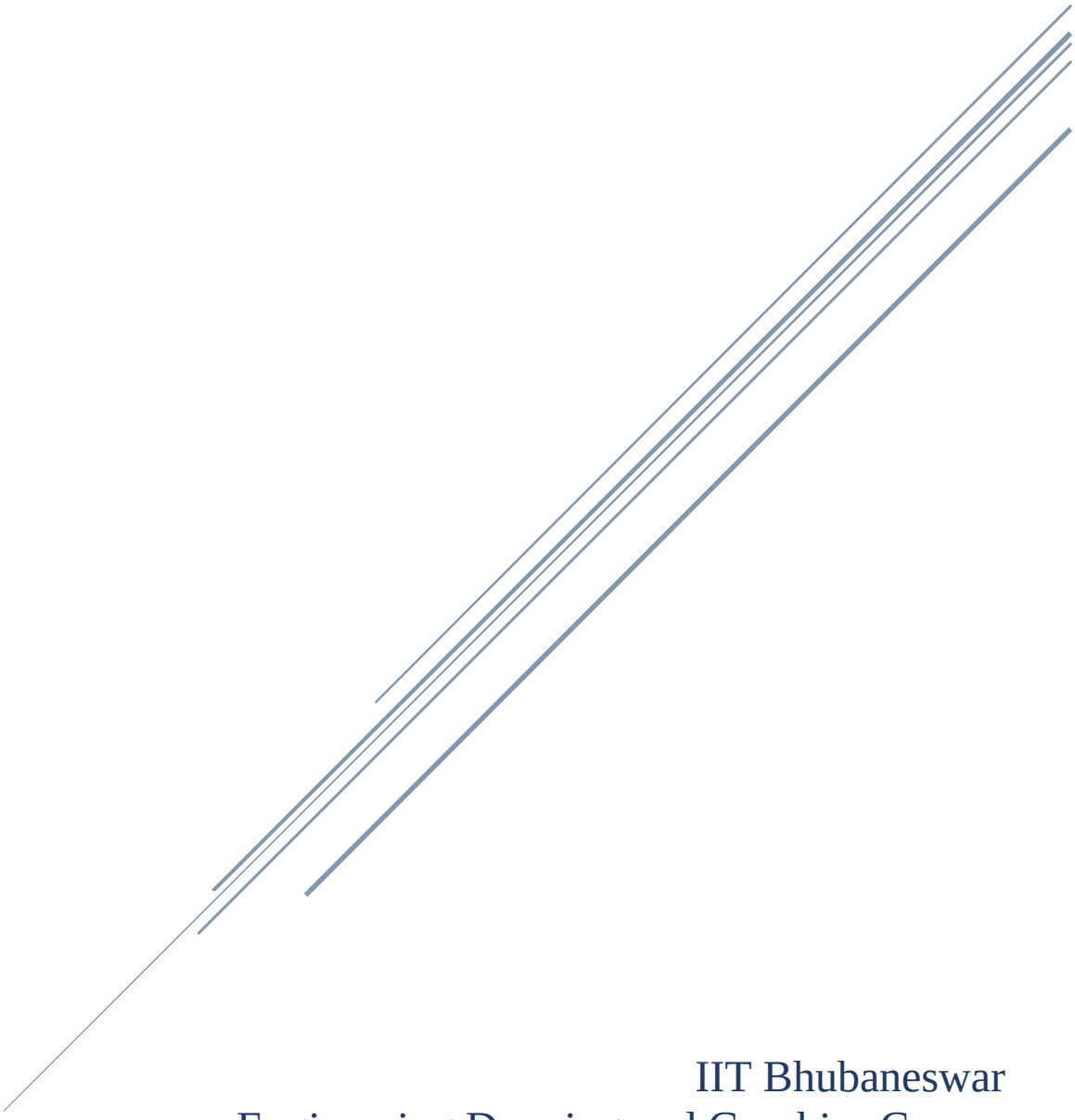
MODELLING OF FIREARMS



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Contents

1 INTRODUCTION TO FIREARMS:

Firearm is a barrelled ranged weapon that inflicts damage on targets by launching one or more projectiles driven by rapidly expanding high-pressure gas produced by exothermic combustion(deflagration) of a chemical propellant, smokeless powder (historically black powder). Revolver is typically a repeating pistol that utilizes a multichambered revolving cylinder behind one barrel.

1.1 Principles of Firearms:

- The trigger lever pushes the hammer backward.
- As it moves backward, the hammer compresses a metal spring in the gun stock (the handle). The diagram above shows a coiled spring; uncoiled tension springs are also used in revolvers.
- Another pawl lodges in a small depression on the cylinder. This stops the cylinder in a particular position so it is perfectly lined up with the barrel.
- When the trigger lever is pushed all the way back, it releases the hammer.
- The compressed spring drives the hammer forward. The firing pin on the hammer extends through the body of the gun and hits the primer. The primer explodes, igniting the propellant.
- The propellant burns, releasing a large volume of gas. The gas pressure drives the bullet down the barrel.

2 HISTORY OF FIREARMS:

The direct ancestor of the firearm is the fire lance. The prototype of the fire lance was invented in China during the 10th century and is the predecessor of all firearms. In the development of firearms, an important limiting factor was the time required to reload the weapon after it was fired. While the user was reloading, the weapon was useless, allowing an adversary to attack the user. Then Several approaches to the problem of increasing the rate of fire were developed.

Repeating and automatic firearms:

A repeating firearm or "repeater" is a firearm that holds more than one cartridge and can be fired more than once between charging. One example of a repeater is the American Springfield Model 1892–99 also made at the Springfield Armory in Springfield, Massachusetts which were used during the Spanish–American War.

2.1 History of revolver:

A revolving three-barrelled matchlock pistol in Venice is dated from at least 1548, followed that, a five-barrelled musket revolver spear were made. Earliest examples of what today is called a revolver were made in Germany. These all revolvers featured a single barrel holding powder and ball, but these weapons were difficult to use. Due to complicated designs and expensive to make these were not also widely distributed.

In 1836, an American, Samuel Colt, patented a popular revolver which led to the widespread use of the revolver. Colt's early revolvers were single-action, in which the cylinder revolved as the hammer was cocked manually, and they used percussion caps. Practical double-action revolvers, in which the hammer is cocked and the cylinder revolves as the trigger is pulled, were developed in Great Britain in the mid-1800s. Both single-action and double-action revolvers became entirely practical about 1870. In the early 19th century multiple-barrel handguns called "pepper-boxes (Some early versions of the revolver, known as "pepperboxes)" were popular. Originally, they were muzzleloaders, but in 1837 the Belgian gunsmith Mariette invented a hammerless pepperbox with a ring trigger and turn-off barrels that could be unscrewed.

2.11 3D PRINTED REVOLVER:

In series of introducing new types of weapons The Zig zag revolver is a 3D printed Revolver made public in May 2014. It was created by a $500 3D-printer using plastic filament, but the name of the printer was not revealed by the creator. It was created by a Japanese citizen from Kawasaki named Yoshitomo Imura He was arrested in May 2014 after he had posted a video online of himself firing a 3D printed Zig Zag revolver. It is the first 3D printed Japanese gun in the world which can discharge live cartridges.

3 REVOLVERS:

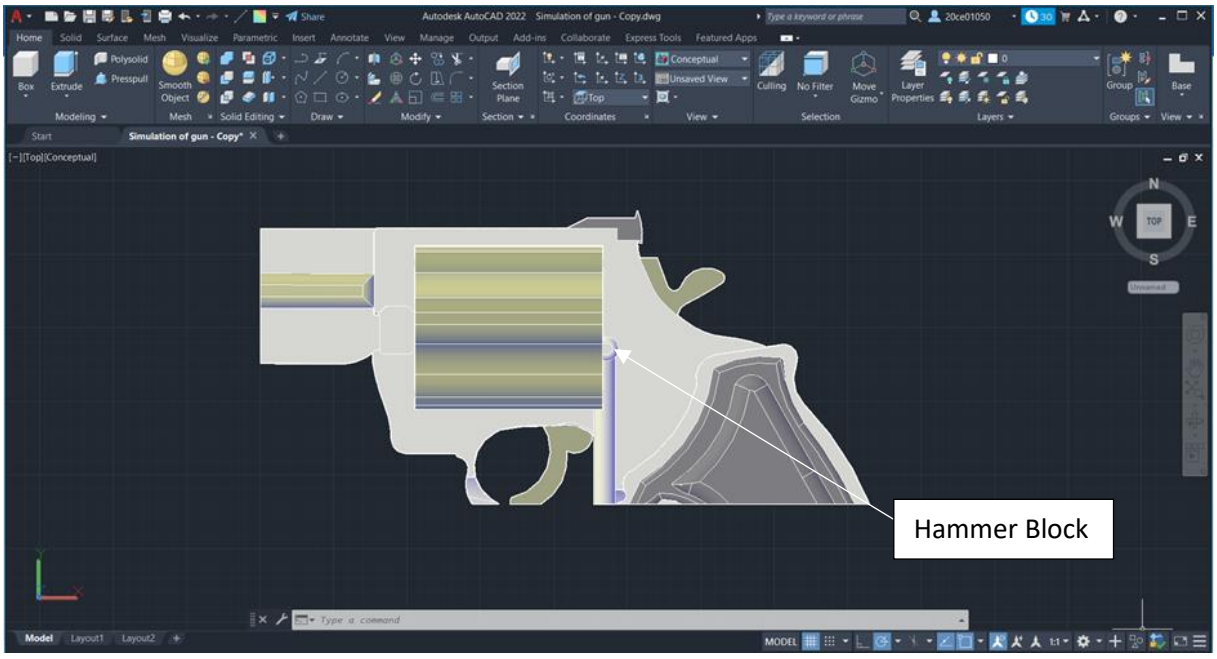
3.1 Single-Action Revolvers:

Single action revolvers require manual cocking of the hammer before sufficient force on the trigger releases the firing mechanism. When the hammer is pulled to the rear (cocking) an internal hand or pawl rotates the cylinder clockwise or counter clockwise, moving the next chamber into alignment with the barrel and firing pin. The hammer then locks into place along with the cylinder. Pulling the trigger releases the hammer, driving the firing pin to detonate the cartridge.

The cylinder of the single-action revolver is usually held in place by a removable pin; a loading gate is located on the right side of the firearm. By opening the loading gate and placing the hammer in an unlocked position, the cylinder can be rotated to ensure that all cylinders are empty. To the front of the chamber (located below the barrel), an ejection rod is used to eject fired cartridge cases from the cylinder.

3.11 Modern Single-Action Revolvers

Modern single-action revolvers generally include an integrated safety feature to prevent accidental discharge. For example, Ruger revolvers use a transfer bar safety. This involves the use of a bar connected to the trigger. When the trigger is pulled, the bar is raised up to be struck by the falling hammer, transferring the energy of the hammer to the firing pin. Without the trigger being pulled, the hammer will not make contact with the firing pin.



Some single-action revolvers use a hammer block safety which, in the safe position, blocks contact between the cartridge and the hammer. When the trigger is pulled, the bar is retracted and the hammer is allowed to make contact with the firing pin, striking the cartridge

Figure: *Single Barrel Drum Loading*

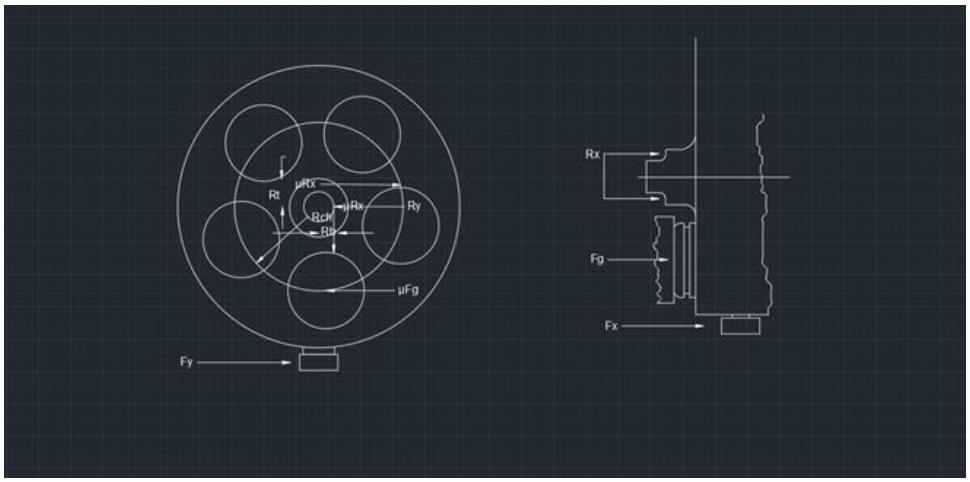
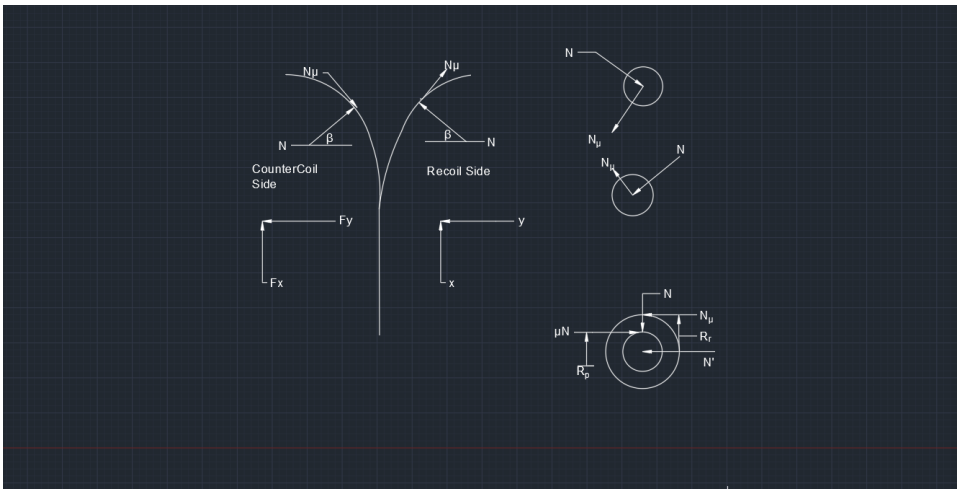


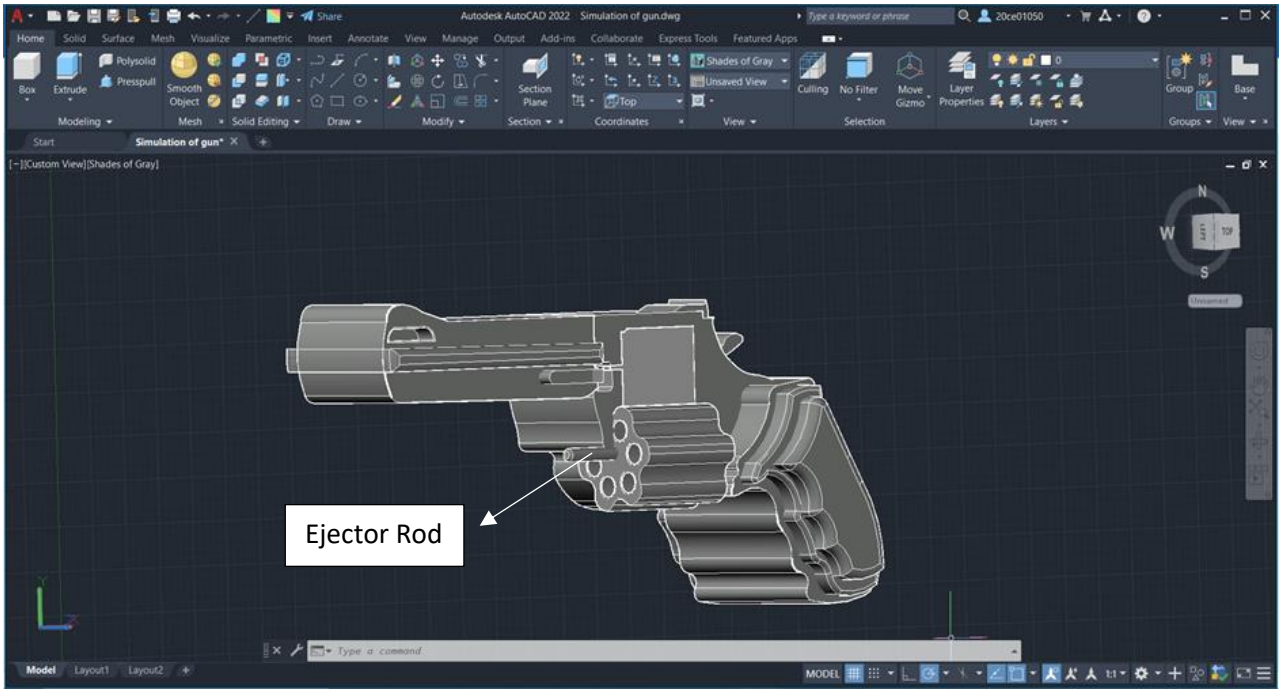
Figure: *Representation of Single Barrel dynamics*



3.2 Double-Action Revolvers:

Double-action revolvers are similar to single-action revolvers, with the following exceptions:

- Function:
    - Double-action revolvers allow the hammer to be cocked and released with a single pull of the trigger.
    - Most double-action revolvers have the capability to function in either the double- or single-action mode. However, some models are designed to fire in the double-action mode only; the hammer cannot be manually cocked and the trigger must be pulled.
    - Used in the double-action mode, the cylinder is locked into place by the cylinder stop; the hammer does not lock into place since the cocking and releasing of the hammer is achieved in one motion.



- Ejection/extraction:
    - In double-action revolvers, the cylinder release device is generally located on the left rear of the frame, whereas in single-action revolvers, the loading gate is located on the right.
    - By manipulating the release device, the cylinder will unlock and swing out to the left of the firearm. The front of the cylinder has an ejection rod, which is used to eject all the fired cartridge cases or cartridges from the cylinder with one movement.
- Modern double-action revolvers generally use the same accidental discharge prevention mechanisms as single-action revolvers – the transfer bar or the hammer block.

Figure: *Representing Location of basic operation in Double Barrel Mechanism*

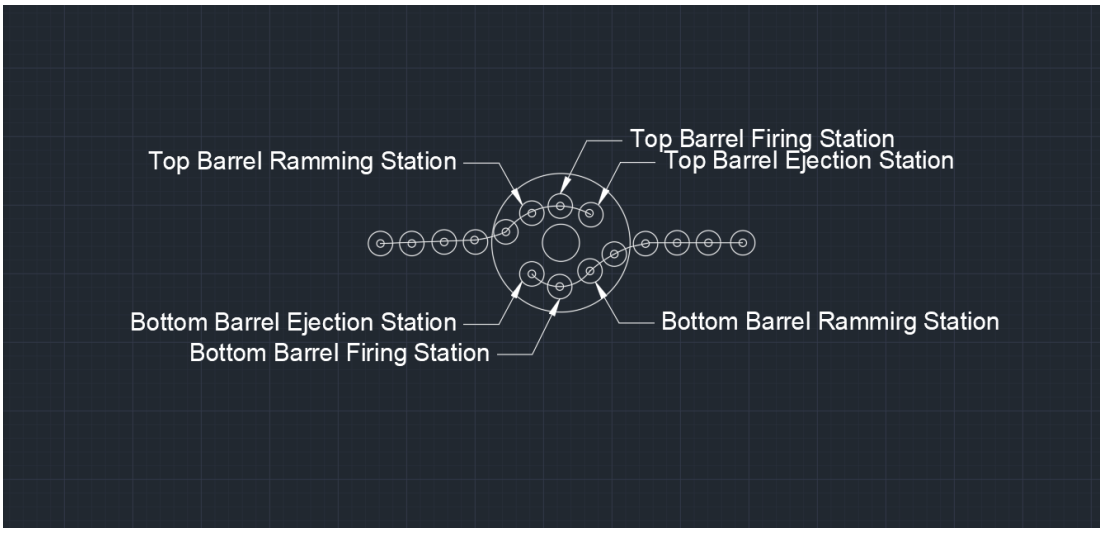
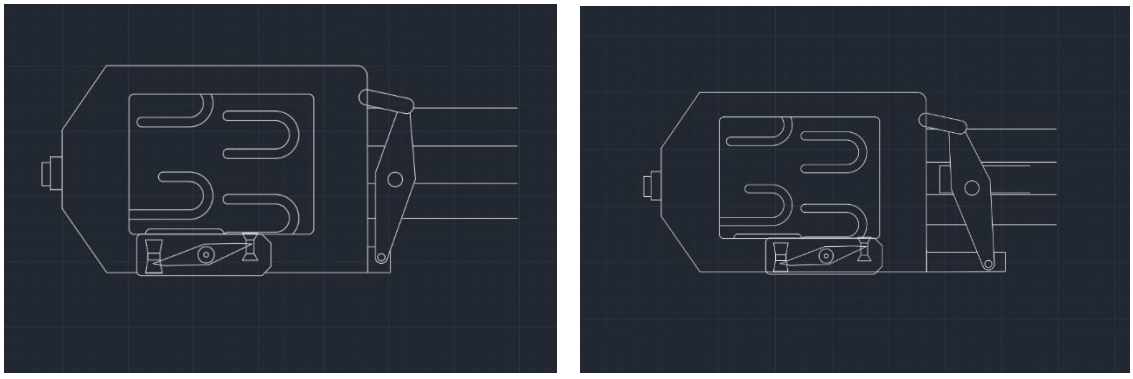
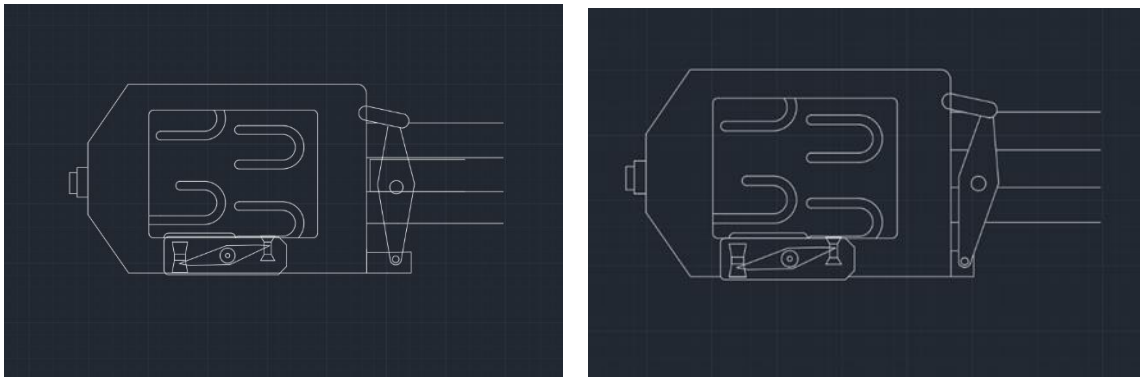


Figure: *Schematic of Double Barrel drum-cam arrangements*

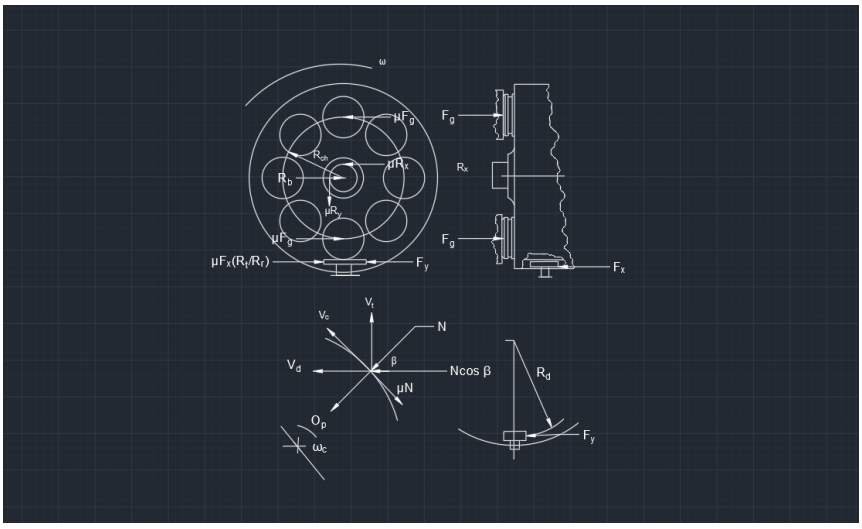


(A) (B)



(C) (D)

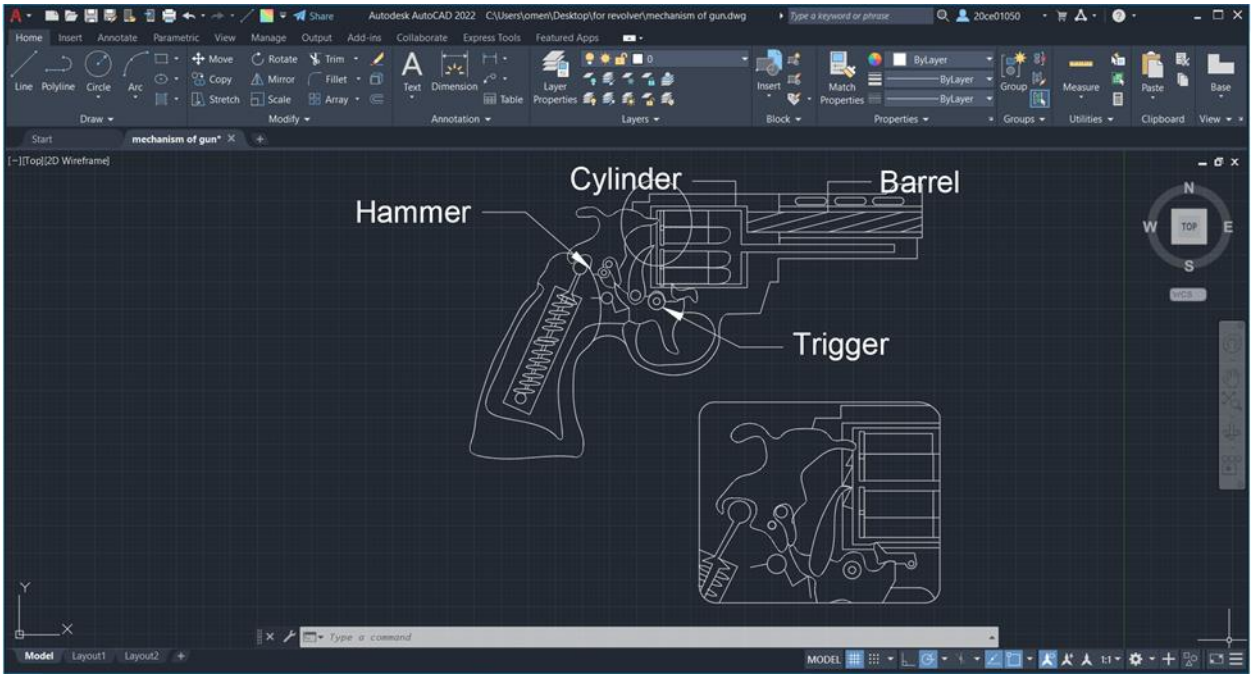
Figure: *Double Barrel Drum Loading and Double Barrel Drum Dynamics*

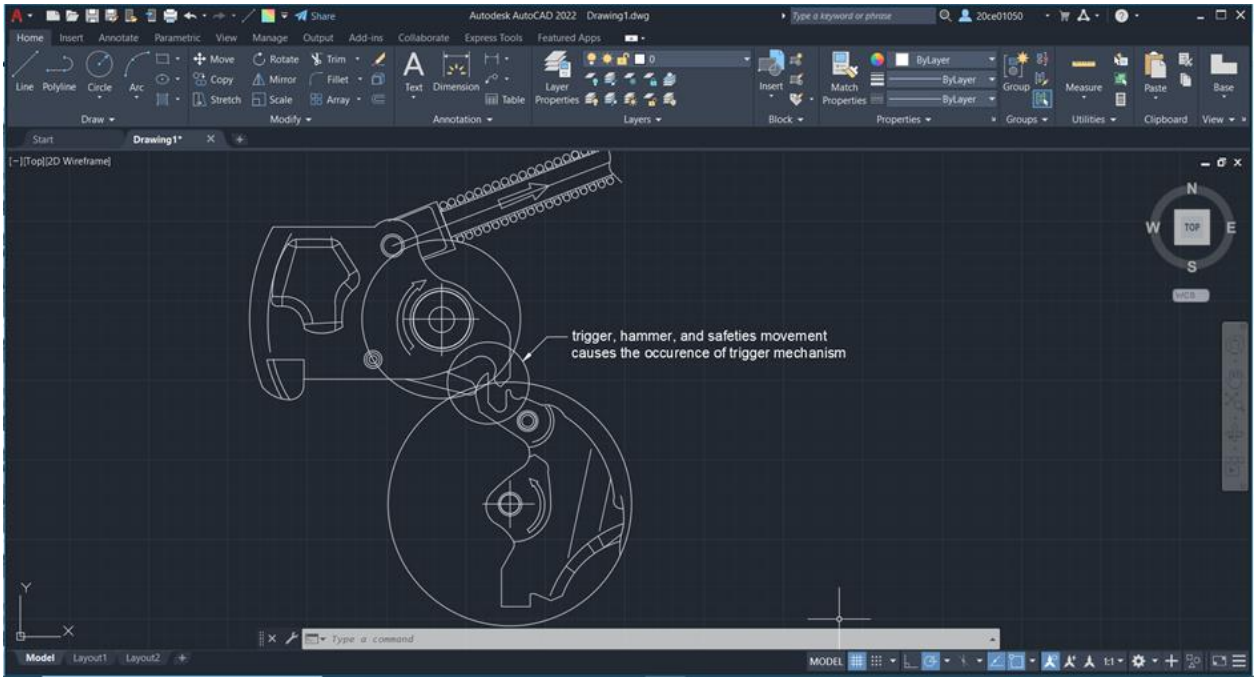


3.3 Revolver trigger mechanism:

A revolver with trigger mechanism for cocking a rotatable hammer. The revolver includes a frame, a barrel supported by the frame and defining a bore, at least one chamber aligned with the bore of barrel for holding a cartridge, a hammer pivotally mounted to the frame and moveable between a forward uncorked position and a rearward cocked position, and a trigger pivotally mounted to the frame. In one embodiment, the trigger includes a contoured camming surface configured and arranged to engage a protrusion extending outwards from the hammer for cocking the hammer in response to pulling the trigger. The protrusion may be a hammer dog pivotally coupled to the hammer in some embodiments. In another embodiment, the hammer may include a sear having a contoured camming surface for engaging the trigger.

Figure: *Trigger Mechanism*





4 PHYSICS BEHIND THE WORKING OF A REVOLVER:

Weapons such as revolvers, cannons, shotguns, and rifles work on the basic idea of conservation of momentum and the change in energy from potential to kinetic.

When the trigger is pulled the hammer hits the firing pin. The firing pin then hits the primer which causes the powder to burn hence producing lots of gases. This causes the volume behind the bullet to fill with extremely high-pressure gas. The gas pushes on every surface it encounters, including the bullet in front of it and the base of the revolver barrel behind it.

The increase in pressure caused by the gases causes the bullet to be forced into the barrel hence causing the bullet to come out of the muzzle at very high speeds. Once the bullet is fired, it remains in motion from its momentum. The momentum will carry the bullet until it strikes an object or gravity pulls the bullet towards the earth.

Firearms change potential chemical energy into kinetic energy in the actual firing of the revolver. Many people do not realize that the force imparted by accelerating the bullet is not the only force acting on the revolver or the shooter. Grains of burned gun powder is sent out the muzzle at high velocity. When the trigger is pulled, the hammer strikes a small charge at the end of the shell, the ammunition.

This charge ignites black gun powder packed behind the lead ball bearings.

When the black gun powder burns, it produces gas that rapidly expands with the burning of blacker gun powder. High-pressure gases exert forces on the back of the bullet and on the revolver. The only way for the gas to escape is to push the bullet out of its way through the end of the barrel. This is how a bullet is fired from a revolver.

Conservation of momentum is the law that is held true when the revolver is fired and a “kick” is felt. When a bullet is fired from a revolver, the total momentum before is zero since nothing is moving. After firing the bullet there is momentum in the forward direction. The revolver must therefore have the same magnitude of momentum but in the opposite direction so that they cancel each other out leaving the total momentum still equal to zero. For this reason, the gun must have a recoil velocity after the bullet is fired (i.e., the revolver ‘jumps’ backward and a ‘kick’ is felt).

4.1 Dynamics in Revolver:

The normal approach to the study of the dynamics during the firing cycle is to consider the various operations in their operational sequence. By considering firing as the initial condition, the first response of the gun is recoil.

The weighted arithmetic means of the impulse which yields an average force $F_a=\Sigma Fg\Delta t/\Delta t$. Let this average force become the adapter resistance and compute what may be considered to be a resisting impulse for each increment of time, which, when subtracted from the original impulse, will yield an effective impulse $(F\Delta t)e = (Fg - Fa)\Delta t$.

The change in velocity during each time interval will be

$$\Delta v = (F\Delta t)e/Mr$$

The recoiling parts continue to accelerate until (FAt)e becomes zero. When this happens, the recoiling parts begin to decelerate but the slide continues to move under its own inertia unless the projectile has already passed the operating cylinder's gas port.

When slide and recoiling parts act as a unit M=Mr+Ms(otherwise M=Mr the mass of the recoiling parts),the recoil acceleration becomes

$$A_r = (F_g - F_t - F_c)/M_r + M_s$$

where F_t=Adapter force

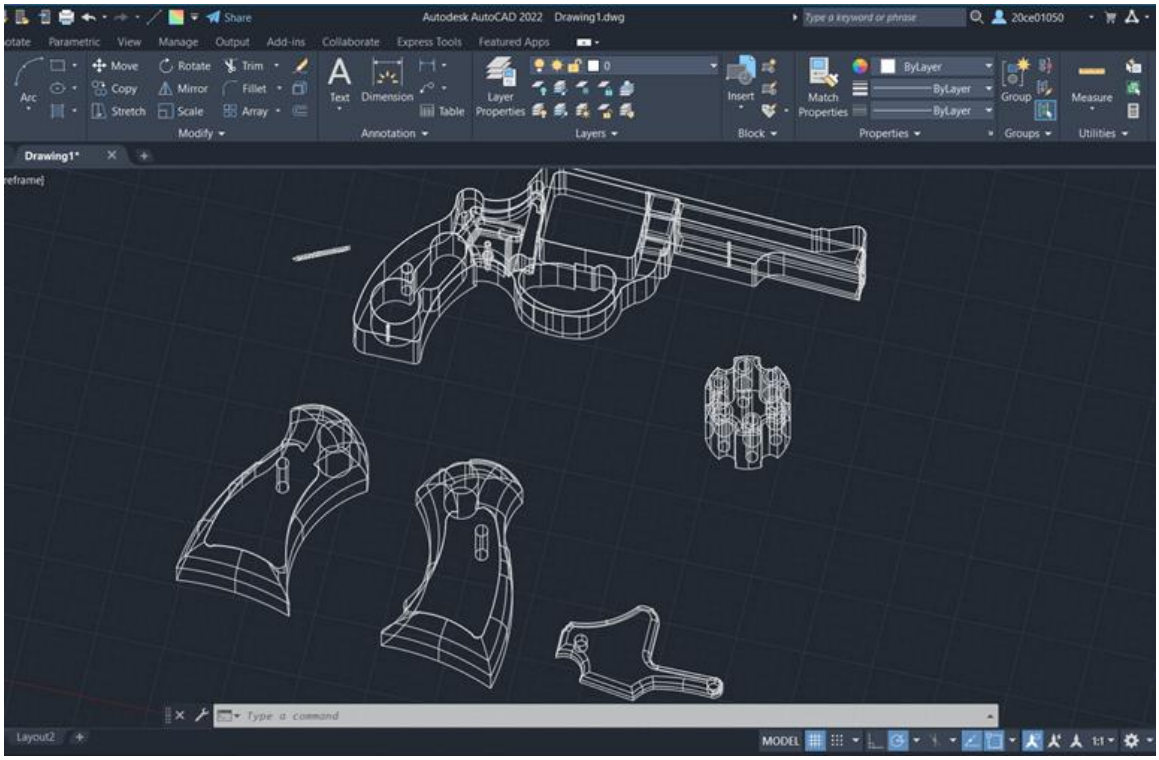
F_c=Operating cylinder force

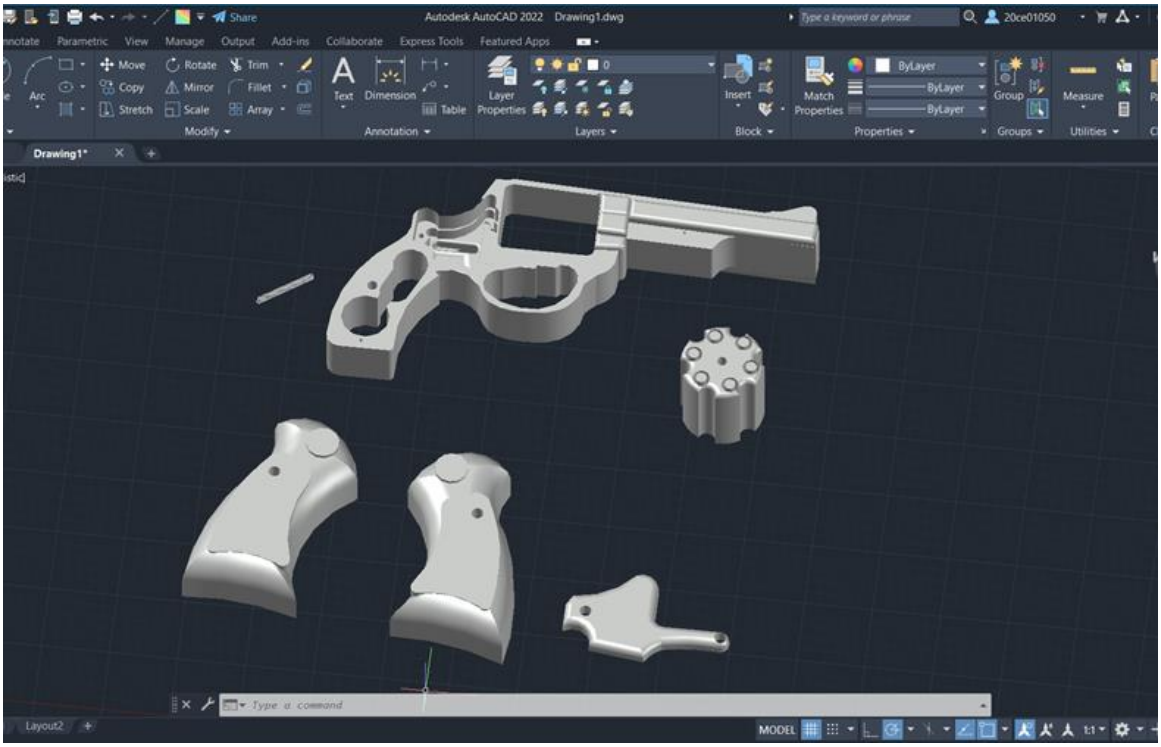
F_g=Propellant gas force

M_s=Mass of slide

The slide acceleration becomes $A_s = A_r + (F_c/M_g)$

AutoCAD Drawings of Gun:





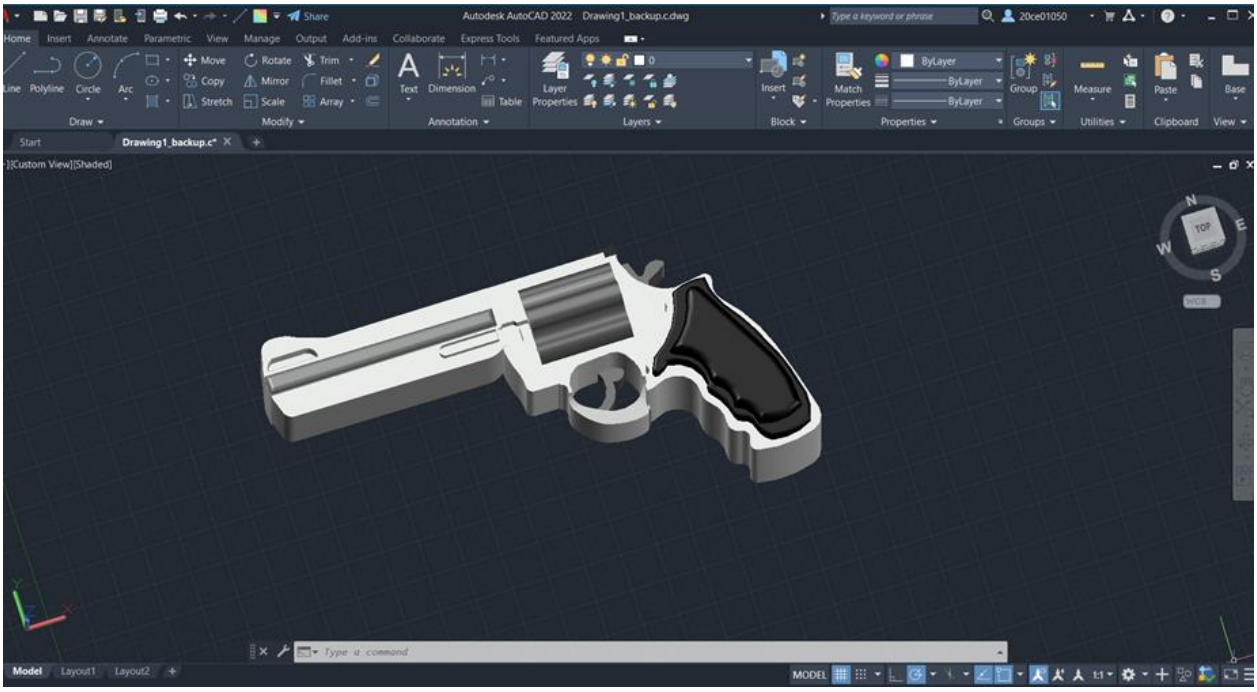
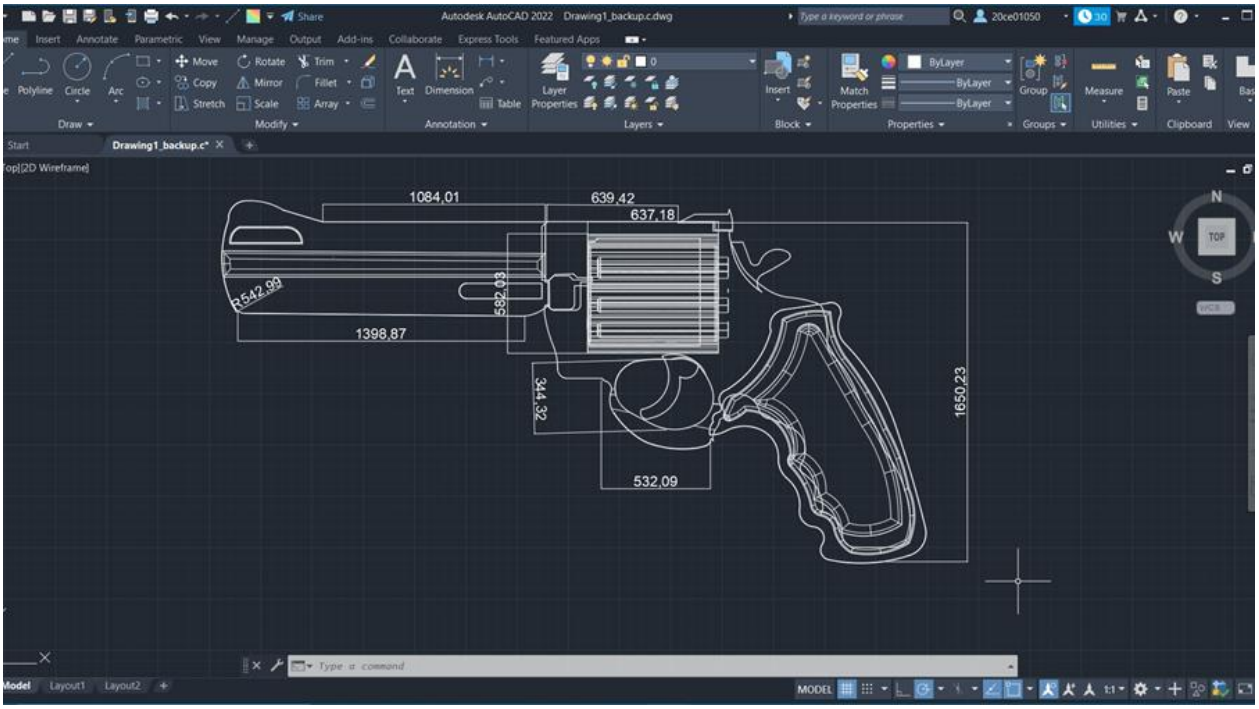


Figure: *AutoCAD Drawing of Gun*



5 TYPES OF FIREARMS:

In the military, firearms are categorized into "heavy" and "light" weapons regarding their portability by foot soldier. Light firearms are those that can be readily carried by individual infantrymen (i.e., "man-portable"), though they might still require multiple individuals (crew-served) to achieve optimal operational capacity. Heavy firearms are those that are too large and heavy to be transported on foot, or too unstable against recoil, and thus require the support of a weapons platform (e.g., a fixed mount, wheeled carriage, vehicle, aircraft or water vessel) to be tactically mobile or useful.

The subset of light firearms that only use kinetic projectiles and are compact enough to be operated to full capacity by a single infantryman (individual-served) are also referred to as "small arms", a hyponym to which the word "firearm" is often referring as a synonym in common usage. Such firearms include handguns such as revolvers, pistols and derringers, and long guns such as rifles (including many subtypes such as anti-material rifles, sniper rifles /designated marksman rifles, battle rifles, assault rifles and carbines), shotguns, submachine guns /personal defense weapons and squad automatic weapons/light machine guns.

Long guns

A long gun is any firearm with a notably long barrel, typically a length of 10 to 30 inches (250 to 760 mm) (there are restrictions on minimum barrel length in many jurisdictions; maximum barrel length is usually a matter of practicality). long guns are designed to be held and fired with both hands, while braced against either the hip or the shoulder for better stability.

Rifles and shotguns

Most modern long guns are either rifles or shotguns. Both are the successors of the musket, diverging from their parent weapon in distinct ways. Rifles and shotguns are commonly used for hunting and often also for home defence, security guard and law enforcement are so named for the spiral grooves (rifling) machined into the inner (bore) surface of its barrel, which imparts a gyroscopically-stabilizing spin to the bullets that it fires. Shotguns are predominantly smoothbore firearms designed to fire a number of shot in each discharge.

Carbines

A carbine is a firearm similar to a rifle in form and intended usage, but generally shorter or smaller than the typical "full-size" hunting or battle rifle of a similar time period, and sometimes using a smaller or less-powerful cartridge. Carbines were and are typically used by members of the military in roles that are expected to engage in combat, but where a full-size rifle would be an impediment to the primary duties of that soldier (vehicle drivers, field commanders and support staff, airborne troops, engineers, etc.).

Machine guns

A machine gun is a fully automatic firearm, most often separated from other classes of automatic weapons by the use of belt-fed ammunition (though some designs employ drum, pan or hopper magazines), generally in a rifle-inspired calibre ranging between 5.56×45mm NATO (.223 Remington) for a light machine gun to as large as .50 BMG or even larger for crewed or aircraft weapons.

Handguns

Handguns are guns that can be used with a single hand, and are the smallest of all firearms. However, the legal definition of a "handgun" varies between countries and regions. For example, in South African law, a "handgun" means a pistol or revolver which can be held in and discharged with one hand. In Australia, the gun law considers a handgun as a firearm carry-able or concealable about the person; or capable of being raised and fired by one hand; or not exceeding 65 cm (26 in). In the United States, Title 18 and the ATF considers a handgun as a firearm which has a short stock and is designed to be held and fired by the use of a single hand.

There are two common types of handguns: revolvers and semi-automatic pistols. Most handguns carried regularly by military, police and civilians were semi-automatic, although revolvers were still widely used. Generally speaking, military and police forces use semi-automatic pistols due to their high magazine capacities and ability to rapidly reload by simply removing the empty magazine and inserting a loaded one. Revolvers are very common among handgun hunters because revolver cartridges are usually more powerful than similar calibre semi-automatic pistol cartridges (which are designed for self-defence) and the strength, simplicity and durability of the revolver design is well-suited to outdoor use.

More types of firearms:

1. Sniper rifles
2. Submachine guns
3. Automatic rifles
4. Assault rifles
5. Personal defense weapons
6. Battle rifles, etc.

6 PARTS OF A REVOLVER:

To understand how a revolver is made, it is important to know how each subsystem functions within the weapon. A revolver contains four main subsystems: the Frame Group; the Cylinder, Extractor, and Crane Group; the Barrel and Sight Group; and the Trigger, Timing Hand, and Hammer Group.

The *Frame Group* consists of the main frame, the trigger guard, and the hand grip. Its purpose is to provide a strong frame to contain the powerful force of the cartridge discharge, position the shooter's hand correctly, and ensure that the trigger functions precisely. All modern revolvers utilize a frame design incorporating a solid top strap that connects the top of the grip area to the barrel mounting area, reinforcing the structural integrity of the frame. All modern revolvers utilize a frame design incorporating a solid top strap that connects the top of the grip area to the barrel mounting area, reinforcing the structural integrity of the frame.

The parts on any firearm can be classified as either a weapon's moving parts or its stationary parts.

6.1 Stationary Parts:

The Grip:
This is the area where the shooter holds the weapon. It is usually the only wooden part of the gun. It will often have a fine checkered pattern to aid in the shooter's grip and may have an implanted manufacturer's medallion. Grips can be customized to different sizes to accommodate the shooter's hand. Some combat grips are constructed of a non-slip hard rubber material.

The Front and Rear Sights:
These are located on top of the barrel and allow the shooter to align the weapon with the intended target.

The Barrel:
The barrel is secured along the top of the weapon and is built into and affixed to the frame. The

inside of the barrel has a spiral pattern of cuts called lands and groves. These cause the bullet to spin as it travels through the barrel.

The Muzzle:
The muzzle of any firearm is the end of the barrel where the bullet will exit. The term muzzle-awareness refers to always knowing in what direction your weapon is pointed.

The Trigger Guard:
This is the piece of metal that encircles the trigger preventing accidental trigger engagement.

The Frame:
The frame can be described as the "bones" of the weapon. It is generally a single piece of metal that is precisely machined to accept all the other parts of the weapon.

6.2 Moving Parts:

The Trigger:
This is located inside the trigger guard toward the bottom of the weapon. When the trigger is pulled to the rear, either one or two things will happen depending on the type of revolver. If it's a double-action model, as the trigger is pulled, the hammer will move to the rear and the cylinder will rotate, aligning the next chamber with the barrel. As the shooter continues to squeeze the trigger, the hammer will be released, traveling quickly forward, striking a firing pin and causing the weapon to fire.

The Cylinder:
The cylinder is one piece of steel usually with either five or six chambers. Each chamber holds one round of ammunition. The cylinder gets its name from its cylindrical shape. As the hammer is drawn back, the cylinder rotates aligning the next chamber and round with the barrel.

The cylinders are loaded differently depending on the type of revolver. Most modern revolvers have a release that allows the cylinder to swing out to the side and down.

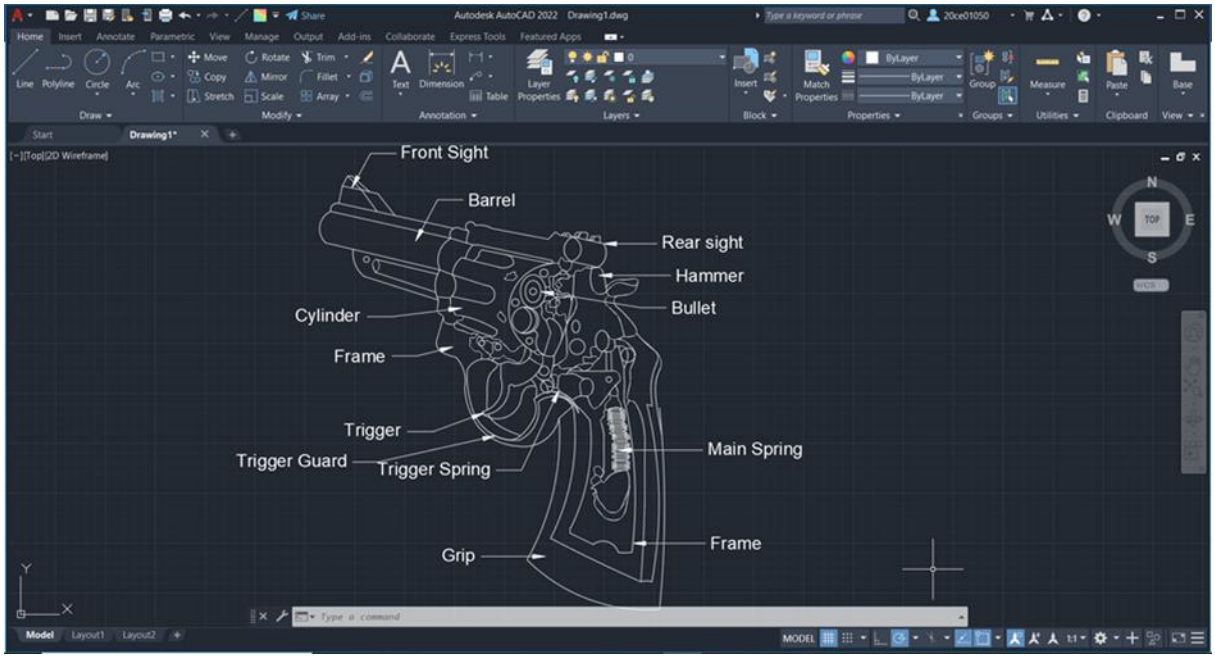
The Ejector Rod & Extractor:
The ejector rod runs through the centre of the cylinder and acts as a fixed axis allowing the cylinder to turn. The extractor is attached to the end of the ejector rod and is recessed into the cylinder. When the revolver is loaded, each cartridge rim rests against the extractor. After the last round is fired, the cylinder release is pressed and the cylinder swings out to the side. The shooter then pushes back on the front of the ejector rod. The rod travels back, catching the rims of the spent cartridges on the extractor. The extractor forces all the spent cartridges from the cylinder at the same time.

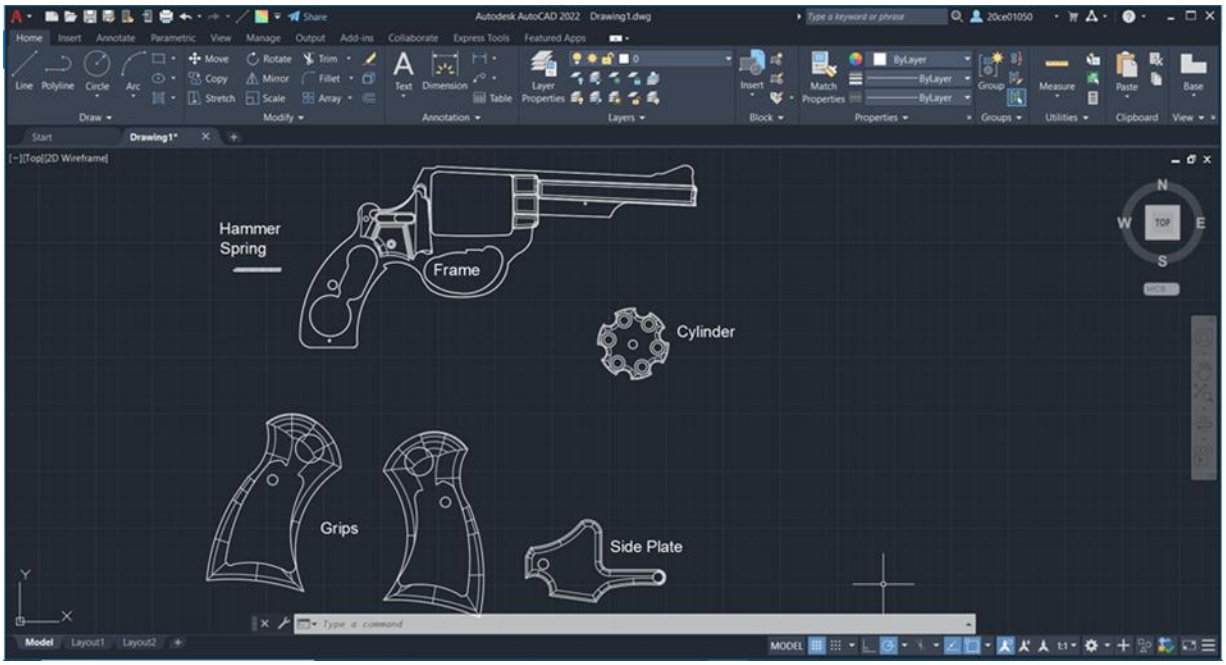
The Cylinder Release:
The cylinder release is usually a small spring-loaded slide lever that is located behind the cylinder. Depending on the revolver model, it is either pushed forward or down. Depressing the cylinder release allows the cylinder to swing out to the side and down for unloading and loading.

The Hammer:

The hammer is located just behind the cylinder and centred with the barrel. The purpose of the hammer is to strike either a firing pin or the cartridge primer, causing the revolver to fire. If the striking surface of the hammer is flat, the weapon uses a floating firing pin. If the striking surface of the hammer is pointed the weapon does not have a separate firing pin. The pointed area of the hammer is the firing pin and comes in direct contact with the cartridge primer.

Figure: *Parts of a Gun*





7 GUN SAFETY

1. Always keep the muzzle pointed in a safe direction.

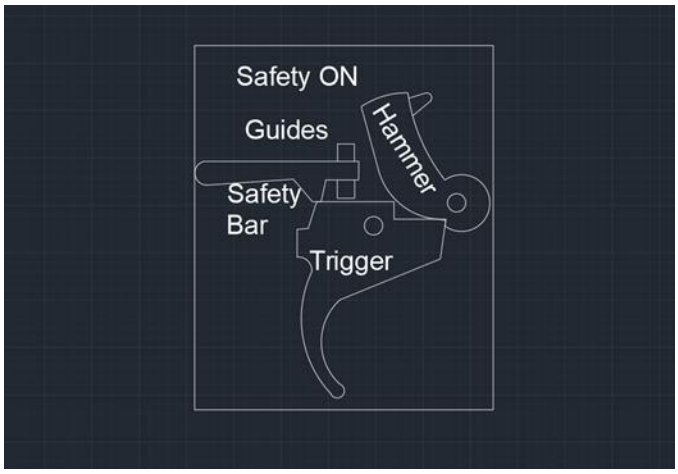
Never point your gun at anything you do not intend to shoot.

2. Firearms should be unloaded when not actually in use.

When not in use, firearms and ammunition should be secured in a safe place, separate from each other. Unload your gun immediately when you have finished shooting.

3. Don't rely on your Gun's safety.

You should never handle a gun carelessly and assume that the gun won't fire just because the "safety is on".



4. Be sure of your target and what's beyond it.

You should keep in mind how far a bullet will travel if it misses your intended target or ricochets in another direction.

5. Use correct Ammunition.

Be absolutely certain that the ammunition you are using matches the specifications that are contained within the gun's instruction manual and the manufacturer's markings on the firearm. Do not spray oil or solvents on ammunition or place ammunition in excessively lubricated firearms.

6. If your gun falls to fire when the trigger is pulled, handle carefully.

Occasionally, a cartridge may not fire when the trigger is pulled. If this occurs, keep the muzzle pointed in a safe direction. Keep your face away from the breech. Then, carefully open the action, unload the firearm and dispose of the cartridge in a safe way.

7. Always wear eye and ear protection while shooting.

Exposure to shooting noise can damage hearing, and adequate vision protection is essential. Shooting glasses guard against twigs, falling shot, clay target chips and the rare ruptured case or firearm malfunction.

8. Make sure the barrel is clear of obstructions before shooting.

Be sure the barrel is clear of any obstruction. Even a small bit of mud, snow, excess lubricating oil or grease in the bore can cause dangerously increased pressures, causing the barrel to bulge or even burst on firing.

9. Don't alter or modify your gun, and have it serviced regularly.

Any alteration or change made to a firearm after manufacture can make the gun dangerous and will usually void any factory warranties. Check with the manufacturer of your firearm for recommended servicing.

10. Learn the mechanical and handling characteristics of the firearm you are using.

Never handle any firearm without first having thoroughly familiarized yourself with the particular type of firearm you are using, the safe gun handling rules for loading, unloading, carrying and handling that firearm, and the rules of safe gun handling in general.

Conclusions:

In this report, we have taken the view of generative designs as a collaboration between human and computer. Generative design techniques use the computer as a designer to create shapes that would be impossible for a human engineer to devise.

The revolver framework which was designed with Auto CAD has a good rigidity and the size also compatible with the specifications.

The modelling of firearms uses various techniques and methodology to finish the final product.it is useful for various security reasons.

From this project work, we have learnt the following things:

- Understand the parametric CAD workflow.
- Articulate the difference between a body and a component.
- Model component defined by parameters.
- Manipulate part materials and appearances.
- Understand the manufacturing methods and 3d designing.

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