

**Tishk International University**  
**Engineering Faculty**  
**Mechatronics Engineering Department**

# **AVIONICS**

## **TOPIC: Measuring Instruments**

**Week5\_Lecture5**

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# AIRCRAFT INSTRUMENTS



# What are the Six Basic Aircraft Instruments?



A quick scan of the six pack provides the pilot with current information on aircraft speed, altitude, climb/descent, attitude, heading, and turning/banking. Individually, the six pack instruments are:

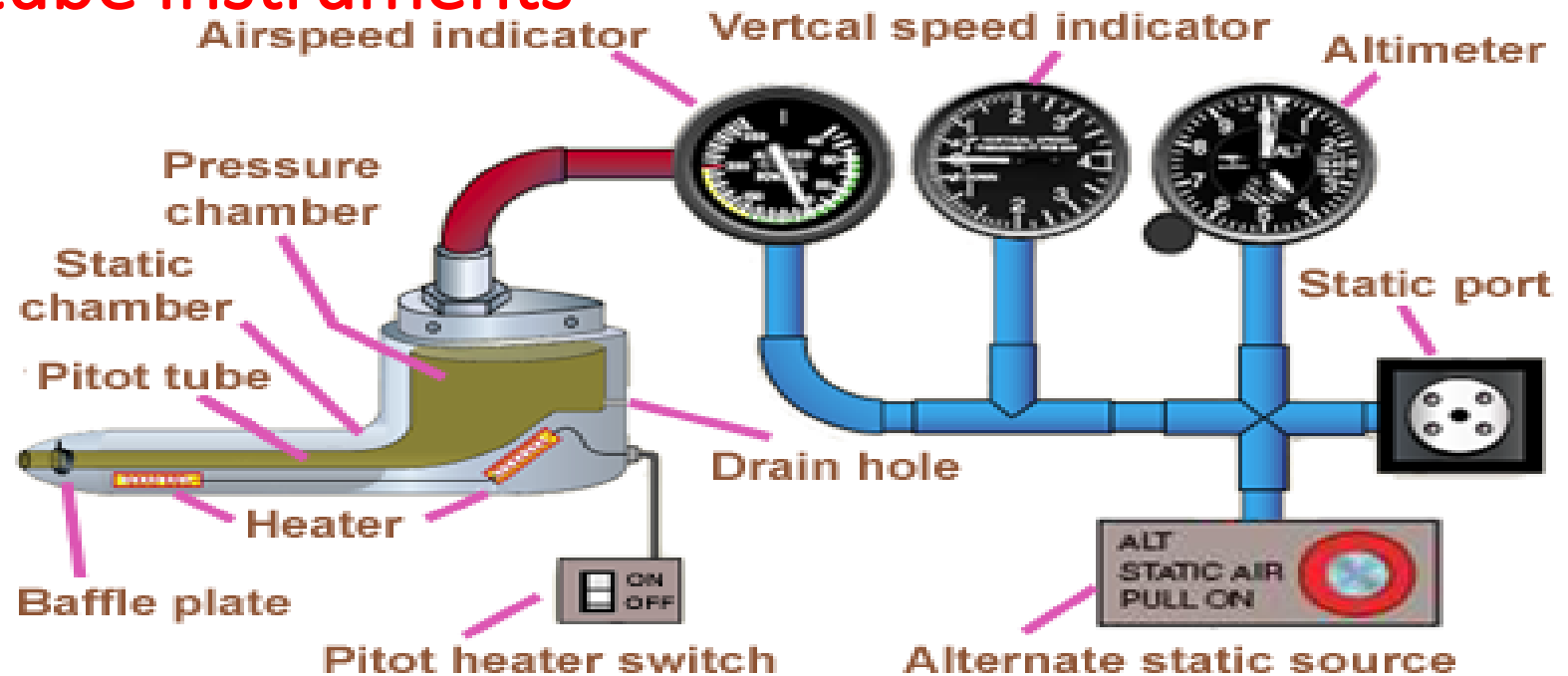
## PITOT TUBE INSTRUMENTS

- Airspeed Indicator (ASI)
- Altimeter
- Vertical Speed Indicator (VSI)

## •GYROSCOPE INSTRUMENTS

- Attitude Indicator (AI)
- Heading Indicator (HI)
- Turn Coordinator (TC)

# Pitot tube Instruments



Source: [www.faa.gov/handbooks\\_manuals/media](http://www.faa.gov/handbooks_manuals/media)

- The following instruments are works by using pitot tube.
- Airspeed Indicator (ASI)
- Altimeter
- Vertical Speed Indicator (VSI)

Pitot Heater is used to prevent or melt the ice in high altitude

Static port is maintain atm.pressure with respect to altitude.

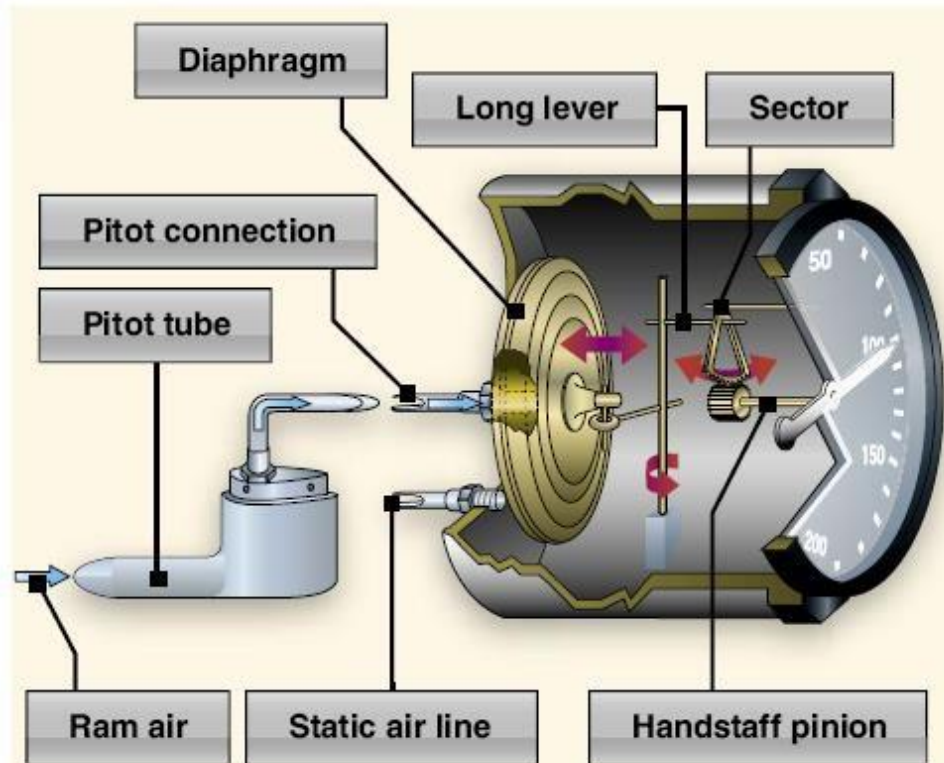
# WHAT SPEED DOES A BOEING 747 TAKE OFF AND LAND ?



- Most airlines and aircraft have a facility to de-rate thrust (or use assumed temperatures) for take off. This occurs on runways where the aircraft has extra performance in hand e.g. The aircraft does not need the full length of the runway to take off. This procedure is essentially where pilots will take off with less than max thrust to save engine wear.
- Speeds vary according to performance, environmental conditions and weight but typically a fully loaded 747 on a normal long haul flight would take off from a typical length runway at around 160 knots which is 184 mph.
- A typical fully loaded 747 would be landing at around 25,000kgs (250 tonnes). The landing speed would be around 145kts-150kts (166mph-172mph) depending on the landing flap setting selected.
- The greater the flap setting the lower the speed. We generally fly the approach speed faster than this to allow a 'buffer'. In light wind conditions we would add 5 kts to the landing speed but in strong wind conditions up to 20kts can be added.

# Working principle

- **THE BASIC PRINCIPLE IS PRESSURE DIFFERENCE** (Dynamic and static pressure differential)
- **THE CONCEPT OF PITOT TUBE MECHANISM IS USED.**
- **Airspeed indicator**, instrument that measures the speed of an aircraft relative to the surrounding air, using the differential between the pressure of still air (static pressure) and that of moving air (DYNAMIC pressure);





# Airspeed Indicator Markings

Marking Color	Type	Meaning
White	Arc	Flap operating range Bottom: Flaps-down stall speed (VS0) Top: Maximum airspeed for full flaps extended (VFE)
Green	Arc	Normal operating range Bottom: Flaps-up stall speed (VS1) Top: Maximum structural cruising speed (VNO)
Blue	Line	Airspeed for best single-engine rate-of-climb at gross weight and sea level
Yellow	Arc	Caution area Bottom: Maximum structural cruising speed (VNO) Top: Never exceed speed (VNE)
Red	Line	Never exceed speed (VNE)



Source: [www.faa.gov/handbooks](http://www.faa.gov/handbooks)

# Airspeed Indicator (ASI)

- Dynamic and static pressure differential
- Types of Airspeed:
  1. Indicated (IAS)
  2. Calibrated (CAS)
  3. True (TAS)
  4. Groundspeed (GS)
- Some V-speeds
  - $V_{SO}$  -stall w/ flaps (“dirty”)
  - $V_{S1}$ -stall w/o flaps (“clean”)
  - $V_{FE}$  -max flap extend
  - $V_{NO}$  -max structural cruise
  - $V_{NE}$  -never exceed

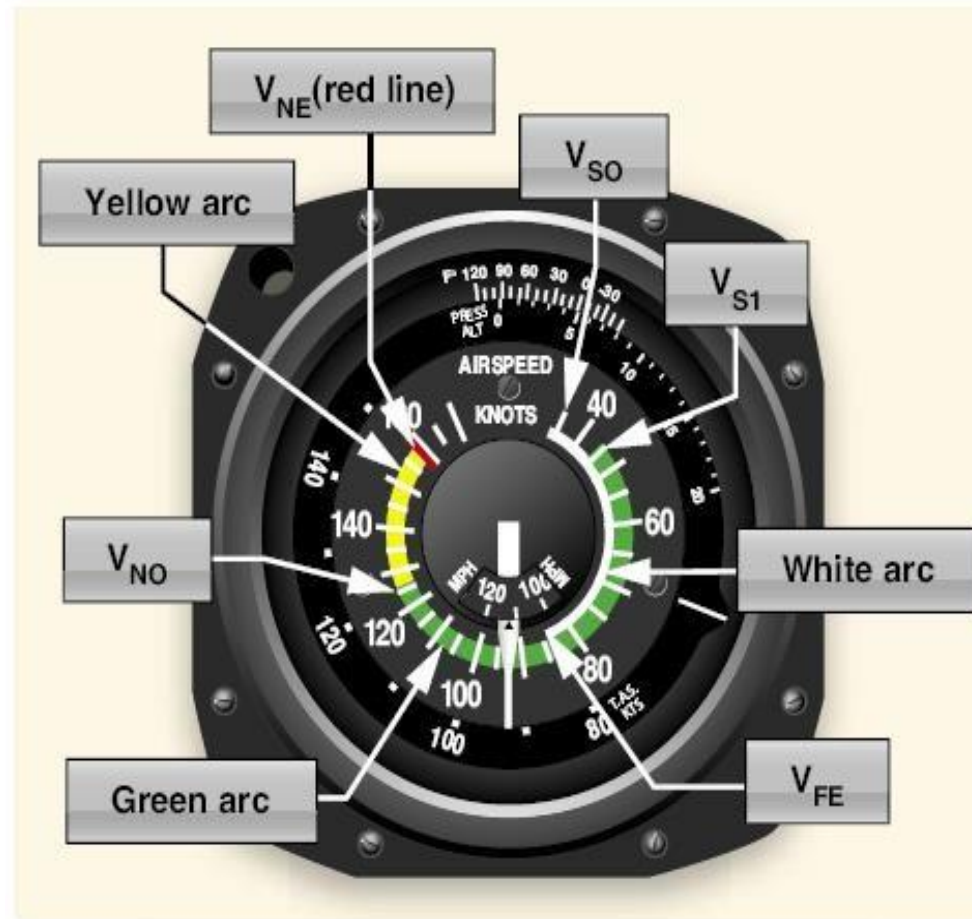
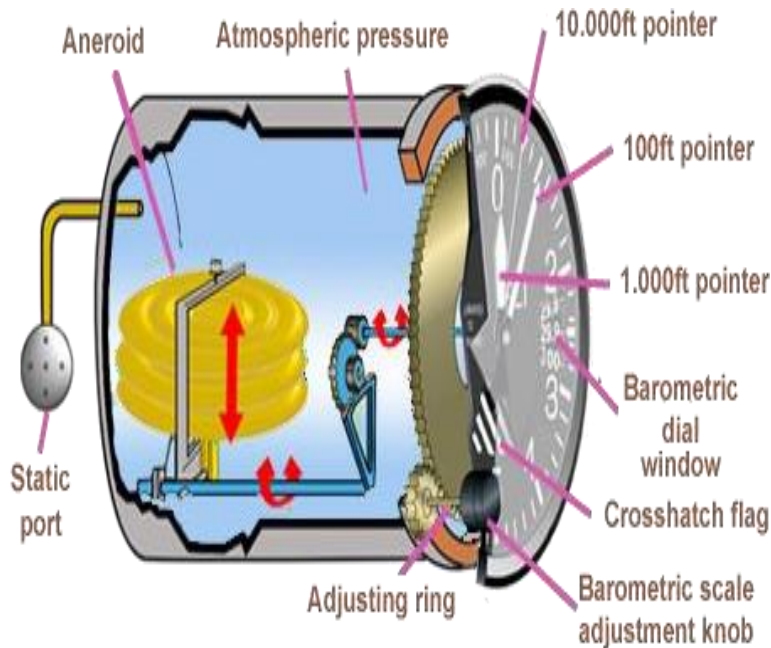


Figure 7-8. Airspeed indicator (ASI).



# Altimeter



Source: [www.faa.gov/handbooks\\_manuals/media](http://www.faa.gov/handbooks_manuals/media)

A sensitive altimeter is an aneroid barometer that measures the absolute pressure of the ambient air and displays it in terms of feet or meters above a selected pressure level.

It gives the height of flying aircraft with respect to sea level.

## Why altitude is important for aircraft?

The "sweet spot" of **flying** is regarded as between 35,000 and 42,000 feet (the airline industry still uses feet and inches as its standard measurements) –

Too **high** and the oxygen becomes too sparse(less) to fuel/ combustion of the engines

Too low and the air resistance is greater so it consume more fuel since fuel cost is more important in aviation industry.

# Altimeter

- Wafers sealed at Standard Pressure of 29.92" Hg
- Adjust altimeter setting in Kollsman Window
  - 1" Hg = 1,000 ft
  - Set to field elevation if no setting available
- Types of Altitude:
  1. Indicated Altitude
  2. True Altitude (MSL)
  3. Pressure Altitude
  4. Absolute Altitude (AGL)
  5. Density Altitude

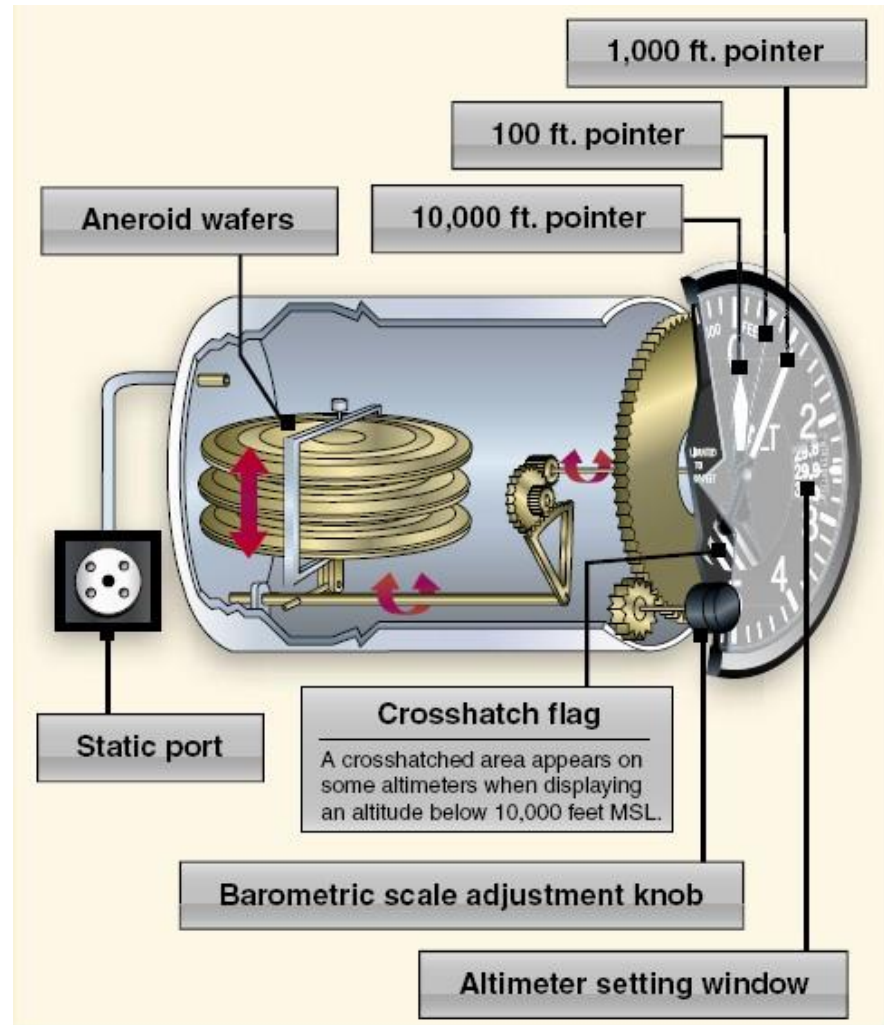
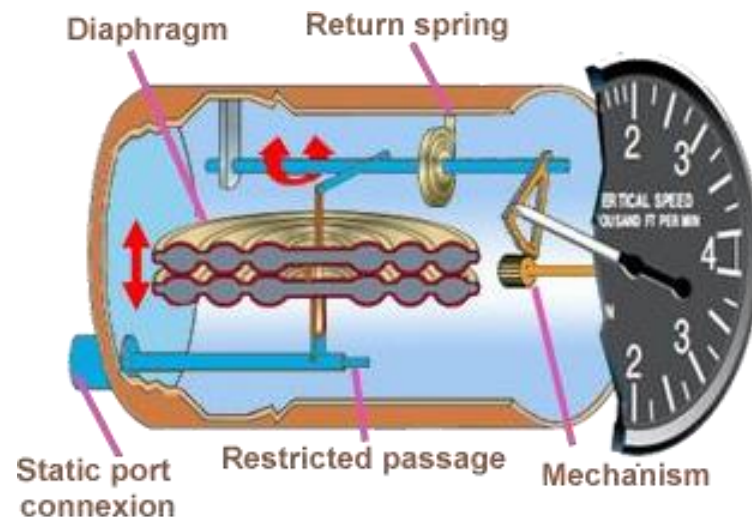


Figure 7-2. Altimeter.

# Vertical Speed Indicator (VSI)

- Vertical Speed Indicator (VSI) is also called a vertical velocity indicator (VVI), and was formerly known as a rate-of-climb indicator. It is a rate-of-pressure change instrument that gives an indication of any deviation from a constant pressure level.



Source: [www.faa.gov/handbooks](http://www.faa.gov/handbooks)

# Vertical Speed Indicator (VSI)

- VSI is used for the Rate of climb or descent in feet per minute.
- Static pressure differential instrument is used.
- The VSI tells the pilot whether the airplane is climbing, descending or in level flight. The vertical speed indicator also gives rate information in feet per minute (fpm) for the climb or descent. For example, the desired climb or descent might be accomplished at 500 feet per minute, and the VSI indicator makes this task easy.
- What is the **normal** climb rate for a heavy such as Boeing **737**?
- The default value is 1800 feet per minute and that takes a long time to attain cruise attitude of 31,000 feet.

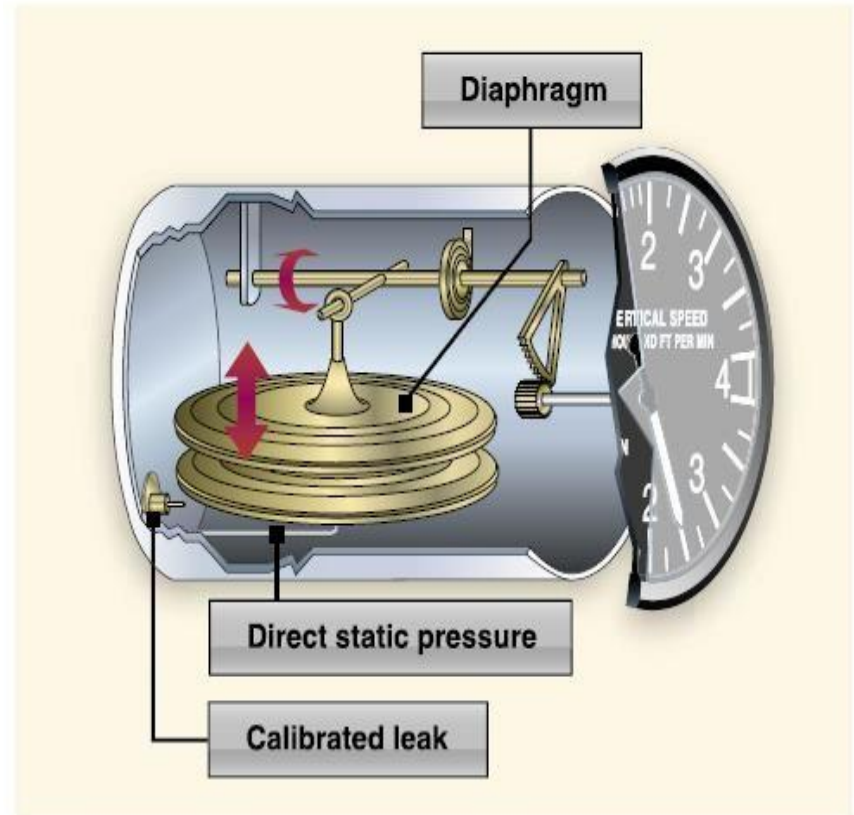


Figure 7-5. Vertical speed indicator (VSI).

# Reference

- [https://www.faa.gov/regulations\\_policies/handbooks\\_manuals/aviation/media/FAA-H-8083-15B.pdf](https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/media/FAA-H-8083-15B.pdf)

# MCQ

- <https://www.sanfoundry.com/a-vionics-questions-answers-pressure-measurements/>



**Thank You!**

