1. MAJOR COMPONENTS OF AN AIRPLANE:

Most airplane structures include a fuselage, wings, an empennage, landing gear, and a power plant.

Fuselage

- The fuselage is the central body of an airplane and is designed to accommodate the crew, passengers, and cargo. It also provides the structural connection for the wings and tail assembly.
- Older types of aircraft design utilized an open truss structure constructed of wood, steel, or aluminum tubing.
- *[Figure 2-5]* The most popular types of fuselage structures used in today's aircraft are the monocoque (French for "single shell") and semimonocoque.

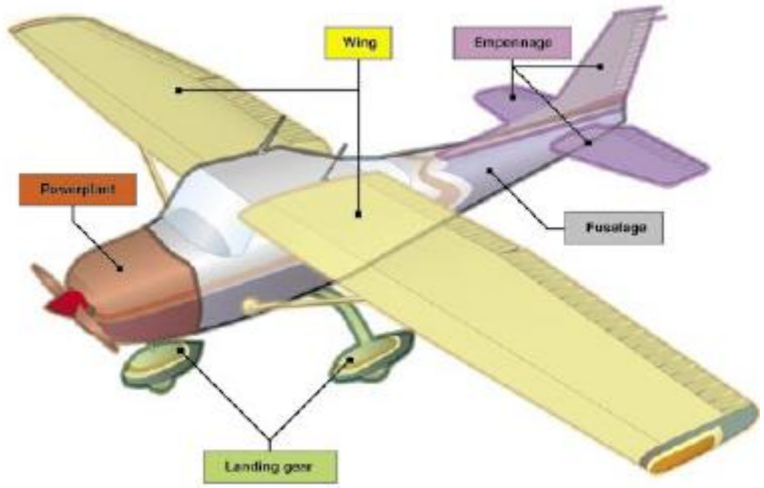


Figure 2-4. *Airplane components.*

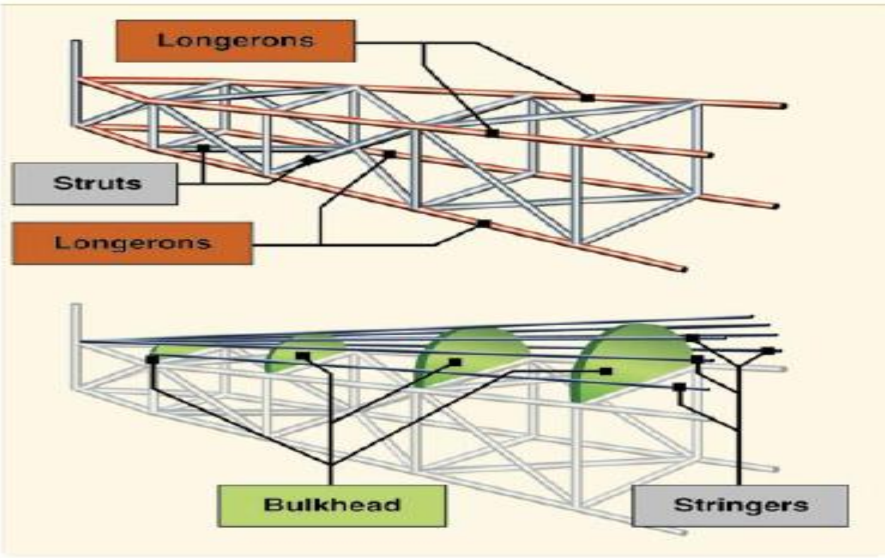


Figure 2-5. *Truss-type fuselage structure.*

Wings

- The wings are airfoils attached to each side of the fuselage and are the main lifting surfaces that support the airplane in flight.
- Wings may be attached at the top, middle, or lower portion of the fuselage.
- These designs are referred to as high-, mid-, and low-wing, respectively. The number of wings can also vary.
- Airplanes with a single set of wings are referred to as monoplanes, while those with two sets are called biplanes.
- Many high-wing airplanes have external braces, or wing struts, which transmit the flight and landing loads through the struts to the main fuselage structure.
- Since the wing struts are usually attached approximately halfway out on the wing, this type of wing structure is called semi-cantilever.
- A few high-wing and most low-wing airplanes have a full cantilever wing designed to carry the loads without external struts.
- The principal structural parts of the wing are spars, ribs, and stringers. *[Figure 2-7]*
- These are reinforced by trusses, I-beams, tubing, or other devices, including the skin. The wing ribs determine the shape and thickness of the wing (airfoil).
- In most modern airplanes, the fuel tanks either are an integral part of the wing's structure, or consist of flexible containers mounted inside of the wing.

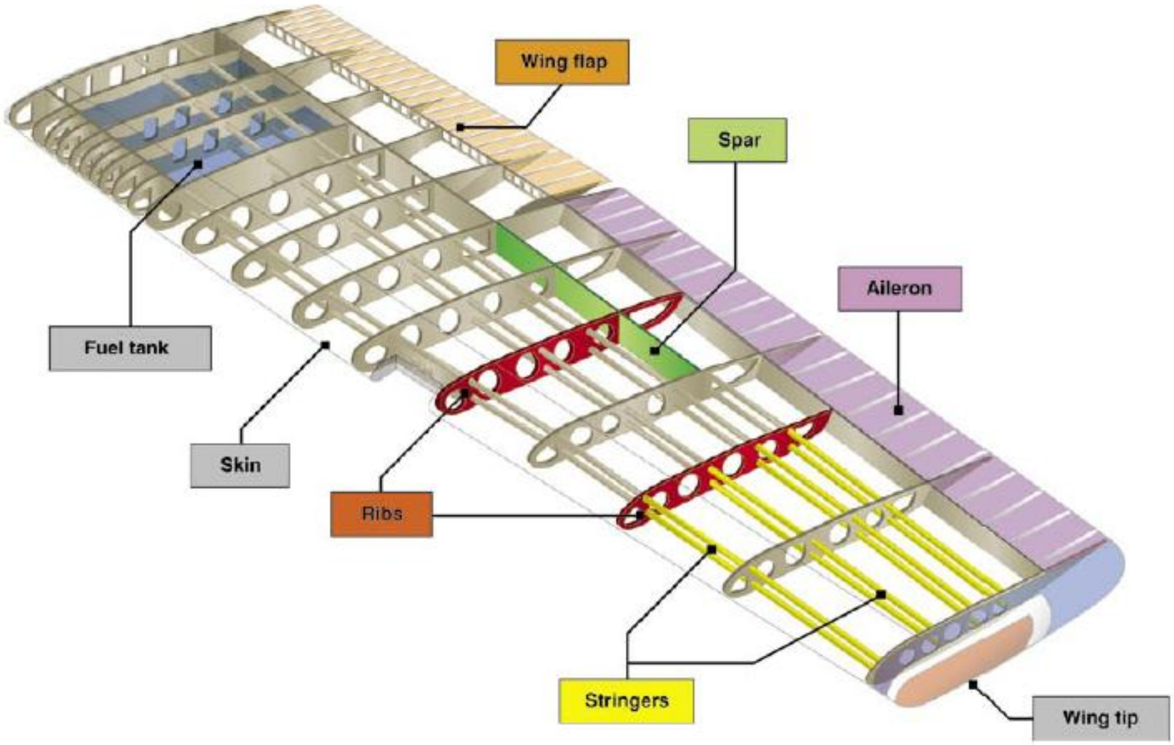


Figure 2-7. *Wing components.*

- **Ailerons** extend from about the midpoint of each wing outward toward the tip, and move in opposite directions to create aerodynamic forces that cause the airplane to roll.

- **Flaps** extend outward from the fuselage to near the midpoint of each wing.

- The flaps are normally flush with the wing's surface during cruising flight.

- When extended, the flaps move simultaneously downward to increase the lifting force of the wing for takeoffs and landings. *[Figure 2-8]*

Empennage

- The empennage includes the entire tail group and consists of fixed surfaces such as the vertical stabilizer and the horizontal stabilizer.

- The movable surfaces include the rudder, the elevator, and one or more trim tabs. *[Figure 2-10]*

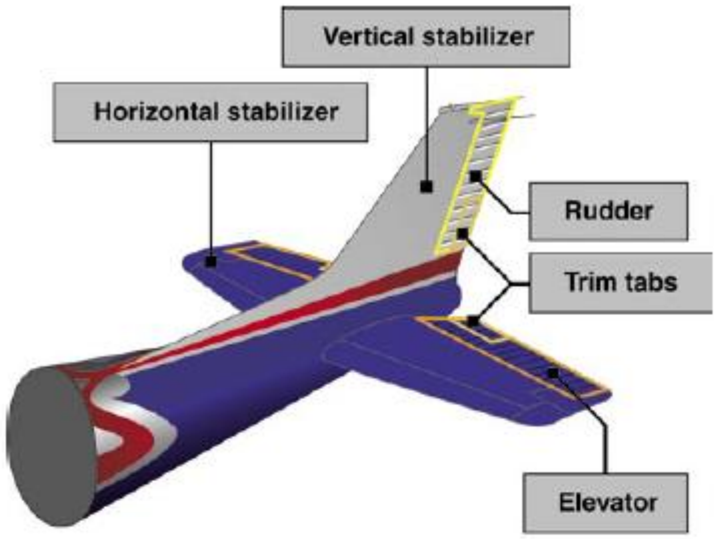


Figure 2-10. *Empennage components.*

- **The rudder** is attached to the back of the vertical stabilizer.
- During flight, it is used to move the airplane's nose left and right.
- **The elevator**, which is attached to the back of the horizontal stabilizer, is used to move the nose of the airplane up and down during flight.
- **Trim tabs** are small, movable portions of the trailing edge of the control surface.
- These movable trim tabs, which are controlled from the flight deck, reduce control pressures.
- Trim tabs may be installed on the ailerons, the rudder, and/or the elevator.
- The antiservo tab also functions as a trim tab to relieve control pressures and helps maintain the stabilator in the desired position.

Landing Gear

- The landing gear is the principal support of the airplane when parked, taxiing, taking off, or landing.
- The most common type of landing gear consists of wheels, but airplanes can also be equipped with floats for water operations, or skis for landing on snow. *[Figure 2-12]*
- The landing gear consists of three wheels—two main wheels and a third wheel positioned either at the front or rear of the airplane.
- Landing gear with a rear mounted wheel is called conventional landing gear.
- Airplanes with conventional landing gear are sometimes referred to as tailwheel airplanes.
- When the third wheel is located on the nose, it is called a nosewheel, and the design is referred to as a tricycle gear.
- A steerable nosewheel or tailwheel permits the airplane to be controlled throughout all operations while on the ground.
- Most aircraft are steered by moving the rudder pedals, whether nosewheel or tailwheel.

The Power plant

- The power plant usually includes both the engine and the propeller.
- The primary function of the engine is to provide the power to turn the propeller.
- It also generates electrical power, provides a vacuum source for some flight instruments, and in most single-engine airplanes, provides a source of heat for the pilot and passengers. *[Figure 2-13]*

- The engine is covered by a cowling, or a nacelle, which are both types of covered housings.

- The purpose of the cowling or nacelle is to streamline the flow of air around the engine and to help cool the engine by ducting air around the cylinders.
- The propeller, mounted on the front of the engine, translates the rotating force of the engine into thrust, a forward acting force that helps move the airplane through the air.
- The propeller may also be mounted on the rear of the engine as in a pusher-type aircraft.
- A propeller is a rotating airfoil that produces thrust through aerodynamic action.
- A low pressure area is formed at the back of the propeller's airfoil, and high pressure is produced at the face of the propeller, similar to the way lift is generated by an airfoil used as a lifting surface or wing.
- This pressure differential pulls air through the propeller, which in turn pulls the airplane forward.
- There are two significant factors involved in the design of a propeller which impact its effectiveness.
- The angle of a propeller blade, as measured against the hub of the propeller, keeps the angle of attack relatively constant along the span of the propeller blade, reducing or eliminating the possibility of a stall.
- The **pitch** is defined as the distance a propeller would travel in one revolution if it were turning in a solid.
- These two factors combine to allow a measurement of the propeller's efficiency.

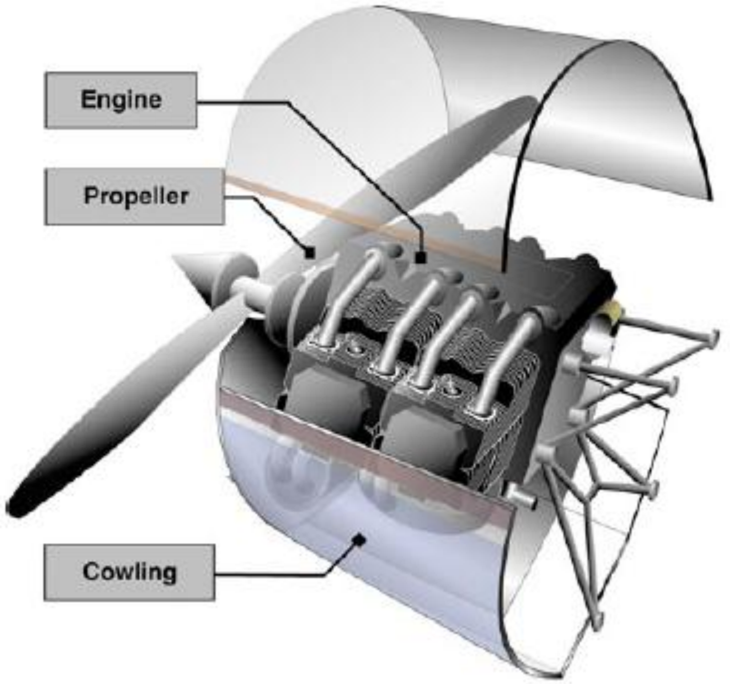


Figure 2-13. *Engine compartment.*

2. TYPES OF AIRCRAFT CONSTRUCTION

- The construction of aircraft fuselages evolved from the early wood truss structural arrangements to monocoque shell structures to the current semimonocoque shell structures.

Truss Structure

- The main drawback of truss structure is its lack of a streamlined shape.

- In this construction method, lengths of tubing, called longerons, are welded in place to form a well-braced framework.

- Vertical and horizontal struts are welded to the longerons and give the structure a square or rectangular shape when viewed from the end.

- Additional struts are needed to resist stress that can come from any direction. Stringers and bulkheads, or formers, are added to shape the fuselage and support the covering.

- Most modern aircraft use a form of this stressed skin structure known as monocoque or semimonocoque construction. *[Figure 2-14]*

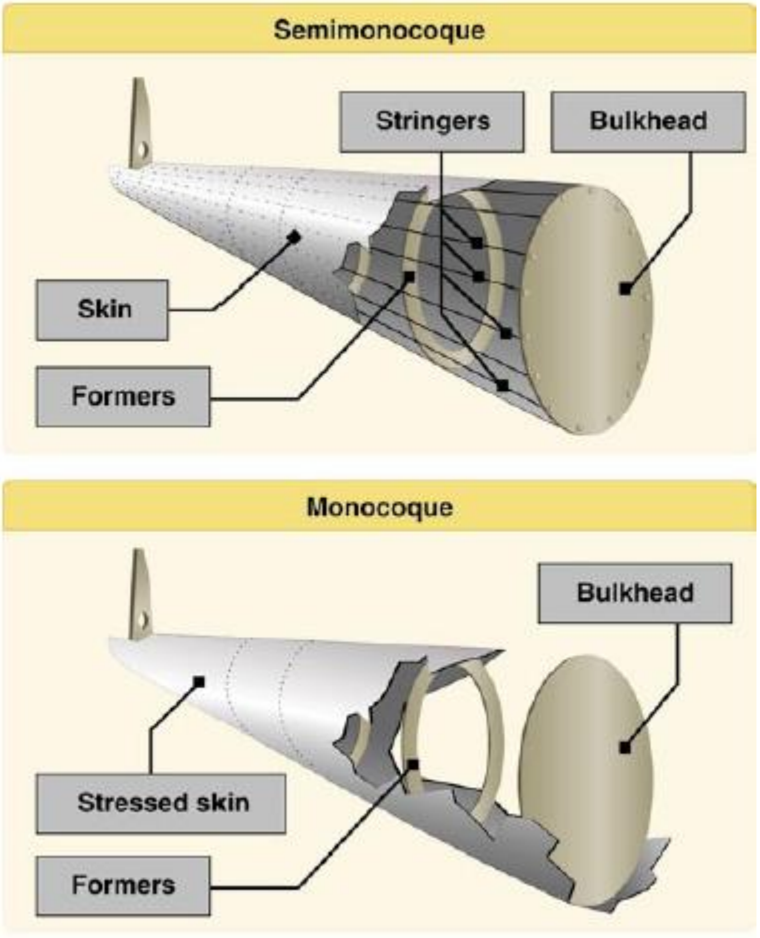


Figure 2-14. *Semimonocoque and monocoque fuselage design.*

Monocoque

- Monocoque construction uses stressed skin to support almost all loads much like an aluminum beverage can.
- Although very strong, monocoque construction is not highly tolerant to deformation of the surface.
- For example, an aluminum beverage can supports considerable forces at the ends of the can, but if the side of the can is deformed slightly while supporting a load, it collapses easily.
- Because most twisting and bending stresses are carried by the external skin rather than by an open framework, the need for internal bracing was eliminated or reduced, saving weight and maximizing space.
- One of the notable and innovative methods for using monocoque construction was employed by Jack Northrop.
- In 1918, he devised a new way to construct a monocoque fuselage used for the Lockheed S-1 Racer.
- The technique utilized two molded plywood half-shells that were glued together around wooden hoops or stringers.
- To construct the half shells, rather than gluing many strips of plywood over a form, three large sets of spruce strips were soaked with glue and laid in a semi-circular concrete mold that looked like a bathtub.

- Then, under a tightly clamped lid, a rubber balloon was inflated in the cavity to press the plywood against the mold.
- Twenty-four hours later, the smooth half-shell was ready to be joined to another to create the fuselage.
- The two halves were each less than a quarter inch thick.
- Although employed in the early aviation period, monocoque construction would not reemerge for several decades due to the complexities involved.
- Every day examples of monocoque construction can be found in automobile manufacturing where the unibody is considered standard in manufacturing.

Semimonocoque

- Semimonocoque construction, partial or one-half, uses a substructure to which the airplane's skin is attached.

- The substructure, which consists of bulkheads and/or formers of various sizes and stringers, reinforces the stressed skin by taking some of the bending stress from the fuselage.

- The main section of the fuselage also includes wing attachment points and a firewall.

- On single-engine airplanes, the engine is usually attached to the front of the fuselage.

- There is a fireproof partition between the rear of the engine and the flight deck or cabin to protect the pilot and passengers from accidental engine fires.

- This partition is called a firewall and is usually made of heat-resistant material such as stainless steel.

- However, a new emerging process of construction is the integration of composites or aircraft made entirely of composites.

Composite Construction (*History)*

- The use of composites in aircraft construction can be dated to World War II aircraft when soft fiberglass insulation was used in B-29 fuselages.
- By the late 1950s, European high performance sailplane manufacturers were using fiberglass as primary structures.
- In 1965, the FAA type certified the first all-fiberglass aircraft in the normal category, a Swiss sailplane called a Diamant HBV.
- Four years later, the FAA certified a four-seat single-engine Windecker Eagle in the normal category.
- By 2005, over 35 percent of new aircraft were constructed of composite materials.
- Composite is a broad term and can mean materials such as fiberglass, carbon fiber cloth, Kevlar$^{©}$ cloth, and mixtures of all of the above.

- Composite construction offers two advantages: extremely smooth skins and the ability to easily form complex curved or streamlined structures. *[Figure 2-15]*

3. DEVELOPMENTS IN AERODYNAMICS

THE FIRST 50 YEARS

- Developments in aerodynamics between the first and second World wars focused on adopting thick airfoil sections, the development of much faster and structurally sound monoplanes, and the development of better flight controls: ailerons, elevators and rudders with spring tabs, trim tabs, and horns.
- For an excellent review of the status of flight control design in 1945 see Morgan and Thomas (1945).
- Effective highlift devices were also developed such as
  - split flaps- Wilbur Wright and J. M. H. Jacobs in 1920
  - slotted wing-Handley Page in 1919 and Lachmann in 1918
  - automatic slat -Handley Page in 1926 (Pleines, 1961)
  - Fowler flap -1924 by Harlan D. Fowler (Miller and Sawers, 1968).
- Most early aircraft development did not benefit from theoretical aerodynamics.
- Inventors and engineers developed ideas and tested them either in the wind tunnel or in the sky.
- They adopted the successes and discarded the many failures.
- But at the same time, the theorists were developing analytic methods and an understanding of how aerodynamics worked.
- Key contributions, prior to the First World War, include Prandtl’s boundary-layer theory and the lifting-line theory.
- The period between the first and second World wars saw the development of important theories for ideal fluid flow, thin airfoil theory, compressible flow, and continued development of boundary-layer theory and wing theory.
- The best reference during this period is the six-volume series, Aerodynamic Theory, edited by Durand. It includes a historical review and contributions from Prandtl, (viscous flow and boundary-layer theory), von Karman and Burgers (ideal fluid flow), and Betz (airfoil theory).

- Other topics include flight dynamics (B. Melvill Jones), experimental research (Toussaint and Jacobs), and compressible fluids (G.I. Taylor).
- Drag rise at transonic speed was recognized as a problem during the 1930s and Adolf Busemann, in Germany, developed the concept of wing sweep in 1935, which would allow aircraft to fly at higher supersonic speeds.
- The first swept wing fighter, the Me-262 was developed by Germany during the Second World War and had a modest amount of sweep.
- So what was the status of aerodynamics in 1953? The sound barrier had been broken by Chuck Yeager 6 years earlier in the Bell X-1, and supersonic aerodynamics, in theory and in practice, was progressing rapidly.
- The United States was developing the Century series of fighters and the first generation of jet transports were also under development.
- Here in Canada, A.V. Roe was about to launch the Avro Arrow program and at the other end of the scale, de Havilland Canada had developed a small bush plane with short takeoff and landing capability, (STOL), the DHC-2, which would be known as the Beaver.

THE LAST 50 YEARS:

Supersonic Aerodynamics

- When German research was examined at the end of the Second World War, the benefits of wing sweep were immediately appreciated by U.S. scientists and engineers and incorporated into new designs.
- The first two U.S. aircraft with sweep were both subsonic, the Boeing B-47 bomber with 35° of sweep (1947) and the F-86 Sabre also with 35° of sweep.
- At that time, R.T. Jones at NACA was also developing an understanding of the benefits of sweep and advocating its use for high-speed aircraft.
- Important contributions to wing theory from that time include Jones' low-aspect-ratio wing theory (Jones, 1946), swept wing theory (Jones, 1947), and wing-body drag theory or supersonic area rule (Jones, 1956; Whitcomb and Sevier, 1960).
- An excellent review of wing aerodynamics is Jones' 1990 book *Wing Theory* and the classic text is Ashley and Landahl, *Aerodynamics of Wings and Bodies* (1965).

Variable Sweep

- The advantages of wing sweep at high speed are a definite disadvantage at low speed.
- With highly swept low-aspect-ratio wings, the angle of attack needed for low-speed flight is very high, which can make it impossible for the pilot to see the runway.
- The Concorde and TU-144 later resolved this problem by drooping the nose at low speeds but a better aerodynamic solution is to vary the wing sweep, low sweep for low speed and high sweep for transonic and supersonic flight.
- Variable sweep was first tested on the Bell X-5 on 20 June 1951. This airplane was based on the Messerschmitt P.1101, which was captured at the end of Second World War.
- The P.1101 had ground adjustable wing sweep and was intended for research but never flew. The X-5 could vary the wing sweep in flight from 20° to 60° and first flew in 1951.
- It was over a decade, however, until a manufacturer adopted the swing-wing.
- The first production airplane with a swing-wing, the F-111, flew in November 1964. Several other swing-wing fighters and bombers were developed

Transonic Aerodynamics

- In the early 1950s, Richard Whitcomb examined wing-body combinations in the 8 ft transonic wind tunnel at NACA's The result was the coke-bottle shaped fuselage, which is evident on many transonic aircraft and supersonic aircraft and delays the onset and reduces the magnitude of drag rise.

- For high-speed transports, the wing-fuselage junction is usually not modified, but the concept is useful in understanding interference problems.

Propeller STOL Aircraft

- Following the cancellation of the Avro Arrow program, the focus of Canadian research and development shifted to STOL.
- Both aircraft had excellent field performance and could be operated on wheels, skis, or floats. de Havilland then moved into small military transports that had the design objective of supplying troops close to the front line on small semi-prepared landing strips.
- Both the DHC-4 Caribou (1958) and the larger DHC-5 Buffalo (1964) had excellent field performance. In STOL operations, the Buffalo carrying a payload of almost 12 000 lbs could operate out of a 1250 ft strip.

The Augmentor Wing

- During the 1960s, while de Havilland was developing successful propeller STOL aircraft, it was also researching ways to apply turbojet and turbofan technology to STOL aircraft. The objective was to develop an aircraft with shortfield performance and jet cruise speeds.
- Don Whittley was working on the augmentor wing concept where trailing-edge blowing from the main airfoil, between upper and lower flaps, can be used to generate very high lift coefficients.
- This configuration can provide performance, which is superior to either blown flaps or jet flaps (Whittley, 1967), and the research was supported by both DRA and NASA.

Beyond STOL — Regional Aircraft

- Development of the 36 passenger Dash 8 airplane in the early 1980s was aimed at the regional, (then called commuter), aircraft market. Good field performance was still a requirement, 3000 ft for takeoff and landing, but STOL operations were not necessary (Jackson, 1982).
- Dash 8 development relied heavily on wind-tunnel testing for the evaluation of various design options that were developed using, primarily, panel methods.
- Panel methods were used for analysis of the whole aircraft, without coupled boundary-layer analysis.
- Panel methods with a coupled boundary layer were used for two-dimensional analysis and design of the thick wing sections and flaps. Both direct analysis and inverse methods were employed, and separated-flow modeling was included to predict maximum lift (Eggleston, 1984).

Advanced Propellers, Prop-Fans, and Unducted Fan (UDF) Research

- As a result of rapidly increasing fuel costs in the 1970s, much research was undertaken to explore the possibility of advanced turboprops to replace turbofans on transonic aircraft.
- Significant fuel savings, perhaps as much as 30%, may be obtained by using propellers with 8, 10 or more blades rather than ducted fans. But to operate effectively at transonic speeds the propeller blades need to be very thin and (or) swept and rotate relatively slowly.

The Dash 8 Series 400

- After several delays, de Havilland, now owned by Bombardier, launched the Dash 8 Series 400 program in 1995.
- The Series 400 turboprop was intended not only as a stretch of the Dash 8 Series 300 from 50 seats to 70 but also as a highspeed alternative to jets.
- Although, $M = 0.7+$ turboprops were being researched, the Series 400 objectives were more modest since the aircraft was to be a derivative with minimum change.

THE FUTURE OF AERODYNAMICS — THE NEXT 50 YEARS

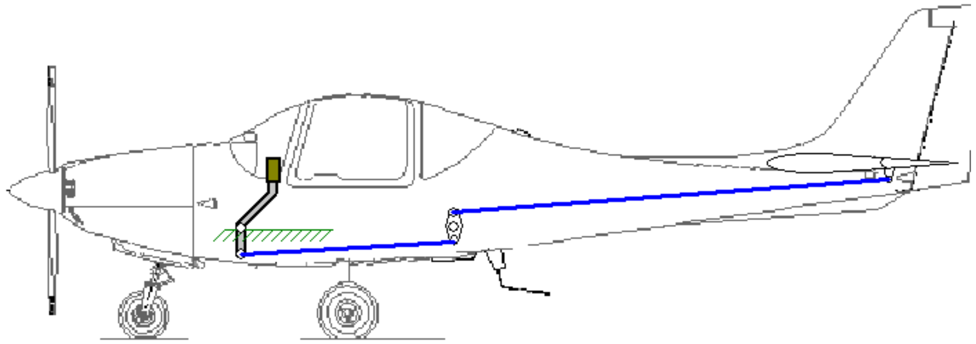
- In 1970, the Future of Aeronautics was published for the Centenary of the Royal Aeronautical Society and authors were asked to make predictions for the next 100 years.
- Many authors predicted V/STOL aircraft as the way of the future, including A.H. Stratford (1970).
- Thirty years on, it’s safe to say the V/STOL is not the way of the future and predictions that cities would need one VSTOL port for each 2 1/2 million people, (giving London 4 or 6!), now seem ridiculous.

- Large airports are going to get larger and ways must be found to cope with the congestion. Aircraft will have to be larger, although it may be quite a while yet before we see the 1000 seat transport, which Stratford expected by the mid-1990s.

DIRECT MECHANICAL (CONVENTIONAL) CONTROL

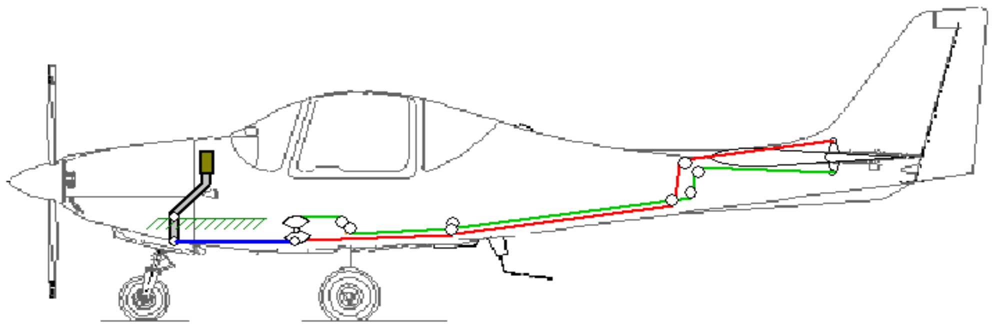
PUSH-PULL RODS SYSTEM

1. The linkage from cabin to control surface can be fully mechanical if the aircraft size and its flight envelop allow;
2. In this case the hinge moment generated by the surface deflection is low enough to be easily contrasted by the muscular effort of the pilot.
3. Two types of mechanical systems are used: push-pull rods and cable-pulley.
4. In the first case a **sequence of rods** link the control surface to the cabin input.
5. **Bell-crank levers** are used to change the direction of the rod routings.
6. Vibrations of the rods can introduce oscillating deflections of the surface.



CABLE-PULLEY SYSTEM

1. The couples of cables are used in place of the rods.
2. In this case **pulleys** are used to alter the direction of the lines,
3. **Idlers** to reduce any slack due to structure elasticity, cable strands relaxation or thermal expansion.
4. Often the cable-pulley solution is preferred, because is more flexible and allows reaching more remote areas of the airplane.

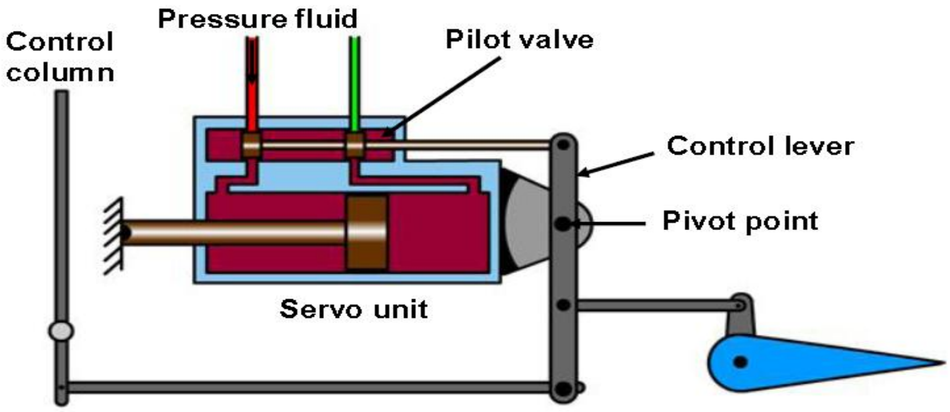


POWER OPERATED AND POWER ASSISTED

- Aircraft with cruise speeds of approximately 300 knots and faster develop significant air loads on the control surfaces that are difficult for the pilot to overcome when operating the controls without mechanical advantage.
- As a result, aircraft in this category will typically employ hydraulically operated flight controls.
- Conventional cable or pushrod systems are installed in the aircraft as usual, but tied into a power transmission quadrant.
- When the system is activated, the pilot's control inputs do not go directly to individual control surfaces.
- Instead, the inputs open and close hydraulic valves that direct hydraulic fluid to individual actuators. The actuator moves the control surface to the requested position.
- There are two primary methods of providing for hydraulic control system failure.

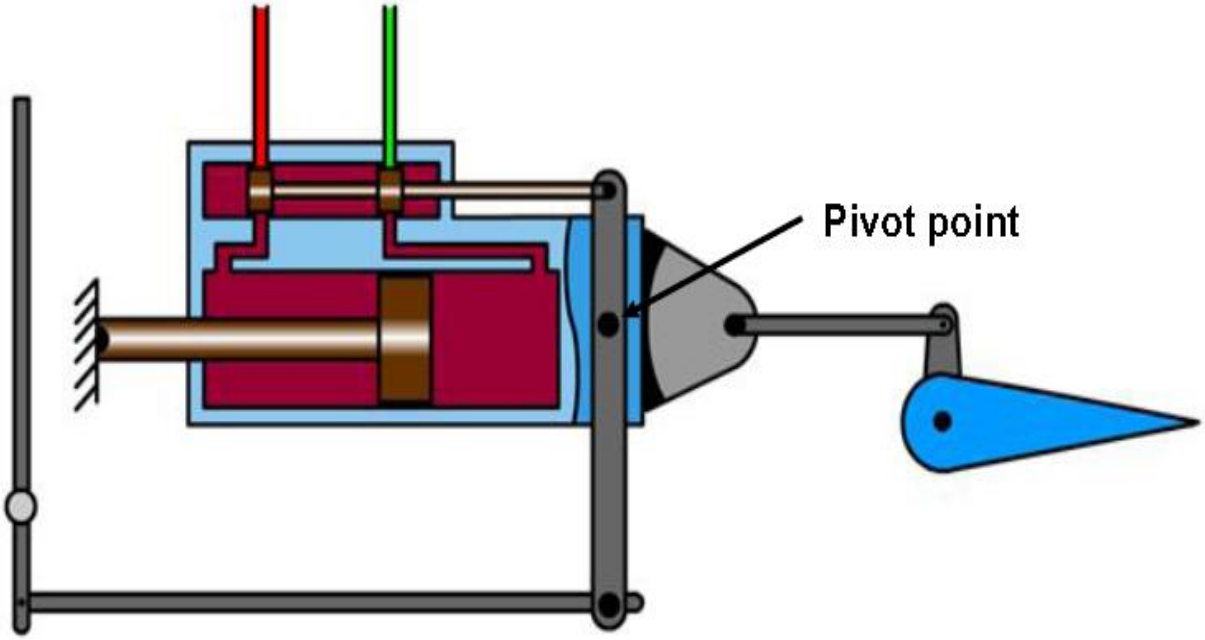
POWER ASSISTED CONTROL

- The pilot’s control is connected to the control surface through push pull rod and control lever.
- E.g., control column to initiate a climb say, the control lever pivots about point ‘X’ and Moving the elevators up**.**
- At the same time, the control valve pistons are displaced and this allows oil from the hydraulic system to flow to the left hand side of the actuating jack piston.
- The rod of which is secured to the aircraft’s structures.
- The reaction of the pressure exerted on the piston causes the whole servo unit, and control lever, to move to the left because of the greater control effort produced.
- The pilot is assisted in making further upward movement of the elevator.



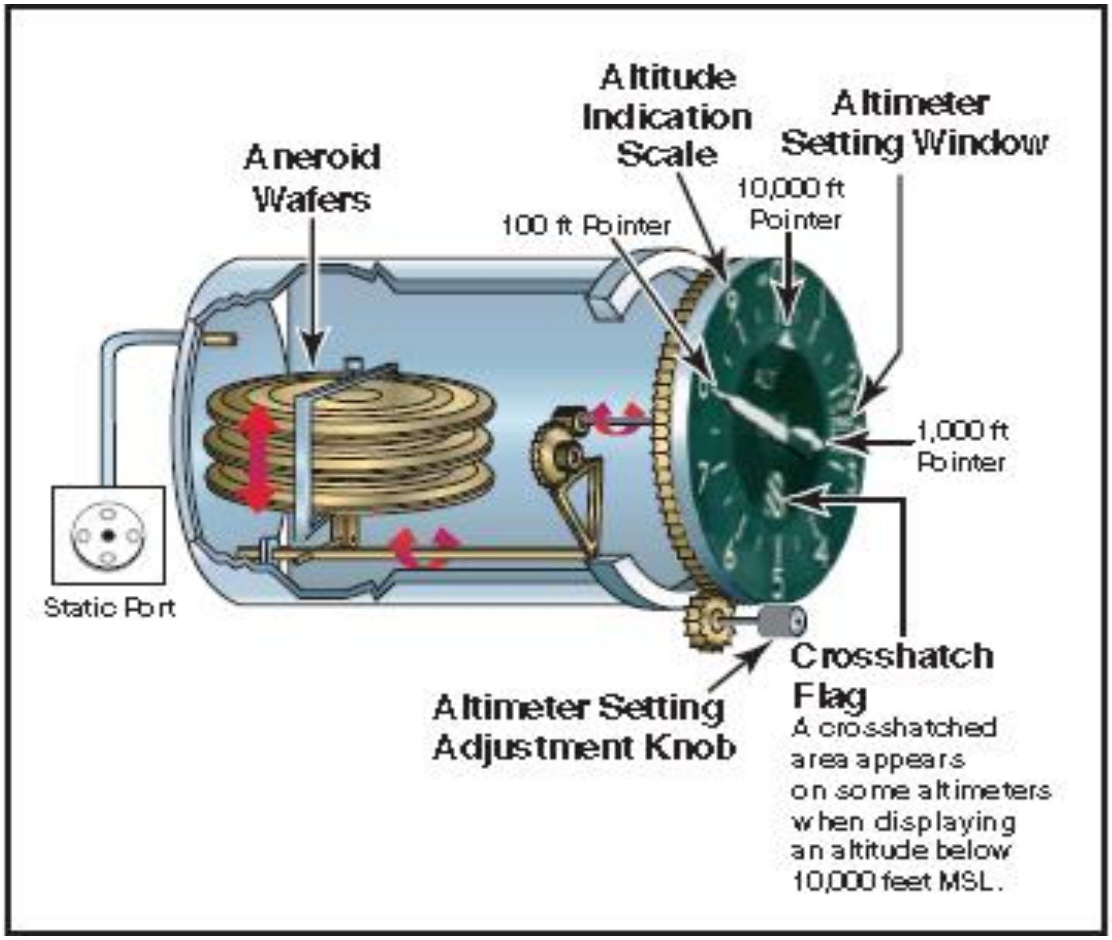
FULLY POWERED CONTROL

- In this system pilot control is connected to the control lever only while servo-unit directly connected to the control surface.
- Thus, the effort required by the pilot to move the control column is simply that needed to move the control lever and control valve piston.
- It does not vary with the effort required to move the control surface, which is supplied solely by servo-unit hydraulic power.
- Since no forces are transmitted back to the pilot. The pilot has no feel of the aerodynamic load acting on the control surfaces.
- It is necessary to incorporate an ‘artificial feel’ device connected between the pilot’s controls and servo-unit control lever.
- A commonly used system for providing artificial feel is the one known as ‘q’ feel.
- In this system, the feel force varies with dynamic pressure of the air, the pressure being sensed by pitot –tube or bellows type sensing element.
- The sensing element connected in the hydraulic powered controls.
- The hydraulic unit produces control forces dependent on the amount of control movement and forward speed of the aircraft.



ALTIMETER

1. The altimeter measures the height of the airplane above a given pressure level. Since it is the only instrument that gives altitude information.
2. A stack of sealed **aneroid** wafers comprises the main component of the altimeter. These wafers expand and contract with changes in atmospheric pressure from the static source.
3. The mechanical linkage translates these changes into pointer movements on the indicator. [Figure 6-2]



PRINCIPLE OF OPERATION

4. The pressure altimeter is an aneroid barometer that measures the pressure of the atmosphere at the level where the altimeter is located, and presents an altitude indication in feet.

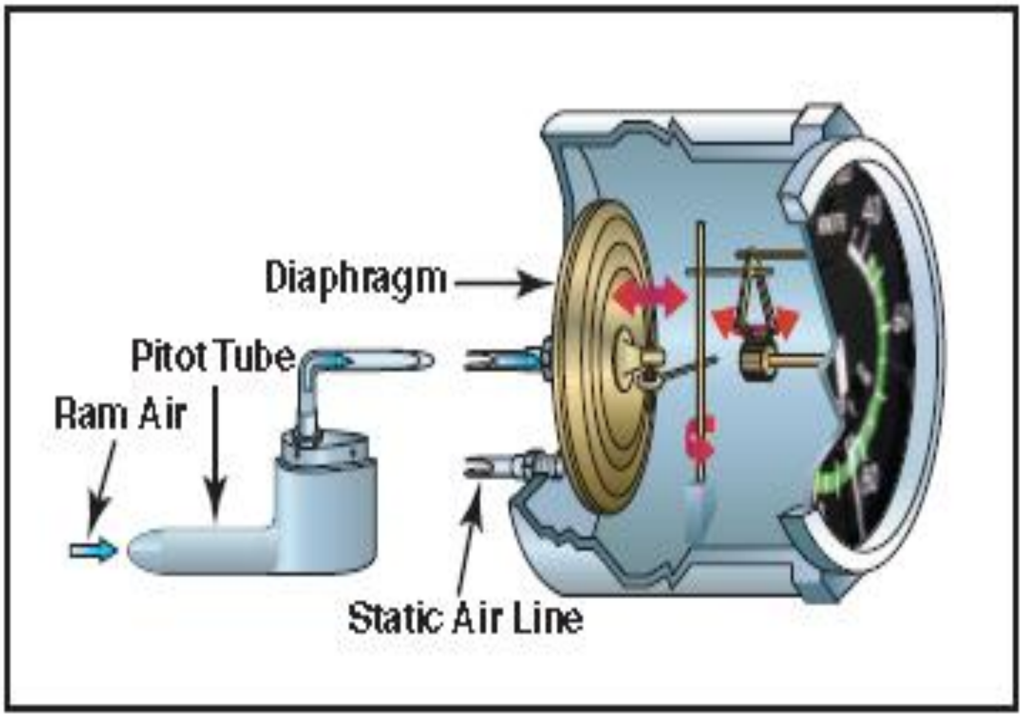
5. The altimeter uses static pressure as its source of operation. Air is denser at sea level than aloft, so as altitude increases, atmospheric pressure decreases.
6. This difference in pressure at various levels causes the altimeter to indicate changes in altitude.
7. Some have one pointer while others have two or more.
8. The dial of a typical altimeter is graduated with numerals arranged clockwise from 0 to 9.
9. Movement of the aneroid element is transmitted through gears to the three hands that indicate altitude.
10. The **shortest hand** indicates altitude in tens of thousands of feet; the **intermediate hand** in thousands of feet; and the **longest hand** in hundreds of feet.
11. This indicated altitude is correct, however, only when the sea level barometric pressure is standard (29.92 inches of mercury), the sea level free air temperature is standard (+15°C or 59°F), and the pressure and temperature decrease at a standard rate with an increase in altitude.

Pilots are mainly concerned with five types of altitudes:

Indicated Altitude	That altitude read directly from the altimeter (uncorrected) when it is set to the current altimeter setting.
True Altitude	The vertical distance of the airplane above sea level—the actual altitude. It is often expressed as feet above mean sea level (MSL). Airport, terrain, and obstacle elevations on aeronautical charts are true altitudes.
Absolute Altitude	The vertical distance of an airplane above the terrain, or above ground level (AGL).
Pressure Altitude	The altitude indicated when the altimeter setting window (barometric scale) is adjusted to 29.92. This is the altitude above the standard datum plane, which is a theoretical plane where air pressure. (corrected to 15°C) equals 29.92 in. Hg. Pressure altitude is used to compute density altitude, true altitude, true airspeed, and other performance data.

AIRSPEED INDICATOR

1. The airspeed indicator is a sensitive, differential pressure gauge which measures and shows promptly the difference between pitot or impact pressure, and static pressure, the undisturbed atmospheric pressure at level flight.
2. These two pressures will be equal when the airplane is parked on the ground in calm air.
3. When the airplane moves through the air, the pressure on the pitot line becomes greater than the pressure in the static lines.
4. This difference in pressure is registered by the airspeed pointer on the face of the instrument, which is calibrated in miles per hour, **knots**, or both.



Pilots should understand the following speeds:

Indicated Airspeed (IAS)—The direct instrument reading obtained from the airspeed indicator, uncorrected for variations in atmospheric density, installation error, or instrument error.

Calibrated Airspeed (CAS)—Indicated airspeed corrected for installation error and instrument error. Although manufacturers attempt to keep airspeed errors to a minimum, it is not possible to eliminate all errors throughout the airspeed operating range.

True Airspeed (TAS)—Calibrated airspeed corrected for altitude and nonstandard temperature. Because air density decreases with an increase in altitude, an airplane has to be flown faster at higher altitudes to cause the same pressure difference between pitot impact pressure and static pressure.

Groundspeed (GS)—The actual speed of the airplane over the ground. It is true airspeed adjusted for wind. Groundspeed decreases with a headwind, and increases with a tailwind.

VERTICAL SPEED INDICATOR

1. The vertical speed indicator (VSI), which is sometimes called a vertical velocity indicator (VVI), indicates whether the airplane is climbing, descending, or in level flight.
2. The rate of climb or descent is indicated in feet per minute. If properly calibrated, the VSI indicates zero in level flight.

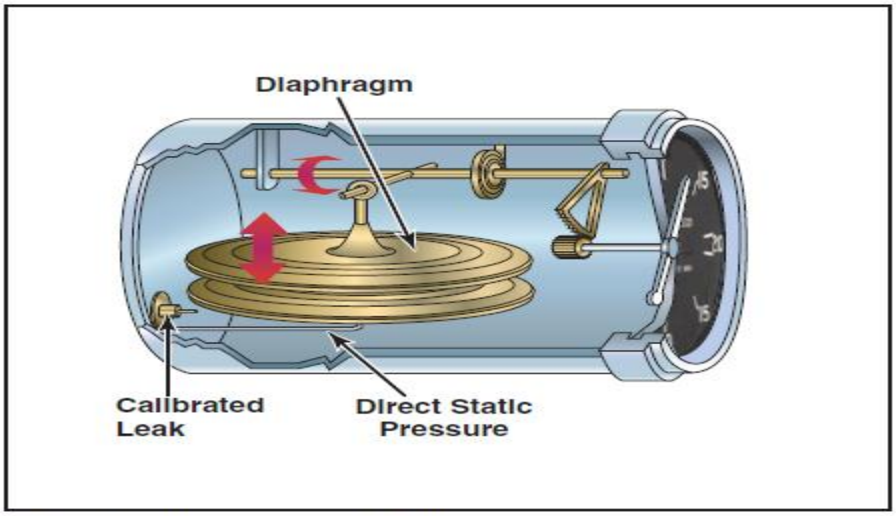


Figure 6-4. Vertical speed indicator.

PRINCIPLE OF OPERATION

1. Although the vertical speed indicator operates solely from static pressure, it is a differential pressure instrument.
2. It contains a diaphragm with connecting linkage and gearing to the indicator pointer inside an airtight case.
3. The inside of the diaphragm is connected directly to the static line of the pitot-static system.
4. The area outside the diaphragm, which is inside the instrument case, is also connected to the static line, but through a restricted orifice (calibrated leak).
5. Both the diaphragm and the case receive air from the static line at existing atmospheric pressure.
6. When the airplane is on the ground or in level flight, the pressures inside the diaphragm and the instrument case remain the same and the pointer is at the zero indication.
7. When the airplane climbs or descends, the pressure inside the diaphragm changes immediately, but due to the metering action of the restricted passage, the case pressure remains higher or lower for a short time, causing the diaphragm to contract or expand.

8. This causes a pressure differential that is indicated on the instrument needle as a climb or descent.
9. When the pressure differential stabilizes at a definite ratio, the needle indicates the rate of altitude change.
10. The vertical speed indicator is capable of displaying two different types of information:
    - Trend information shows an immediate indication of an increase or decrease in the airplane's rate of climb or descent.
    - Rate information shows a stabilized rate of change in altitude.

PITOT-STATIC FLIGHT INSTRUMENTS

1. There are two major parts of the pitot-static system: the impact pressure chamber and lines, and the static pressure chamber and lines.
2. They provide the source of ambient air pressure for the operation of the altimeter, vertical speed indicator (vertical velocity indicator), and the airspeed indicator.

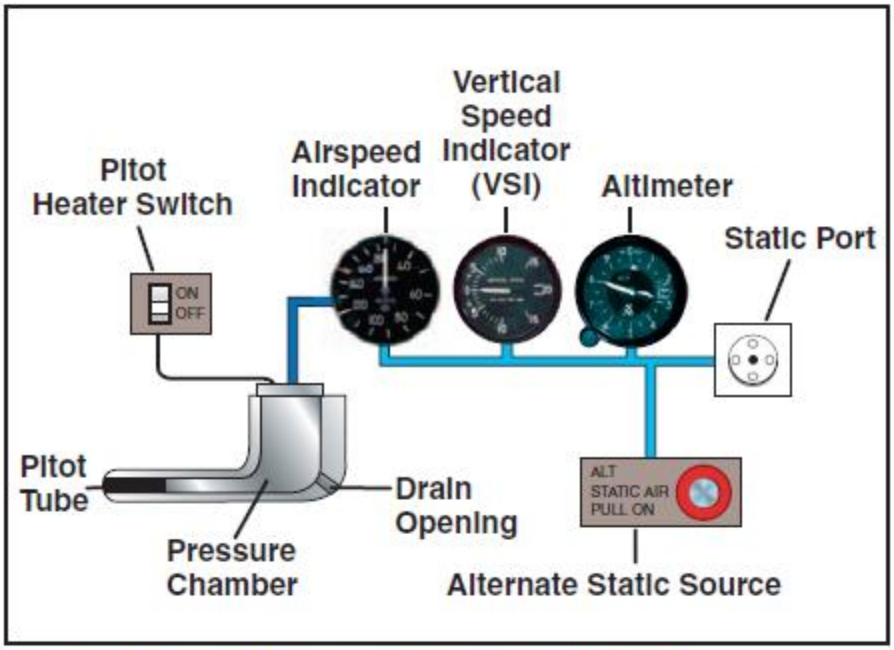


Figure 6-1. Pitot-static system and instruments.

IMPACT PRESSURE CHAMBER AND LINES

1. In this system, the impact air pressure (air striking the airplane because of its forward motion) is taken from a pitot tube
2. The static pressure (pressure of the still air) is usually taken from the static line attached to a vent or vents mounted flush with the side of the fuselage.
3. This compensates for any possible variation in static pressure due to erratic changes in airplane attitude.
4. The openings of both the pitot tube and the static vent must be checked during the preflight inspection to assure that they are free from obstructions.
5. Blocked or partially blocked openings should be cleaned by a certificated mechanic.
6. Blowing into these openings is not recommended because this could damage the instruments.
7. As the airplane moves through the air, the impact pressure on the open pitot tube affects the pressure in the pitot chamber.
8. Any change of pressure in the pitot chamber is transmitted through a line connected to the airspeed indicator, which utilizes impact pressure for its operation.

STATIC PRESSURE CHAMBER AND LINES

1. The static chamber is vented through small holes to the free undisturbed air, and as the atmospheric pressure increases or decreases, the pressure in the static chamber changes accordingly.
2. Again, this pressure change is transmitted through lines to the instruments which utilize static pressure.
3. An alternate source for static pressure is provided in some airplanes in the event the static ports become blocked.
4. This source usually is vented to the pressure inside the cockpit.
5. When the alternate static source is used, the following differences in the instrument indications usually occur: the altimeter will indicate higher than the actual altitude, the airspeed will indicate greater than the actual airspeed, and the vertical speed will indicate a climb while in level flight.
6. Consult the Airplane Flight Manual or Pilot’s Operating Handbook (AFM/POH) to determine the amount of error.