographed using Comparison Microscope

- Modern firearms examination began with the introduction of the comparison microscope, with its ability to give the firearms examiner a side by side magnified view of bullets.





- Firearm is manufactured of various components that is Firing pin, Breech Face, Extractor, Ejector, Chamber, etc.
- Go through process of cutting, hammering, grinding, filing, polishing.
- As a result acquire microscopic irregularities in the form of nicks, notches & striations running in different directions.
- Each weapon possess its own pattern of irregularities by which it can be identified.

- Cartridge Case –Firing pin marks due to striking of firing pin on percussion cap.
- Pressure of 2 to 20tons / sq. inch is developed due to burning of propellant.
- Breech Face marks on the head of cartridge case as case is pushed back by the pressure of gases.

- Extractor & Ejector marks.
- Shotguns cartridge case has Chamber .
- Bullets when pass through the barrel the irregularities of barrel lands will leave their individual characteristics.

Nature of material objects Encountered.

- Firearm evidence may be encountered from scene of crime, Victim, Accused, or from any other concealed area.
- At the Scene of Crime-Firearm, Part of firearm, wads, pieces of wads, pellets, Bullets, disintegrated pieces of Bullets, Cartridge & cartridge cases.
- Accused –Firearm, Cartridge, cartridge cases.
- Victim –Bullets, pellets, gunshot holes on body or clothes.

Examination of Firearm Evidence

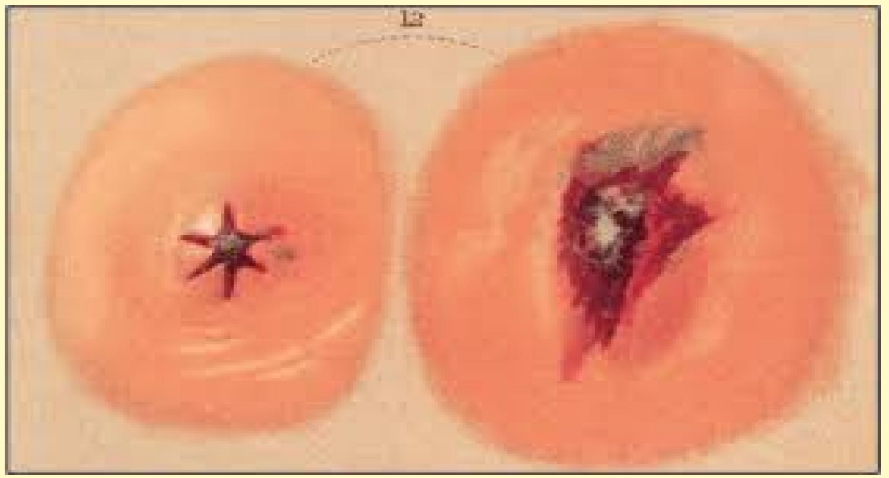
- Firearm.
- Cartridges & Cartridge Cases.
- Bullets.
- Wads.
- Clothes.
- Identification of Shooter.

Distinction Between Entry Wound & Exit wound.

- Entry wound is generally smaller then the diameter of projectile except in very close range when blast of out coming gases also tears the skin.
- Exit wound is generally bigger then the diameter of projectile, the bone may fragment & large fragment of bone cause large exit wound.
- Entry wound in skull is clear cut.
- Exit wound is beveled & sometimes it is star shaped.

- Entrance wound edges are inverted.
- Exit wound edges are averted.
- Entry wound burning ,tattooing &blackening is present.
- Entry wound abrasion is present .
- Exit wound abrasion is found when firm object is pressed against the body.

- Entry wound has dirt ring.
- Exit wound does not have dirt ring.
- Entry wound has slight bleeding.
- Exit wound has profuse bleeding.
- Entry wound track may be pink due to presence of carbon monoxide.
- Exit wound not so.
- Entry wound when bullet strikes bones the bone particles are displaced in the direction of fire.
- Exit wound it is vice versa.



- Entry wound when bullet strikes bones the bone particles are displaced in the direction of fire.
- Exit wound it is vice versa.





Problems Encountered In Forensic ballistics.

- Whether the cartridge case/bullets/pellets recovered from S.OC /body of victim or accused have been fired from suspected firearm.
- What is Caliber, make, model & type of action of the firearm used from the cartridge case/bullets recovered from scene of crime & body of victim?
- Whether firearm is in working condition or not?
- Whether weapon can fire accidentally if the suspect takes plea of accidental fire?
- Whether the firearm is firearm as defined in arms act?
- Whether firearm has been fired or not?

- What is the range of fire?
- What is the direction of fire?
- Which is entry wound & which is exit wound?
- Which of the wounds was fatal?
- Whether multiple wounds would have been caused by one bullet?
- Whether injuries were caused by gunfire? If so what type of projectile has caused these injuries?
- What is the course of projectile in body?