



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF AEROSPACE ENGINEERING

19AST101 – INTRODUCTION TO AEROSPACE ENGINEERING I YEAR II SEM

UNIT-V AIRCRAFT INSTRUMENTATION

TOPIC: Electronics Instrumentation

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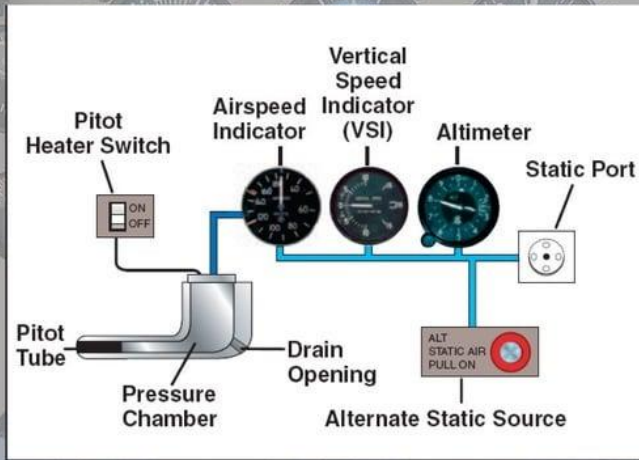


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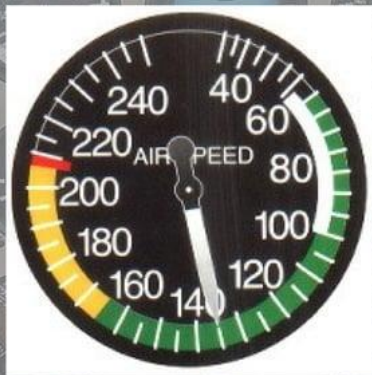


Pitot – Static System





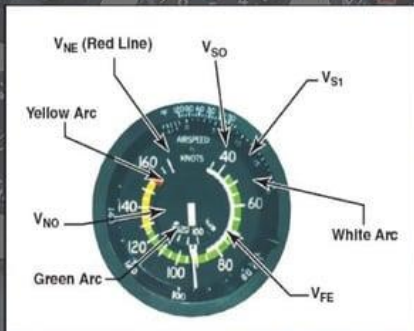
Airspeed Indicator





Airspeed Indicator Symbology

- ▶ **White Arc** – Flap operating Range
- ▶ **Green Arc** – Normal Operations
- ▶ **Yellow Arc** – Caution Area (Only use in smooth air)
- ▶ **Red Line** – Never Exceed Speed





Aircraft Airspeeds

- ▶ V_{so} – Stall speed in landing configuration
- ▶ V_s – Stall speed in clean (flaps up) configuration
- ▶ V_y – Climb speed for the max amount of height v. time
- ▶ V_x – Climb speed for the max amount of height for distance
- ▶ V_{fe} – Flap Extension speed: Flaps should not be used above this speed
- ▶ V_a – Design maneuvering/rough air speed: Speed at which abrupt full control inputs can be used without risking structural damage. Should never be exceeded in rough air. Changes with weight
- ▶ V_{no} – Max structural Cruise speed



Types of Airspeeds

▶ Calibrated

- Speed corrected for installation and instrument errors.
- At high angle of attack, the pitot tube does not point straight into the relative wind, this tends to make the airspeed indicate lower than normal at low airspeeds.
- Not usually a problem in cruise, usually we only worry about calibrate airspeed when we are converting to true airspeed.

▶ True

- The actual speed of your airplane is moving through undisturbed air.
- On a standard day, Calibrated airspeed will be equal to TAS.
- As density altitude increases, true airspeed increases for a given CAS or amount of power.
- TAS can be calculated by using CAS with temperature and pressure on your E6B

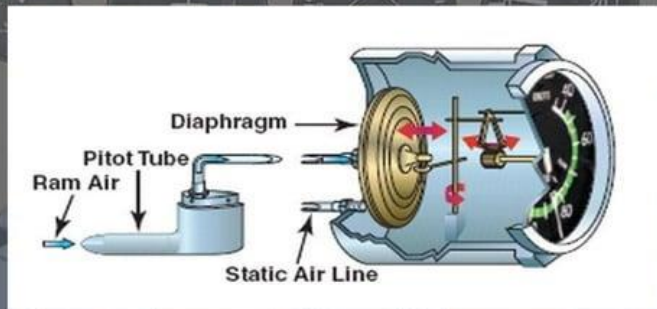
▶ Equivalent

- Calibrated airspeed corrected for adiabatic compressible flow at a particular altitude.
- Above 200 kts and 20,000 feet air compresses in front the pitot tube causing abnormally high airspeeds. Many flight computers are designed to compensate.



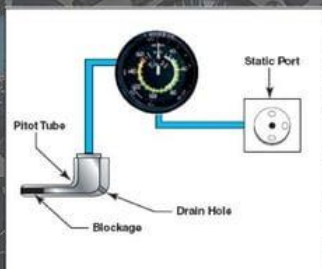
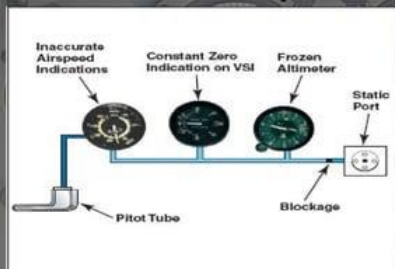
Airspeed Indicator

- ▶ Uses ram air from the pitot tube as well as static air.
- ▶ Ram air pushes against a diaphragm inside the airspeed indicator, which will then be able to expand or contract accordingly. This movement of the diaphragm is then translated into needle movement.





Airspeed Indicator



- ▶ If the Pitot tube is blocked and the drain is open, speed will go to zero.
- ▶ If the Pitot tube is blocked and the drain is open, it will act as an altimeter.
- ▶ If the the Static vent is blocked, the airspeed will read higher than it should above altitude where it became blocked and lower than it should below.
- ▶ If all three all blocked, the needle will freeze.



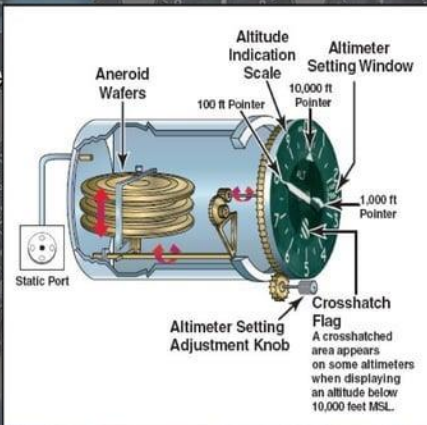
Altimeter





Altimeter

- ▶ Static Input Only
- ▶ Manufacturer seals the aneroid wafer(s) at a specific pressure. As the static pressure fills in the area around these sealed wafers, they will be able to contract or expand accordingly





Types of Altitude

- ▶ Indicated
 - What you read on the altimeter when it is correctly adjusted to show approximate height above mean sea level
- ▶ Calibrated
 - Indicated altitude corrected to compensate for instrument error
- ▶ Pressure
 - Displayed when altimeter is set to standard sea level (29.92).
 - Vertical distance above the standard datum plane
- ▶ Density
 - Pressure altitude corrected for non – standard temperature
 - Used to determine aircraft performance, when high (temp above standard), performance will be worse.
- ▶ True
 - Actual height above mean sea level
 - Sectional charts
- ▶ Absolute
 - Actual height of aircraft above the earth's surface.

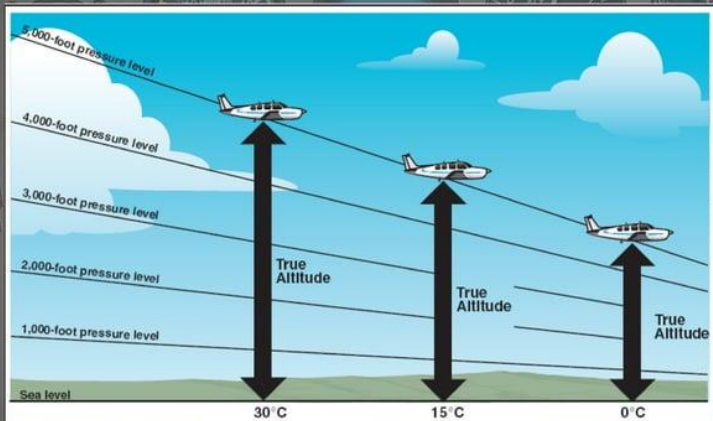


Altimeter Errors

- ▶ Make sure you update your altimeter setting as often as possible (or at least every 100 miles)
- ▶ If you fly to an area with a lower altimeter setting, without resetting your altimeter, you may fly at a lower altitude than you had intended.
- ▶ “High to low, look out below”
- ▶ On warm days, true altitude is higher than indicated. Aircraft true altitude is lower than indicated in colder air.
- ▶ Static Blockage
 - Altimeter will freeze at the altitude the blockage occurred



High to Low, Look out Below!





Vertical Speed Indicator

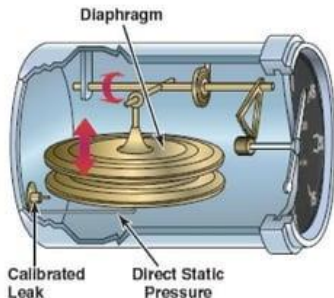


- ▶ Rate of climb and descent
 - ▶ Trend will show immediate indication of an increase in the airplanes rate of climb or descent
 - ▶ Rate shows a stabilized change in altitude



Vertical Speed Indicator

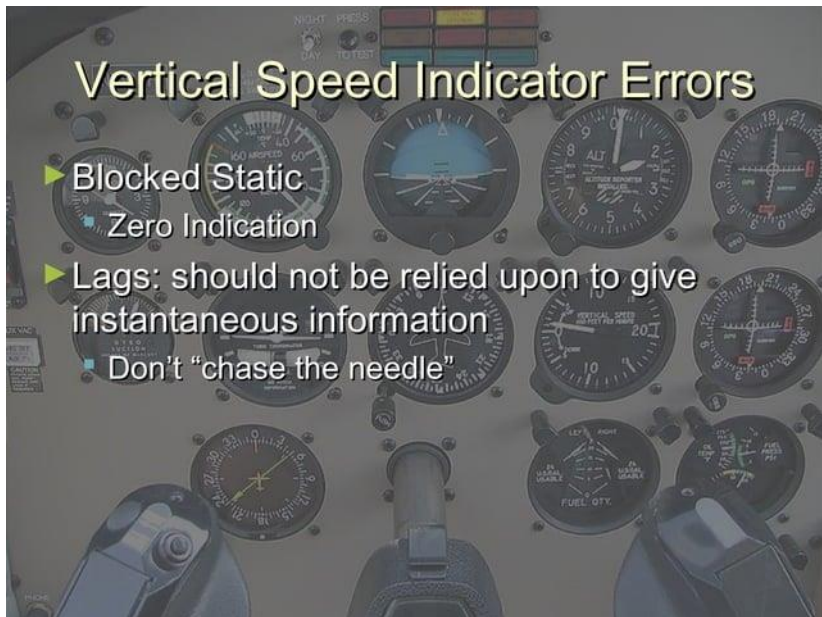
- ▶ Static air enters both the diaphragm and the area around it. However, the air in the diaphragm is constantly updated while the air outside of it is very slowly allowed to escape through a calibrated leak. The instrument measures the difference in these two pressures (the air where you are where you are)





Vertical Speed Indicator Errors

- ▶ Blocked Static
 - Zero Indication
- ▶ Lags: should not be relied upon to give instantaneous information
 - Don't "chase the needle"



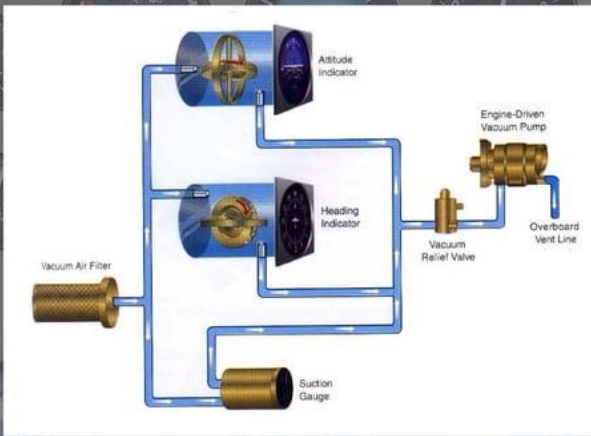


Pitot – Static Summary

- ▶ While the Altimeter, VSI and airspeed indicator all use Static air, only the airspeed indicator uses Pitot
- ▶ If you notice all of your pitot static instruments are giving conflicting information, try turning using the alternate air source
- ▶ If only your airspeed indicator is not working properly, try turning on pitot heat



Gyro Instruments





Which instruments are Gyroscopic?

- ▶ Which instrument(s) are powered by the vacuum system?
- ▶ Which are powered by the electrical system?
 - Why?



Gyroscopic Principles

▶ Rigidity in Space

- A wheel with a heavily weighted rim spun rapidly tends to remain fixed in the plane in which it is spinning
- The wheel is mounted on a set of gimbals so that the gyro is able to rotate freely in any plane
- As the gimbals' base tilts and twists, the gyro remains spinning in its original plane
- Allows a gyroscope to measure changes in the attitude or direction of an airplane





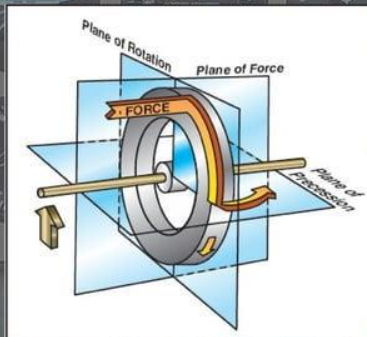
Precession

▶ What is precession?

When an outside force tries to tilt a spinning gyro, the gyro responds as if the force had been applied at a point 90 degrees in the direction of rotation

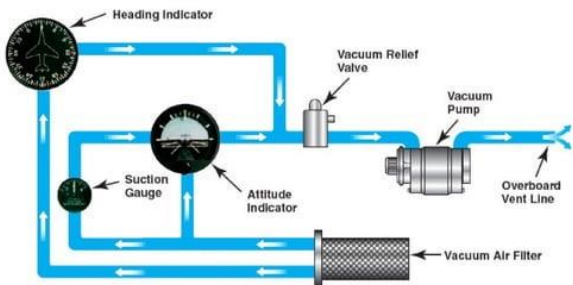
▶ Precession side – effects?

Friction in gimbals and bearings may cause a slow drifting in the heading indicator and occasional small errors in the attitude indicator





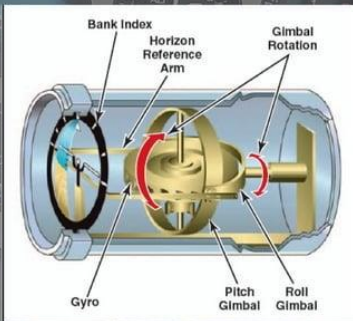
Vacuum Instruments





Attitude Indicator

- ▶ Only instrument that gives immediate and direct indication of the airplane's pitch and bank attitude.
- ▶ Operation
 - Gyro spins in the horizontal plane, mounted on dual gimbals that allow it to remain in the plane regardless of aircraft movement.
 - Pendulous vanes allow the attitude indicator erect itself on taxi





Attitude Indicator Errors

- ▶ Usually less than 5 degrees of bank error and 1 bar width of pitch error in a 180 degree turn.
- ▶ Pendulous vanes act on the attitude indicators gyro in an undesirable way during turns.
- ▶ The same pendulous vanes will cause the gyro to try to line up with the g – forces of a turn.
- ▶ Acceleration and Deceleration can induce precession errors. During acceleration, horizon bar may show a climb, reinforcing the somatogravic illusion.
- ▶ Tumbling: Past 100 degrees of bank or 60 degrees of pitch



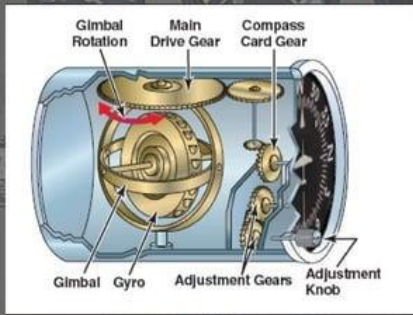
Heading Indicator

▶ What does it do?

- Senses rotation about the aircraft's vertical axis.

▶ Errors?

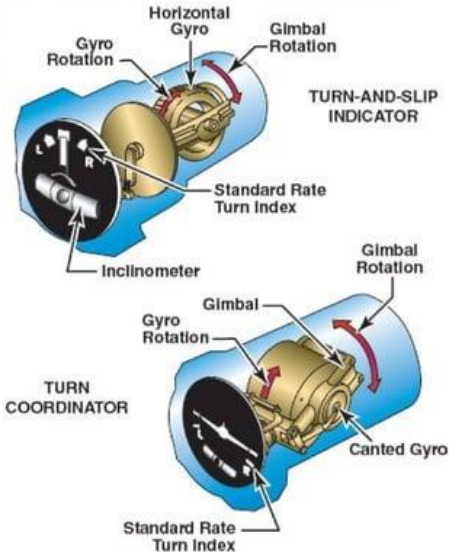
- Precession can cause heading to drift, so remember to re-check about every 15 min.





Turn Indicators

- ▶ Turn Coordinator:
 - Rate and Roll
- ▶ Slip and Skid
 - Rate ONLY – older aircraft
- ▶ What is the inclinometer?
 - Slip? Rate of turn is too slow for the angle of bank, ball moves inside
 - Skid? Rate of turn is too great for the angle of bank.
- ▶ Standard Turn?





THANK YOU