AIRCRAFT RECIPROCATING ENGINE

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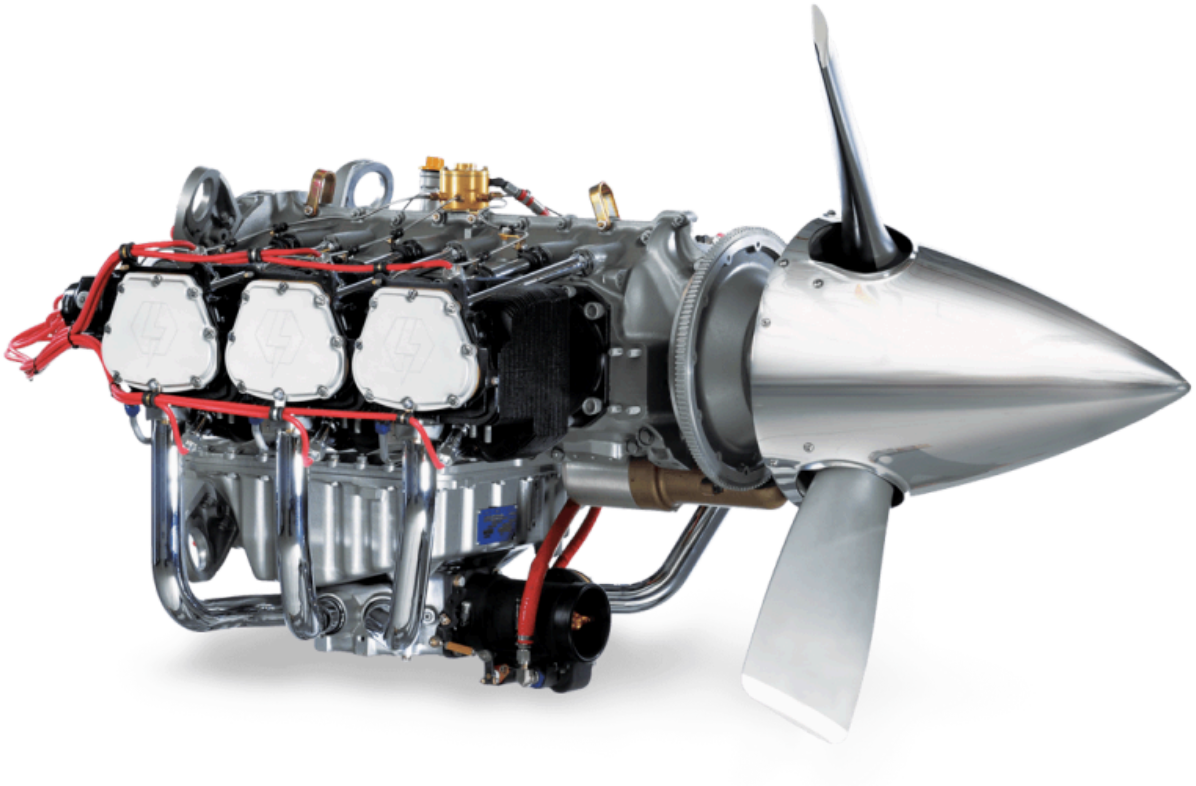

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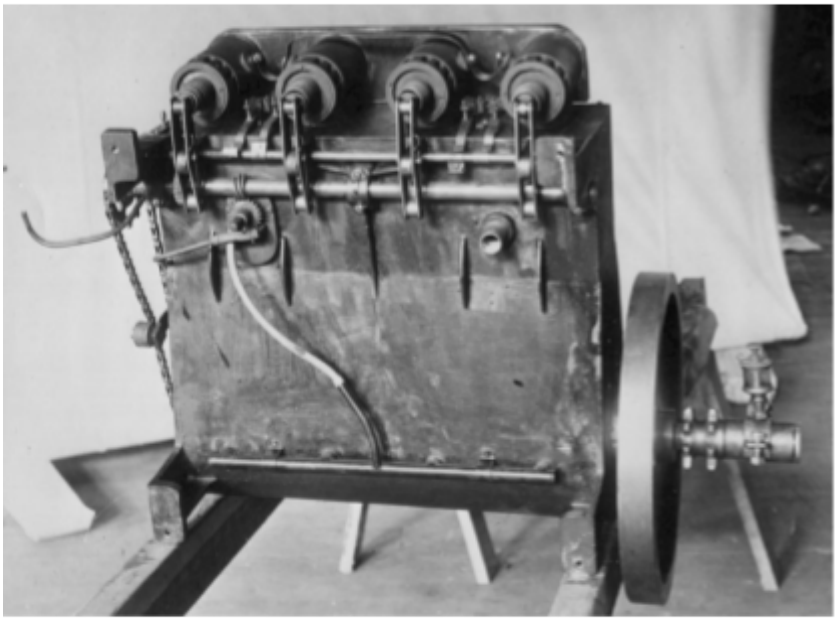
Brief History

Reciprocating engines, or piston engines, played a key role in aviation history. They powered aircraft from the earliest flights through much of the 20th century.The story starts with the Wright brothers. In 1903, they achieved the first powered, controlled flight with a custom reciprocating engine. Their 12-horsepower, four-cylinder gasoline engine weighed 180 pounds. Designed with mechanic Charlie Taylor, it drove two propellers via chains. This lightweight internal combustion engine proved powered flight was possible.

In early aviation the reciprocating engines were adapted from the automotive vehicles. These early engines were engineered poorly since they were simple and air cooled which was unreliable. During the first World War the reciprocating engines developed rapid enhancement, the engines went from being air cooled to water cooled. They enabled faster, larger aircraft for combat and scouting. The years of war introduced different models of the reciprocating engine but it all followed the same principles of the 5 stage cycle which will be discussed in the writing. By the mid-20th century, reciprocating engines in aviation mostly filled niche roles. They powered private planes, trainers, and bush aircraft. Their simplicity, fuel efficiency, and low-speed performance kept them useful. These engines were also used for learning purposes for future aviation enthusiasts and technicians.

Figure 1

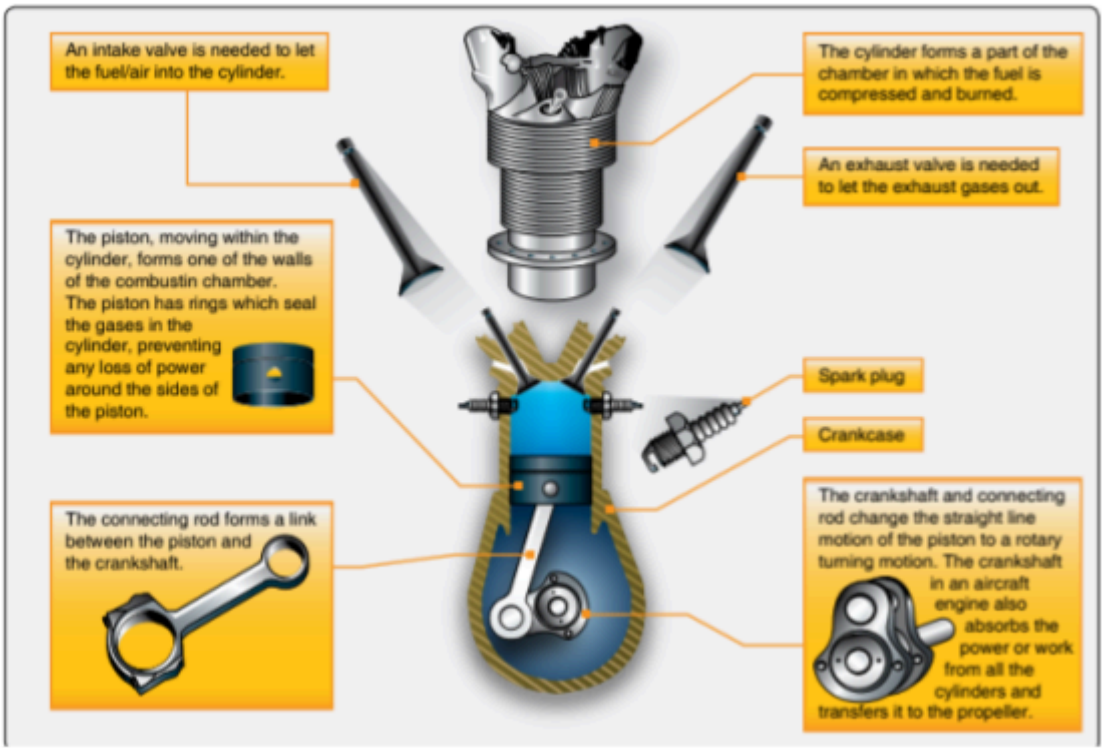


First engine created by the wright brother

Reciprocating Engine Operation

The reciprocating engine, also known as a piston engine, is a type of internal combustion engine that converts energy from burning fuel into mechanical energy. A reciprocating engine could be seen in our cars, generators and aircraft. The primary function of a reciprocating engine is to generate power from the burning of fuel, and converting that energy into mechanical energy to rotate wheels, propellers or other mechanical usage.

Figure 2



Explosive view of a cylinder of a reciprocating engine

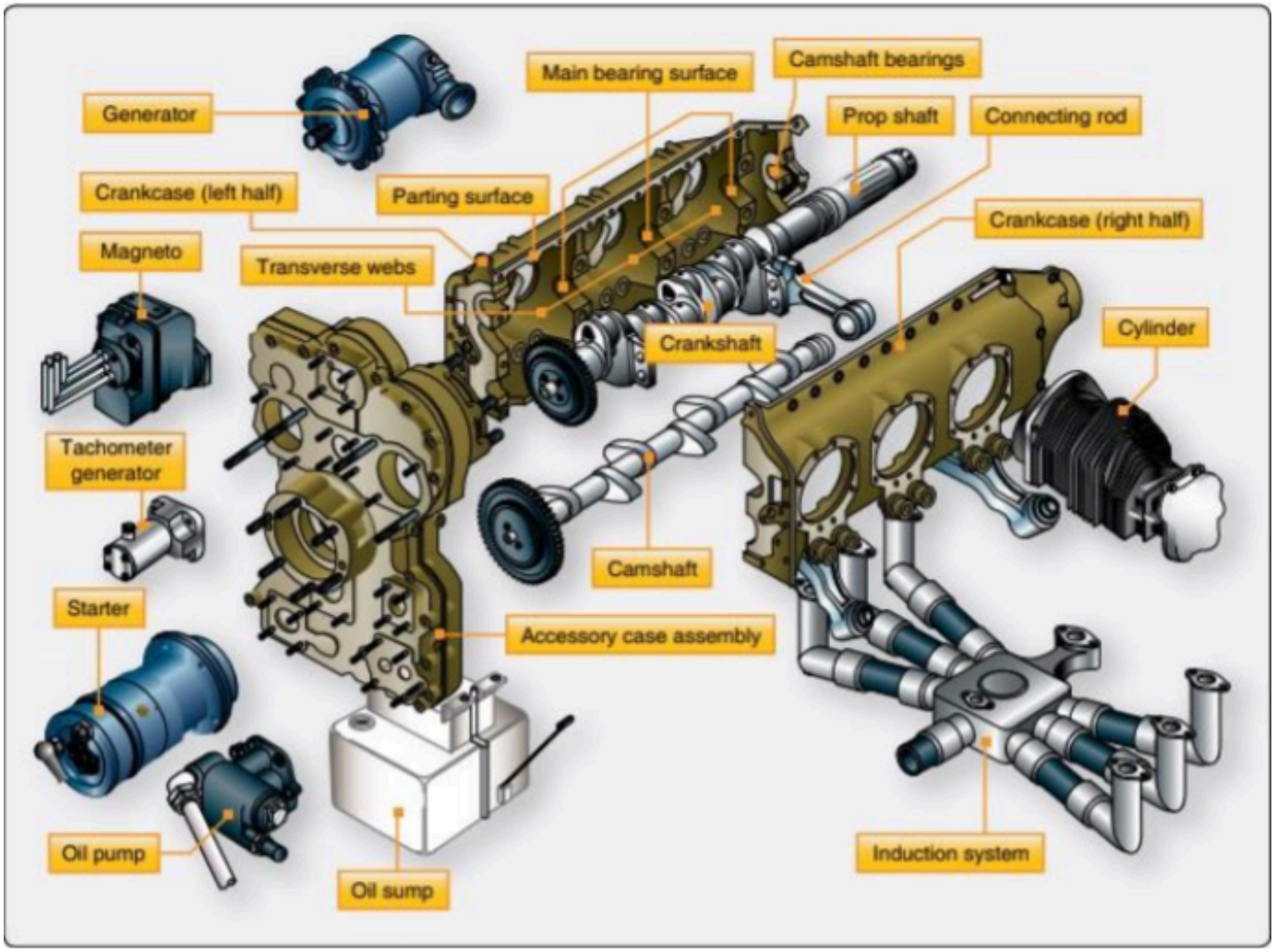
A typical reciprocating engine consists of a cylinder block which consists of multiple cylinder holes where the piston can move up and down. The engine block is usually made of heavy metal so it can withstand the heat. The usual composition of the cylinder is usually cast iron or aluminum mixed with other metal, and the head is often covered with cylinder head, intake and exhaust manifold. To convert this rotary energy to mechanical energy the engine is connected to other parts of the vehicle or aircraft by the crankshaft.

The reciprocating engine works through burning fuel inside the cylinder, by creating a high pressure gas from the mixture of fuel and compressed air inside the cylinder causing the piston to move up and down. The piston is connected to a crankshaft which changes the linear motion to a rotary motion of the crankshaft. This motion than powers the belt or the propeller of an aircraft or the vehicle(*figure 2*).

Principal parts of a reciprocating engine

The main parts of reciprocating engine include (All these parts can be seen in figure -2 including other extra parts)

Figure 3



Detailed description of each part of the reciprocating engine

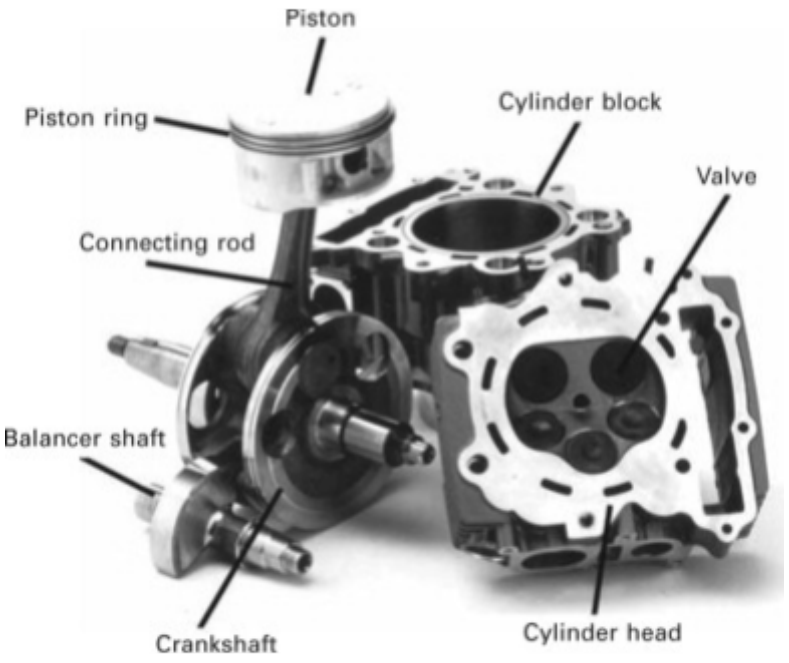
- **Engine Block:** The main structure that houses the cylinders and other components.
- **Piston** - the component that moves inside the cylinder and pushed by the mixture of gases.
- **Crankshaft-** The shaft that converts the linear motion of the piston to a rotary motion.
- **Cylinder head-**The top part of the engine that covers the cylinders and contains the valves.
- **Valves**: Components that control the flow of air and fuel into the cylinders and the exhaust gases out of the cylinders
- **Connecting Rods**: Rods that connect the pistons to the crankshaft.
- **Spark plug-** the device that is made out of ceramic coating to ignite the fuel air mixture inside the cylinder

Details: Description of Each Part

1. Engine Block

The engine block is the foundation of the engine. The engine block is usually made of metal that could be cast iron or aluminum mixed with other metal, this is due to the intense temperature of the engine and it provides extra baffles to cool the engine and its components(*figure 3*)

Figure 3



Usual recip engine block

Subparts:

Cylinder Bores: The holes in the engine block where the pistons move.

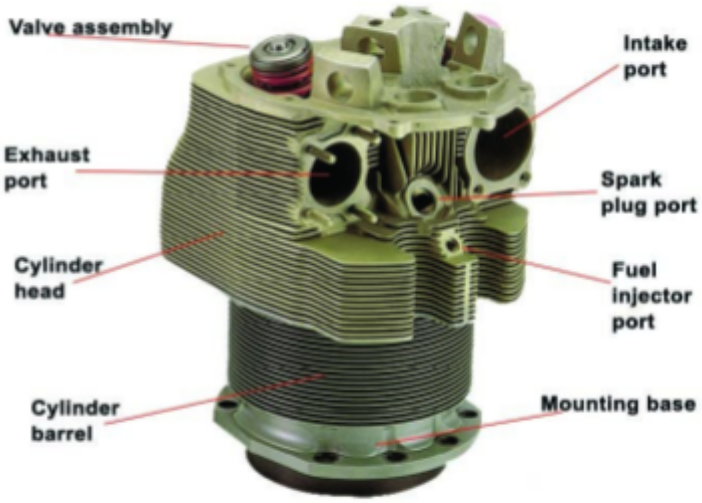
Coolant Passages: baffles or channels that allow oil or other coolant to prevent the engine from overheating.

Oil Passages: valve that allows oil to flow by to allow cooling in the piston

2. Cylinders

The cylinders are the cylindrical holes in the engine block where the pistons move up and down. The number of cylinders in an engine can vary, with common configurations being 4, 6, or 8 cylinders. The size and the number of cylinders in an engine can affect the power output, this is why we hear how fast a V8 corvette is since it has 8 cylinders to maximize more horsepower than a regular vehicle.(*figure 4*)

Figure 4



Recip engine cylinder and various parts

Subparts:

Cylinder Walls: The inner surfaces of the cylinders that the pistons move against.

3. Pistons

The pistons are cylindrical components that move in a linear motion inside the cylinders. They are connected to the crankshaft via connecting rods. The piston compresses the fuel/air mixture entering the cylinder and transfer the force of the mixture to the crankshaft(f*igure 3*)

Subparts:

Piston Rings: Piston rings fit around the piston; it usually consists of three rings that has a tight fighting to ensure the gas doesn't escape out of the cylinder.

Piston Skirt: The lower part of the piston that helps guide it within the cylinder.

4. Crankshaft

The crankshaft is a long, rotating shaft that converts the linear motion of the pistons into rotational motion. It is located at the bottom of the engine block and is connected to the pistons via connecting rods. The crankshaft is responsible for transferring the engine's power to the transmission or propeller.(*figure 5*)

Figure 5

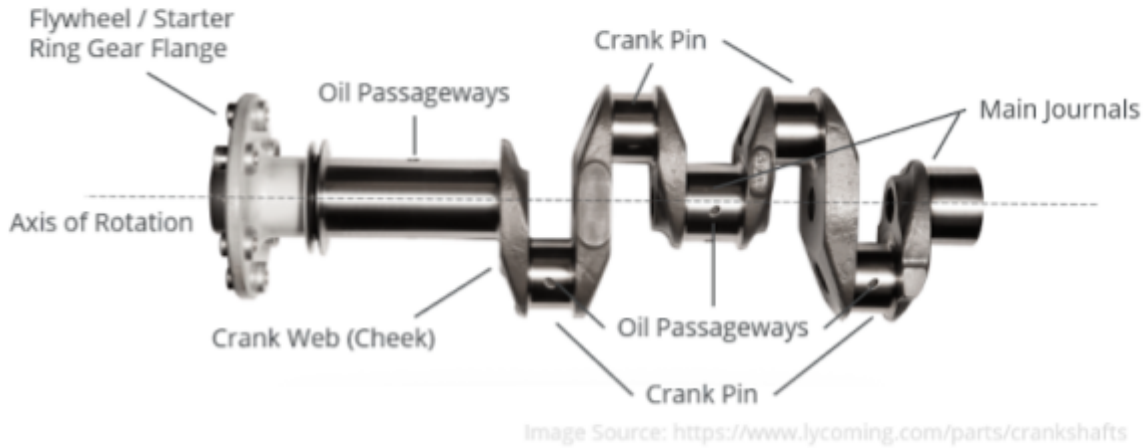


Illustration of crankshaft and its various parts

Subparts:

Crankpins: The offset parts of the crankshaft that the connecting rods are attached to.

Main Journals: The parts of the crankshaft that rotate within the engine block's main bearings.

5. Cylinder Head

The cylinder head is the top part of the engine that covers the cylinders. It contains the valves, spark plugs, and fuel injectors (in some engines). The cylinder head also forms the combustion chamber, where the air-fuel mixture is burned.(*figure 4*)

Subparts:

Combustion Chamber: The space where the air-fuel mixture is compressed and burned.

Valve Seats: The surfaces where the valves rest when closed, ensuring a tight seal.

6. Valves

The valves control the flow of air and fuel into the cylinders and the exhaust gases out of the cylinders. There are two types of valves: intake valves, which allow the air-fuel mixture into the cylinders, and exhaust valves, which allow the exhaust gases to exit. *(figure 2*)

Subparts:

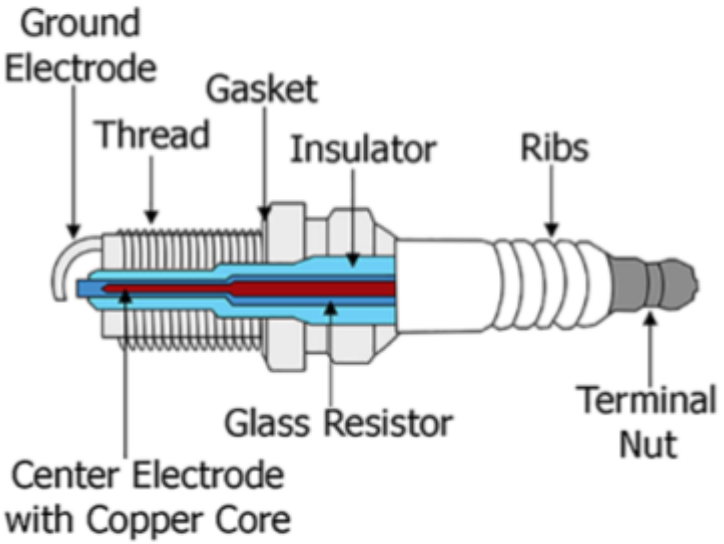
Valve Stem: The long, thin part of the valve that moves up and down.

Valve Spring: The spring that returns the valve to its closed position after it has been opened.

7. Spark Plugs

In gasoline engines, the spark plugs are responsible for igniting the air-fuel mixture in the cylinders. They generate a spark that ignites the mixture, causing it to burn and expand, which pushes the piston down.

Figure 6



Schematic of a spark plug

Subparts:

Electrode: The part of the spark plug that generates the spark.

Insulator: The ceramic part of the spark plug that prevents electrical leakage.

8. Connecting Rods

The connecting rods are the components that connect the pistons to the crankshaft. They transfer the force from the pistons to the crankshaft, causing it to rotate.(*figure 2)*

Subparts:

Big End: The end of the connecting rod that attaches to the crankshaft.

Small End: The end of the connecting rod that attaches to the piston.

How the reciprocating system operates

The reciprocating system operates through a four cycle phase- the intake, compression, power and exhaust. During the intake stroke mixture of air and fuel enters the cylinder through the intake valve and when enough mixture is entered and the piston moves downward, creating a vacuum that draws in a precise mixture of air and fuel through the open intake valve.Once the cylinder fills, the intake valve closes, and the compression stroke begins, the piston moves upward, tightly squeezing the air-fuel mixture to make it highly.l Afterwards in the power stroke the spark plug ignites the compressed mixture, causing a

Figure 7

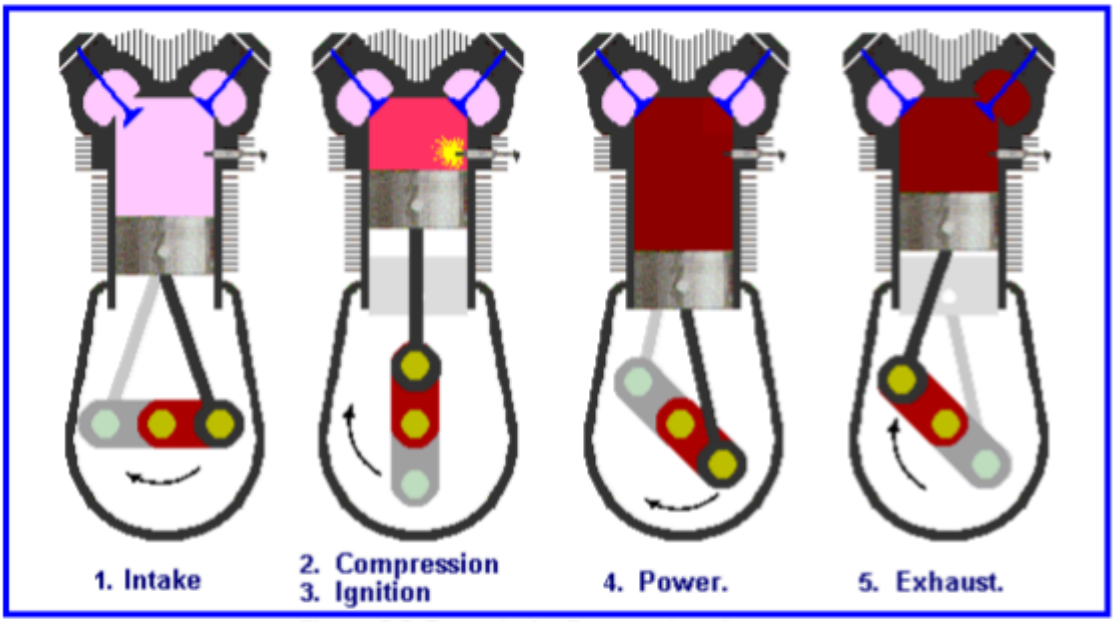


Figure 6-3 Four-stroke five-event cycle.

The four stroke cycle of reciprocating engine

controlled explosion that forces the piston back down with tremendous energy, turning the crankshaft and generating power, which supported in moving the propeller of the aircraft.

Finally, during the exhaust stroke, the piston rises again while the exhaust valve opens, pushing out the burnt gases to prepare the cylinder for the next cycle. This four-step sequence repeats continuously, allowing the engine to run smoothly and efficiently.

Conclusion

Though modern engines have shifted towards turbine engines, the reciprocating engine still plays a crucial role in aviation and other fields. In the automotive world, piston engines power millions of cars globally, and innovation in fuel injection and turbocharging is guaranteeing their long-term efficiency and lower emissions. Portable generators also use reciprocating engines, which are appreciated for being inexpensive, simple to fix, and able to run on various fuels. The innovation of Reciprocating and its advancement across these fields highlights its reliability and versatility. While newer technologies such as electric motors, which are seen in recent automobiles, which will soon be used in aviation are starting to dominate these sectors, the reciprocating engine's simplicity, cost-effectiveness and performance plays a vital role in modern engineering.

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