A REPORT ON INDUSTRIAL TRAINING IN

HINDUSTAN AERONAUTICS LIMITED
LUCKNOW (ACCESSORIES DIVISON)

SUBMITTED BY

GAURAV ANAND

BACHELORS OF TECHNOLOGY

ELECTRONICS AND COMMUNICATIONS

ROLL NO. - 1130434019

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तकनीकी प्रशिक्षण केन्द्र
TECHNICAL TRAINING CENTRE

प्रमाण पत्र
CERTIFICATE

नाम/ Name: GAURAV ANAND

क्षेत्र/ Area : B.TECH (ELECTRONICS & COMMUNICATION ENGINEERING)

संस्थान Institute : BABU BANARASI DAS UNIVERSITY

प्रशिक्षण अवधि/ Training Period : 01/07/2016 To 30/07/2016

प्रशिक्षण क्षेत्र/ Training Area : TECHNICAL TRAINING CENTRE

प्रशिक्षण अवधि में प्रगति/ Training Performance: संतोषजनक/ Satisfactory

प्रशिक्षण अवधि में आचरण/ Conduct During Training Period:

संतोषजनक/ Satisfactory

वरिष्ठ प्रबन्धक (प्रशिक्षण)
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Reg. No. : 262

दिनाँक/ Date: 30/07/2016

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Last but not least I would like to thank my family and friends for their co-operation and suggestion for this report.

GAURAV ANAND
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INTRODUCTION TO HAL

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HAL was established as Hindustan Aircraft in Bangalore in 1940 by Seth Walchand Hirachand to produce military aircraft for the Royal Indian Air Force. The initiative was actively encouraged by the Kingdom of Mysore, especially by the Diwan, Sir Mirza Ismail and it also had financial help from the Indian Government. Mysore was favored because of the availability of cheap electricity. The organization and equipment for the factory at Bangalore was set up by William D. Pawley of the Intercontinental Aircraft Corporation of New York, an exporter of American aircraft to the region. Pawley managed to obtain a large number of machine-tools and equipment from the United States.

After India gained independence in 1947, the management of the company was passed over to the Government of India.

Hindustan Aeronautics Limited (HAL) was formed on 1 October 1964 when Hindustan Aircraft Limited joined the consortium formed in June by the IAF Aircraft Manufacturing Depot, Kanpur.

During the 1980s, HAL's operations saw a rapid increase which resulted in the development of new indigenous aircraft such as HAL Tejas and HAL Dhruv. HAL also developed an advanced version of the MiG-21, known as MiG-21 Bison, which increased its life-span by more than 20 years. HAL has also obtained several multi-million dollar contracts from leading international aerospace firms such as Airbus, Boeing and Honeywell to manufacture aircraft spare parts and engines.

. Presently, HAL has 19 production units and 10 research and design units at 8 different locations. Two of the main divisions are:

- Aircraft Division, Bangalore- handles mostly aircrafts of Western origin
- Aircraft Division, Nasik- handles aircrafts of Russian origin mostly

HAL LUCKNOW (ACCESSORIES DIVISION)

HAL's contribution to the Indian Air Force includes 80% of the fighters, 100% of trainers and 50% of helicopters. HAL Lucknow division is involved in the process of accessories development for aircrafts.

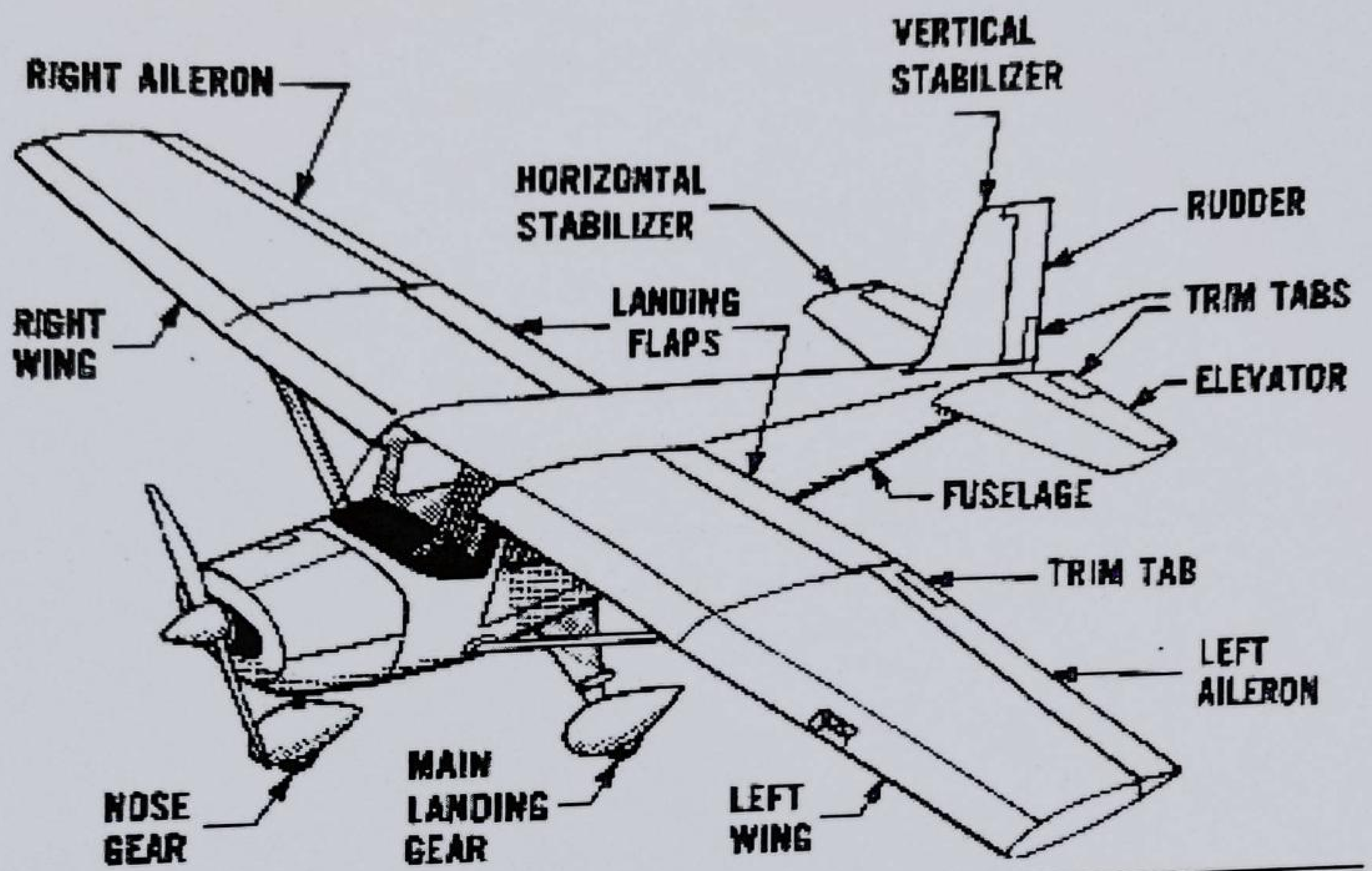
The main departments within Lucknow division are:

- Instrument department
- Fuel department
- Mechanical department

In addition, the division also manufactures the wide variety of ground support equipment like Ground Power Unit, hydraulic trolley, weapon loading trolley, Test equipment undercarriages, gyro and barometric instruments , air conditioning and pressurization and electrical system items etc . The Aerospace & equipment research & design Centre is involved in the design and development of hydraulic pumps, actuators, wheels and brakes etc.

The division today has a prime name in the aviation market and various international companies are interested to join hands with it for future project.

PARTS OF AN AEROPLANE



THE IMPORTANT PARTS OF AN AROPLANE

- WINGS
- FUSELAGE
- EMPENNAGE
- LANDING GEARS
- CONTROL SURFACE
- ENGINE

AIRCRAFT : CLASSIFICATION AND PARTS

1. Classification by configuration
   - Position of the wing
     - Low wing
     - Mid wing
     - High wing
   - Number of wings
     - Mono plane
     - Bi plane
     - Tri plane
   - Shape of the wings
     - Delta wing
     - Diamond wing
     - Swept wing
     - Gull shaped wing
   - Position of the wings
     - Conventional wing
     - No tail or tailess
     - Horizontal tail located aove the vertical tail
     - canard type
2. Location and type of landing gear
   - Retractable
   - Non retractable
   - Tail wheel
   - Nose wheel
3. Classification by power plants

A. Power plant types

- Piston engine
- Turbo prop
- Turbo shaft
- Turbo jet
- Turbo fan
- Rocket

B. Number of engines

- Single engine
- Two engine
- Multi engine

C. Location of the engines

- Nose
- Fuselage
- Jet engine submerged in wing
- Pylon mounting

4. Types of fuselage

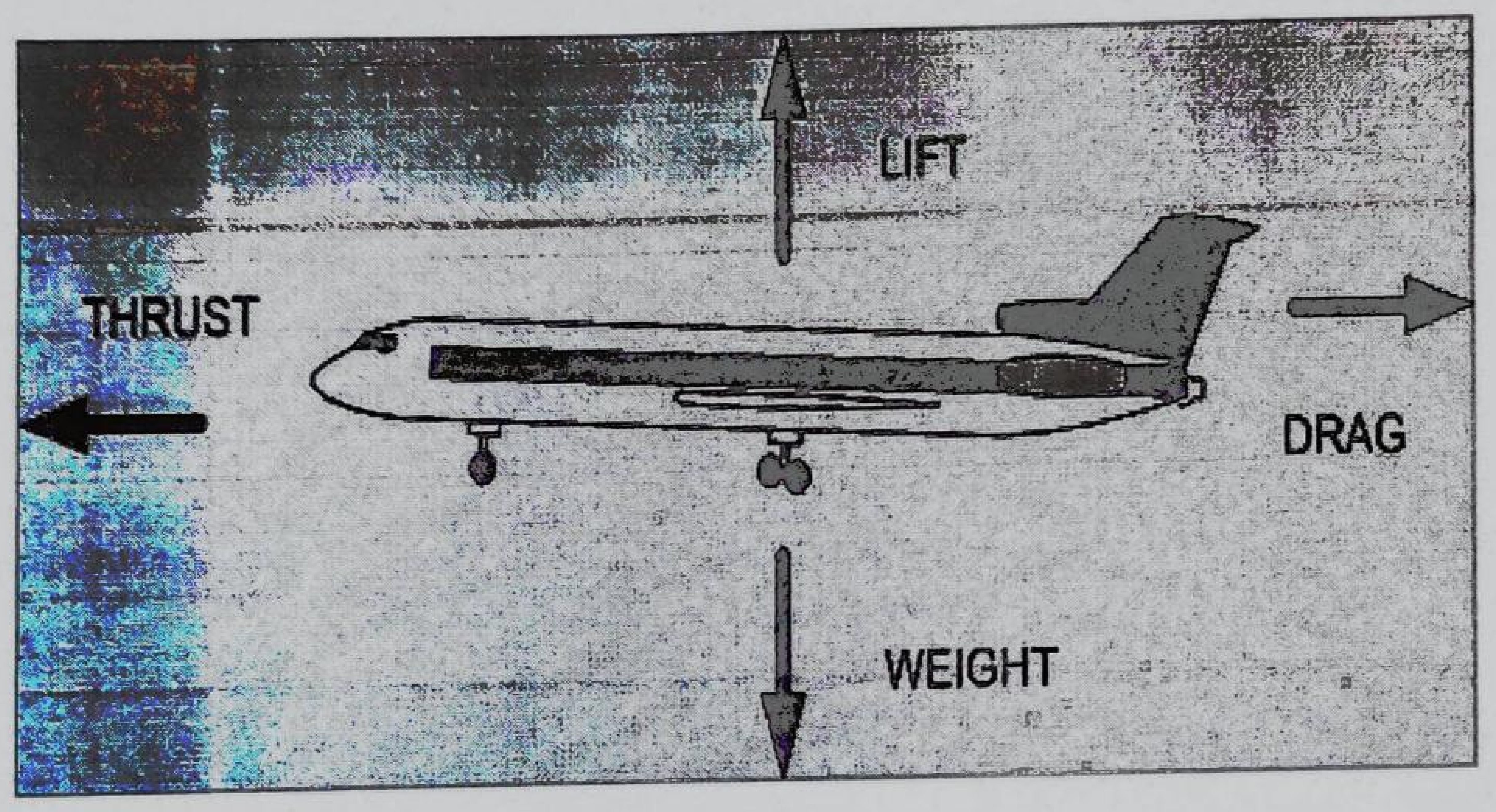
- Round
- Square
- Oval

5. Classification by purpose

a. Civil
b. Cargo
c. Military
    i. Bombers

BASIC AERODYNAMIC FLIGHT THEORY

In the 1400's Leonardo de Vinci designed a magnificent flying machine. 500 years later man succeeded in flying.



FORCES OF FLIGHT

The four forces are lift, thrust, drag, and weight .They push a plane up, down, forward, or slow it down.

- **WEIGHT**

Weight is a force that is always directed toward the center of the earth. The magnitude of the weight depends on the mass of all the airplane parts, plus the amount of fuel, plus any payload on board (people, baggage, freight, etc.). The weight is distributed throughout the airplane. But we can often think of it as collected and acting through a single point called the center of gravity.

- **LIFT**

To overcome the weight force, airplanes generate an opposing force called lift. Lift is generated by the motion of the airplane through the air and is an aerodynamic force. "Aero" stands for the air, and "dynamic" denotes motion. Lift is directed perpendicular to the flight direction. The magnitude of the lift depends on several factors including the shape, size, and velocity of the aircraft. As with weight, each part of the aircraft contributes to the aircraft lift force. Most of the lift is generated by the wings. Aircraft lift acts through a single point called the center of pressure. The center of pressure is defined just like the center of gravity, but using the pressure distribution around the body instead of the weight distribution. The distribution of lift around the aircraft is important for solving the control problem.

- **DRAG**

As the airplane moves through the air, there is another aerodynamic force present. The air resists the motion of the aircraft and the resistance force is called drag. Drag is directed along and opposed to the flight direction. Like lift, there are many factors that affect the magnitude of the drag force including the shape of the aircraft, the "stickiness" of the air, and the velocity of the aircraft. Drag acts through the aircraft center of pressure.

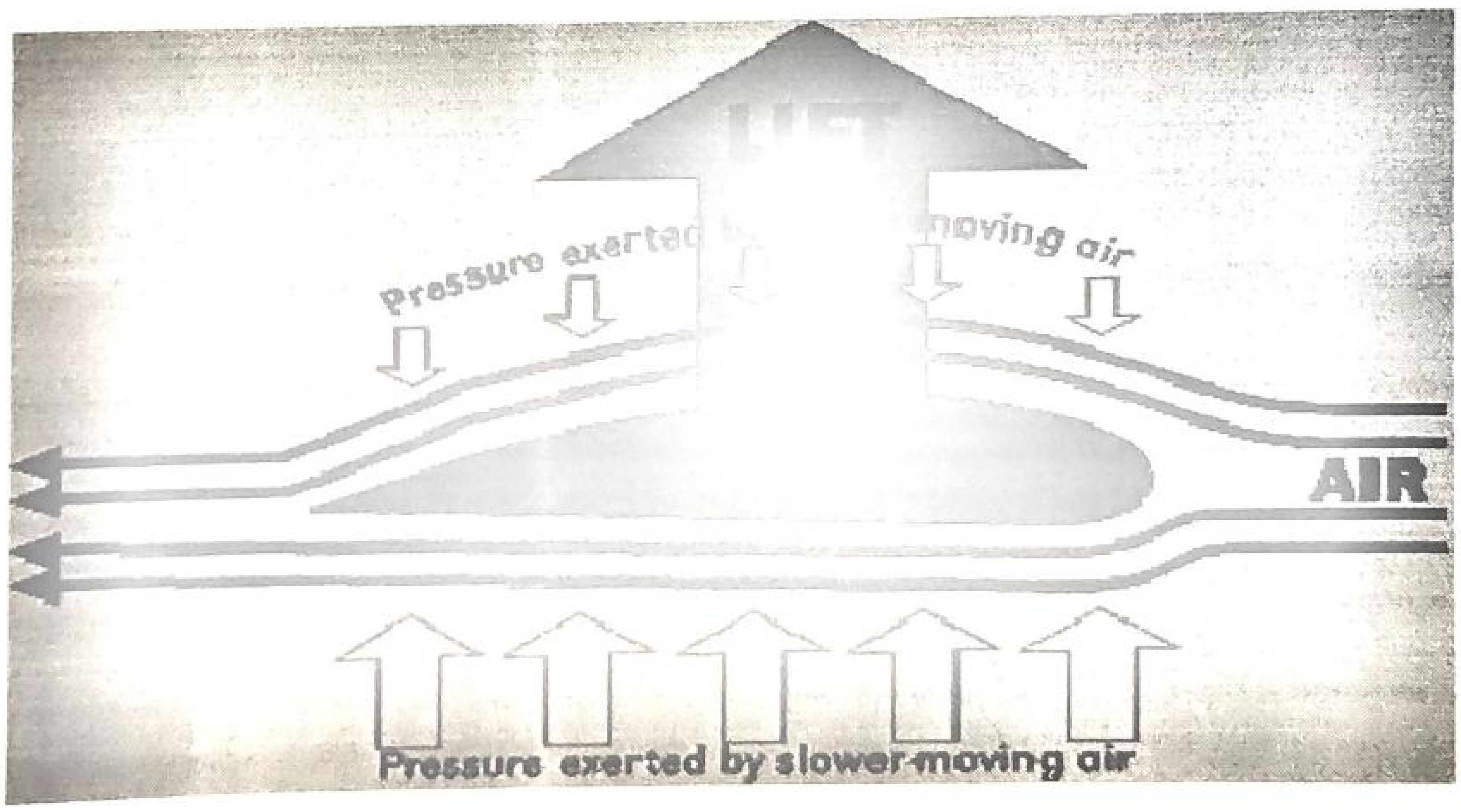
- **THRUST**

To overcome drag, airplanes use a propulsion system to generate a force called thrust. The direction of the thrust force depends on how the engines are attached to the aircraft.

The magnitude of the thrust depends on many factors associated with the propulsion system including the type of engine, the number of engines, and the throttle setting.

AIRPLANE WINGS – HOW LIFT IS CREATED

All vertical movement of the aircraft is a consequence of a relative imbalance between the weight of the aircraft and the force of lift produced by the airplane wings. The wings of an aircraft are airfoils designed to create this force of vertical motion. Any surface that alters the airflow to the advantage of a produced force in a particular direction is termed as an airfoil. Airplane wings, designed as airfoils, achieve this by interacting with the remote airflow to produce the desired lift.



ELECTRICAL AND ELECTRONICS ACCESSORIES

VOLTAGES IN AIRCRAFT

Aircraft electrical components operate on many different voltages both AC and DC. The most of the aircraft systems use:

- 115 volts (V) AC at 400 hertz (Hz)
- 28 volts DC

DC power is generally provided by "self-exciting" generators containing electromagnetics, where the power is generated by acommutatorwhich regulates the output voltage of28 volts DC. AC power, normally at a phase voltage of 115 V, is generated by an alternator, generally in a three-phase system and at a frequency of 400 Hz.

Aircraft used to use generators to generate electricity but modern designs use an alternator which is lighter and has more capacity and can generate more power at lower RPMs than the good old generator could.

GENERATORS

In a generator the magnetic field is generated by a stationary permanent magnet and a coil is rotated within the field (the other way around works too). Two slip rings are used to pick up the AC voltage. If a DC voltage is required the slip rings are replaced by a commutator. A commutator makes sure that the same polarity voltage is pickup by the brushes at the same angular position. This will rectify the alternating voltage for use in the aircraft.

engine drives the generator) and with a variety of electrical demands, all generators must be regulated by some control system. The generator control system is designed to keep the generator output within limits for all flight variables. Generator control systems are often referred to as voltage regulators or generator control units (GCU).

Aircraft generator output can easily be adjusted through control of the generator's magnetic field strength.

Functions of Generator Control Systems

Most generator control systems perform a number of functions related to the regulation, sensing, and protection of the DC generation system. Light aircraft typically require a less complex generator control system than larger multiengine aircraft. Some of the functions of generator control units are listed below:

- Voltage Regulation
- Overvoltage Protection
- Parallel Generator Operations
- Over excitation Protection
- Reverse Current Sensing

ALTERNATOR CONTROL UNIT

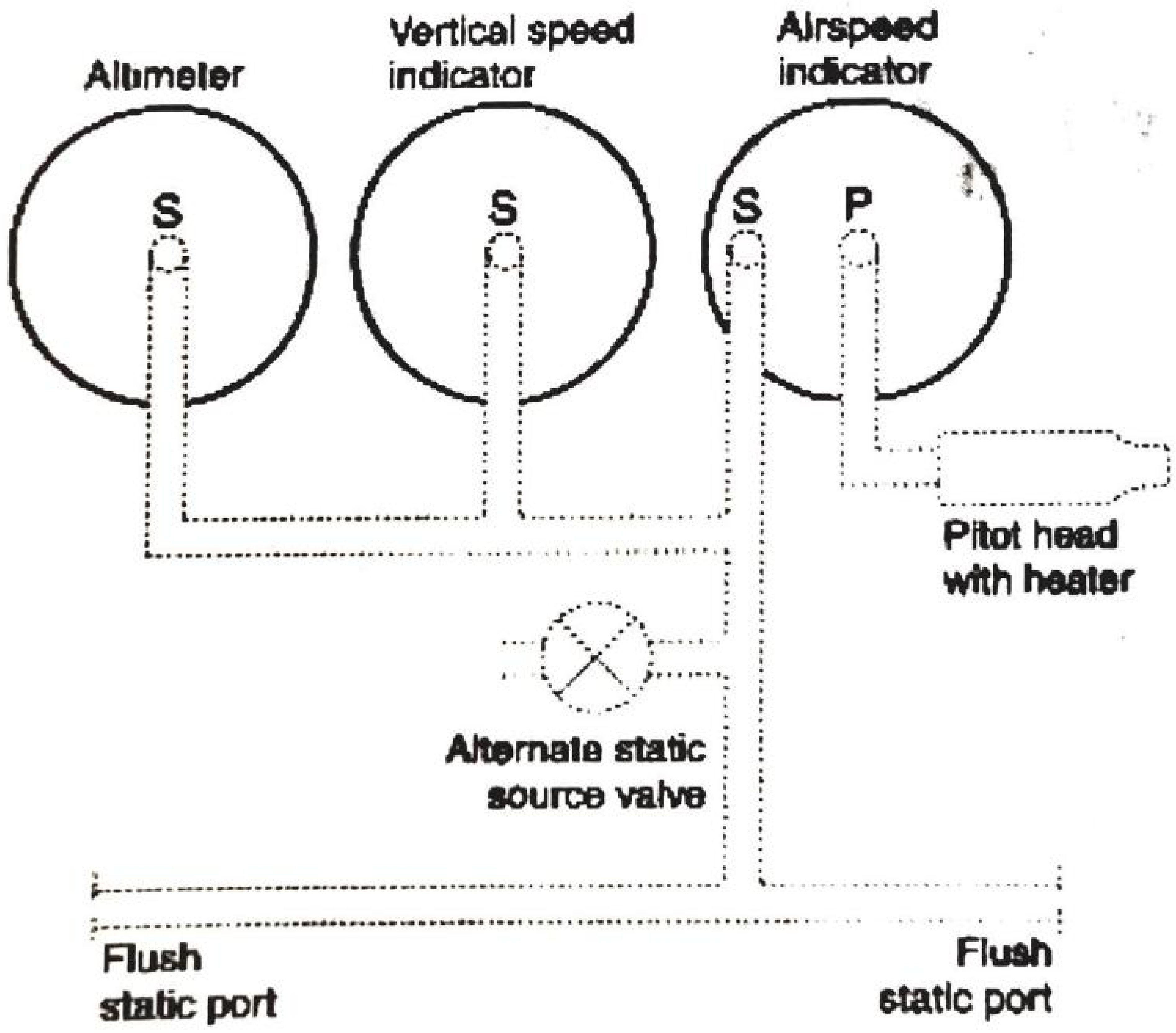
Solid-state regulators for modern light aircraft are often referred to as alternator control units (ACUs). These units contain no moving parts and are generally considered to be more reliable and provide better system regulation than other types of regulators. Solid-state regulators rely on transistor circuitry to control alternator field current and alternator

FLIGHT INSTRUMENTS

Flight instruments are the instruments in the cockpit of an aircraft that provide the pilot with information about the flight situation of that aircraft, such as altitude, airspeed and direction. They improve safety by allowing the pilot to fly the aircraft in level flight, and make turns, without a reference outside the aircraft such as the horizon.

Most regulated aircraft have these flight instruments as dictated by the US Code of Federal Regulations, Title 14, Part 91. They are grouped according to pitot-static system, compass systems, and gyroscopic instruments

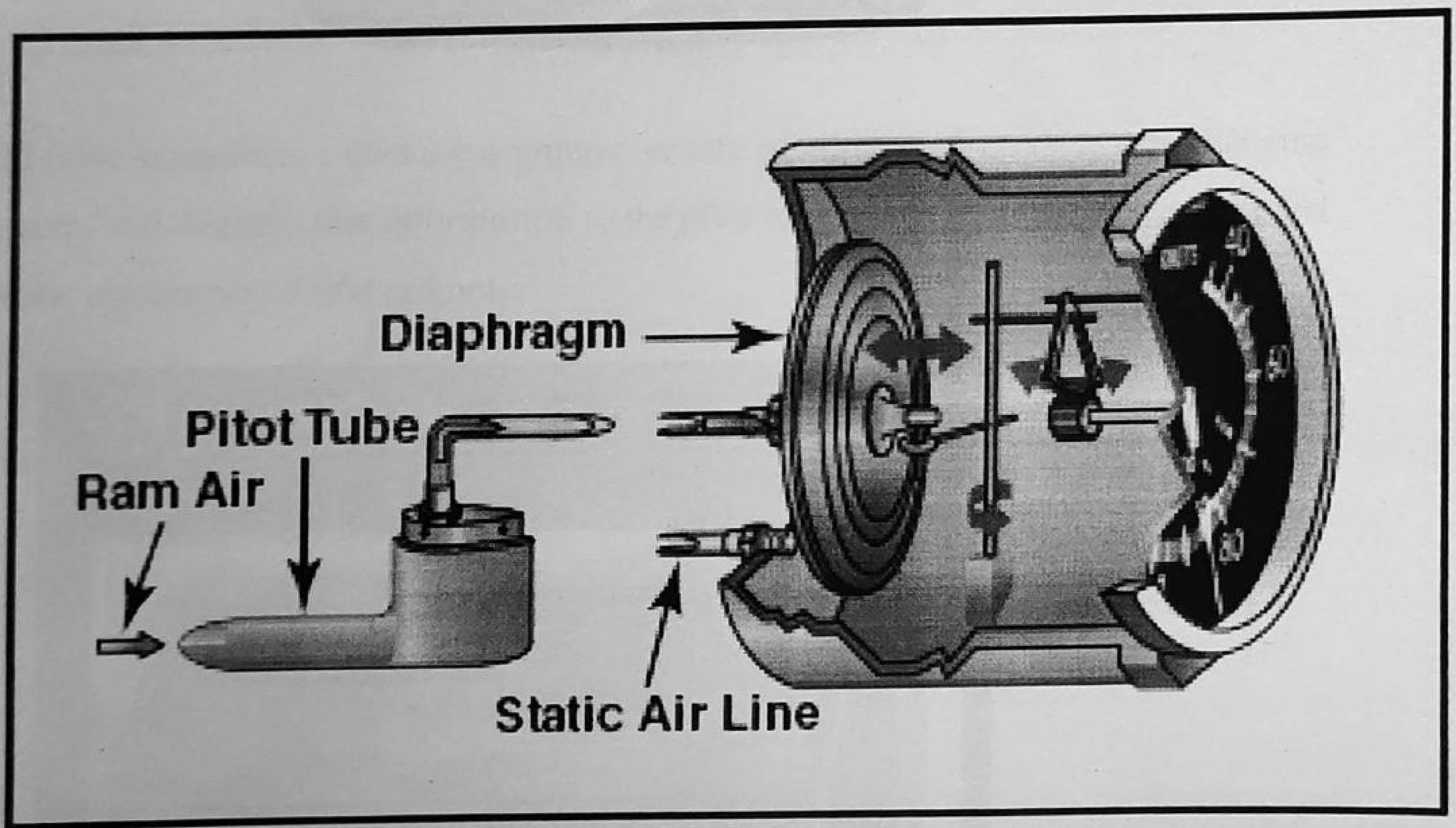
1.PILOT STATIC SYSTEM



A typical pitot-static system.

by the appearance of a small window with oblique lines warning the pilot that he/she is nearer to the ground. This modification was introduced in the early sixties after the recurrence of air accidents caused by the confusion in the pilot's mind. At higher altitudes the window will disappear.

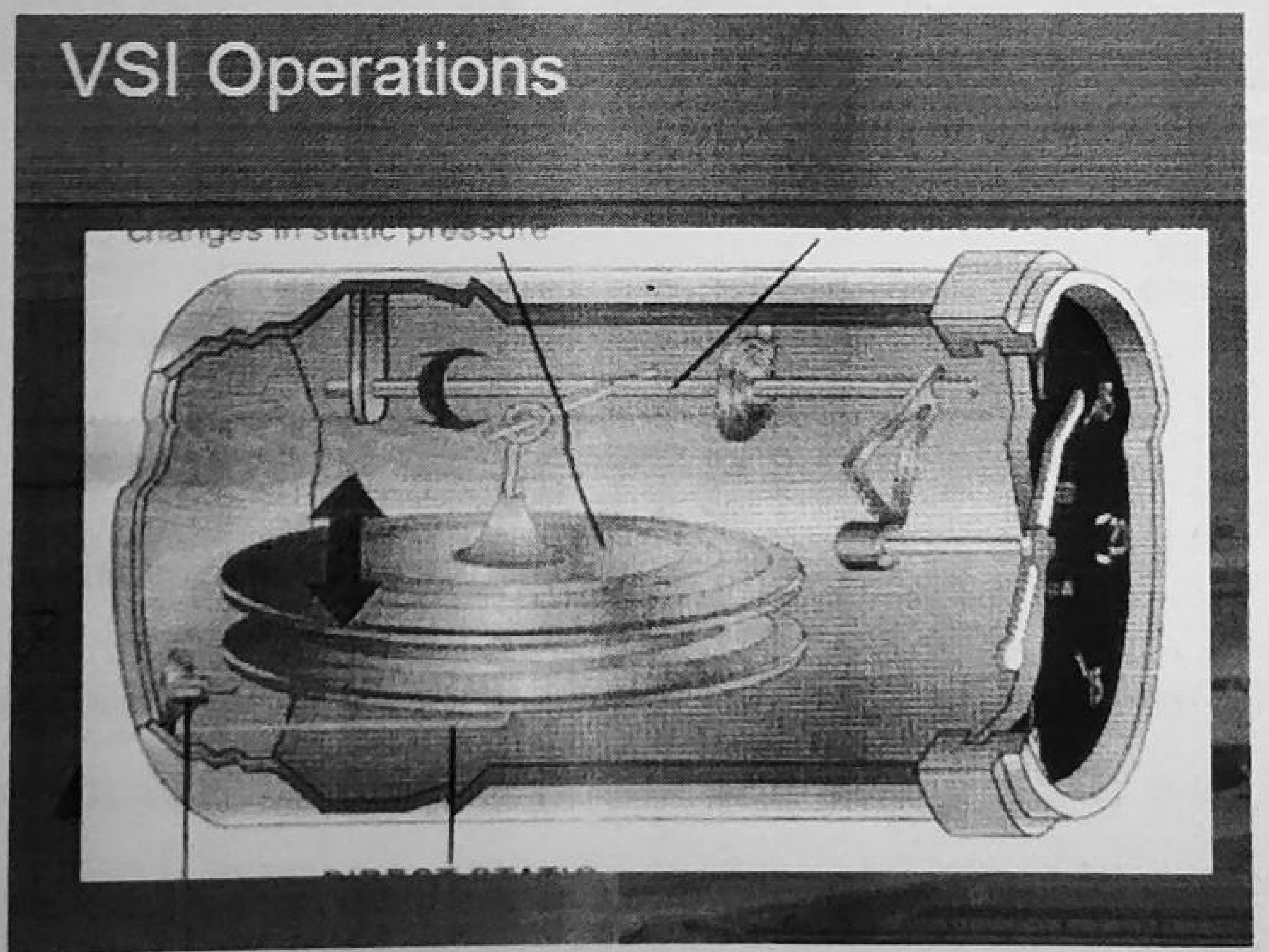
- **AIRSPEED INDICATOR**



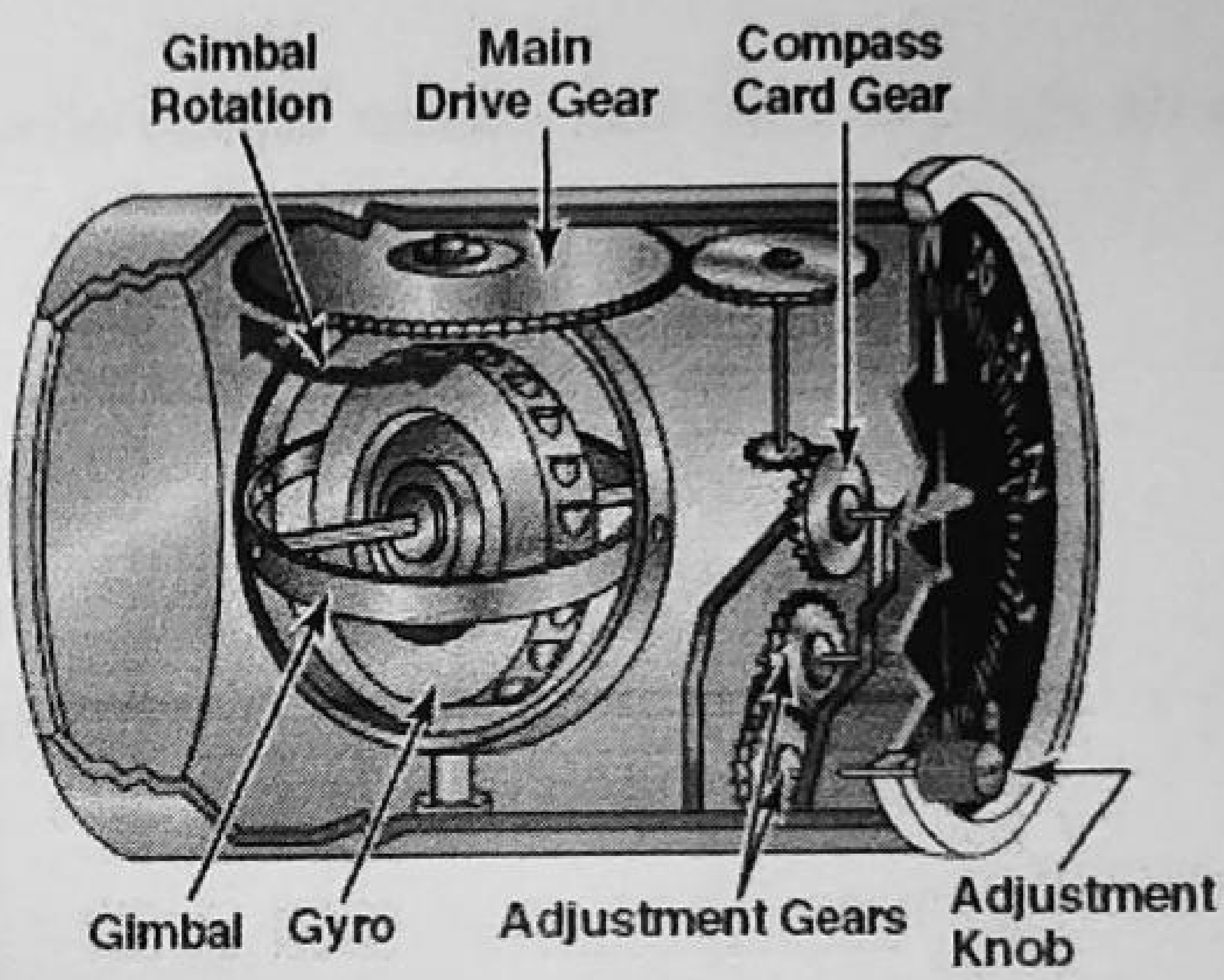
The airspeed indicator shows the aircraft's speed (usually in knots) relative to the surrounding air. It works by measuring the ram-air pressure in the aircraft's Pitot tube relative to the ambient static pressure. The Indicated airspeed (IAS) must be corrected for nonstandard pressure and temperature in order to obtain the True airspeed (TAS). The instrument is color coded to indicate important airspeeds such as the stall speed, never-exceed airspeed or safe flap operation speeds.

Vertical speed indicator

The VSI (also sometimes called a variometer, or rate of climb indicator) senses changing air pressure, and displays that information to the pilot as a rate of climb or descent in feet per minute, meters per second or knots.



(including almost all jet aircraft), the heading indicator is replaced by a horizontal situation indicator (HSI) which provides the same heading information, but also assists with navigation.



Aircraft Fuel System

The purpose of an aircraft fuel system is to store and deliver the proper amount of clean fuel at the correct pressure to the engine.

Fuel systems should provide positive and reliable fuel flow through all phases of flight including:

- Changes in altitude
- Violent maneuvers
- Sudden acceleration and deceleration

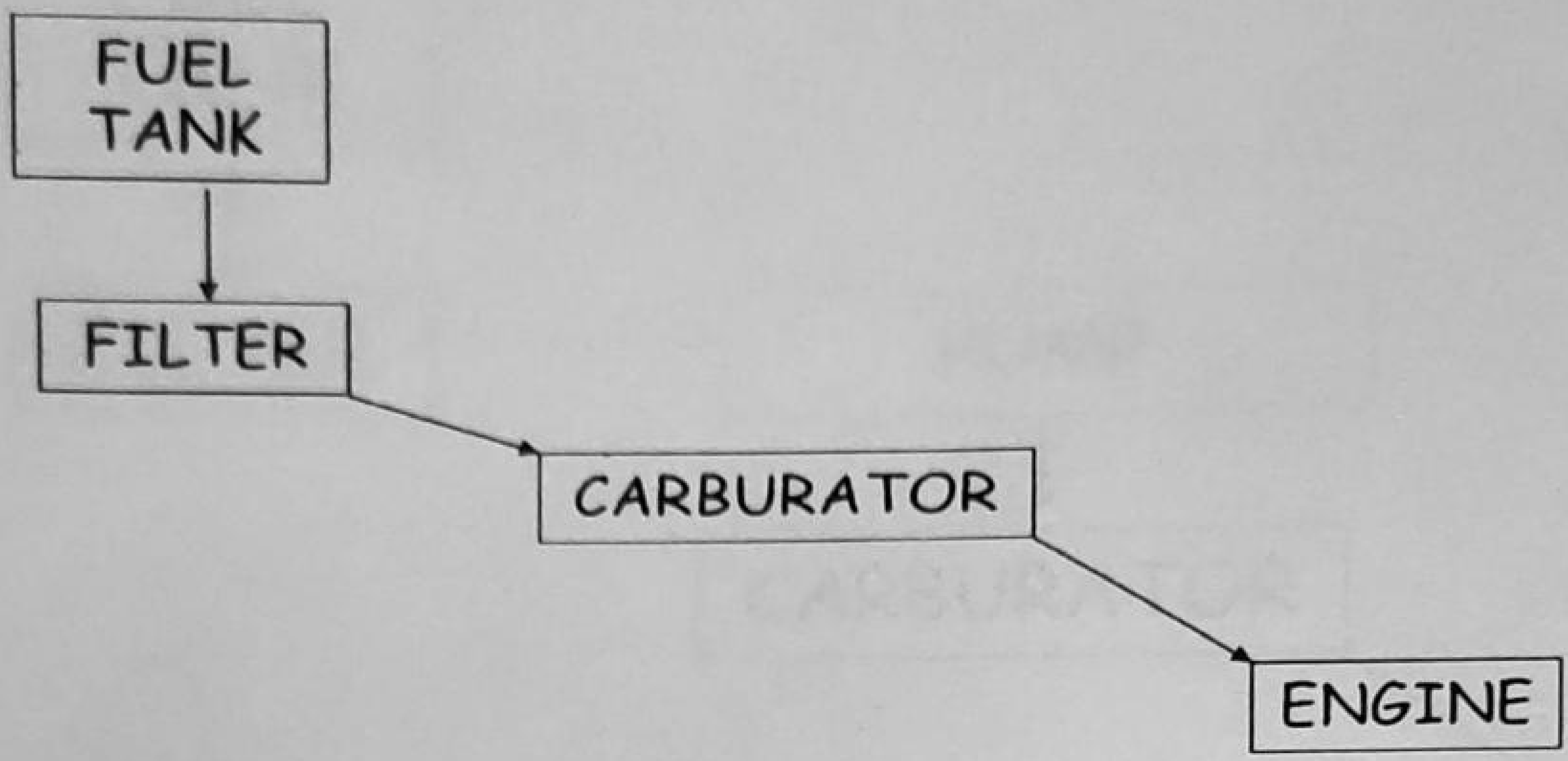
Requirements of a good fuel system:

- Since fuel load can be a significant portion of the aircraft's weight, a sufficiently strong airframe must be designed.
- Varying fuel loads and shifts in weight during maneuvers must not negatively affect control of the aircraft in flight.
- Each system must provide contaminant free fuel regardless of the aircraft's attitude.
- Monitor fuel pressure, fuel flow, warning signal and tank quantity.

Types of Fuel systems:

1. GRAVITY FEED SYSTEM –

   In this system, gravity is used to deliver the fuel to engine fuel control mechanism. The space above the liquid fuel is vented to maintain atmospheric pressure on the fuel as the tank empties. It has no fuel pump and is used for high wing aircrafts.



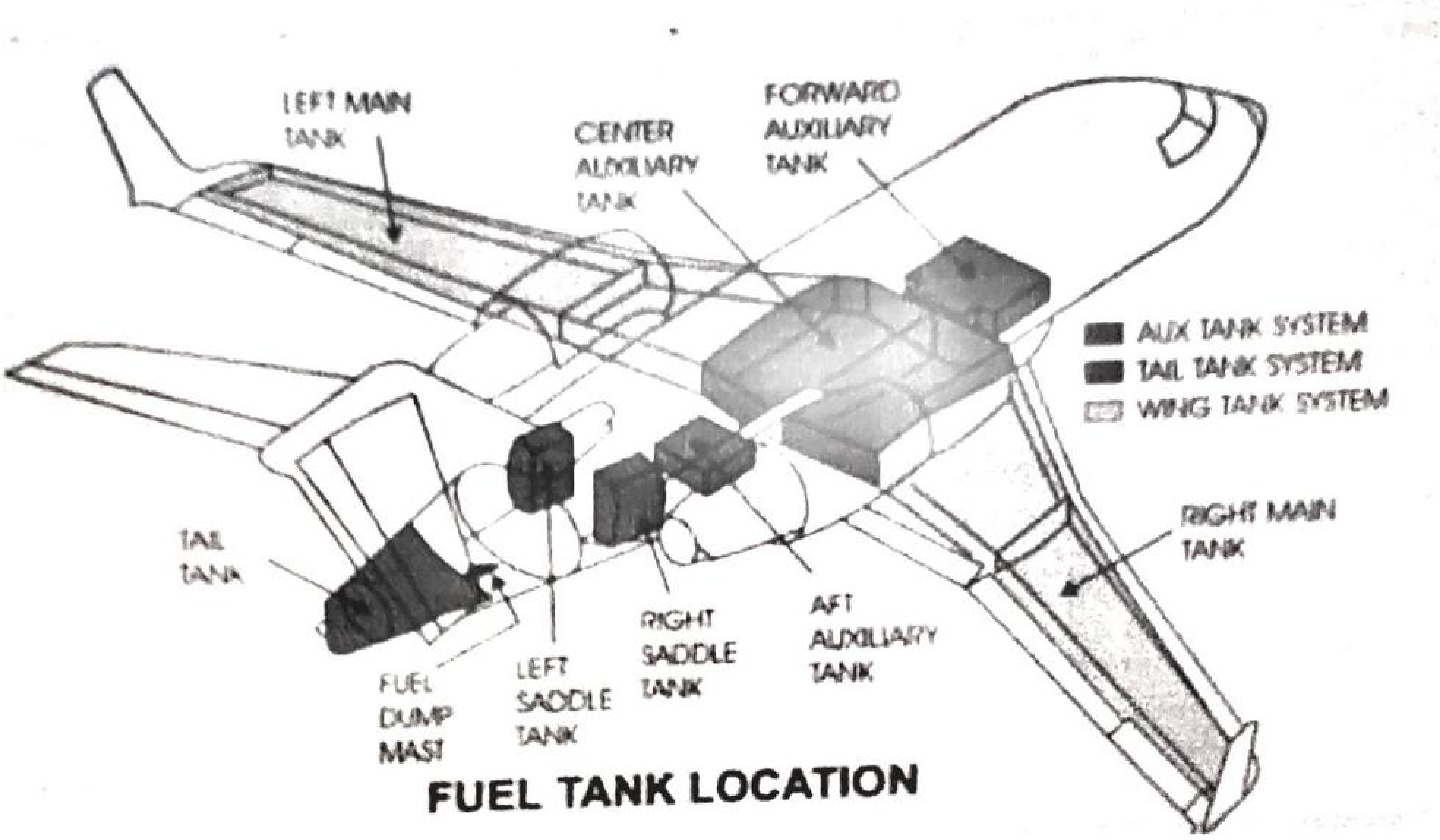
2. PRESSURE FEED SYSTEM –

This system requires the use of a fuel pump to provide required fuel pressure to the engine fuel control component.

There are two main reasons these systems are necessary:

- The fuel tanks are too low to provide enough pressure from gravity
- The fuel tanks are a great distance from the engine

Also, most large aircraft with higher powered engines require a pressure system regardless of the fuel tank location because of the large volume of fuel used by the engines.



FUEL TANK LOCATION

- Fuel pump: There are main pumps and emergency pumps. Any pump required for operation is considered a main fuel pump. Emergency pumps are used and must be immediately available to supply fuel to the engine if any main pump fails. Auxiliary pumps are used on many aircraft as well. Sometimes known as booster pumpsor boost pumps, auxiliary pumps are used to provide fuel under positive pressure to the engine-driven pump and during starting when the engine-driven pump is not yet up to speed for sufficient fuel delivery. Some aircraft use ejector pumps to help ensure that liquid fuel is always at the inlet of the pump.

- Fuel Pipelines:Aircraft fuel lines can be rigid or flexible depending on location and application. Rigid lines are often made of aluminum alloy, stainless steel lines also used. Flexible fuel hose has a synthetic rubber interior with a reinforcing fiber braid wrap covered by a synthetic exterior.

  Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions. Lines connected to components of the airplane, between which relative motion could exist, must have provisions for flexibility. Flexible hose assemblies are used when lines may be under pressure and subject to axial loads. Any hose that is used must be shown to be suitable for a particular application. Where high temperatures may exist during engine operation or after shutdown, fuel hoses must be capable of withstanding these temperatures.

- Valves: Shutoff valve, Check valves, Fuel tank selector valves, etc. are used in aircrafts. They are used to shut off fuel flow or to route the fuel to a desired location. Fuel valves can be manually operated, solenoid operated, or operated by electric motor.

- Fuel flow meters: A fuel flowmeter indicates an engine's fuel use in real time. This can be useful to the pilot for ascertaining engine performance and for flight planning calculations.

- Filters, strainers: They are usedfor draining and cleaning. The fuel strainer should have a sediment trap and drain. Fuel strainers are usually constructed of relatively coarse wire mesh. Fuel filters generally are usually fine mesh.

- Quantity indicators: These are Fuel Quantity Indicating Systems. Electric fuel quantity indicators are more common than mechanical indicators in modern aircraft. Digital indicators are also available.

- Warning device (Pressure Warning Signal):On aircraft of any size, visual and audible warning devices are used in conjunction with gauge indications to draw the pilot's attention to certain conditions.

ENVIRONMENT CONTROL SYSTEM

An environmental control system in an aircraft controls the environment inside the cockpit of the aircraft so that even when there are extremely harsh conditions outside the aircraft, the inner portion of the aircraft remains within certain limits. This is done by controlling various parameters like:

- Temperature
- Pressure
- Humidity
- Ventilation

The major functions of an ECS include:

- Air-conditioning and pressure maintenance inside the cockpit and cabin.
- Cooling of avionics bay- The electronic components in an aircraft also need cooling. This is taken care by ECS of the aircraft.
- Cockpit Seal tube- The cockpit is sealed by inflating tubes using air and opened by deflating these tubes. This is also taken monitored by ECS.
- Demisting of cockpit glass

Most of the air present in the cockpit comes by tapping a portion of incoming air in the engine of the aircraft. This air however is at a very high temperature and is first passed through a primary heat exchanger to cool it down. Further, it is sent to the cold air unit (CAU) that cools the air by compressing and then expanding it (Bell-Coleman cycle or Reverse Brayton Cycle). Further, we have secondary heat exchange units which provide air at low temperatures. If the temperature is very low, it is again mixed with air from the engine and the combination is fed to the cockpit. Everything is monitored by ECS.

CONCLUSION

The joy of flying has fascinated the human race for centuries. Defense avionics major& Navratana PSU Hindustan Aeronautics Limited (H A L) is in the business of building a whole range of aircraft, helicopters and jet trainers.

Besides, the company manufactures aircraft components, overhauls fighterplanes and trains future pilot's its success in the design and development of lightcombat aircraft Tejas and advanced light helicopter Dhruv has won admiration. HALis the backbone of India's air defense and continues to occupy the strategic importancereflecting a new pace of growth.

Today the faster growing sector is the aviation sector & is likely to be a boon for the entire job market. It deals with the manufacture, design &development of aircrafts.

The project is based on the instruments that are used in the manufacture of thevarious aircrafts. A deep knowledge of these instruments is crucial in the perfectdesign & manufacture of the air crafts. The project will benefit those who haveinterest in the instrument & will provide the reader with the deeper knowledge of the topic.