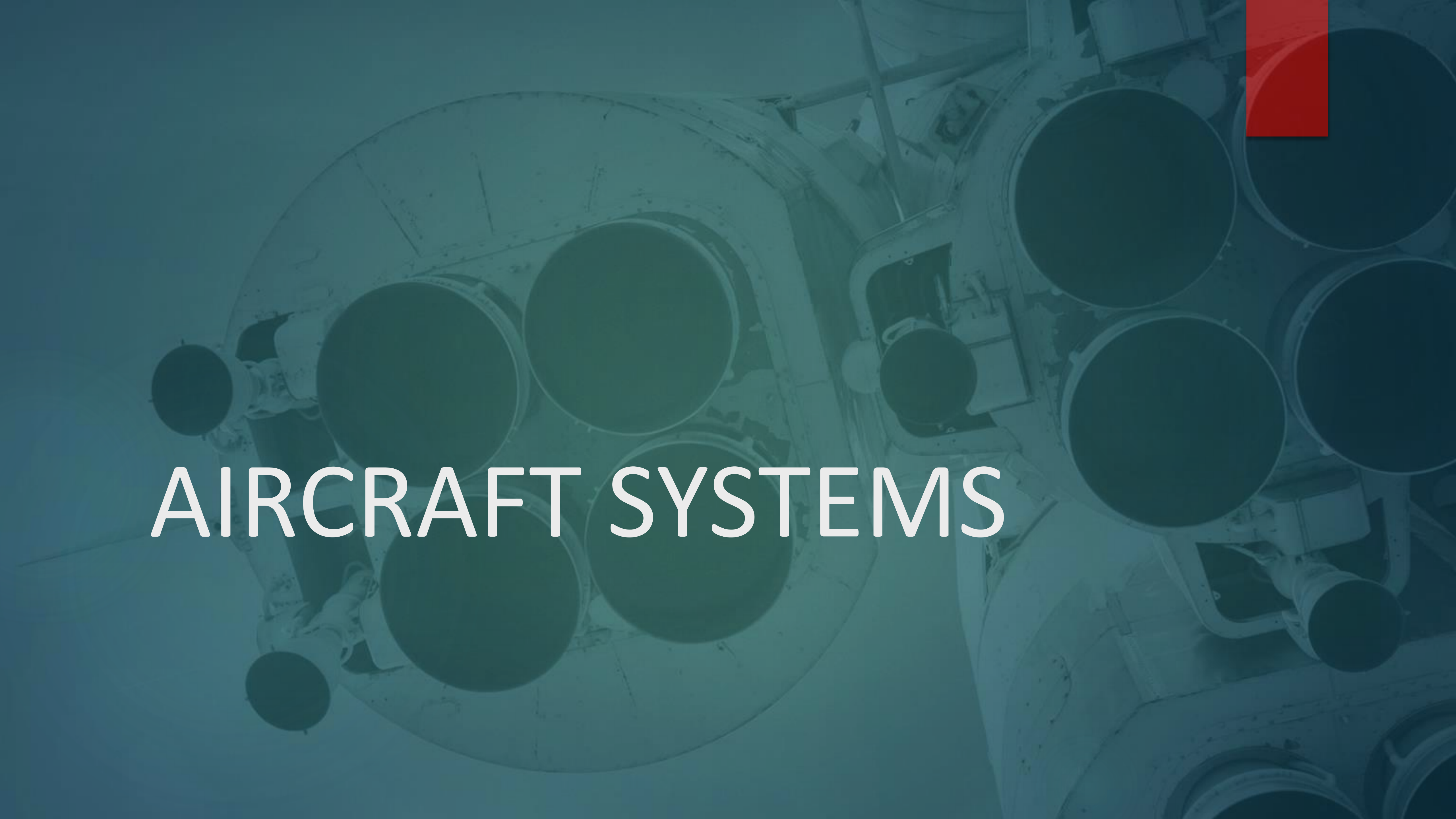


AIRCRAFT SYSTEMS

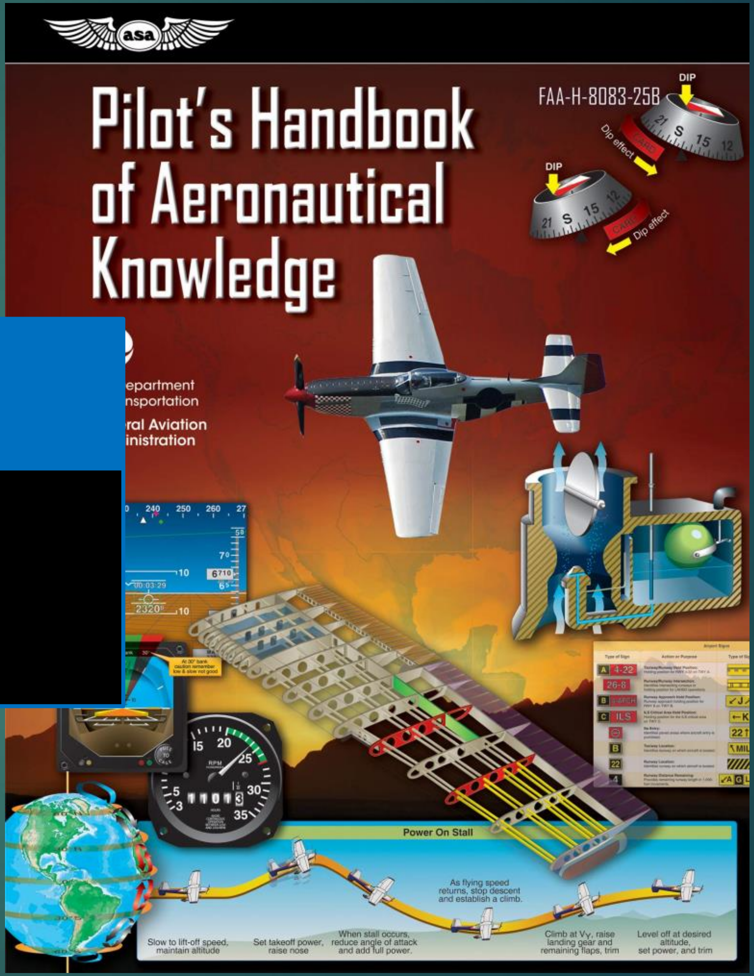
Lesson Outline

LESSON OBJECTIVE

To determine that the student exhibits proficient knowledge of the elements related to the operation of systems, as applicable to the airplane being flown, by describing the elements on the following slide.

LESSON SOURCE(S)

Pilot's Handbook of Aeronautical Knowledge
FAA-H-8083-25



Lesson Outline

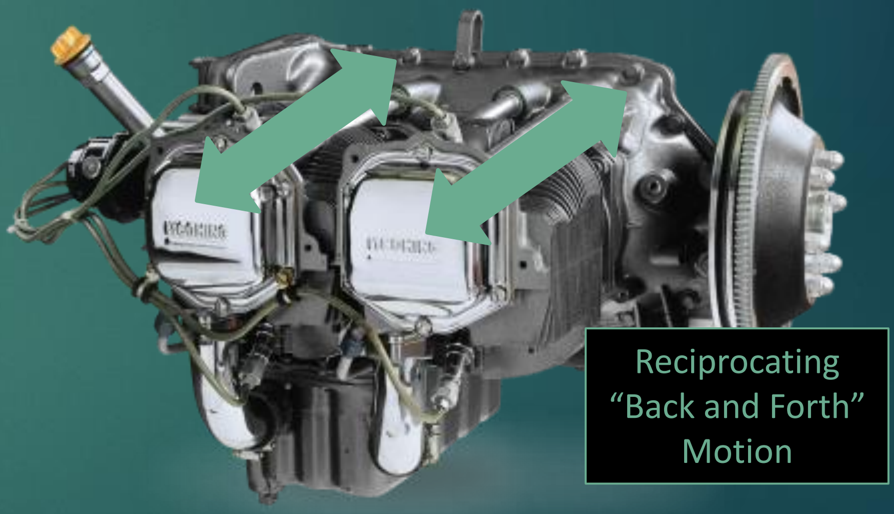
LESSON ELEMENTS	TIMEFRAME	EQUIPMENT/TOOLS
Powerplant and Propeller Landing Gear Fuel, Oil, and Hydraulics Electrical System Environmental System Deicing and Anti-Icing	90 Minutes *approximately* Discuss Objectives Present and Review Material Student Questions Conclusion and Quiz	Lesson Presentation Whiteboard and Markers FAA Sources and References

The Powerplant

An aircraft engine, or powerplant, produces thrust to propel an aircraft. Reciprocating engines and turboprop engines work in combination with a propeller to produce thrust.

Reciprocating Engines

Most small aircraft are designed with reciprocating engines. The name is derived from the back-and-forth, or reciprocating, movement of the pistons that produces the mechanical energy necessary to accomplish work. Reciprocating engines operate on the basic principle of converting chemical energy (fuel) into mechanical energy. This conversion occurs within the cylinders of the engine through the process of combustion.



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Spark Ignition

Uses spark plugs to combust the fuel/air mixture in the cylinders. This has been the most popular type of ignition over the years.

Compression Ignition

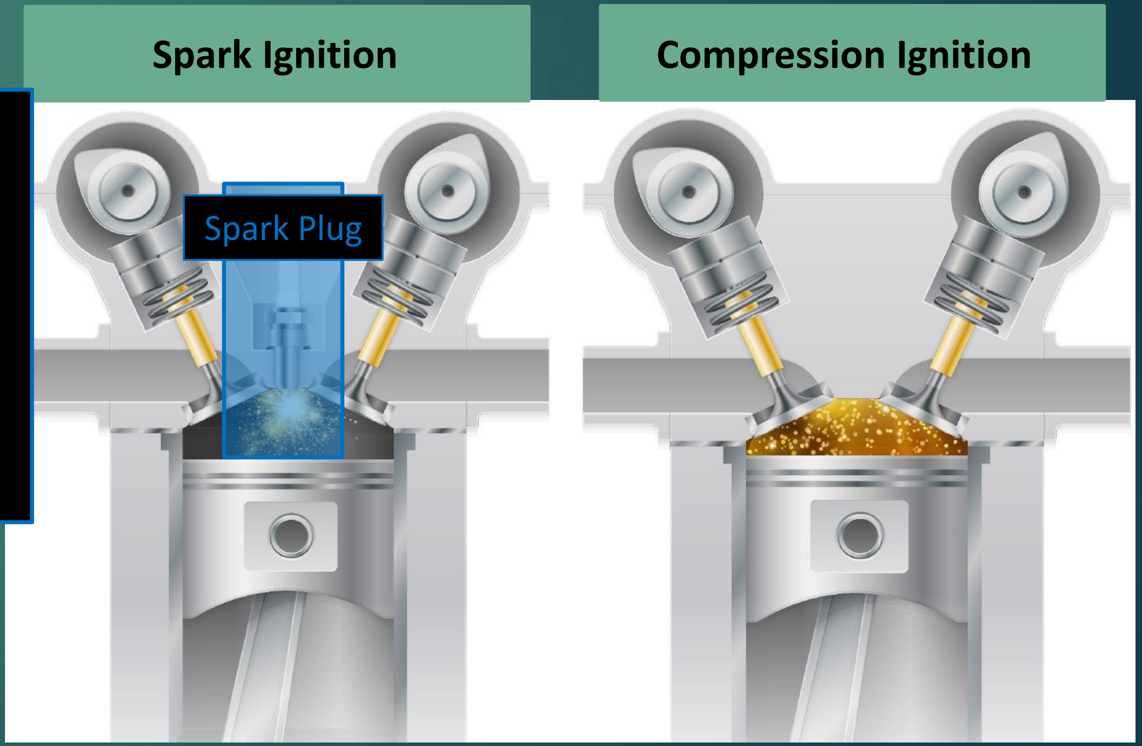
Achieves ignition by compressing the fuel/air mixture to the point where they ignite on their own under heat. These engines do not utilize spark plugs.

The Powerplant

An aircraft engine, or powerplant, produces thrust to propel an aircraft. Reciprocating engines and turboprop engines work in combination with a propeller to produce thrust.

Spark and Compression Ignition

The main mechanical components of the spark ignition and the compression ignition engine are essentially the same. Both use cylindrical combustion chambers and pistons that travel the length of the cylinders to convert linear motion into the rotary motion of the crankshaft. The main difference between spark ignition and compression ignition is the process of igniting the fuel.



The Powerplant

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Cylinder Arrangements

Cylinders can be arranged around the crankshaft (which turns the propeller) in various styles or arrangements. Each with its own set of characteristics.

Radial Engine

These engines have a row or row of cylinders that are arranged in a circular pattern around the crankshaft. Their main advantage is a favorable power-to-weight ratio.

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Cylinder Arrangements

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In-Line Engine

These engines have a comparatively small frontal area, but their power-to-weight ratios are relatively low. In addition, the rear most cylinders do not receive as much cooling as the front most.

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Cylinder Arrangements

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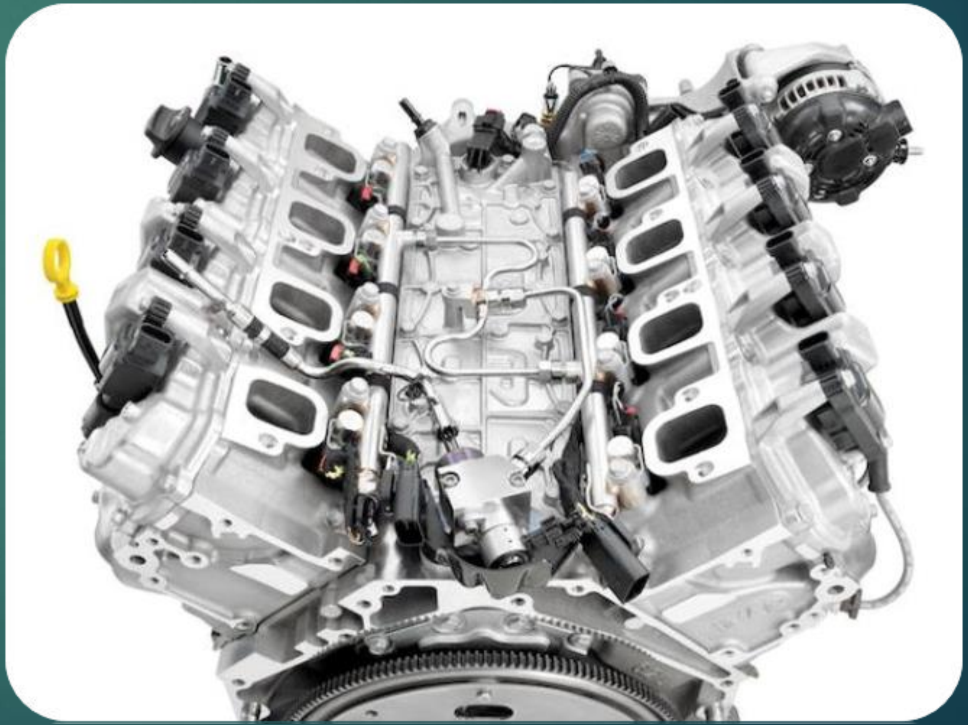
V-Type Engine

The V-Type engine provides more horsepower than In-Line Engines and they still are able to maintain a relatively small frontal area.



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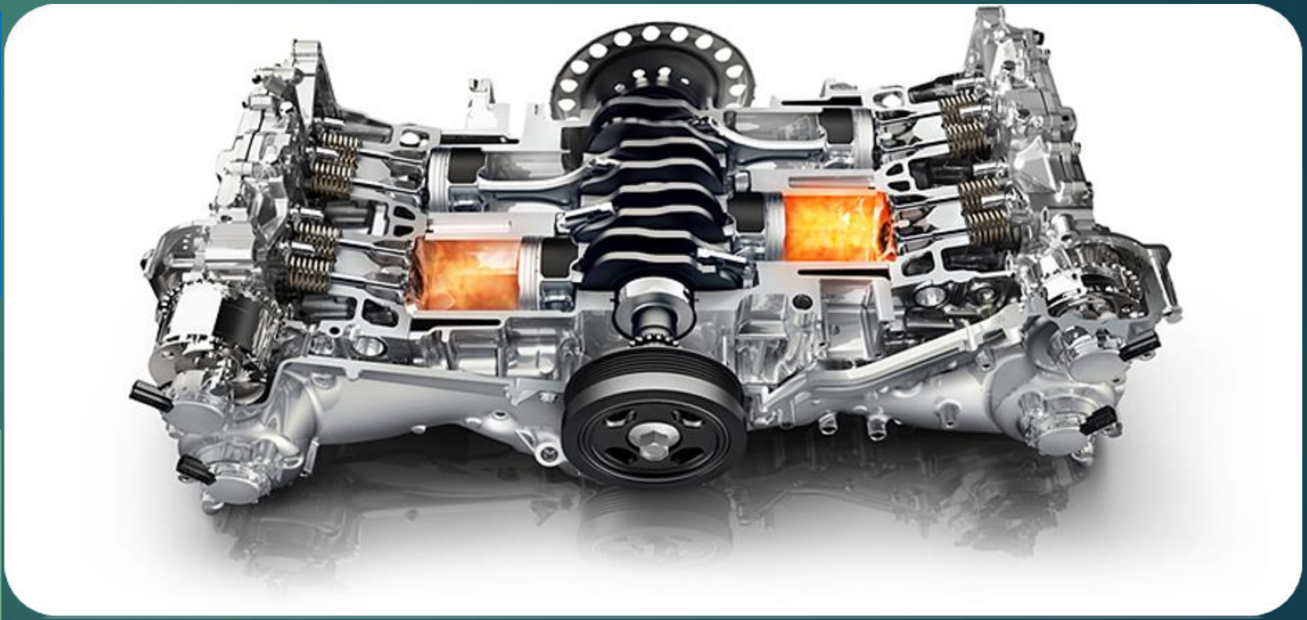
Cylinder Arrangements

Cylinders can be arranged around the crankshaft (which turns the propeller) in various styles or arrangements. Each with its own set of characteristics.

Horizontally Opposed Engine

These are the most popular engines on smaller airplanes. The cylinders "oppose" each other. They have high power-to-weight ratios, relatively small frontal areas, and work well with aerodynamic cooling of the cylinders.



The Powerplant

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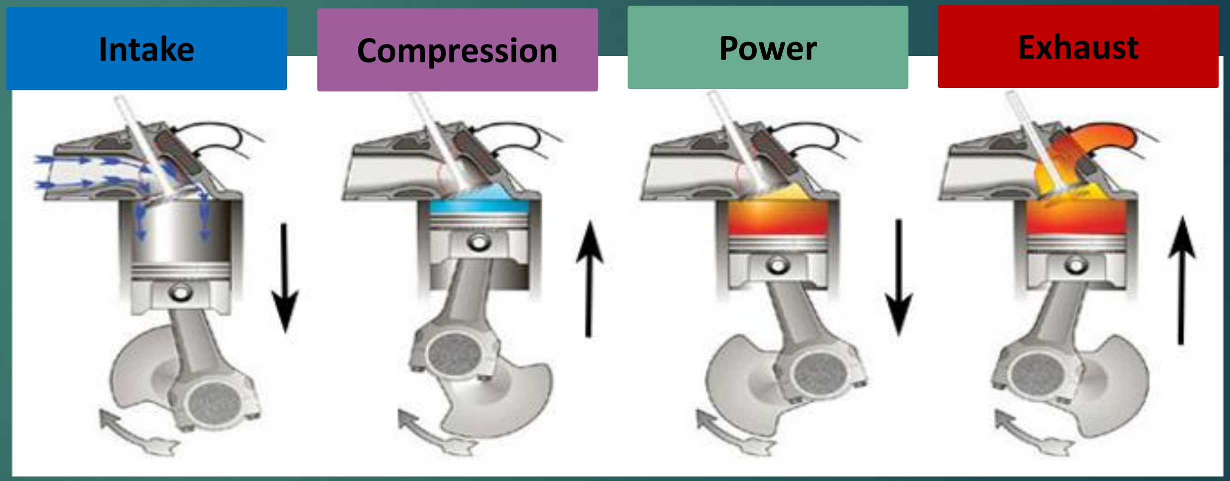
The 4 Stroke Cycle

In a four-stroke engine, the conversion of chemical energy into mechanical energy occurs over a four-stroke operating cycle. The intake, compression, power, and exhaust processes occur in four separate strokes of the piston in the following order:



The Powerplant

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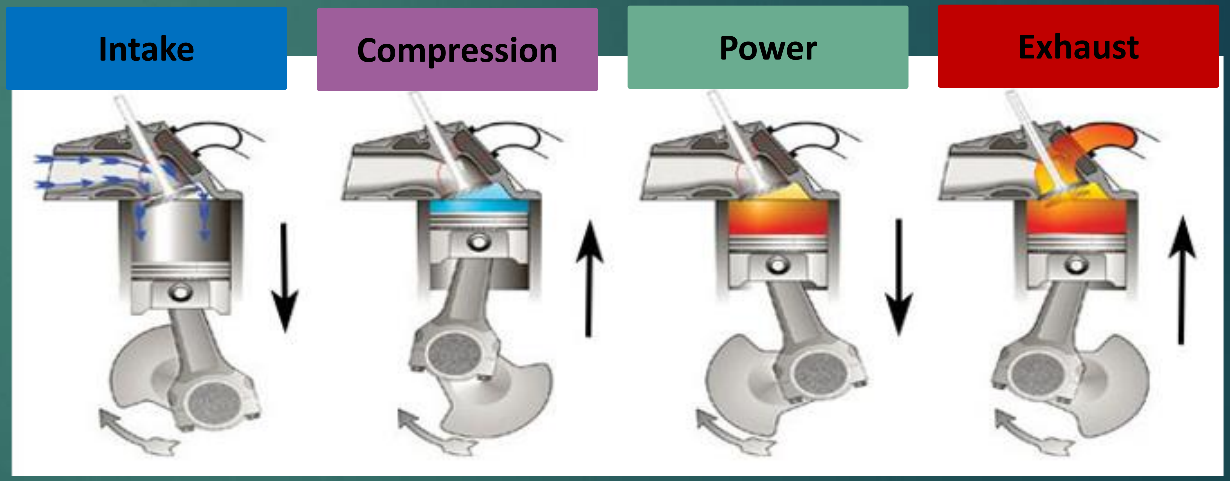
Intake	Compression	Power	Exhaust
The intake stroke begins as the piston starts its downward travel. When this happens, the intake valve opens and the fuel-air mixture is drawn into the cylinder.	The compression stroke begins when the intake valve closes, and the piston starts moving back to the top of the cylinder. This phase of the cycle is used to obtain a much greater power output from the fuel-air mixture once it is ignited.	The power stroke begins when the fuel-air mixture is ignited. This causes a tremendous pressure increase in the cylinder and forces the piston downward away from the cylinder head, creating the power that turns the crankshaft.	The exhaust stroke is used to purge the cylinder of burned gases. It begins when the exhaust valve opens, and the piston starts to move toward the cylinder head once again.

The Powerplant

An aircraft engine, or powerplant, produces thrust to propel an aircraft. Reciprocating engines and turboprop engines work in combination with a propeller to produce thrust.

The 4 Stroke Cycle

In a four-cylinder engine, each cylinder operates on a different stroke. Continuous rotation of the crankshaft is maintained by the precise timing of the power strokes in each cylinder.



The Powerplant

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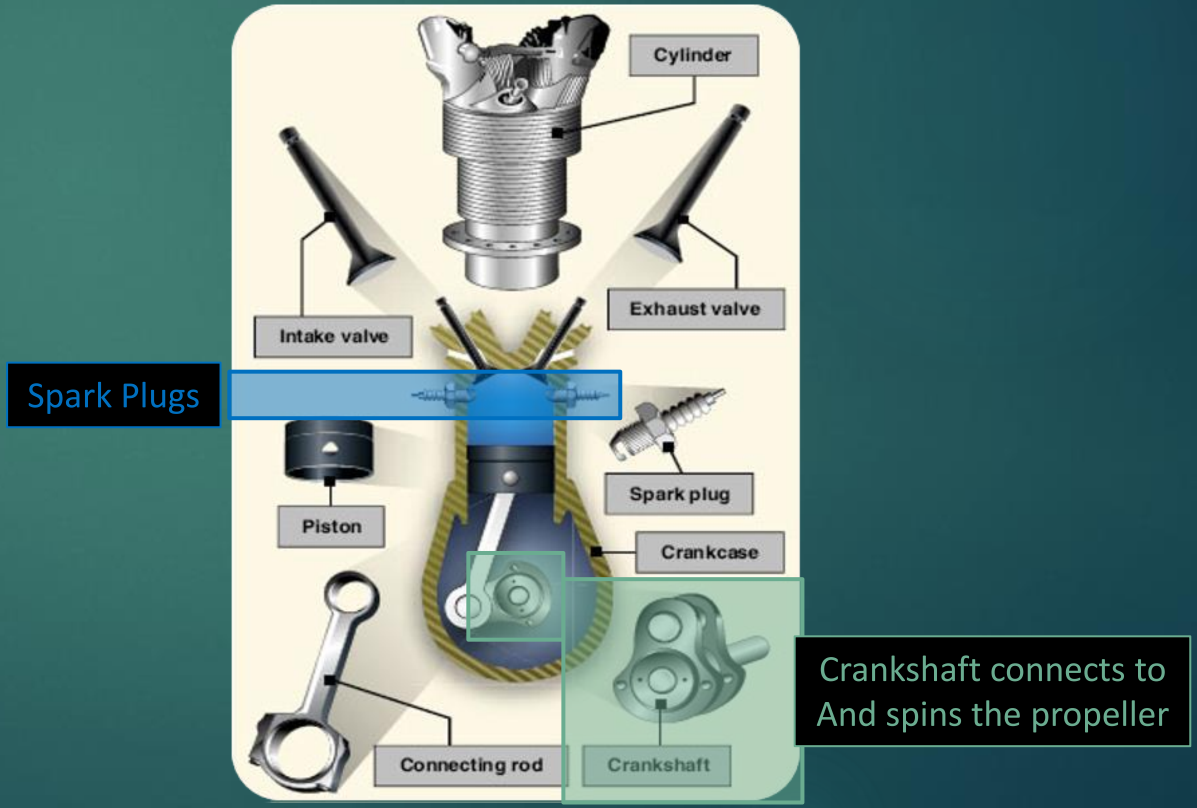
Cylinder Components

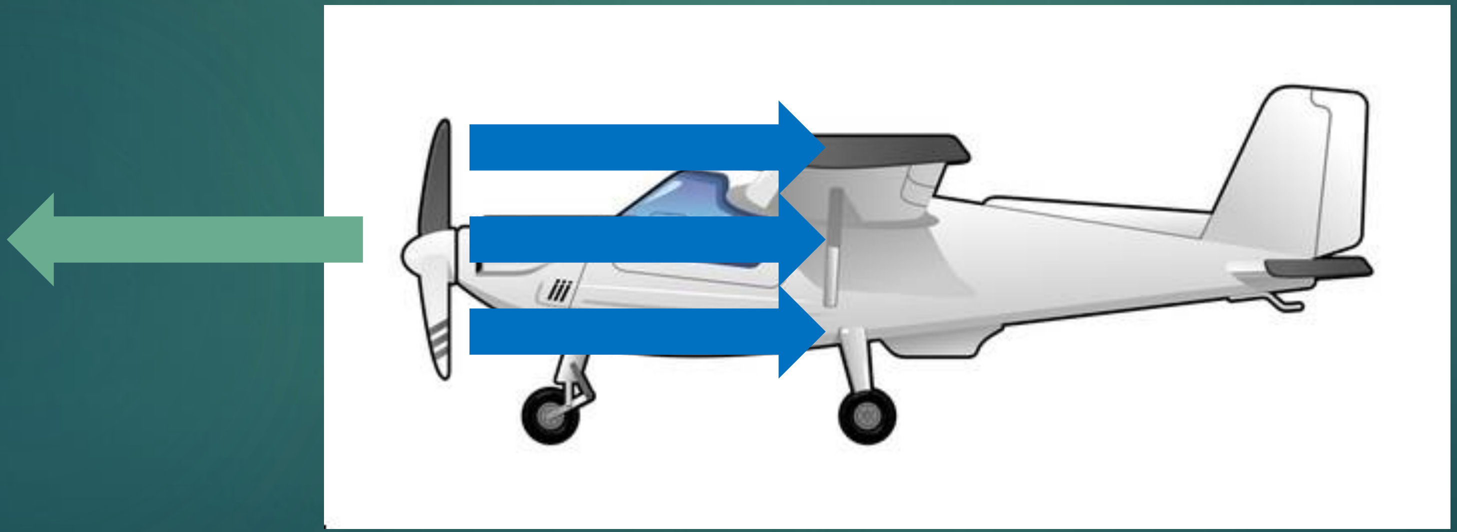
Pictured here you will see the different components of a spark ignition cylinder. Note, most airplane engines incorporate 2 spark plugs per cylinder for safety and redundancy reasons. This also helps with the even burning of the fuel/air mixture and provides additional power.



The Propeller

The Propeller

The propeller is considered an airfoil because it interacts with airflow to produce a desired effect. While wings produce lift, a propeller produces “horizontal lift” or thrust to propel an airplane forward.



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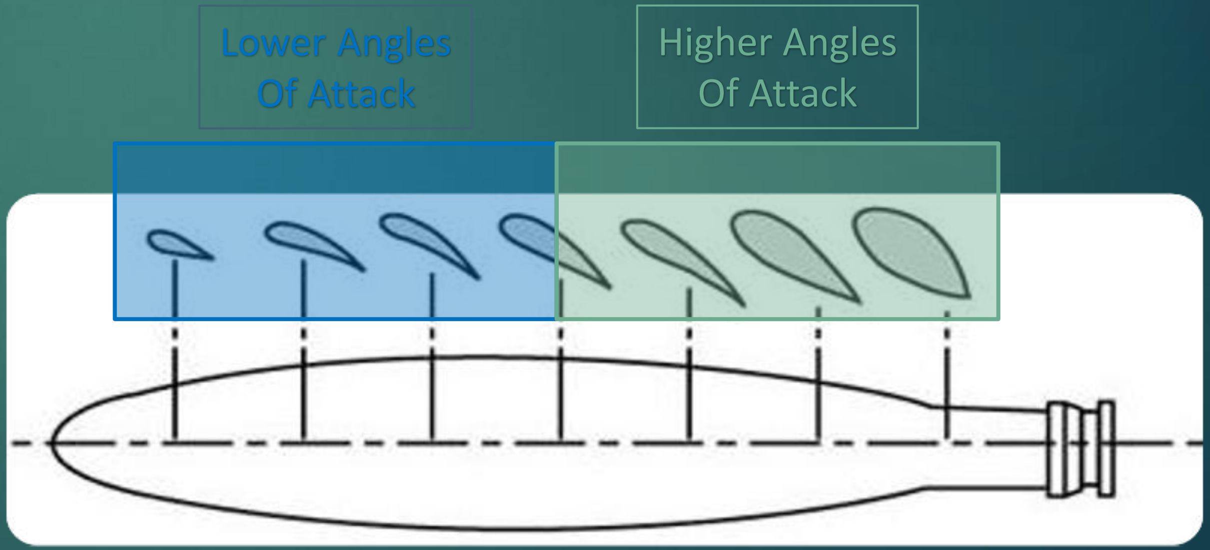
Propeller Twist

In order for a propeller to produce uniform thrust along the entire length of its blades, it is twisted as seen in the depiction on this slide.



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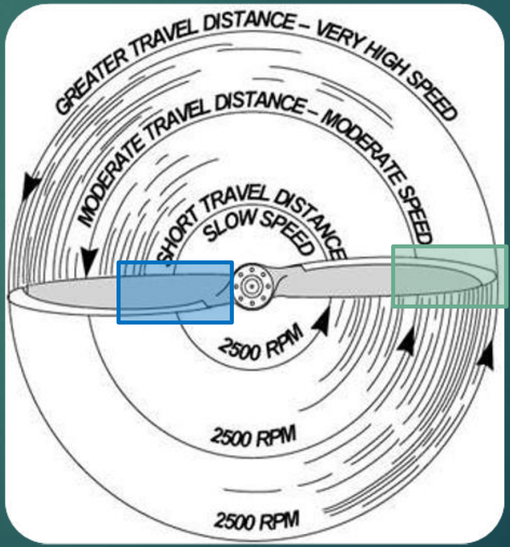
Why is Propeller Twist Necessary?

This is because the propeller blades are spinning faster at the tips and slower towards the hub. Hence, the tips will need a lower angle of attack and the sections near the hub will need a greater angle of attack to produce the desired uniform amounts of thrust.

Slower Speeds
Higher AOA



Higher Speeds
Lower AOA

The Propeller

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Fixed Pitch Propeller

A propeller with fixed blade angles is a fixed-pitch propeller. The pitch of this propeller is set by the manufacturer and cannot be changed. Since a fixed-pitch propeller achieves the best efficiency only at a given combination of airspeed and rpm, the pitch setting is ideal for neither cruise nor climb. Thus, the aircraft suffers a bit in each performance category. The fixed-pitch propeller is used when low weight, simplicity, and low cost are needed.

Climb Prop

The climb propeller has a lower pitch, therefore less drag. Less drag results in higher rpm and more horsepower capability, which increases performance during takeoffs and climbs but decreases performance during cruising flight.

The Propeller

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Cruise Prop

The cruise propeller has a higher pitch, therefore more drag. More drag results in lower rpm and less horsepower capability, which decreases performance during takeoffs and climbs but increases efficiency during cruising flight.

The Propeller

The Propeller

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Fixed Pitch Propeller

In a fixed-pitch propeller, the tachometer is the indicator of engine power. A tachometer is calibrated in hundreds of rpm and gives a direct indication of the engine and propeller rpm. The instrument is color coded with a green arc denoting the maximum continuous operating rpm. Some tachometers have additional markings to reflect engine and/or propeller limitations. The rpm is regulated by the throttle, which controls the fuel/air flow to the engine.

The Propeller

The Propeller

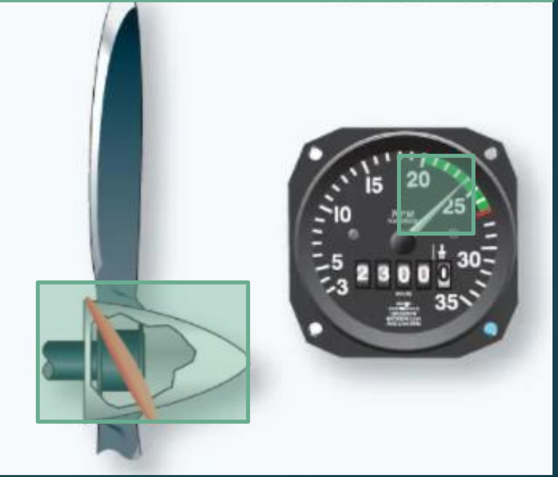
The propeller is considered an airfoil because it interacts with airflow to produce a desired effect. While wings produce lift, a propeller produces “horizontal lift” or thrust to propel an airplane forward.

Adjustable Pitch Propeller

The adjustable-pitch propeller was the forerunner of the constant-speed propeller. It is a propeller with blades whose pitch can be adjusted on the ground with the engine not running, but which cannot be adjusted in flight. The first adjustable-pitch propeller systems provided only two pitch settings: low and high. Today, most adjustable-pitch propeller systems are capable of a range of pitch settings.

High Pitch, Low RPM

Low Pitch, High RPM



Can only be adjusted on the ground, not in flight.

The Propeller

The Propeller

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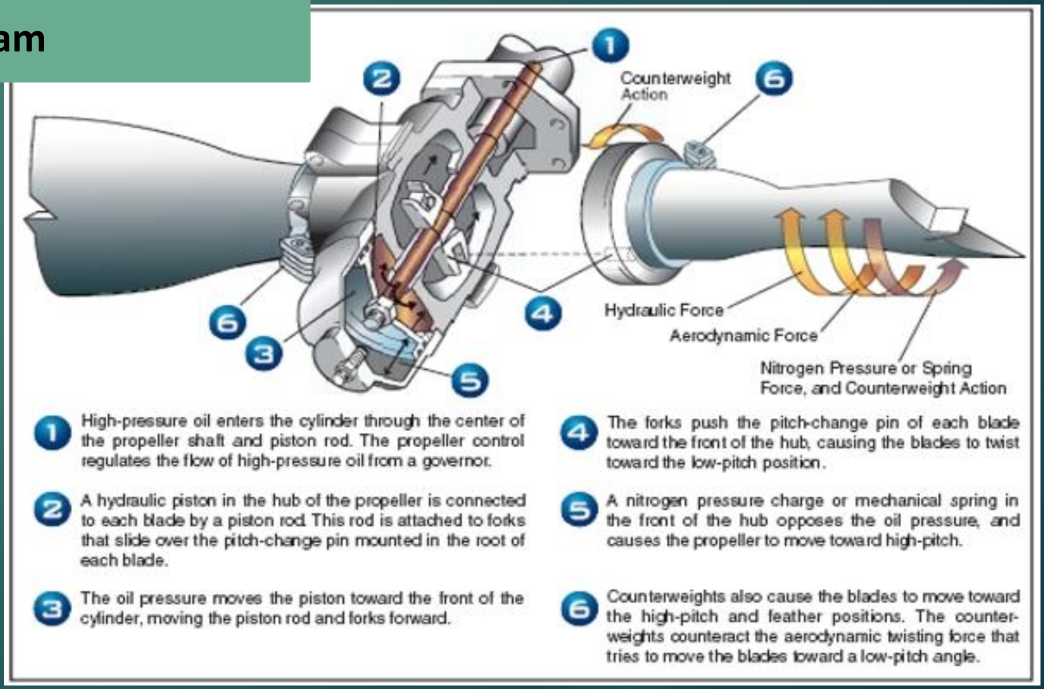
Constant Speed Propeller

A constant-speed propeller is a controllable-pitch propeller whose pitch is automatically varied in flight by a governor maintaining constant rpm despite varying air loads. It is the most common type of adjustable-pitch propeller. A constant-speed propeller is more efficient than other propellers because it allows selection of the most efficient engine rpm for the given conditions.

Diagram



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Constant Speed Propeller

An aircraft with a constant-speed propeller has two controls: the throttle and the propeller control. The throttle controls power output, and the propeller control regulates engine rpm. This regulates propeller rpm, which is registered on the tachometer.

Manifold Pressure

Controlled with Throttle Lever

Tachometer

Controlled with Prop Lever

The Propeller

The Propeller

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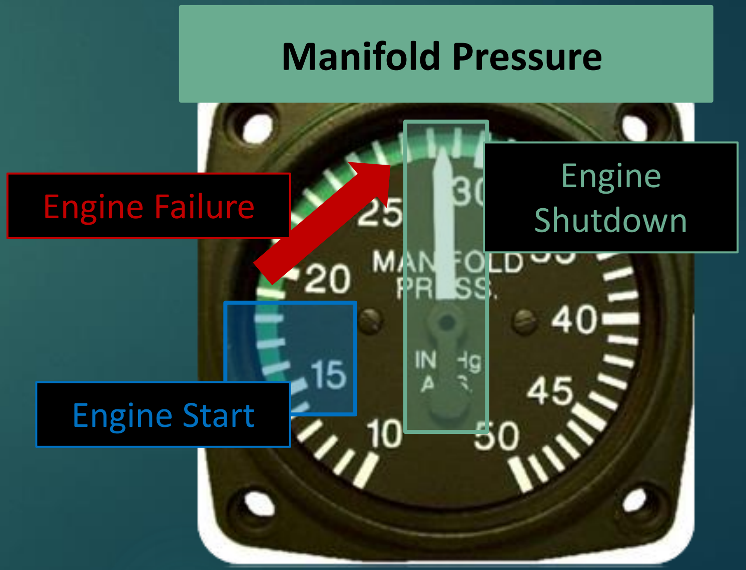
Manifold Pressure Gauge

The gauge measures the absolute pressure of the fuel-air mixture inside the intake manifold and is more correctly a measure of manifold absolute pressure (MAP). At a constant rpm and altitude, the amount of power produced is directly related to the fuel-air mixture being delivered to the combustion chamber. As the throttle setting is increased, more fuel and air flows to the engine and MAP increases. When the engine is not running, the manifold pressure gauge indicates ambient air pressure. When the engine is started, the manifold pressure indication decreases to a value less than ambient pressure. Engine failure or power loss is indicated on the manifold gauge as an increase in manifold pressure to a value corresponding to the ambient air pressure at the altitude where the failure occurred.



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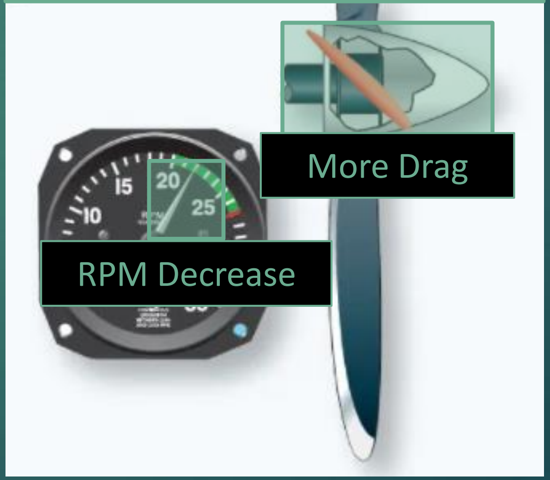
The Tachometer

Once a specific rpm is selected, a governor automatically adjusts the propeller blade angle as necessary to maintain the selected rpm. For example, after setting the desired rpm during cruising flight, an increase in airspeed or decrease in propeller load causes the propeller blade angle to increase as necessary to maintain the selected rpm. A reduction in airspeed or increase in propeller load causes the propeller blade angle to decrease.

- High Blade Pitch = Lower RPM (more drag)
- Low Blade Pitch = Higher RPM (less drag)

High Pitch, More Drag



Low Pitch, Less Drag

Induction Systems

The induction system brings in air from the outside, mixes it with fuel, and delivers the fuel-air mixture to the cylinder where combustion occurs. Outside air enters the induction system through an intake port on the front of the engine cowling. This port normally contains an air filter that inhibits the entry of dust and other foreign objects.

Carburetor System

This system mixes the fuel and air in the carburetor before the mixture enters the intake manifold.

Fuel Injection System

Mixes the fuel and air immediately before entry into each cylinder or injects fuel directly into each cylinder.

Induction Systems

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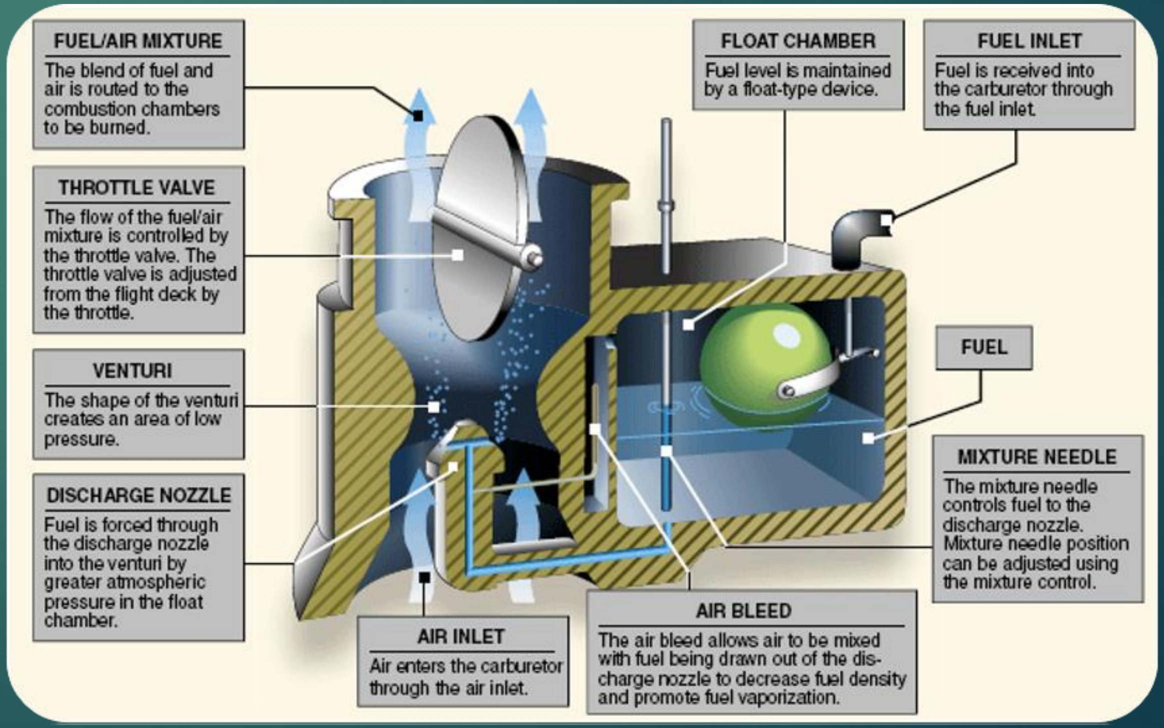
Carburetor System

The float-type carburetor has several distinct disadvantages. First, they do not function well during abrupt maneuvers. Secondly, the discharge of fuel at low pressure leads to incomplete vaporization and difficulty in discharging fuel into some types of supercharged systems. The chief disadvantage of the float-type carburetor, however, is its icing tendency.



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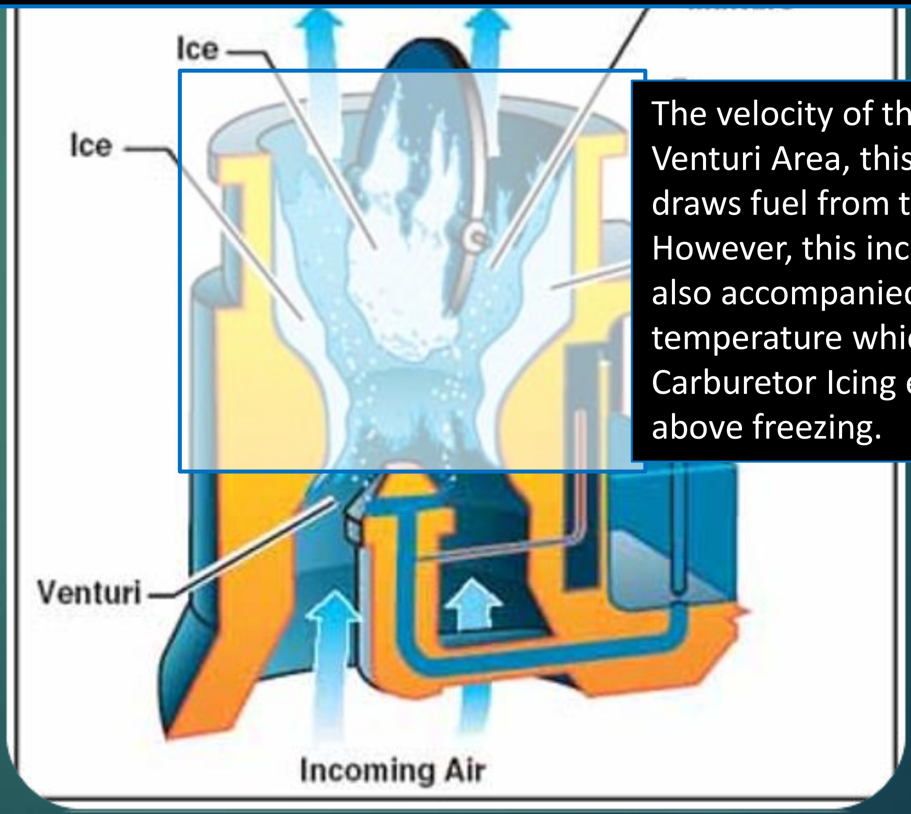

The velocity of the air increases in the Venturi Area, this decrease in pressure draws fuel from the fuel supply. However, this increase in velocity is also accompanied by a decrease in temperature which can lead to Carburetor Icing even when the OAT is above freezing.

Induction Systems

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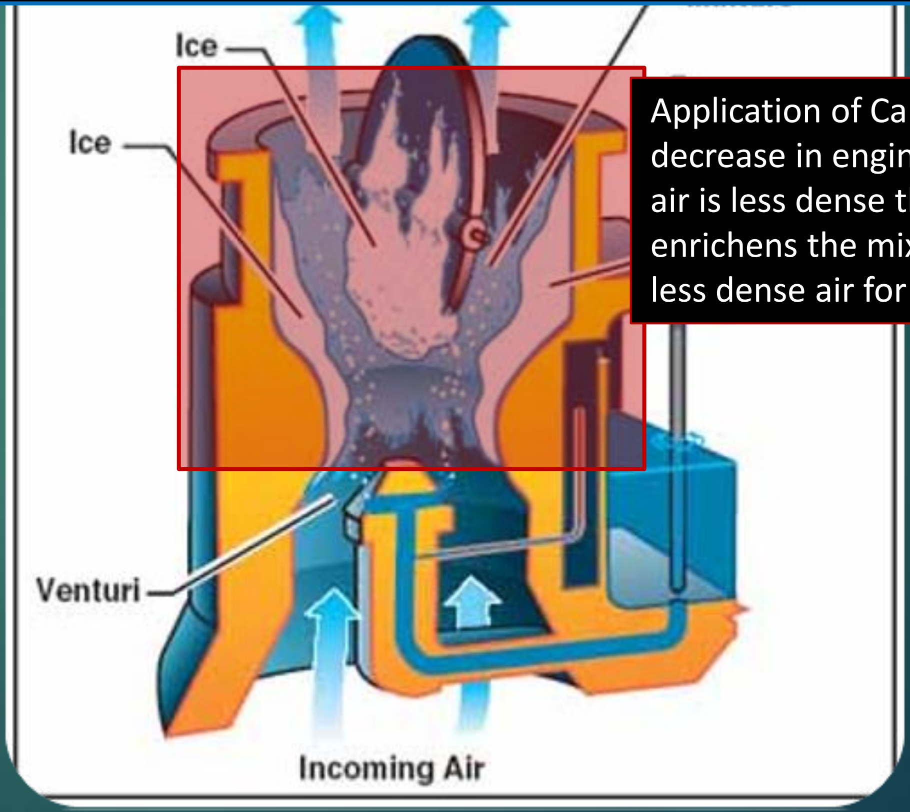
Carburetor Heat

Carburetor heat is an anti-icing system that preheats the air before it reaches the carburetor and is intended to keep the fuel-air mixture above freezing to prevent the formation of carburetor ice. Carburetor heat can be used to melt ice that has already formed in the carburetor if the accumulation is not too great.



Application of Carb Heat will cause a decrease in engine power because hot air is less dense than cold air. This enrichens the mixture and provides less dense air for combustion.

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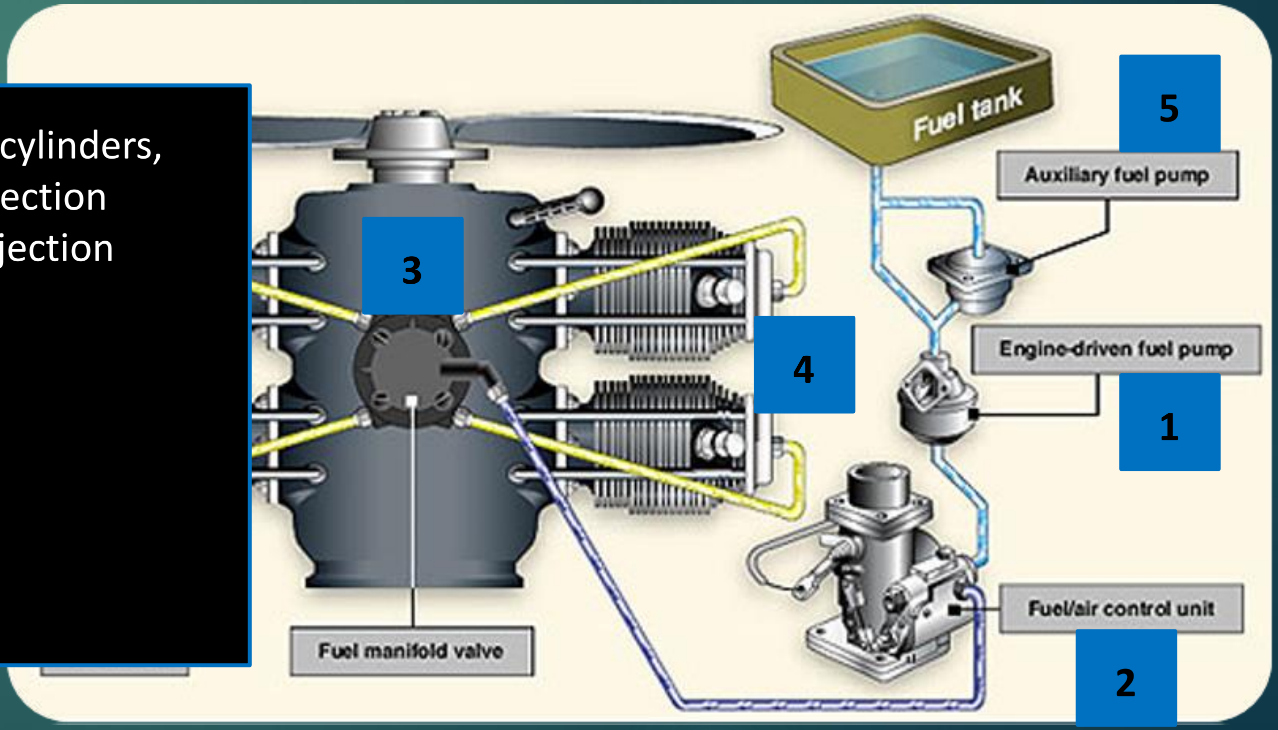
Fuel Injection

In a fuel injection system, the fuel is injected directly into the cylinders, or just ahead of the intake valve. The air intake for the fuel injection system is similar to that used in a carburetor system. A fuel injection system usually incorporates six basic components:

1. An engine-driven fuel pump
2. A fuel-air control unit
3. A fuel manifold (fuel distributor)
4. Discharge nozzles
5. An auxiliary fuel pump
6. And fuel pressure/flow indicators.



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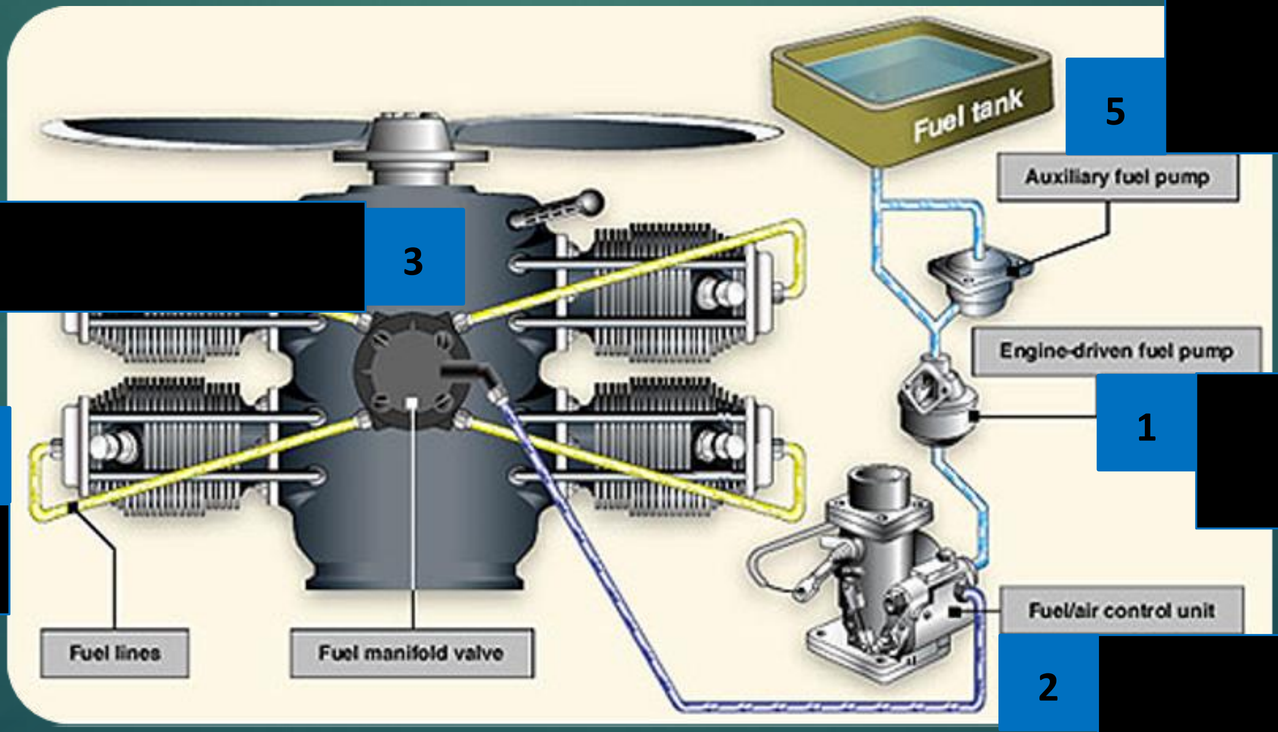

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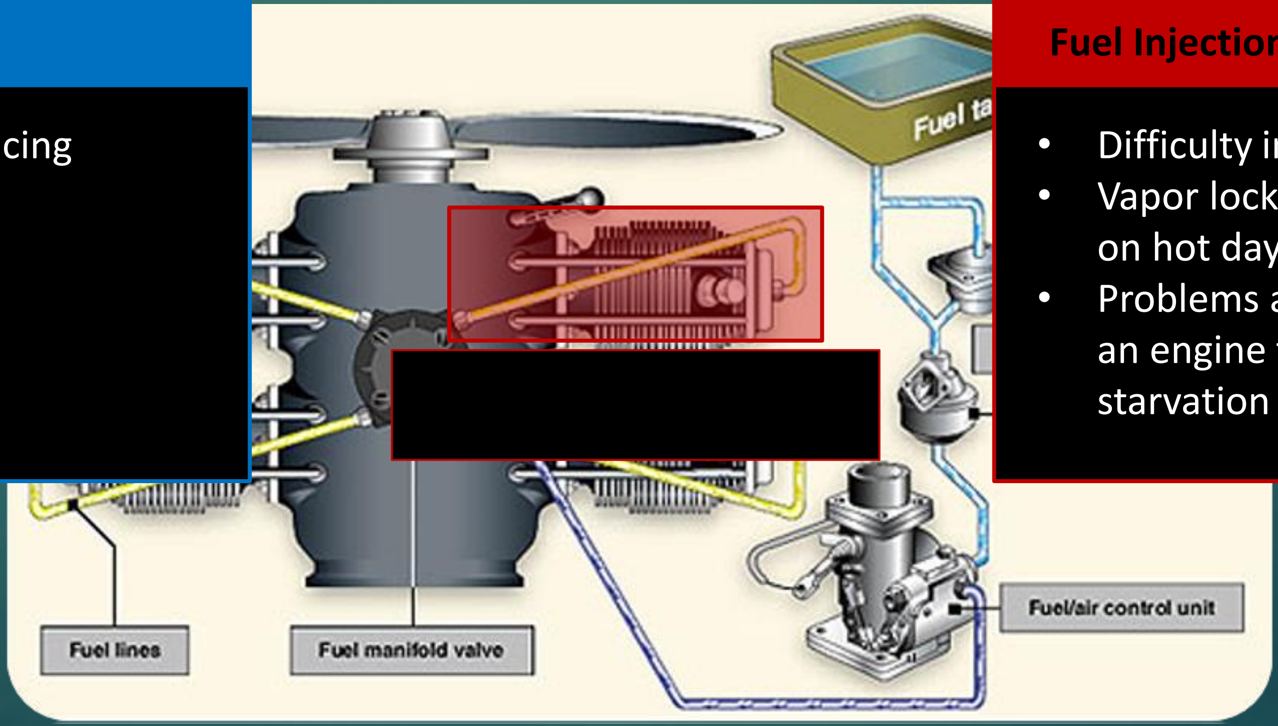
Fuel Injection Advantages

- Reduction in evaporative icing
- Better fuel flow
- Faster throttle response
- Precise control of mixture
- Better fuel distribution
- Easier cold weather starts



Fuel Injection Disadvantages

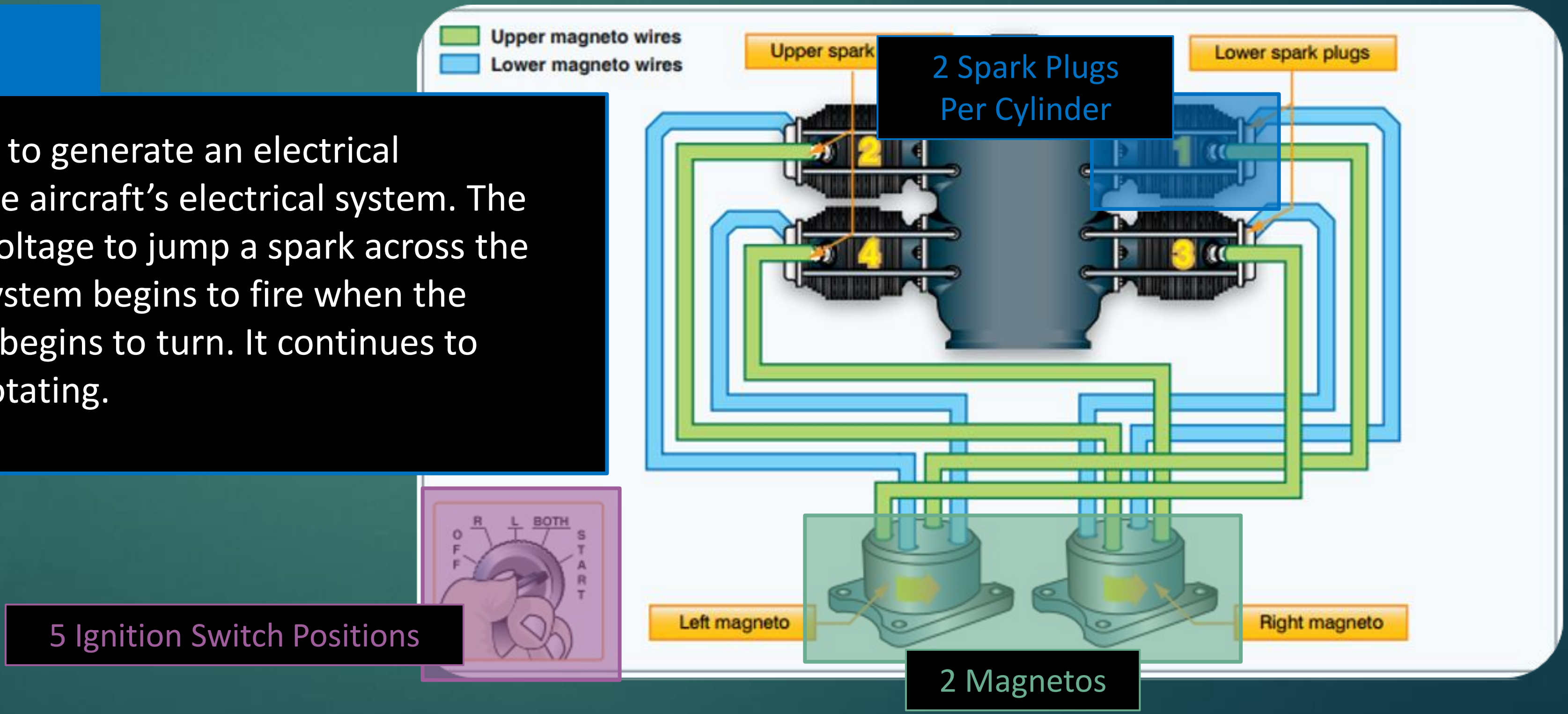
- Difficulty in starting a hot engine
- Vapor locks during ground operations on hot days
- Problems associated with restarting an engine that quits because of fuel starvation

Ignition System

In a spark ignition engine, the ignition system provides a spark that ignites the fuel-air mixture in the cylinders and is made up of: magnetos, spark plugs, high tension leads, and an ignition switch.

Magnetos

A magneto uses a permanent magnet to generate an electrical current completely independent of the aircraft's electrical system. The magneto generates sufficiently high voltage to jump a spark across the spark plug gap in each cylinder. The system begins to fire when the starter is engaged and the crankshaft begins to turn. It continues to operate whenever the crankshaft is rotating.



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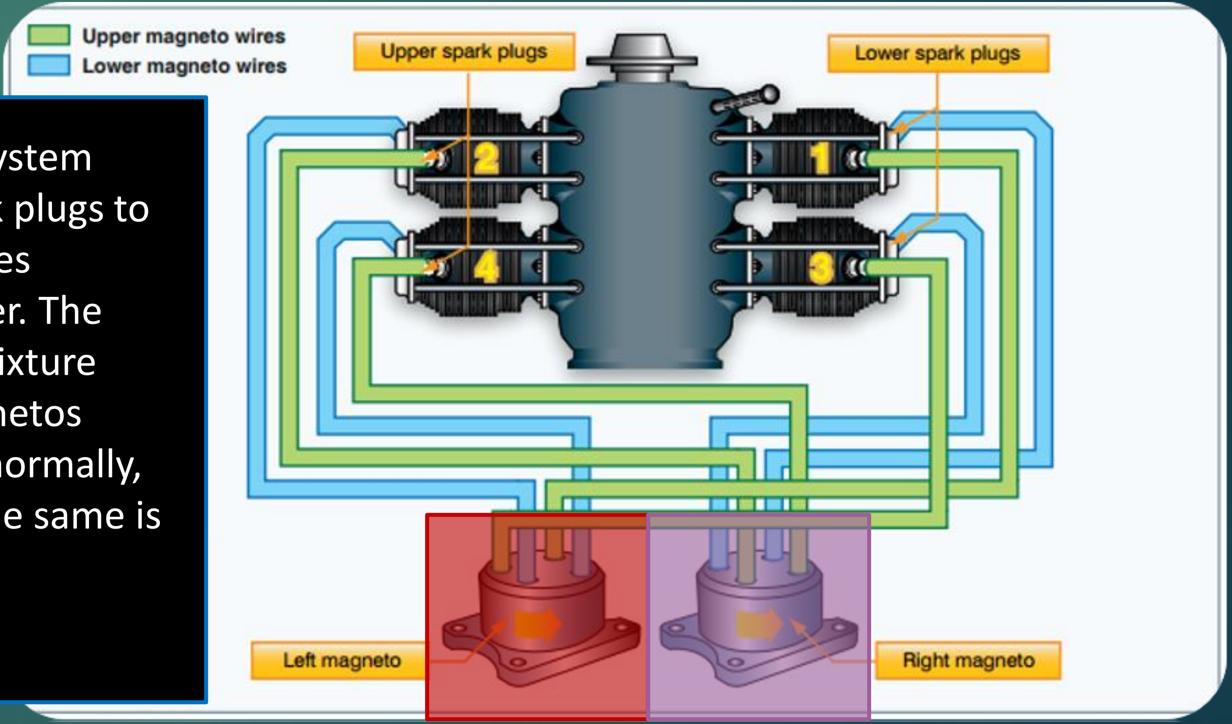
Magnetos

Most standard certificated aircraft incorporate a dual ignition system with two individual magnetos, separate sets of wires, and spark plugs to increase reliability of the ignition system. Each magneto operates independently to fire one of the two spark plugs in each cylinder. The firing of two spark plugs improves combustion of the fuel-air mixture and results in a slightly higher power output. If one of the magnetos fails, the other is unaffected. The engine continues to operate normally, although a slight decrease in engine power can be expected. The same is true if one of the two spark plugs in a cylinder fails.



This Magneto Fails

This Magneto is Unaffected

Ignition System

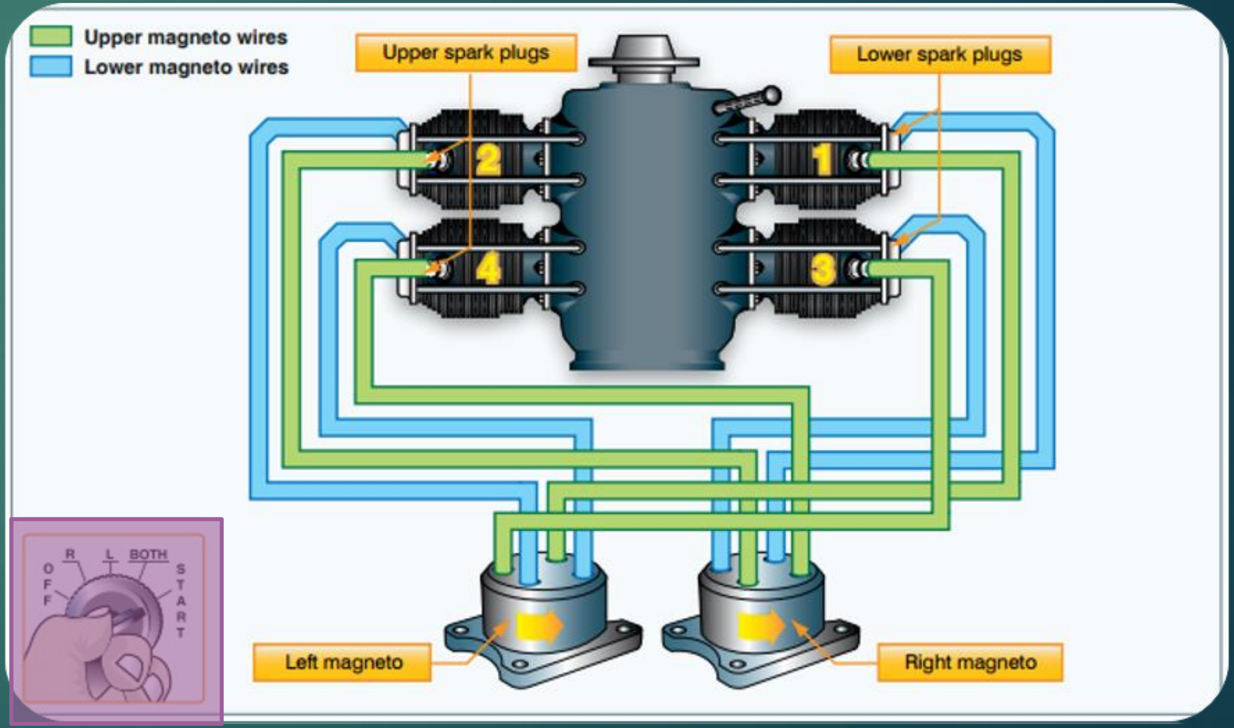
In a spark ignition engine, the ignition system provides a spark that ignites the fuel-air mixture in the cylinders and is made up of: magnetos, spark plugs, high tension leads, and an ignition switch.

Magnetos

The operation of the magneto is controlled in the flight deck by the ignition switch. The switch has five positions:

1. OFF
2. R (right)
3. L (left)
4. BOTH
5. START

With RIGHT or LEFT selected, only the associated magneto is activated. The system operates on both magnetos when BOTH is selected.

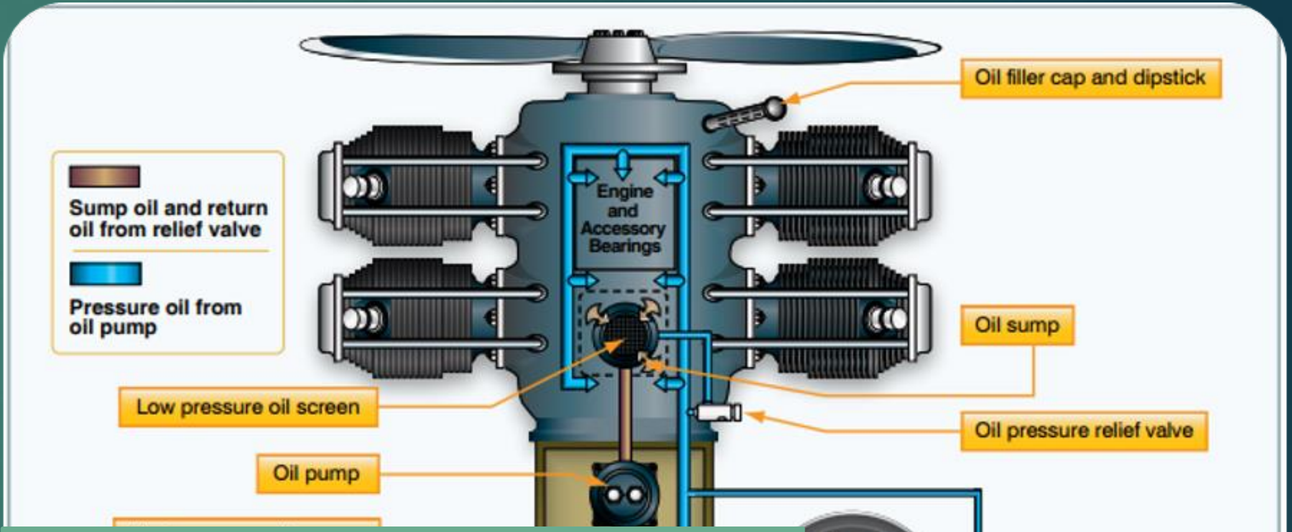


Oil System

The engine oil system performs several important functions. There are basically two types of systems: wet sump and dry sump systems.

Oil System Functions

- Lubrication of the engine's moving parts.
- Cooling of the engine by reducing friction.
- Removing heat from the cylinders.
- Providing a seal between the cylinder walls and pistons.
- Carrying away contaminants.



Wet Sump System

In a wet-sump system, the oil is located in a sump that is an integral part of the engine.

Dry Sump System

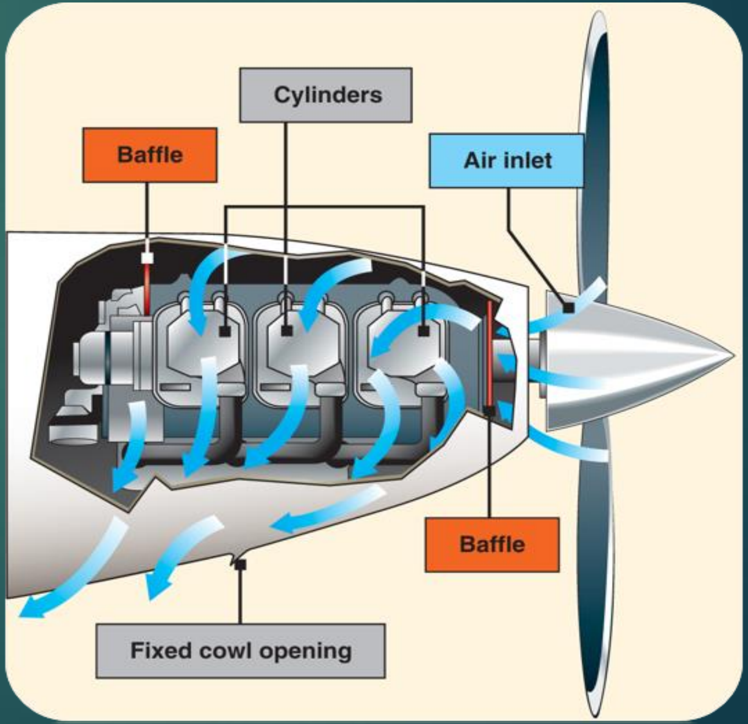
In a dry-sump system, the oil is contained in a separate tank and circulated through the engine via pumps.

Engine Cooling System

The burning fuel within the cylinders produces intense heat, most of which is expelled through the exhaust system. Much of the remaining heat, however, must be removed, or at least dissipated, to prevent the engine from overheating.

Engine Baffling

Air cooling is accomplished by air flowing into the engine compartment through openings in front of the engine cowling. Baffles route this air over fins attached to the engine cylinders, and other parts of the engine, where the air absorbs the engine heat. Expulsion of the hot air takes place through one or more openings in the lower, aft portion of the engine cowling.



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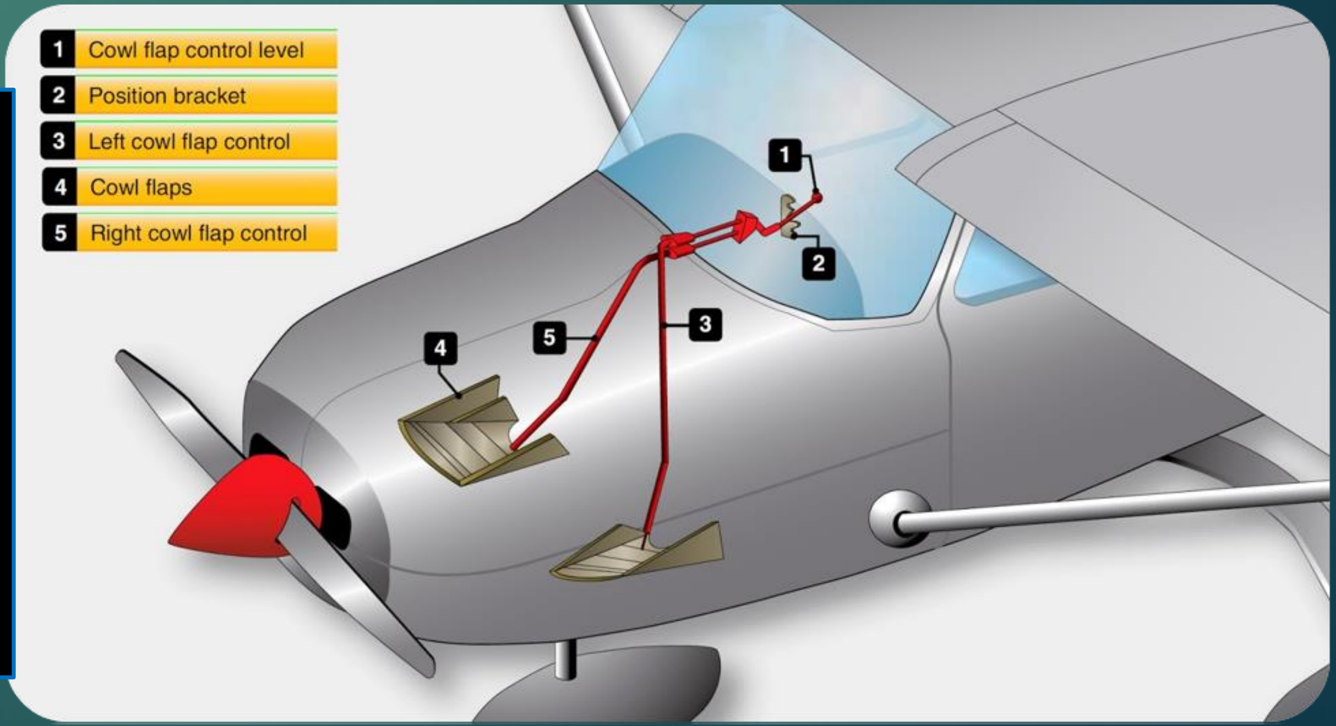
The burning fuel within the cylinders produces intense heat, most of which is expelled through the exhaust system. Much of the remaining heat, however, must be removed, or at least dissipated, to prevent the engine from overheating.

Cowl Flaps

On aircraft equipped with cowl flaps, use the cowl flap positions to control the temperature. Cowl flaps are hinged covers that fit over the opening through which the hot air is expelled. If the engine temperature is low, the cowl flaps can be closed, thereby restricting the flow of expelled hot air and increasing engine temperature. If the engine temperature is high, the cowl flaps can be opened to permit a greater flow of air through the system, thereby decreasing the engine temperature.



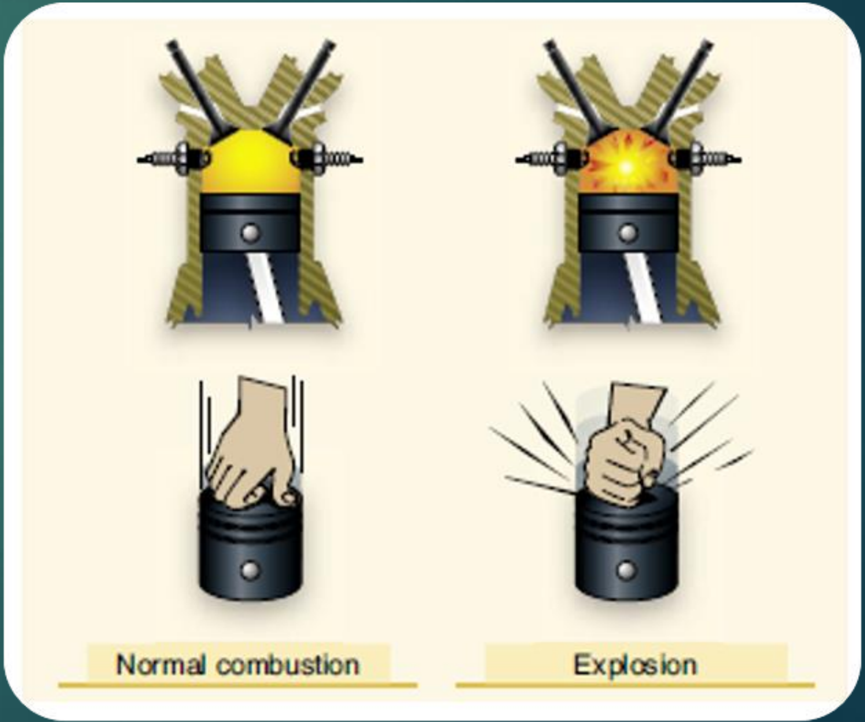
Combustion System

During normal combustion, the fuel-air mixture burns in a very controlled and predictable manner. In a spark ignition engine, the process occurs in a fraction of a second.

Detonation

Detonation is an uncontrolled, explosive ignition of the fuel-air mixture within the cylinder's combustion chamber. It causes excessive temperatures and pressures which, if not corrected, can quickly lead to failure of the piston, cylinder, or valves. Common operational causes of detonation are:

- Use of a lower fuel grade than that specified by the aircraft manufacturer.
- Operation of the engine with extremely high manifold pressures in conjunction with low rpm.
- Operation of the engine at high power settings with an excessively lean mixture.
- Maintaining extended ground operations or steep climbs in which cylinder cooling is reduced.

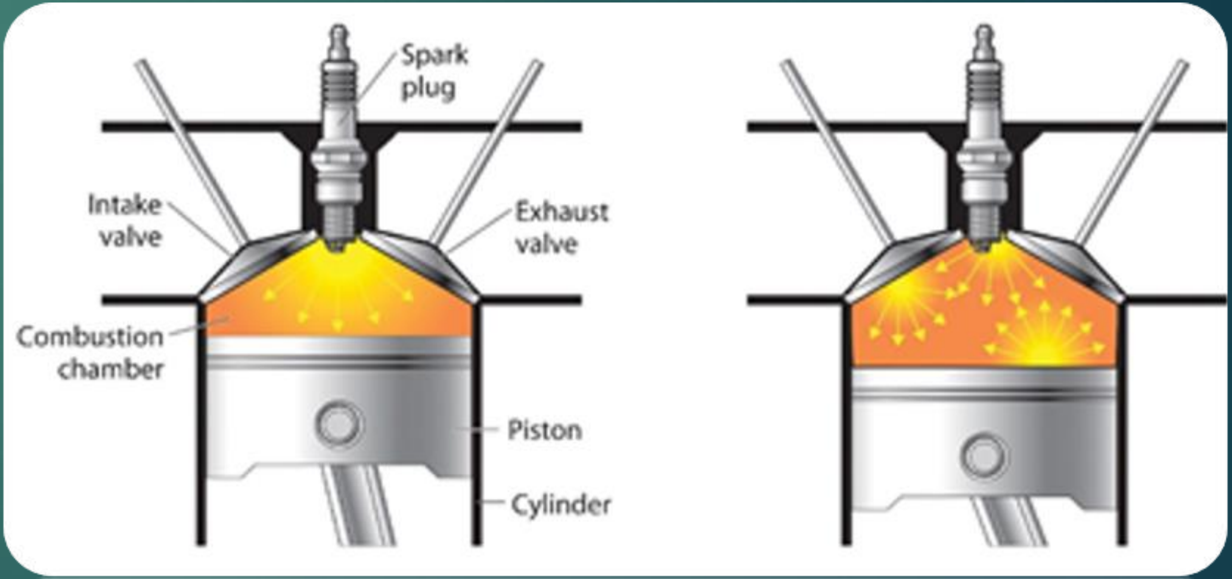


Combustion System

During normal combustion, the fuel-air mixture burns in a very controlled and predictable manner. In a spark ignition engine, the process occurs in a fraction of a second.

Pre-Ignition

Preignition occurs when the fuel-air mixture ignites prior to the engine's normal ignition event. Premature burning is usually caused by a residual hot spot in the combustion chamber, often created by a small carbon deposit on a spark plug, a cracked spark plug insulator, or other damage in the cylinder that causes a part to heat sufficiently to ignite the fuel-air charge. Preignition causes the engine to lose power and produces high operating temperature.

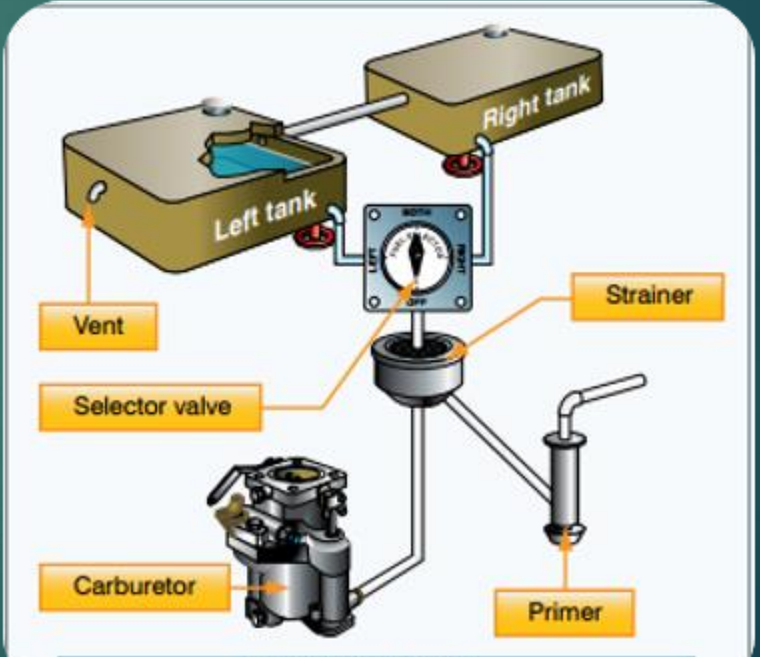


Fuel System

The fuel system is designed to provide an uninterrupted flow of clean fuel from the fuel tanks to the engine. The fuel must be available to the engine under all conditions of engine power, altitude, attitude, and during all approved flight maneuvers.

Gravity Feed System

The gravity-feed system utilizes the force of gravity to transfer the fuel from the tanks to the engine. For example, on high-wing airplanes, the fuel tanks are installed in the wings. This places the fuel tanks above the carburetor, and the fuel is gravity fed through the system and into the carburetor.



Gravity-feed system

Fuel System

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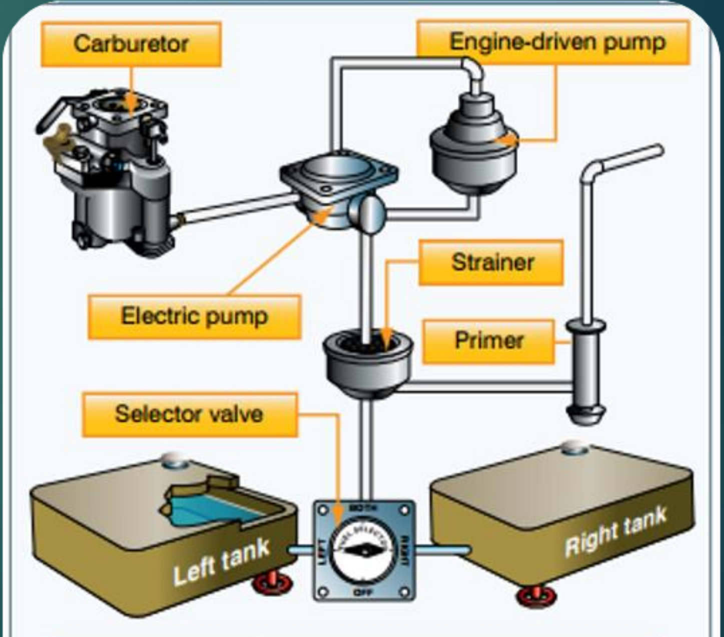
Fuel Pump System

If the design of the aircraft is such that gravity cannot be used to transfer fuel, fuel pumps are installed. For example, on low-wing airplanes, the fuel tanks in the wings are located below the carburetor. Aircraft with fuel-pump systems have two fuel pumps.

- The main pump system is engine driven with an electrically driven auxiliary pump provided for use in engine starting and in the event the engine pump fails.
- The auxiliary pump, also known as a boost pump, provides added reliability to the fuel system.



Fuel-pump system

Fuel System

The fuel system is designed to provide an uninterrupted flow of clean fuel from the fuel tanks to the engine. The fuel must be available to the engine under all conditions of engine power, altitude, attitude, and during all approved flight maneuvers.

The Fuel Tanks

The fuel tanks, normally located inside the wings of an airplane, have a filler opening on top of the wing through which they can be filled. A filler cap covers this opening. The tanks are vented to the outside to maintain atmospheric pressure inside the tank. Fuel tanks also include an overflow drain that may stand alone or be collocated with the fuel tank vent. This allows fuel to expand with increases in temperature without damage to the tank itself.

Fuel System

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Fuel Gauges

The fuel quantity gauges indicate the amount of fuel measured by a sensing unit in each fuel tank and is displayed in gallons or pounds. Any reading other than "empty" should be verified. If a fuel pump is installed in the fuel system, a fuel pressure gauge is also included.

Quantity Gauge

Pressure Gauge

Fuel System

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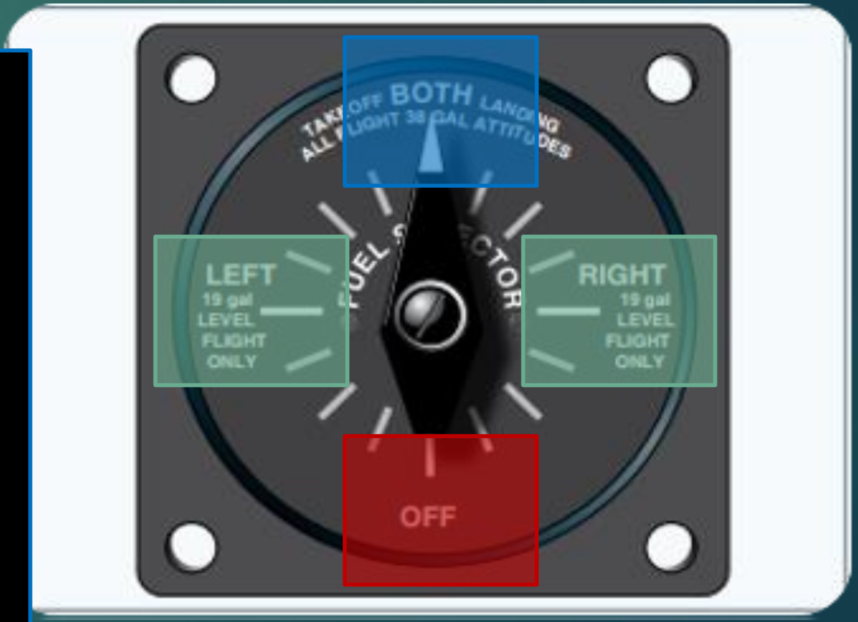
Fuel Selectors

The fuel selector valve allows selection of fuel from various tanks. A common type of selector valve contains four positions:

1. LEFT
2. RIGHT
3. BOTH
4. OFF

Selecting the LEFT or RIGHT position allows fuel to feed only from the respective tank, while selecting the BOTH position feeds fuel from both tanks. The LEFT or RIGHT position may be used to balance the amount of fuel remaining in each wing tank.



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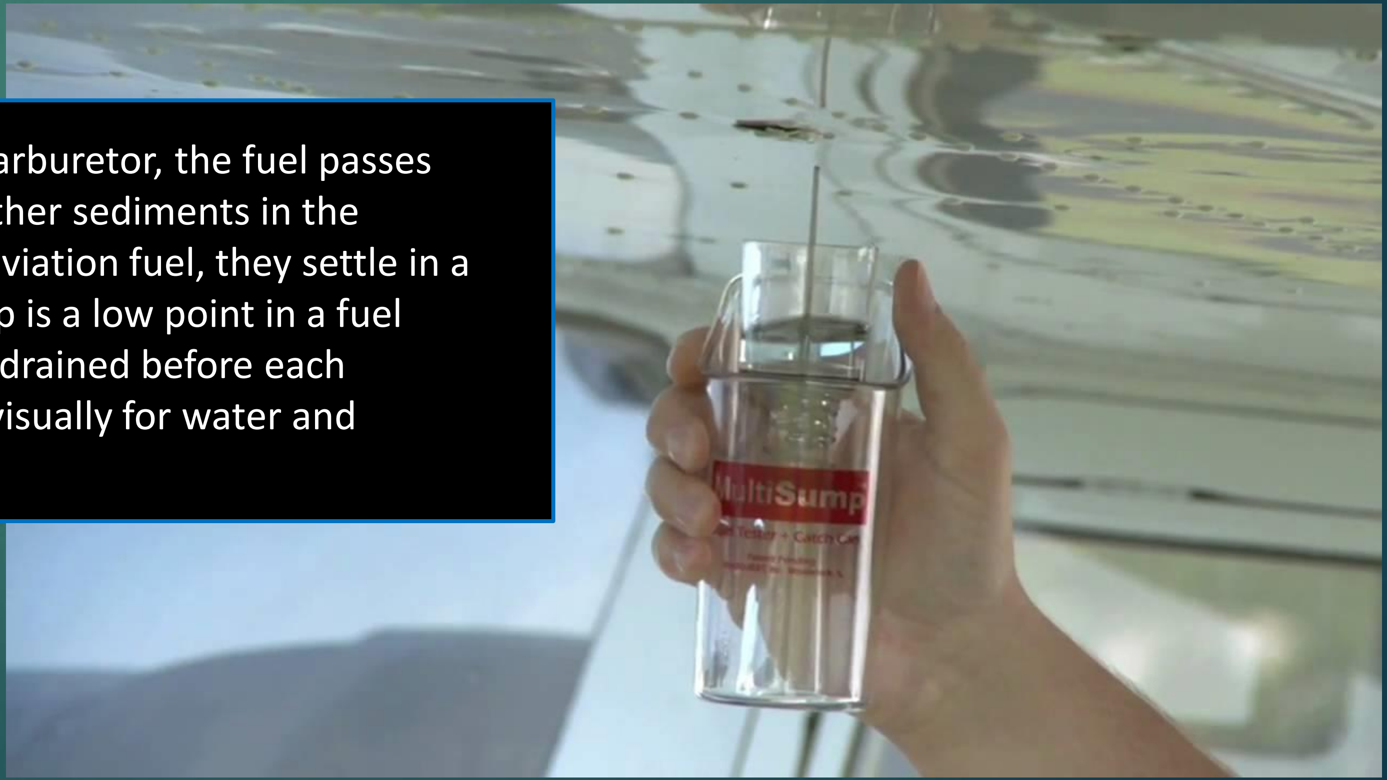
Strainers and Sumps

After leaving the fuel tank and before it enters the carburetor, the fuel passes through a strainer that removes any moisture and other sediments in the system. Since these contaminants are heavier than aviation fuel, they settle in a sump at the bottom of the strainer assembly. A sump is a low point in a fuel system and/or fuel tank. The fuel strainer should be drained before each flight. Fuel samples should be drained and checked visually for water and contaminants.

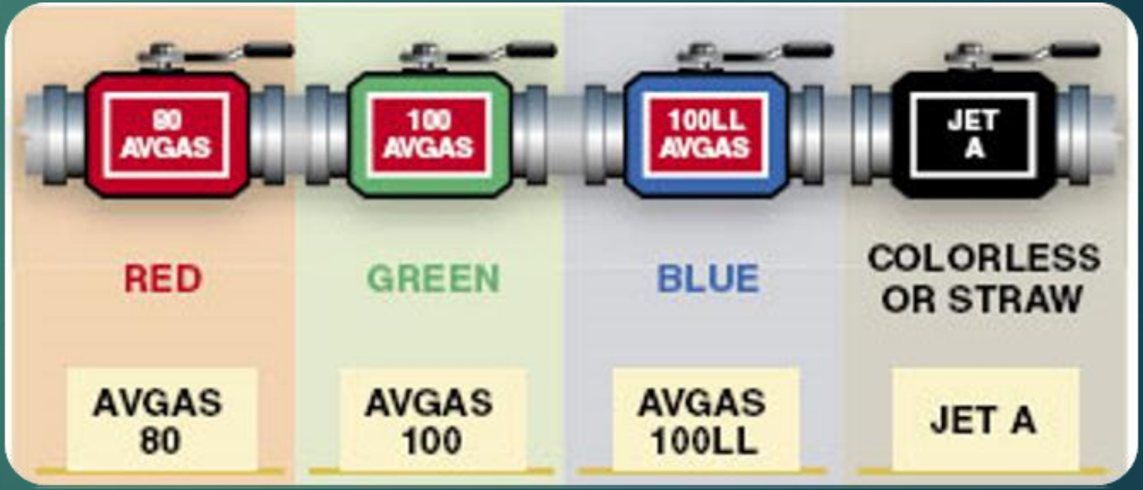


Fuel System

The fuel system is designed to provide an uninterrupted flow of clean fuel from the fuel tanks to the engine. The fuel must be available to the engine under all conditions of engine power, altitude, attitude, and during all approved flight maneuvers.

Fuel Grades

Aviation gasoline (AVGAS) is identified by an octane or performance number (grade), which designates the antiknock value or knock resistance of the fuel mixture in the engine cylinder. The higher the grade of gasoline, the more pressure the fuel can withstand without detonating. Lower grades of fuel are used in lower-compression engines because these fuels ignite at a lower temperature. Higher grades are used in higher-compression engines because they ignite at higher temperatures, but not prematurely. If the proper grade of fuel is not available, use the next higher grade as a substitute. Never use a grade lower than recommended.

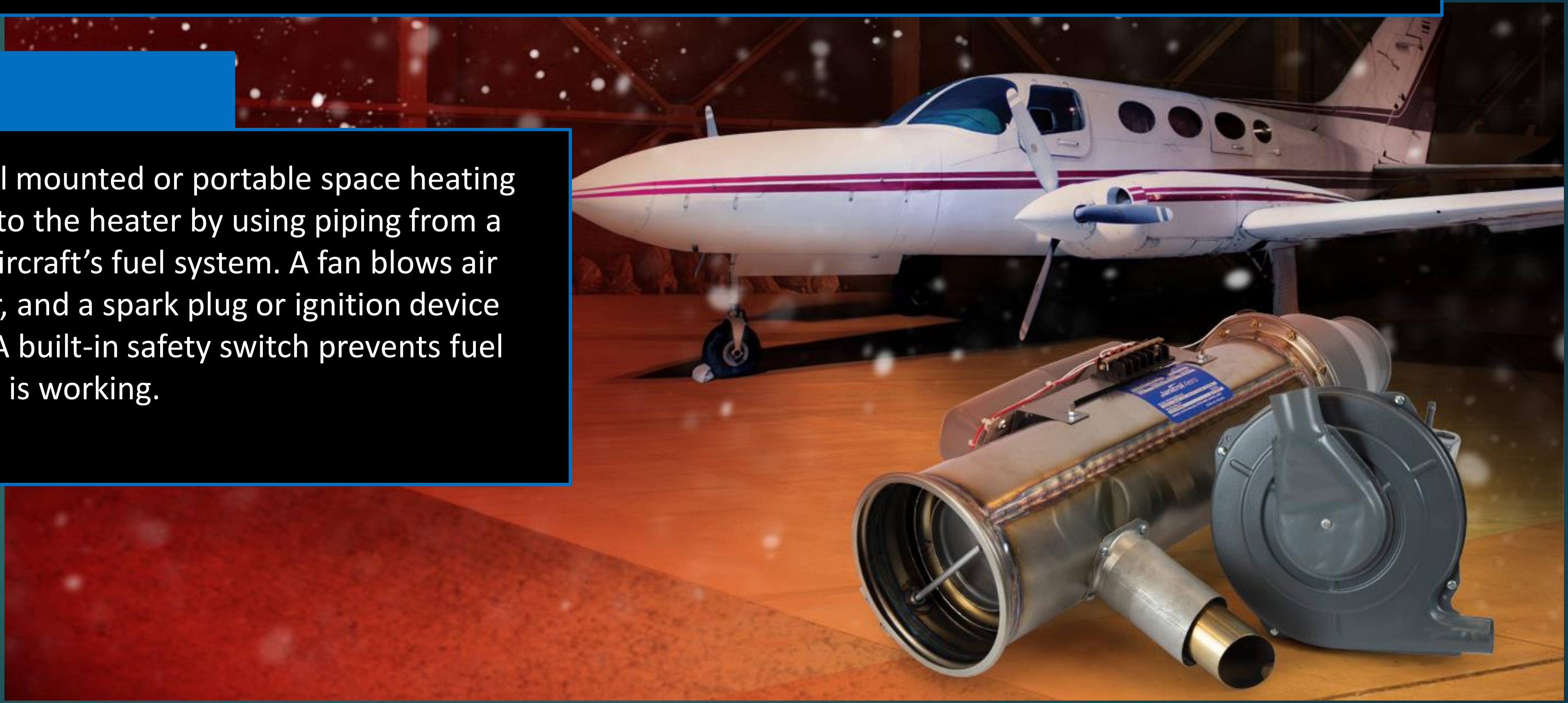


Environmental Systems

There are many different types of aircraft heating systems that are available depending on the type of aircraft. We will discuss: fuel fired heaters, exhaust heating systems, and combustion heater systems.

Fuel Fired Heaters

A fuel fired heater is a small mounted or portable space heating device. The fuel is brought to the heater by using piping from a fuel tank, or taps into the aircraft's fuel system. A fan blows air into a combustion chamber, and a spark plug or ignition device lights the fuel-air mixture. A built-in safety switch prevents fuel from flowing unless the fan is working.



Environmental Systems

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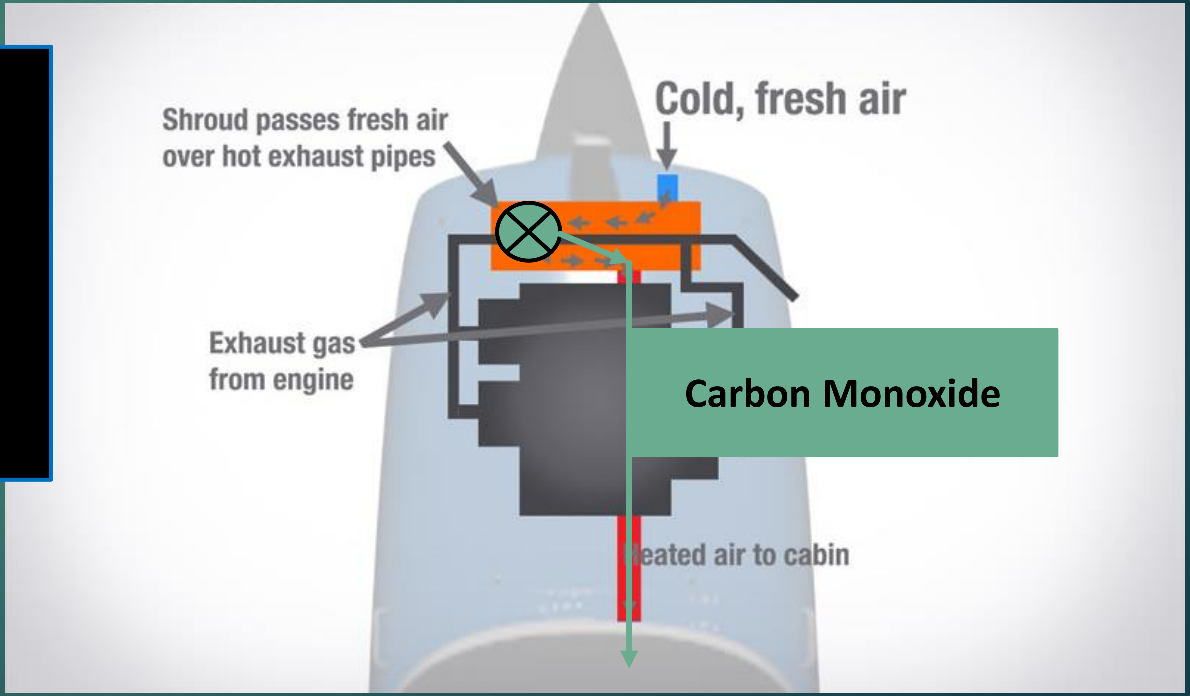
Exhaust Heating System

Exhaust heating systems are used to route exhaust gases away from the engine and fuselage while reducing engine noise. The exhaust systems also serve as a heat source for the cabin and carburetor. The risks of operating an aircraft with a defective exhaust heating system include carbon monoxide poisoning, a decrease in engine performance, and an increased potential for fire.



Environmental Systems

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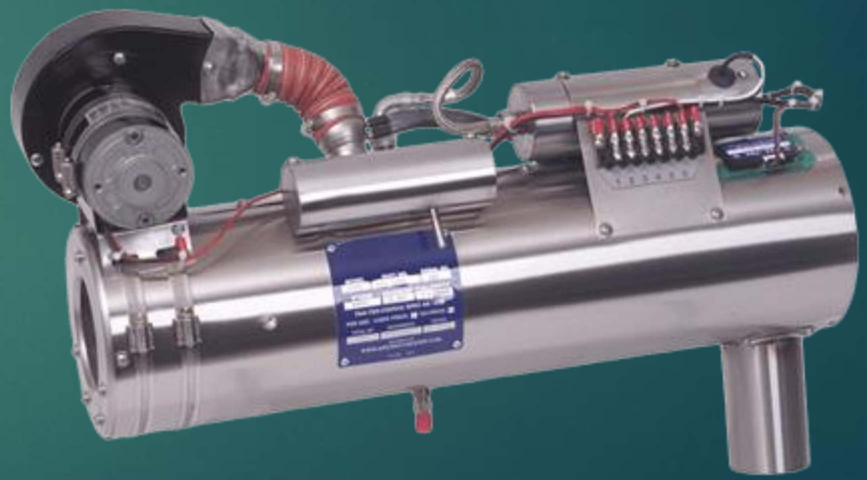
Combustion Heater System

This type of heater burns the aircraft's fuel in a combustion chamber or tube to develop required heat, and the air flowing around the tube is heated and ducted to the cabin. A combustion heater is an airtight burner chamber with a stainless-steel jacket. Fuel from the aircraft fuel system is ignited and burns to provide heat.

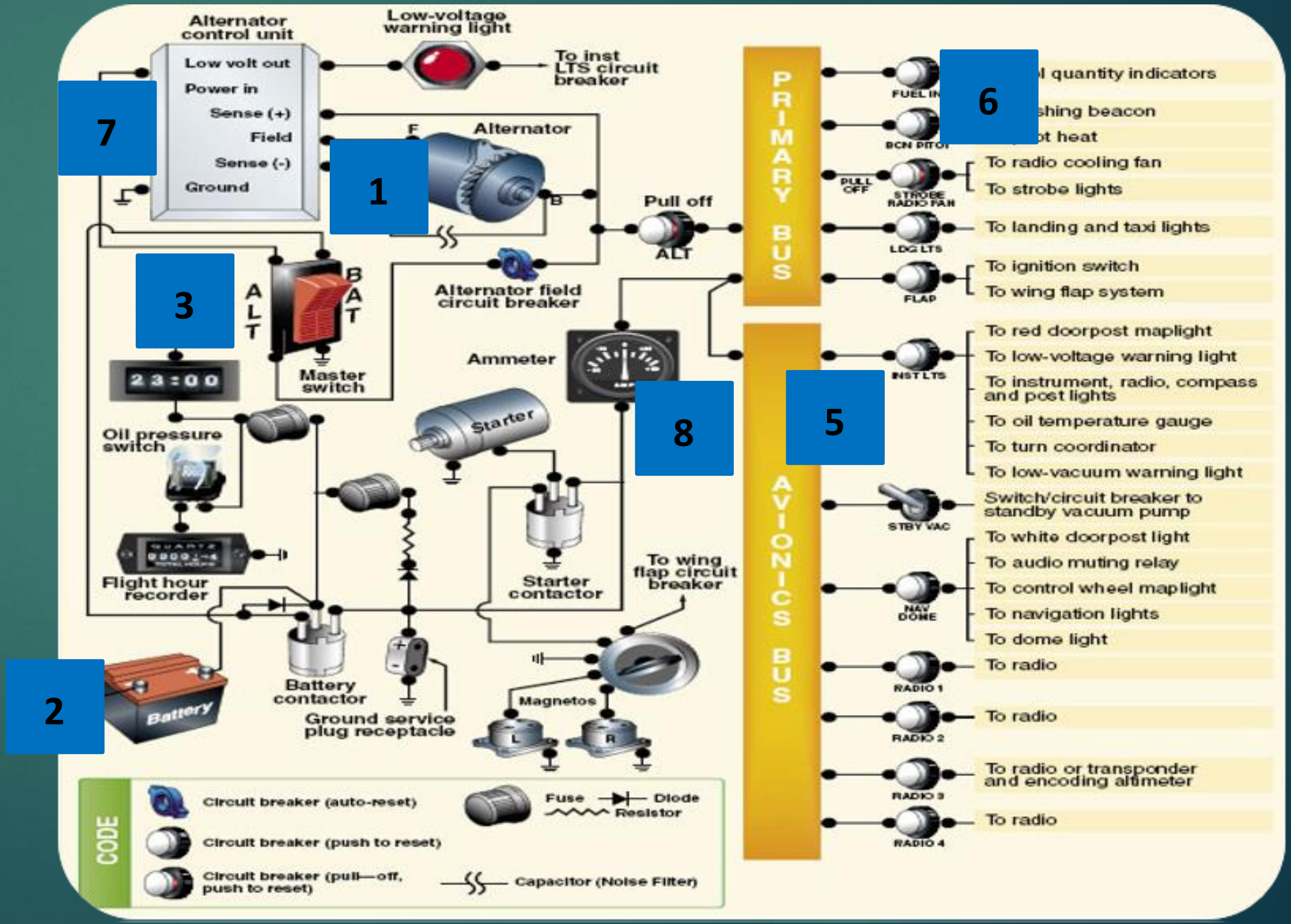


Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Electrical System Components

1. Alternator/Generator
2. Battery
3. Master/Battery Switch
4. Alternator/Generator Switch
5. Bus Bars
6. Fuses or Circuit Breakers
7. Voltage Regulator
8. Ammeter or Loadmeter
9. Associated Electrical Wiring



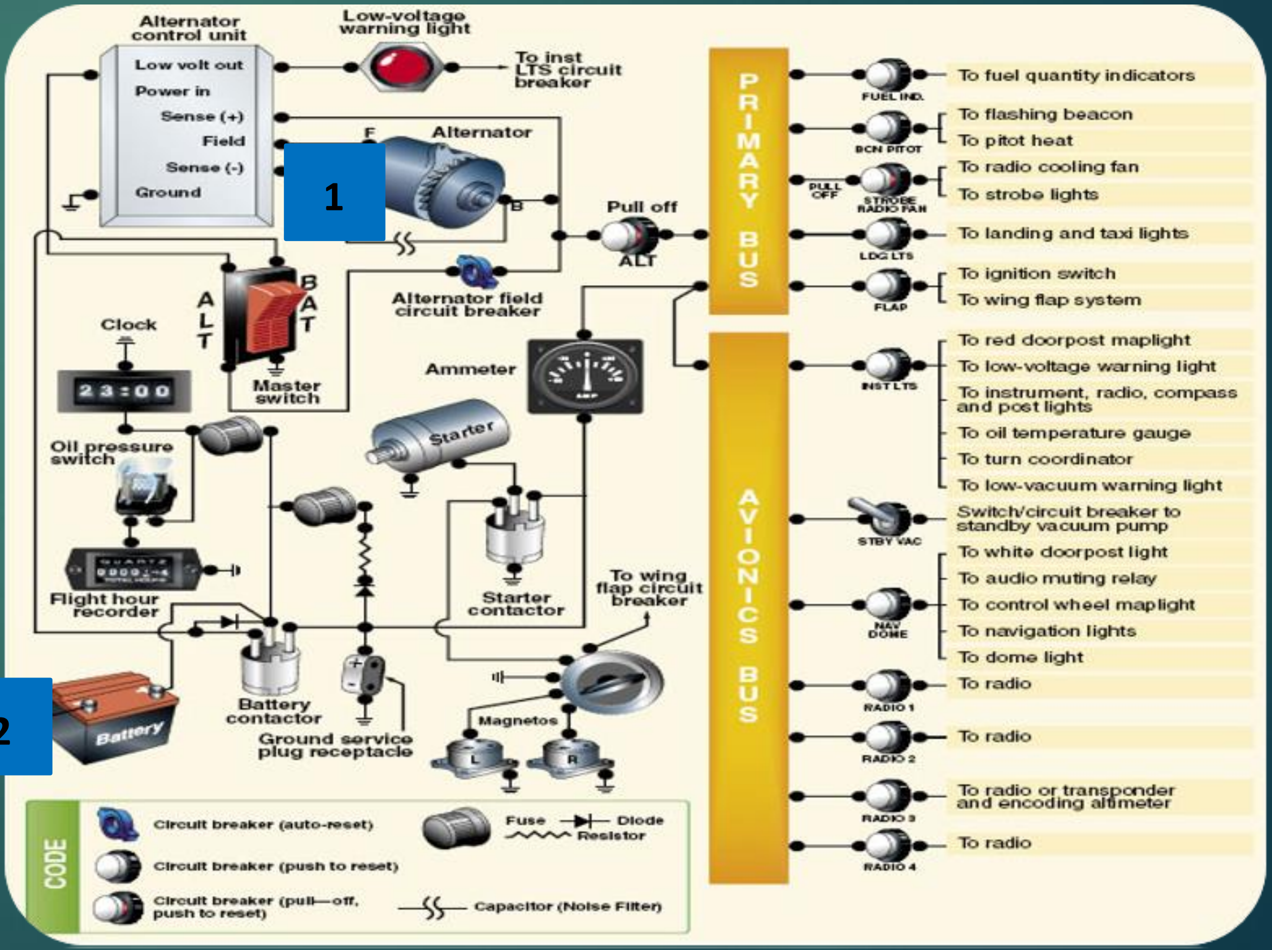
Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Alternator/Generator and Battery

Engine-driven alternators or generators supply electric current to the electrical system. They also maintain a sufficient electrical charge in the battery.

Electrical energy stored in a battery provides a source of electrical power for starting the engine and a limited supply of electrical power for use in the event the alternator or generator fails.

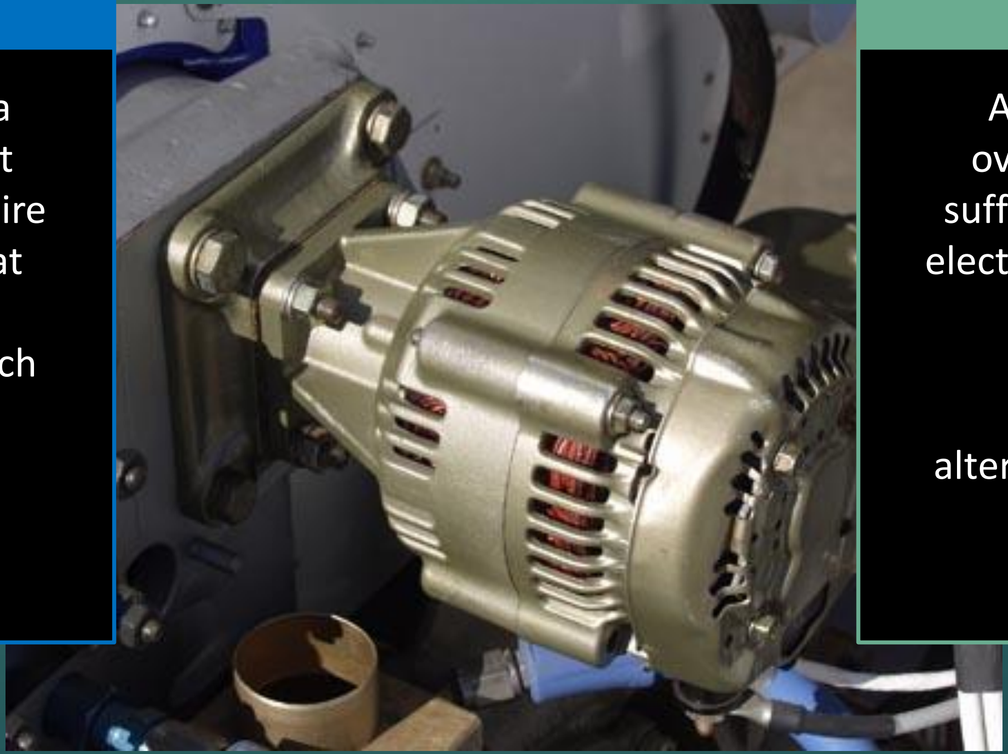


Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Generators

Most DC generators do not produce a sufficient amount of electrical current at low engine rpm to operate the entire electrical system. During operations at low engine rpm, the electrical needs must be drawn from the battery, which can quickly be depleted.



Alternators

Alternators have several advantages over generators. Alternators produce sufficient current to operate the entire electrical system, even at slower engine speeds, by producing alternating current (AC), which is converted to DC. The electrical output of an alternator is more constant throughout a wide range of engine speeds.

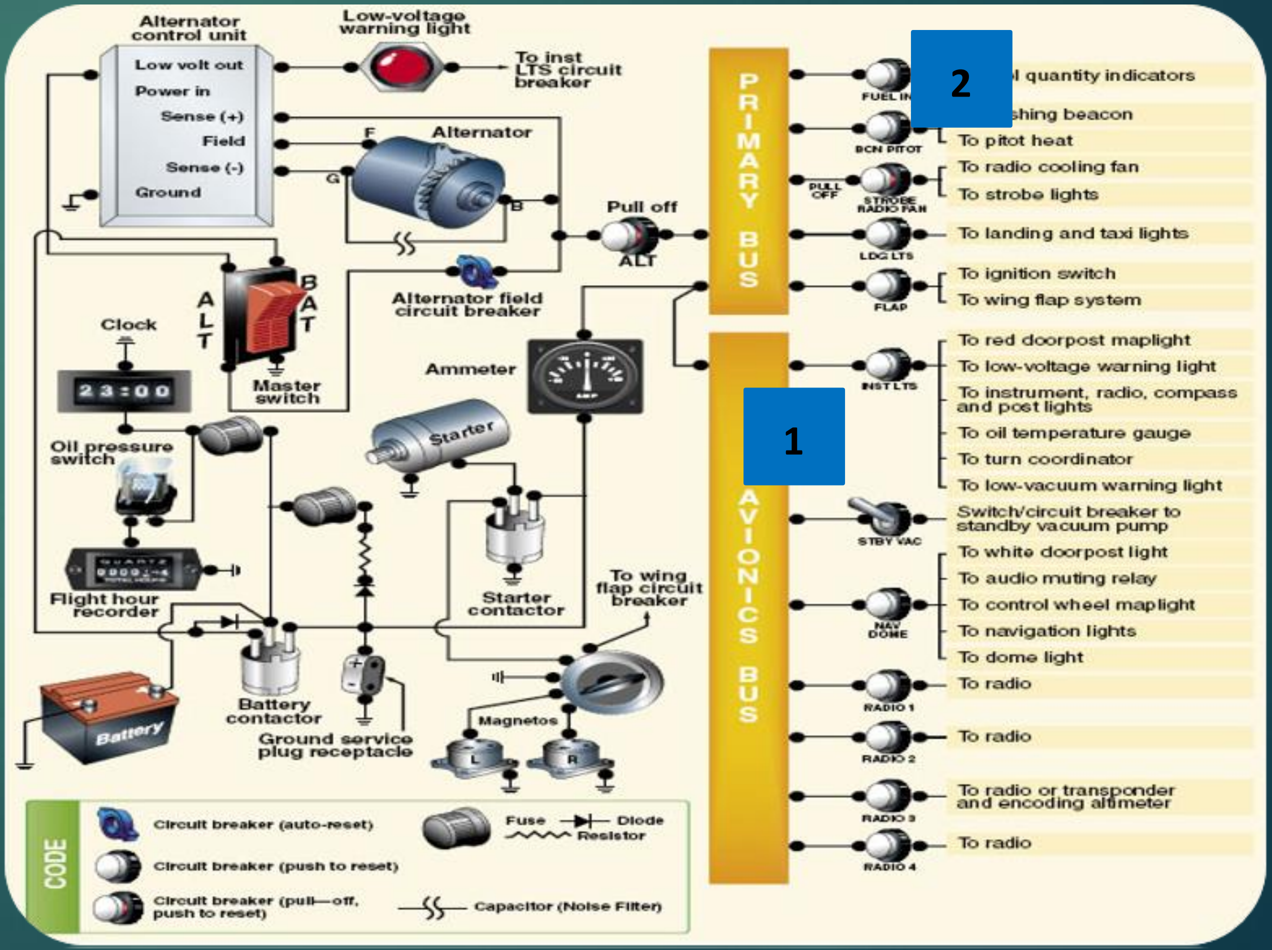
Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Bus Bars and Circuit Breakers

A bus bar is used as a terminal in the aircraft electrical system to connect the main electrical system to the equipment using electricity as a source of power. This simplifies electrical wiring.

Fuses or circuit breakers are used in the electrical system to protect the circuits and equipment from electrical overload. Spare fuses of the proper amperage limit should be carried in the aircraft to replace defective or blown fuses. Circuit breakers have the same function as a fuse but can be manually reset, rather than replaced.

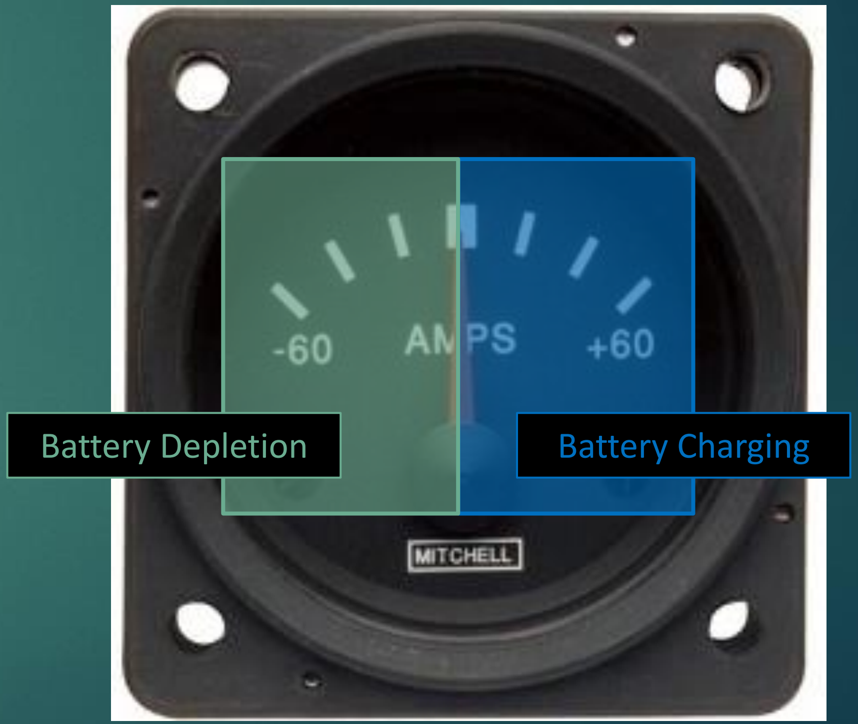


Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Ammeters

An ammeter is used to monitor the performance of the aircraft electrical system. The ammeter shows if the alternator/ generator is producing an adequate supply of electrical power. It also indicates whether or not the battery is receiving an electrical charge. Ammeters are designed with the zero point in the center of the face and a negative or positive indication on either side. When the pointer of the ammeter is on the plus side, it shows the charging rate of the battery. A minus indication means more current is being drawn from the battery than is being replaced.

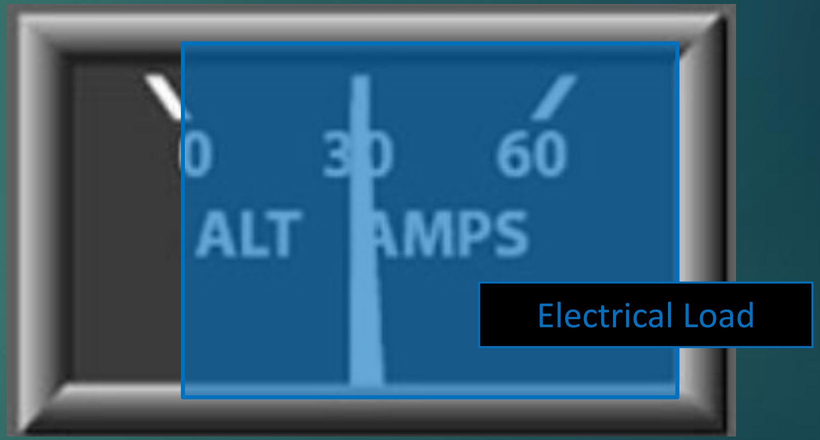


Electrical System

Most aircraft are equipped with either a 14- or a 28-volt direct current (DC) electrical system.

Loadmeter

This type of gauge has a scale beginning with zero and shows the load being placed on the alternator/generator.
The loadmeter reflects the total percentage of the load placed on the generating capacity of the electrical system by the electrical accessories and battery. When all electrical components are turned off, it reflects only the amount of charging current demanded by the battery.

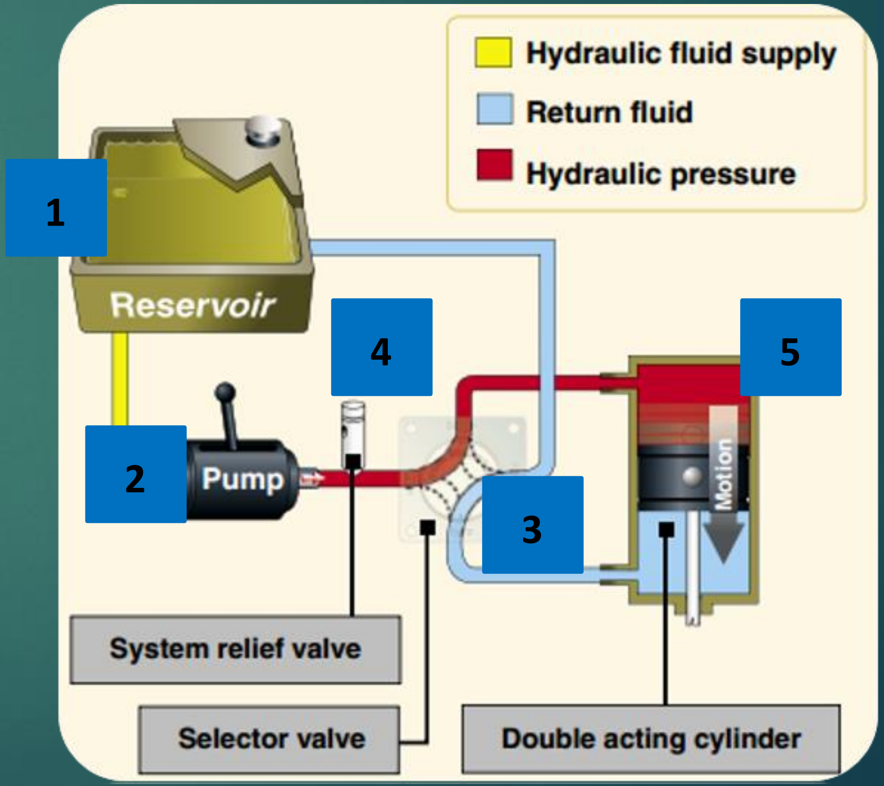


Hydraulic System

The hydraulic system is often used on small airplanes to operate wheel brakes, retractable landing gear, and some constant speed propellers.

Hydraulic System Components

1. A reservoir.
2. Pump (either hand, electric, or engine-driven).
3. A filter to keep the fluid clean.
4. A selector valve to control the direction of flow.
5. A relief valve to relieve excess pressure.
6. An actuator.

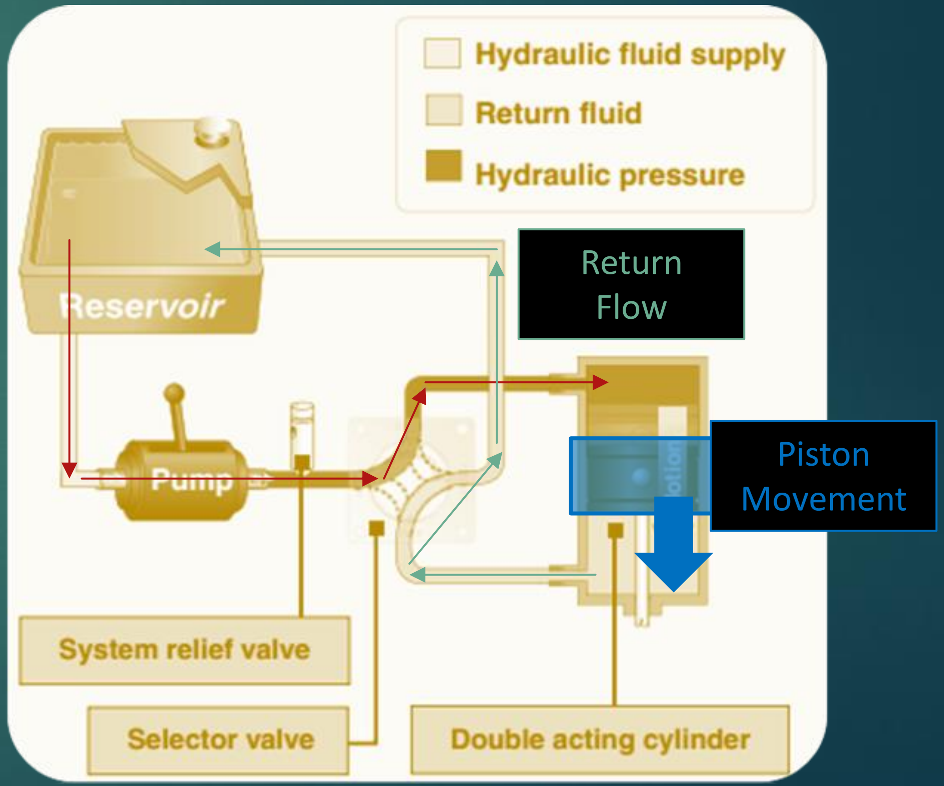


Hydraulic System

The hydraulic system is often used on small airplanes to operate wheel brakes, retractable landing gear, and some constant speed propellers.

Hydraulic System Operation

The hydraulic fluid is pumped through the system to an actuator or servo. A servo is a cylinder with a piston inside that turns fluid power into work and creates the power needed to move an aircraft system or flight control. Servos can be either single-acting or double-acting, based on the needs of the system. This means that the fluid can be applied to one or both sides of the servo, depending on the servo type.



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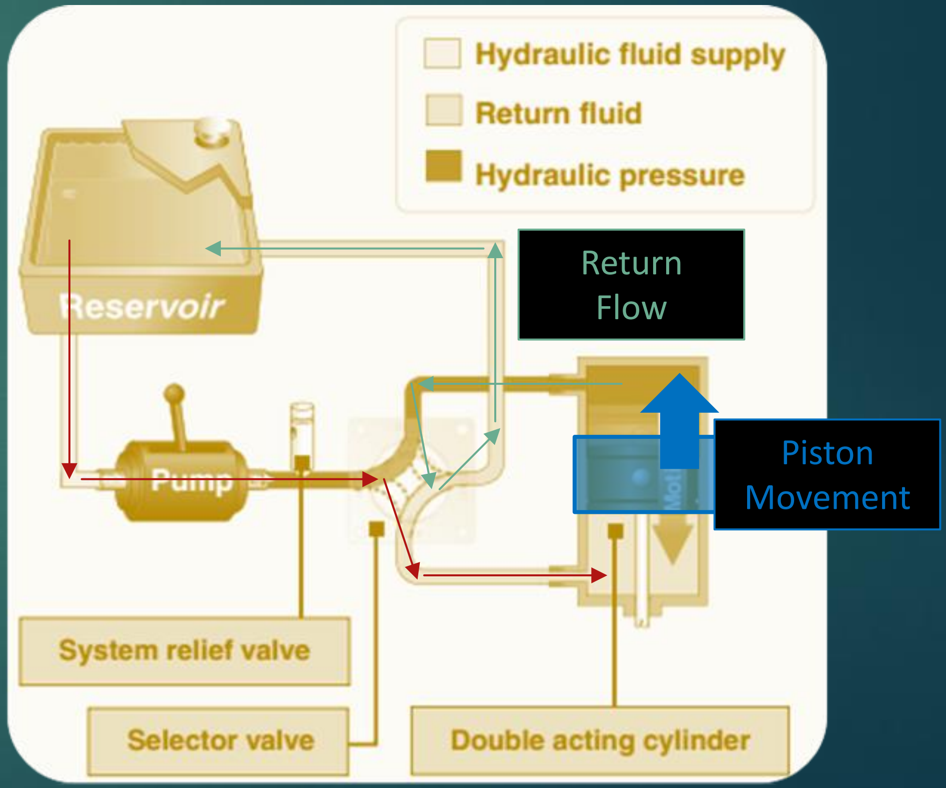
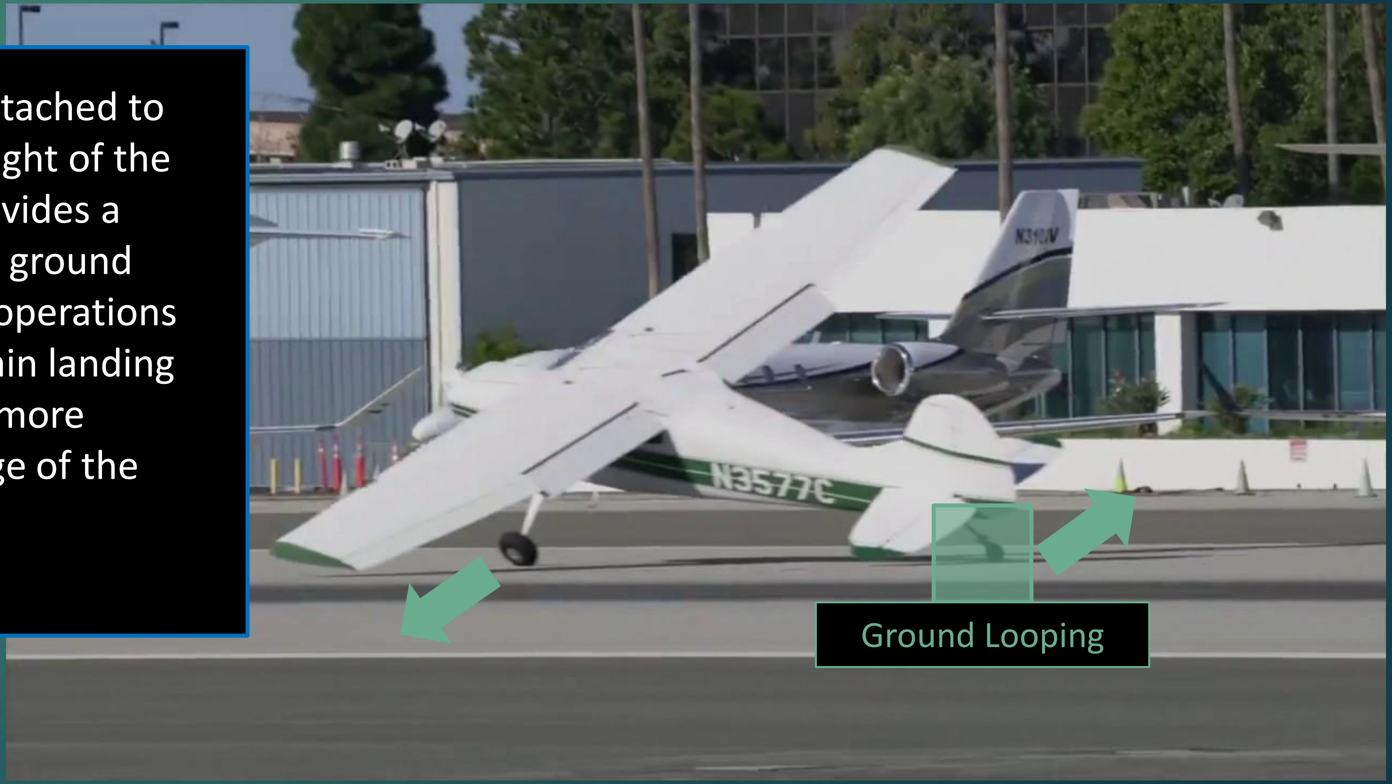


Landing Gear Systems

The landing gear forms the principal support of an aircraft on the surface.

Conventional Gear

Tailwheel landing gear airplanes have two main wheels attached to the airframe ahead of its CG that support most of the weight of the structure. A tailwheel at the very back of the fuselage provides a third point of support. This arrangement allows adequate ground clearance for a larger propeller and is more desirable for operations on unimproved fields. With the CG located behind the main landing gear, directional control using this type of landing gear is more difficult while on the ground. This is the main disadvantage of the tailwheel landing gear.



Landing Gear Systems

The landing gear forms the principal support of an aircraft on the surface.

Tricycle Type Gear

This type of landing gear has a few advantages over Conventional Gear Systems. It allows more forceful application of the brakes during landings at high speeds without causing the aircraft to nose over. It permits better forward visibility for the pilot during takeoff, landing, and taxiing. It tends to prevent ground looping (swerving) by providing more directional stability during ground operation since the aircraft's center of gravity (CG) is forward of the main wheels. The forward CG keeps the airplane moving forward in a straight line rather than ground looping.

Landing Gear Systems

The landing gear forms the principal support of an aircraft on the surface.

Fixed vs Retractable

Landing gear can also be classified as either fixed or retractable. Fixed landing gear always remains extended and has the advantage of simplicity combined with low maintenance. Retractable landing gear is designed to streamline the airplane by allowing the landing gear to be stowed inside the structure during cruising flight.

Anti-Ice and Deice Systems

Anti-icing equipment is designed to prevent the formation of ice, while deicing equipment is designed to remove ice once it has formed.

Aircraft Icing

These systems protect the leading edge of wing and tail surfaces, pitot and static port openings, fuel tank vents, stall warning devices, windshields, and propeller blades. Most light aircraft have only a heated pitot tube and are not certified for flight in icing. These light aircraft have limited cross-country capability in the cooler climates during late fall, winter, and early spring. Noncertificated aircraft must exit icing conditions immediately.

Anti-Ice and Deice Systems

Anti-icing equipment is designed to prevent the formation of ice, while deicing equipment is designed to remove ice once it has formed.

Deicing Boots

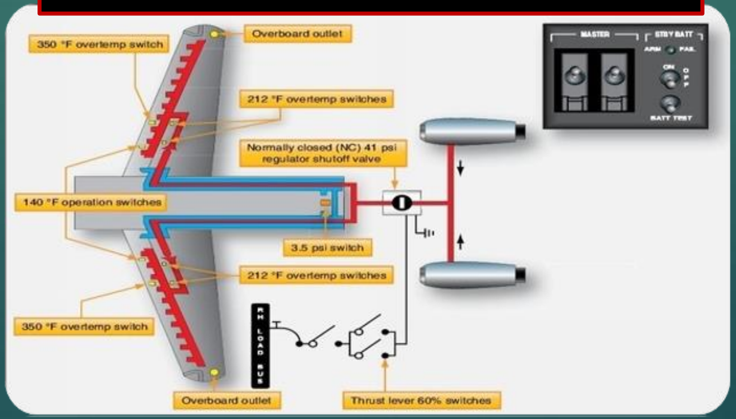
Inflatable deicing boots consist of a rubber sheet bonded to the leading edge of the airfoil. When ice builds up on the leading edge, an engine-driven pneumatic pump inflates the rubber boots.

Heated Wing

High performance turbine aircraft often direct hot air from the compressor section to the leading edge surfaces. The hot air heats the leading edge to prevent ice formation.

Weeping Wing

Small holes located in the leading edge of the wing prevent ice build up by pumping an anti-freeze solution through those small holes.



Anti-Ice and Deice Systems

Anti-icing equipment is designed to prevent the formation of ice, while deicing equipment is designed to remove ice once it has formed.

Propeller Anti-Ice

Propellers are protected from icing by the use of alcohol or electrically heated elements. Some propellers are equipped with a discharge nozzle that is pointed toward the root of the blade.

Alcohol is discharged from the nozzles, and centrifugal force drives the alcohol down the leading edge of the blade. Propellers can also be fitted with propeller anti-ice boots. The propeller boot is divided into two sections: the inboard and the outboard sections.

Lesson Summary

In this lesson we discussed the powerplant, propeller, induction systems, ignition system, oil system, engine cooling and combustion, fuel system, environmental control systems, electrical systems, hydraulics, landing gear, and anti-ice and deicing systems.

Do Your Homework