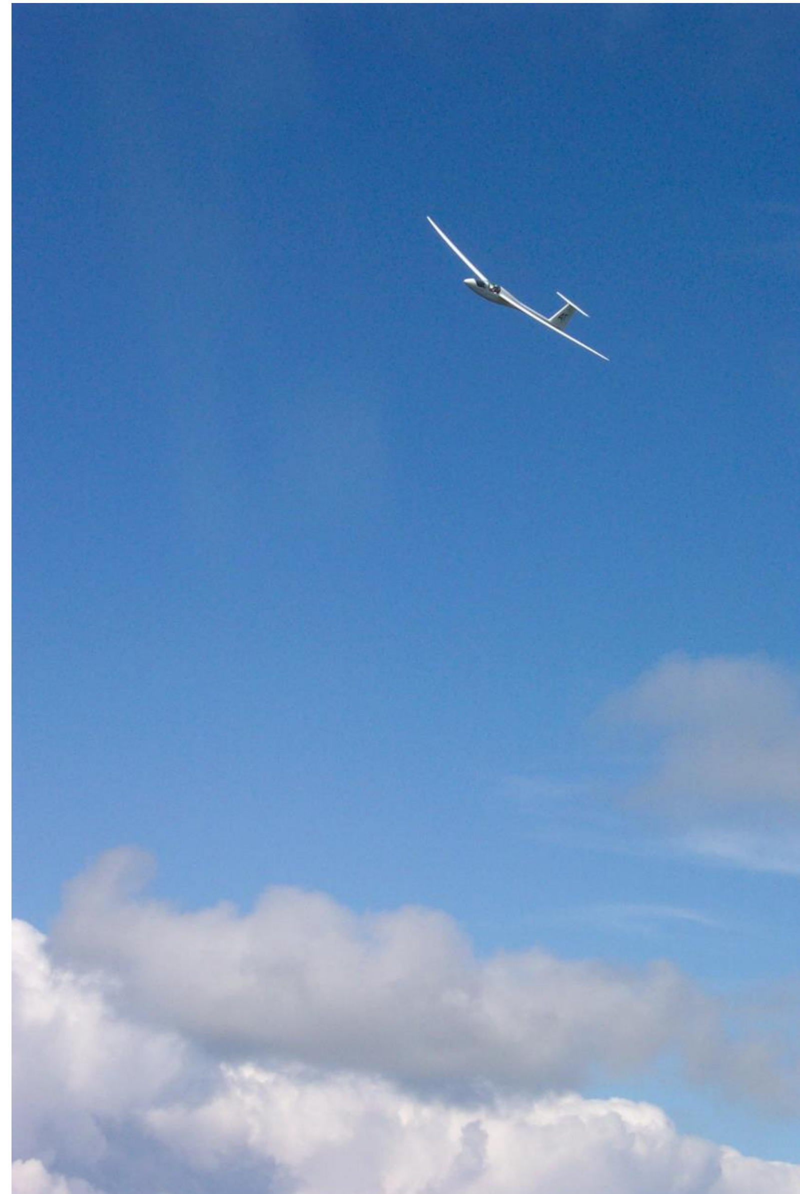
2026 GGC/RVSS Glider Pilot Ground School



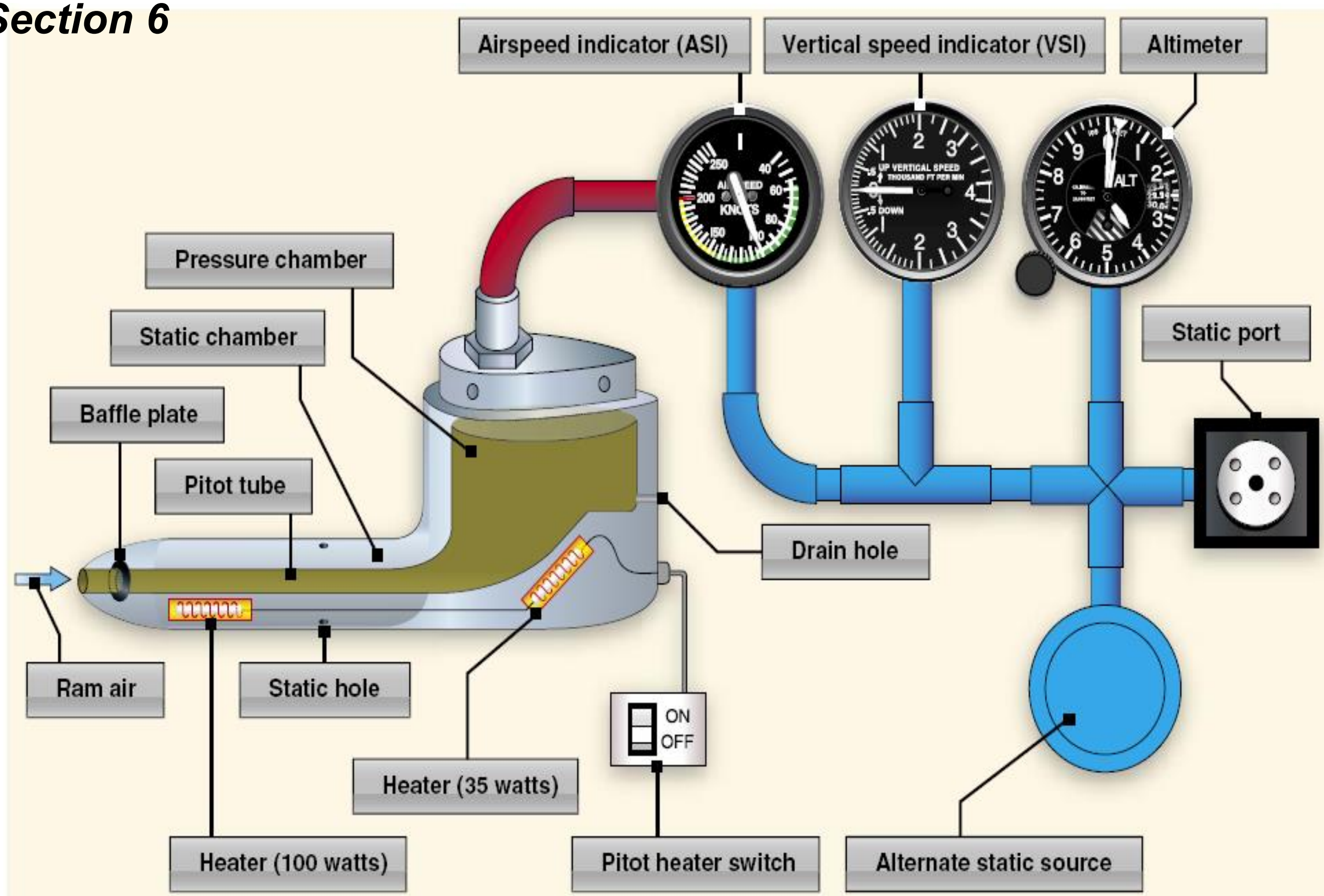
AGENDA – Part 1 (Instruments)

- Introduction
- Instrumentation
  - Pitot/Static System
  - Airspeed
  - Variometer
  - Altimeter
  - Magnetism
  - Direct Reading Compass
- **SUMMARY**

Cockpit & Instrumentation

Instrumentation – Pitot/Static System

TP 876 – Section 6



Static

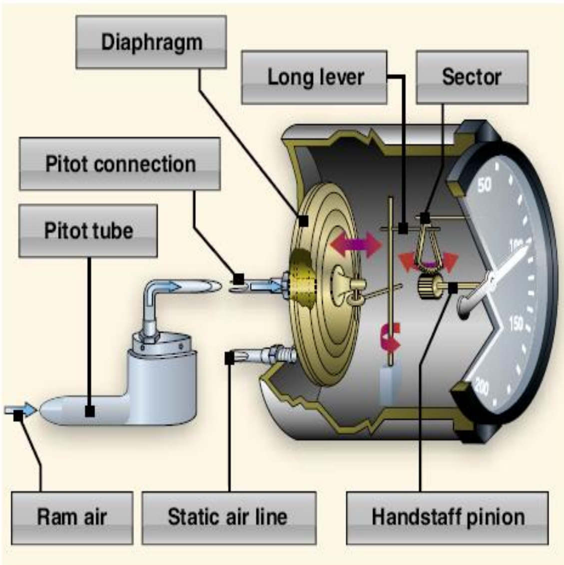
- The static is a reference port(s) positioned away from any potential airflow disturbances.
- It is used a reference pressure source for aircraft instruments

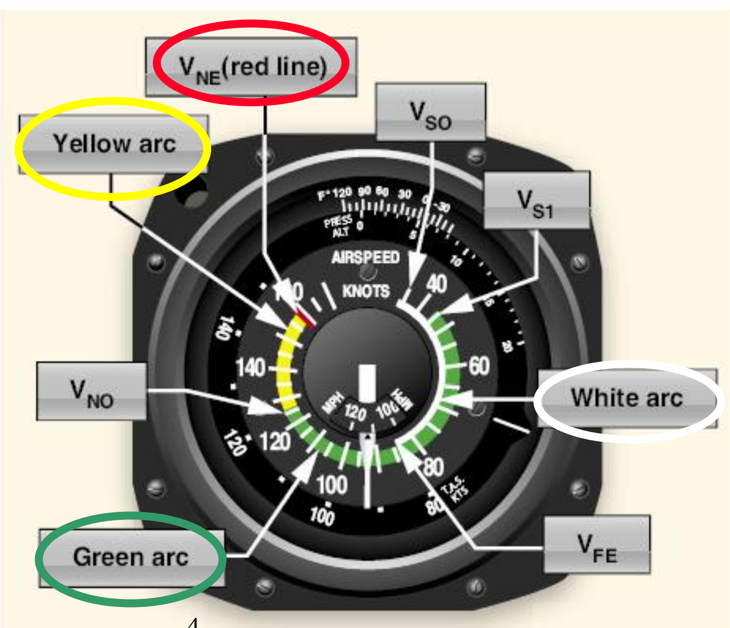
Pitot

- The pitot is a tube mounted on the forward (nose) of the aircraft used to capture the air pressure resulting from the forward movement of the aircraft.

Instrumentation – Airspeed Indicator (ASI)

TP 876 – Section 6





Principle of Operation

– The ASI measures the difference between the pitot pressure and the static pressure to calculate the airspeed of the aircraft.

Markings

– ***Red*** = a red line is placed at the Never Exceed Speed (Vne)

– ***Yellow*** = the yellow arc indicates the “caution speed” range. The aircraft should only be operated in the yellow arc range in smooth air. The lowest limit of this arc is the Vno (max. structural cruising speed)

– ***Green*** = the green arc indicates the normal operating range

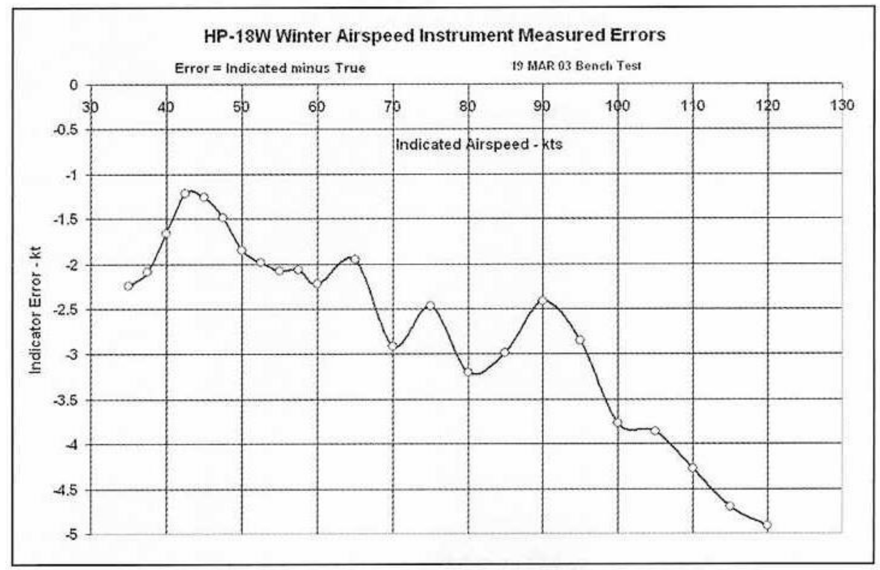
– ***White*** = the white arc depicts the speed range in which fully extended flaps may be used

Definitions

- **Indicated Airspeed** = the uncorrected speed read from the airspeed dial
- **Calibrated Airspeed** = the indicated airspeed corrected for measurement error and installation error in the pitot/static system
- **True Airspeed (TAS)** = is the calibrated airspeed corrected for air density error

Instrumentation – Airspeed Indicator

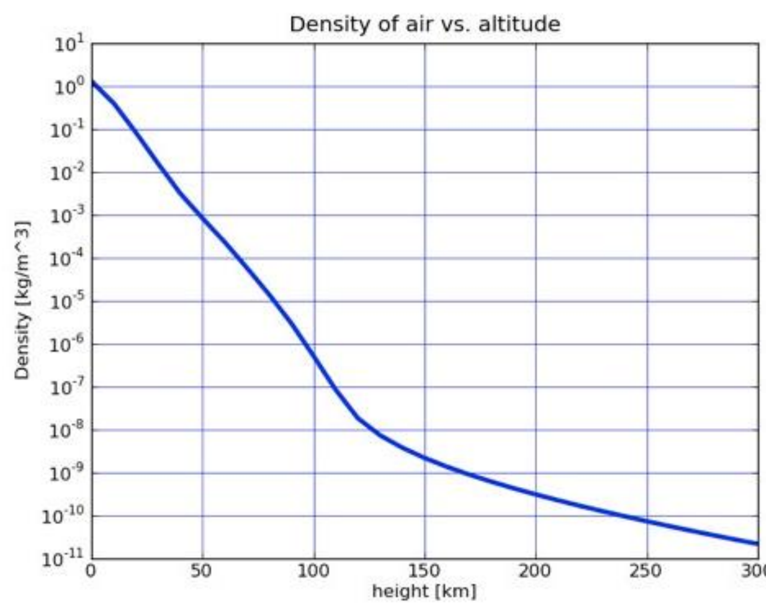
TP 876 – Section 6



Errors

Position Error

- angle at which the pitot tube meets the airflow



Density

- The calibrating standard is normal sea level pressure, 29.92 inHg at 15 degrees C.
- An approximate correction to calculate true airspeed may be made by adding 2% to the airspeed for every 1000ft of pressure altitude

Instrumentation – Airspeed Indicator

TP 876 – Section 6

- **What is Unusual About this Cockpit Photograph?**
- **What is the Indicated Airspeed?**
- **What is the Altitude?**
- **What is the True Airspeed?**

<u>Hint:</u>

+2% per 1000 ft of altitude

(.02 x 15) x 42 kts = +12.6 kts

Therefore True Airspeed

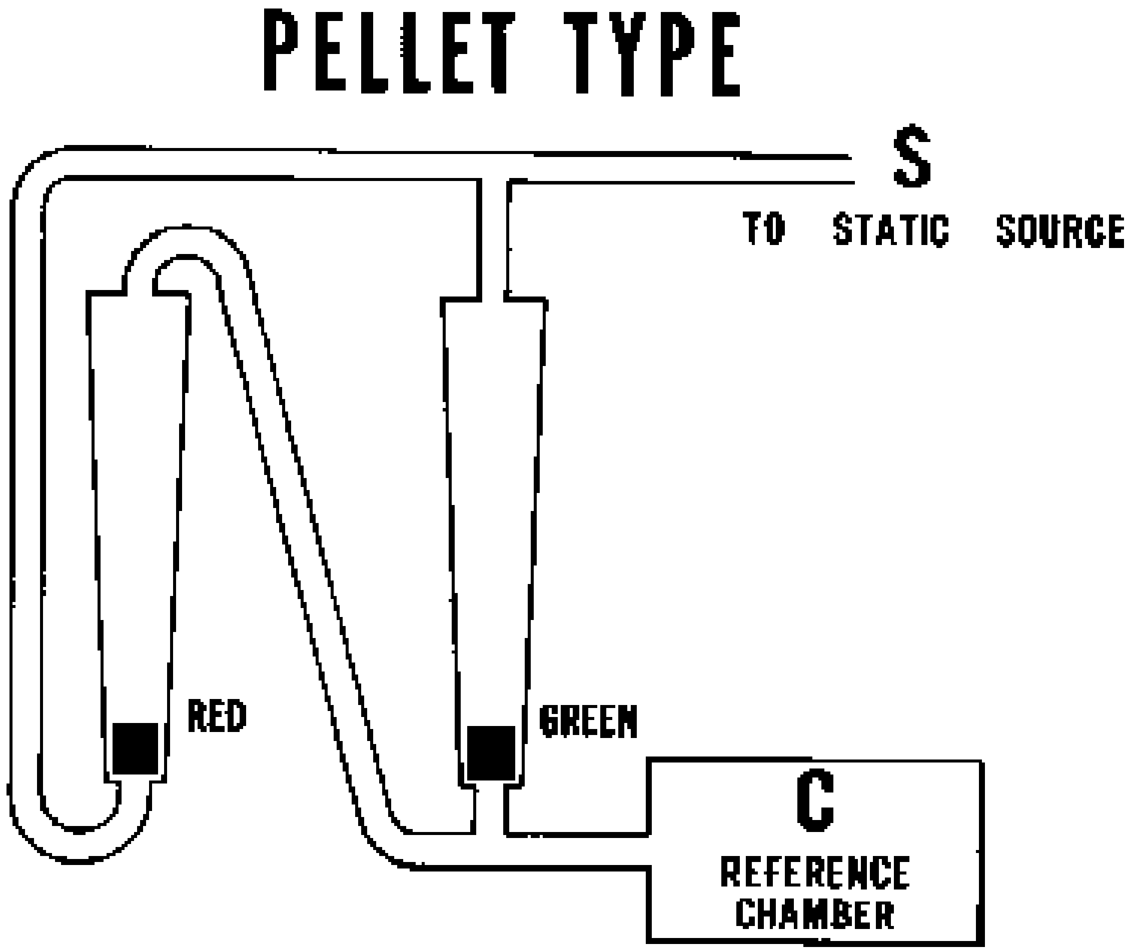
= **<u>55 kts</u>** (approx.)

Instrumentation – Variometer
TP 876 – Section 6

<u>Principle of Operation</u>
- The variometer functions by measuring the rate of change in air pressure as the aircraft climbs and descends

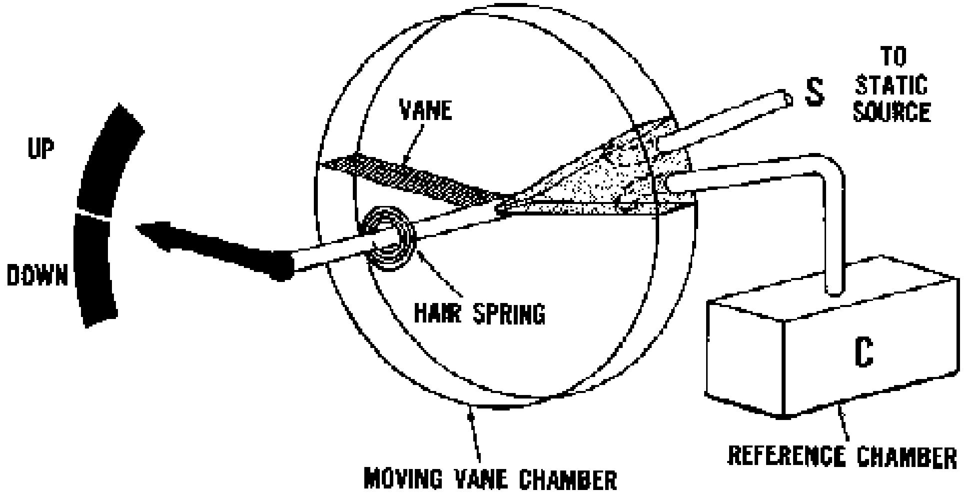
<u>Lag (Delay) Error</u>
- Mechanical variometers tend to have a fixed “lag” or delay time due to their internal moving parts
- Electronic variometers tend to respond much quicker to rates of change of altitude.
- Most pilots use both type in gliders to provide high responsivity (electronic) and averaged readings (mechanical) to properly center themselves in thermals.

Instrumentation – Simple Pellet Variometer
TP 876 – Section 6

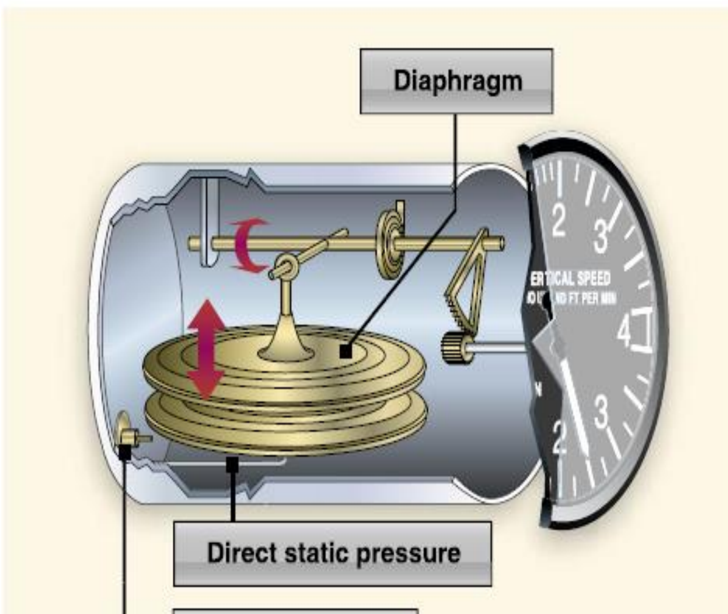


Instrumentation – Typical Mechanical Variometer

TP 876 – Section 6



Simple Mechanical Vane Variometer



Simple Mechanical Dial Variometer

Instrumentation – Compensated Variometer

TP 876 – Section 6

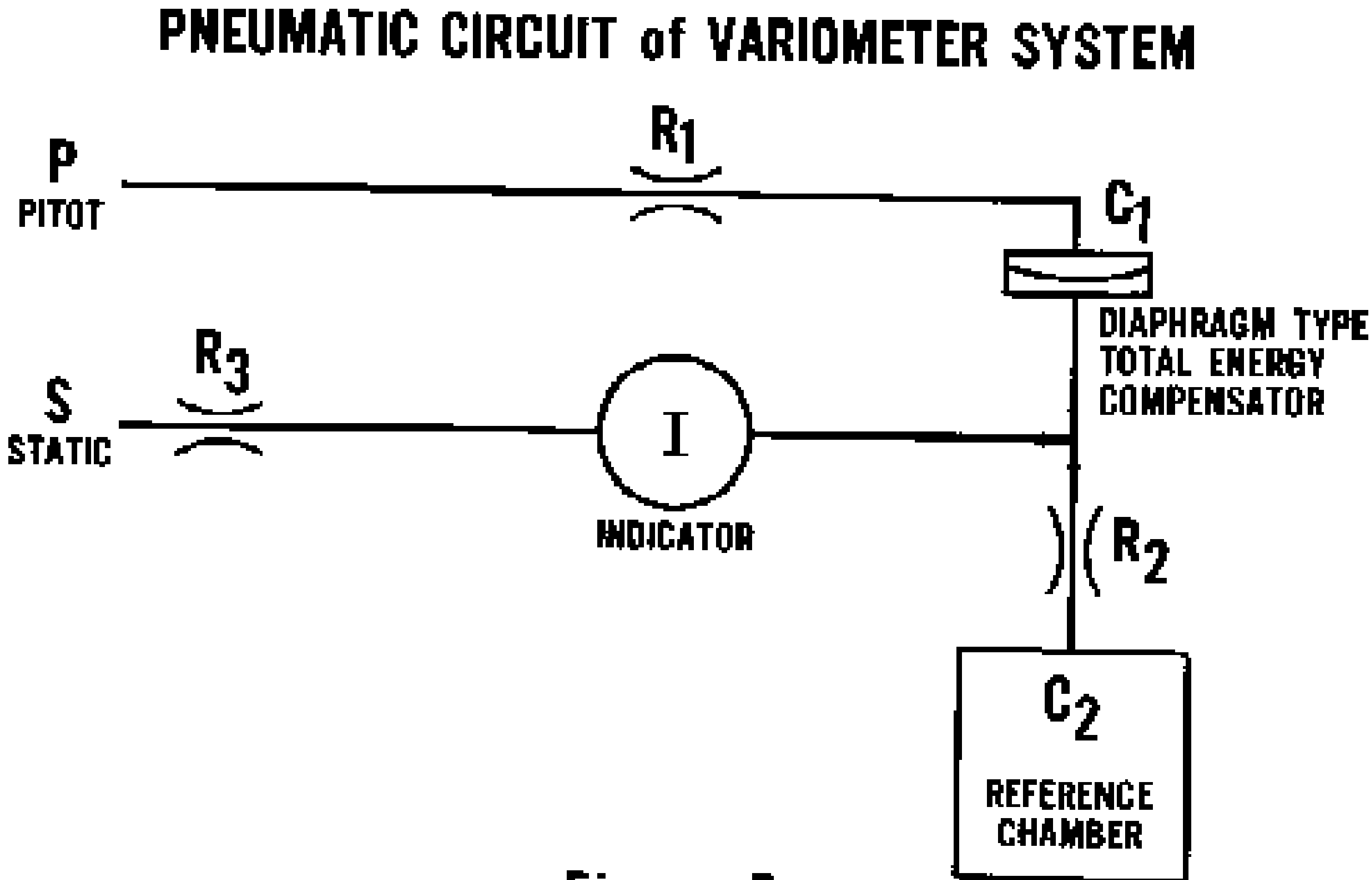


Figure 7

Instrumentation – Electronic Variometer
TP 876 – Section 6

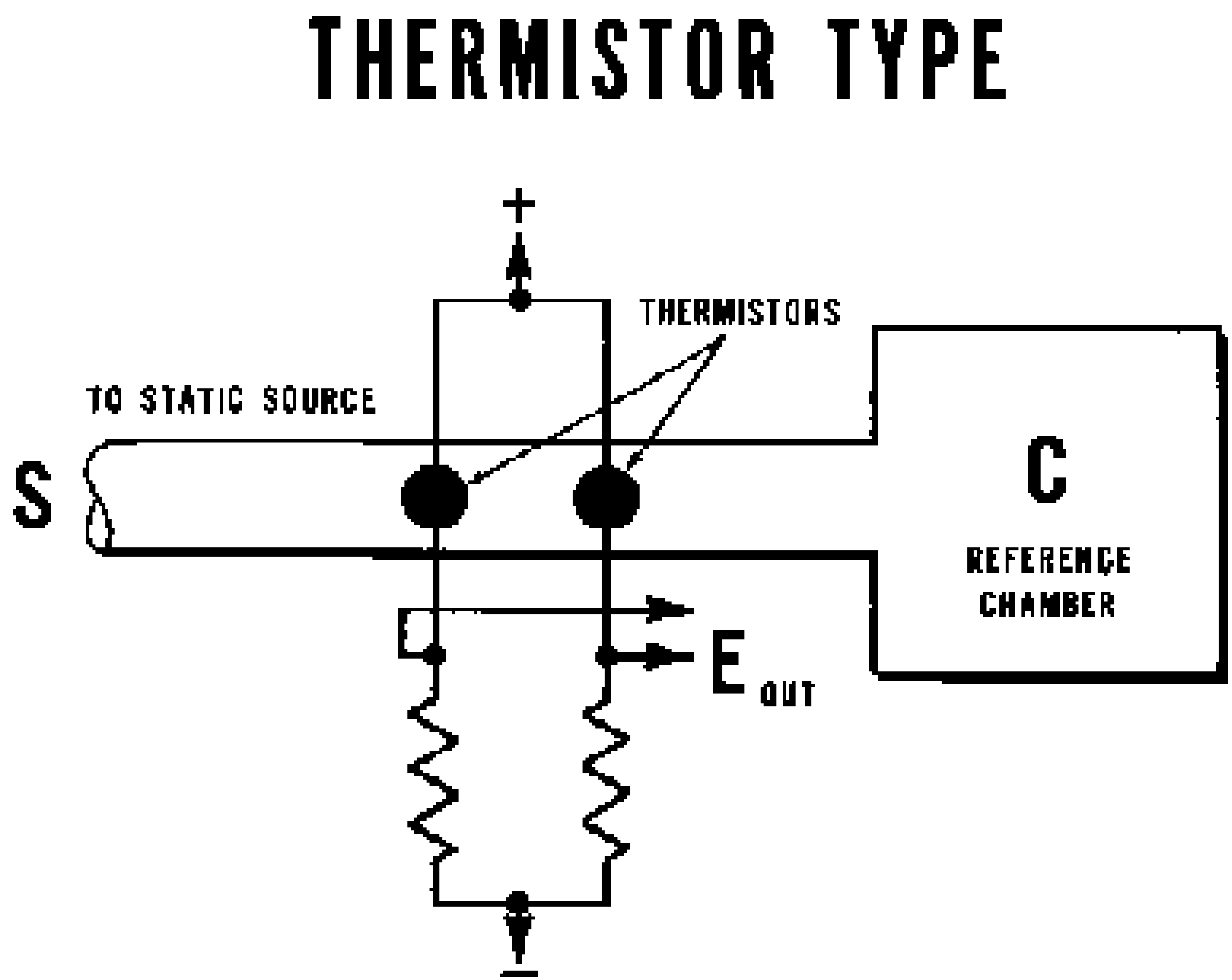
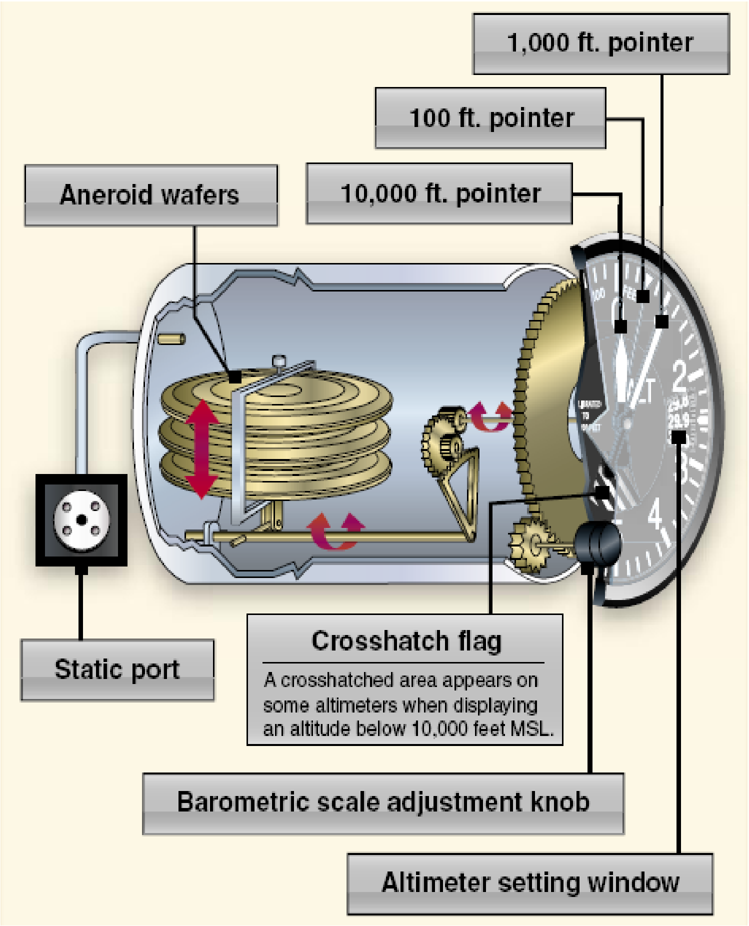


Figure 5

Instrumentation – Altimeter

TP 876 – Section 6

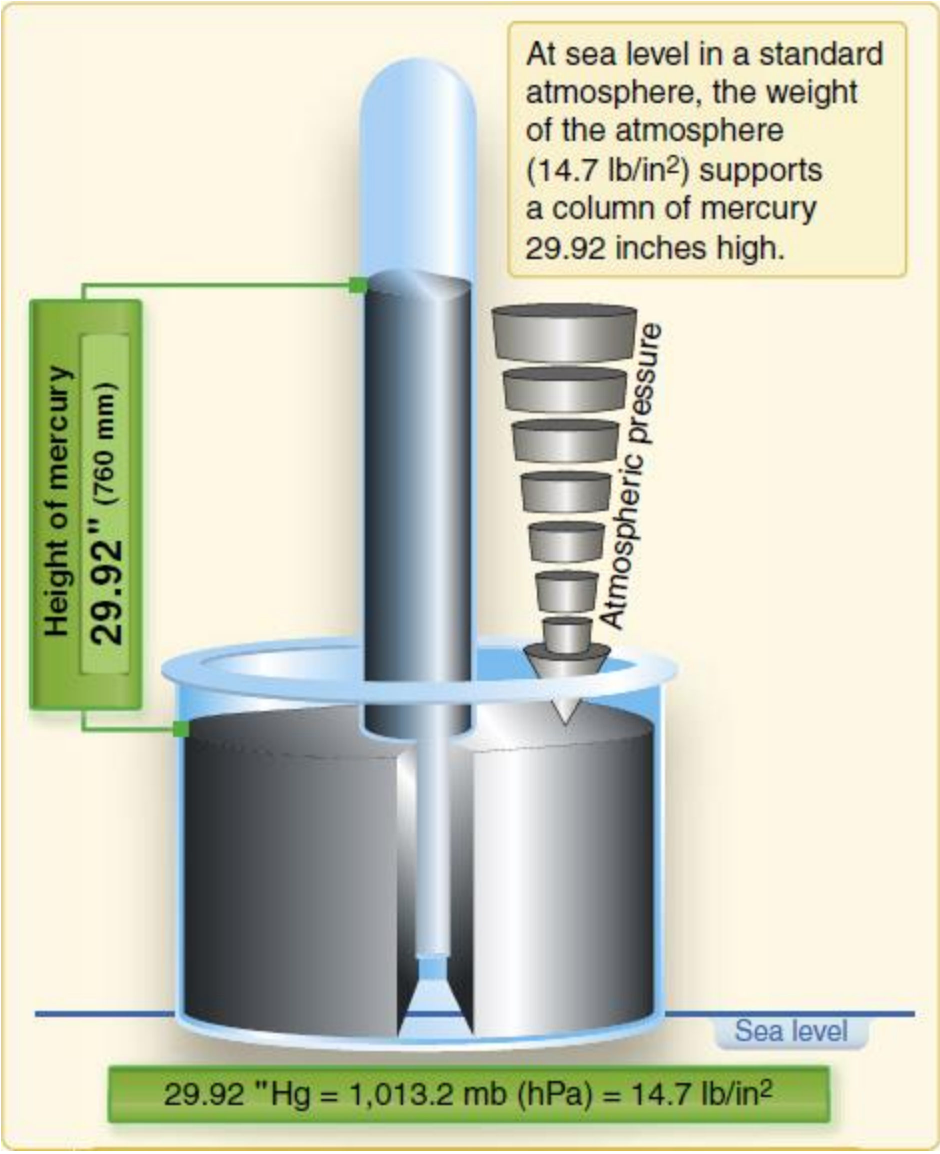


<u>Principles of Operation</u>

- The altimeter measures the altitude of the aircraft above a reference altitude by measuring the change in air pressure
- standard air conditions (at sea level and 15 degrees C)
  - pressure = 14.7 lb./sq. in. = 29.92 inches of mercury (inHg)
- as the aircraft climbs, pressure decreases (i.e. 10,000 ft = 10.1 lb./sq. in)

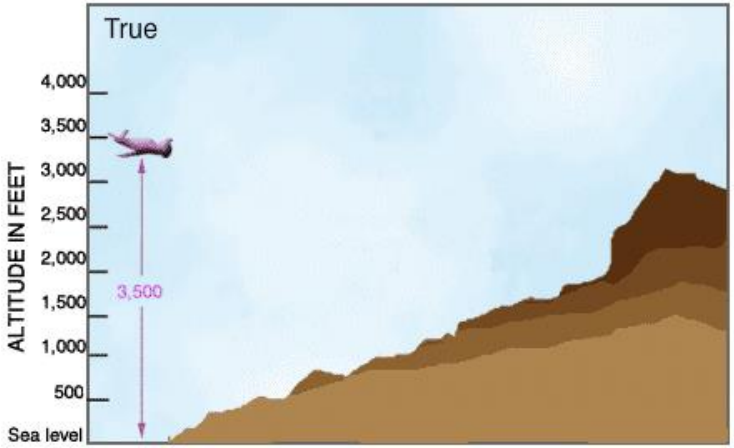
Instrumentation – Altimeter
TP 876 – Section 6

Standard Pressure Definition

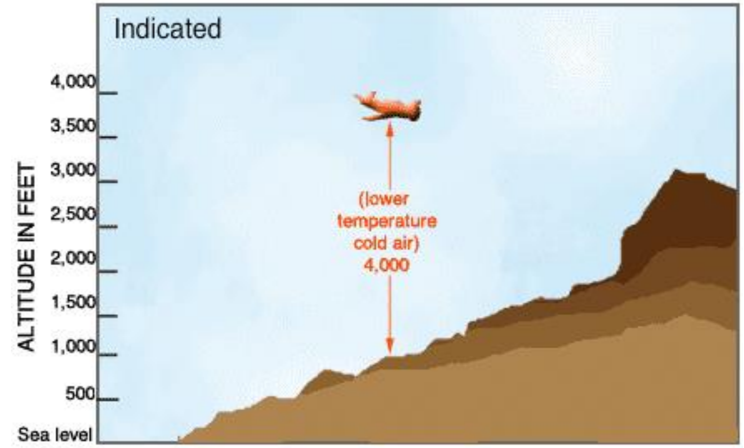


Instrumentation – Altimeter

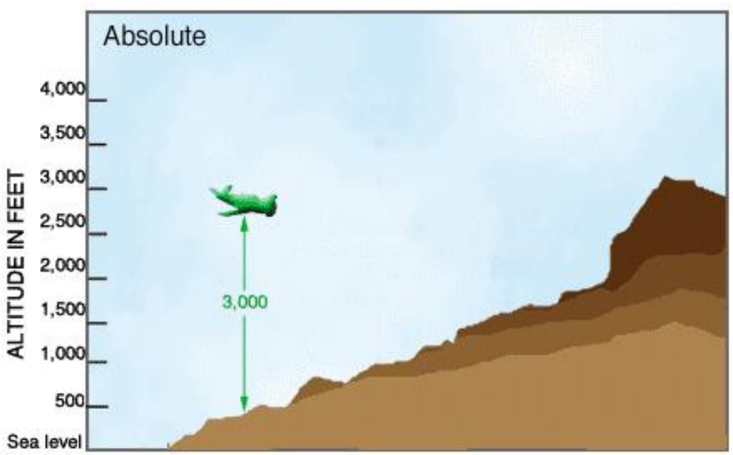
TP 876 – Section 6



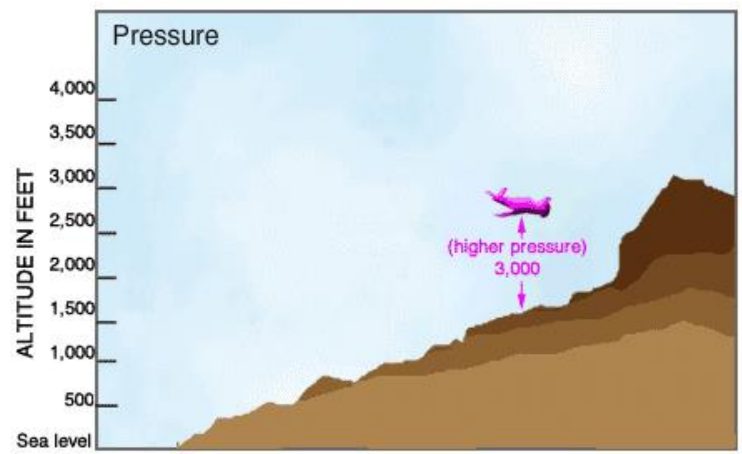
True Altitude = actual aircraft's height above sea level usually expressed as MSL (mean sea level); all elevations on aeronautical charts are expressed in terms of true altitude.



Indicated Altitude = after setting the altimeter at the current altimeter setting this is the uncorrected altitude read directly from that altimeter.



Absolute Altitude = actual height above the earth's surface (altimeter set to field level pressure): the height of an aircraft above the terrain over which it is flying.



Pressure Altitude = after adjusting the altimeter's setting to 29.92 inHg, this is the altimeter reading that corresponds to the altitude in the standard atmosphere.

Calculating Pressure Altitude (PA)

Temperature decreases by approx. 2°C /1000 ft

Method #1

Dial the altimeter setting to 29.92 inHg and read the PA off the dial.

Pressure decreases by approx. 1 inHg/1000 ft

Method #2

Note the airport altimeter setting.

PA = (Standard Pressure – Alt. Setting) x 1000 + Field Elev.

Example

Airport at 1500 MSL with an altimeter setting of 28.92 inHg

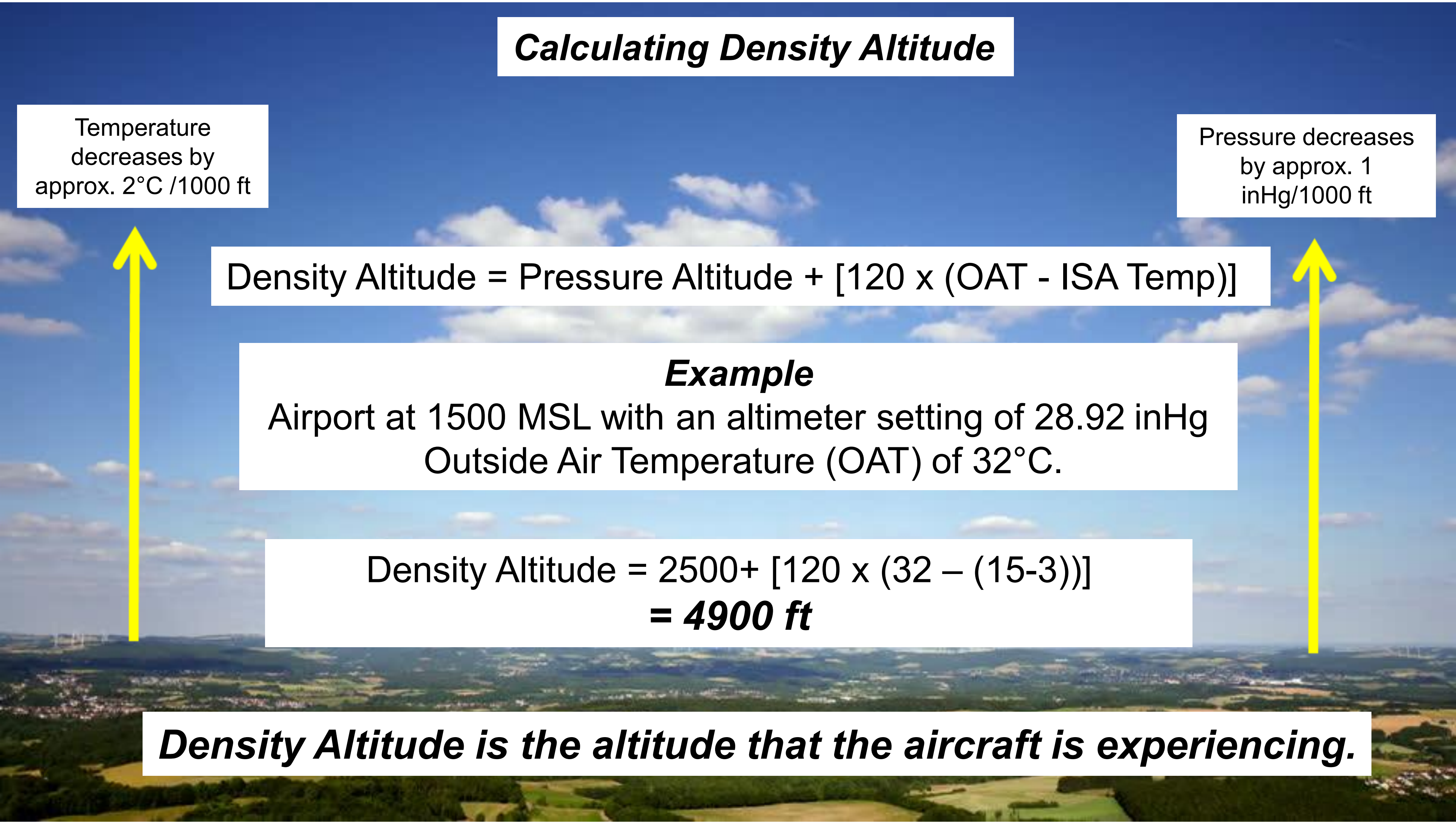
Pressure Altitude = (29.92 – 28.92) x 1000 + 1500

= 2500 ft

Standard Temperature = +15 C at sea level
Standard Pressure: 29.92 inHg at sea level

Instrumentation – Altimeter

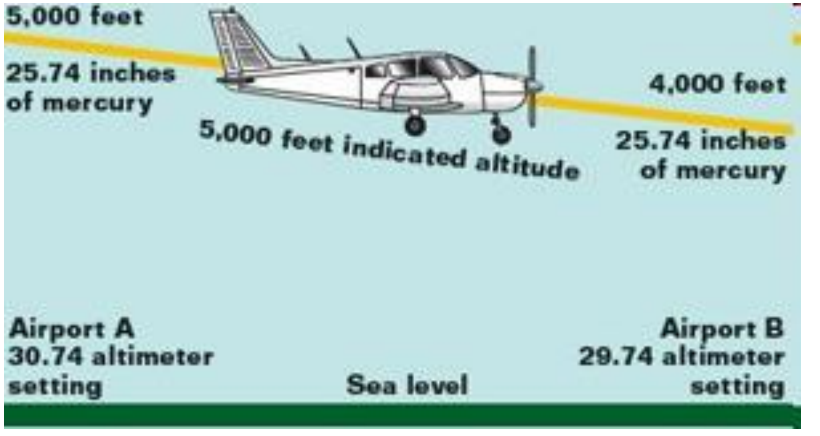
TP 876 – Section 6



Standard Temperature = +15 C at sea level
Standard Pressure: 29.92 inHg at sea level

Instrumentation – Altimeter
TP 876 – Section 6

"FROM HIGH TO LOW WATCH OUT BELOW"



Pressure Error

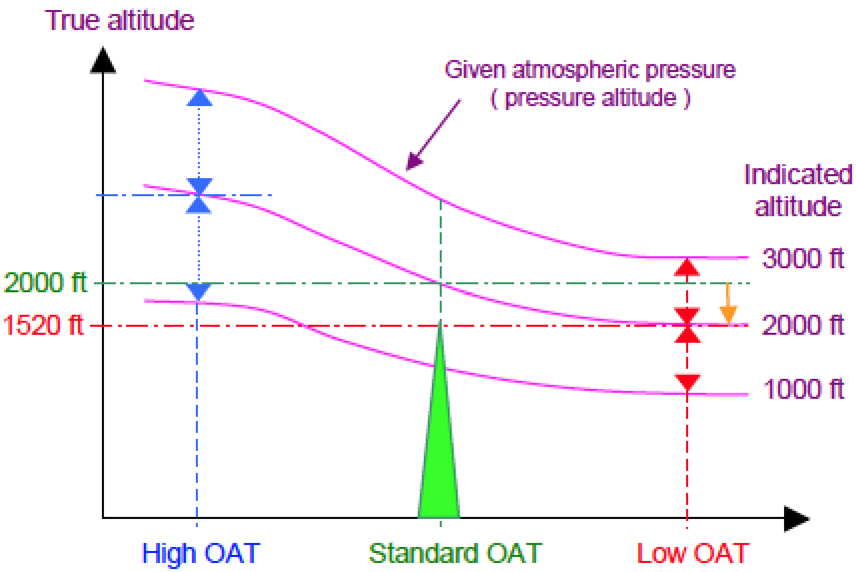
- each 0.1 inHg = approximately 100 ft
- when an aircraft flies from an area of high pressure to and area of low
- pressure, the altimeter will read high , unless corrected.

Mountain Effect Error

- When winds are deflected around mountain peaks or mountain ranges, they tend to increase in speed which results in a local decrease in pressure. A pressure altimeter in such an airflow would give an altitude reading that is too high.

Instrumentation – Altimeter

TP 876 – Section 6



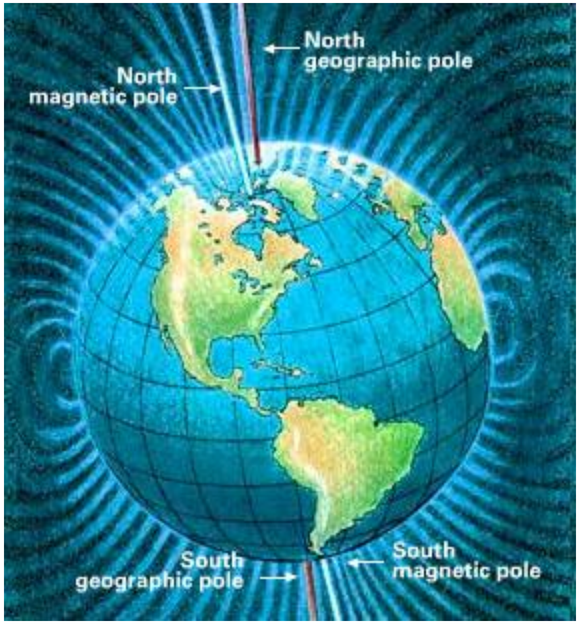
Temperature Error

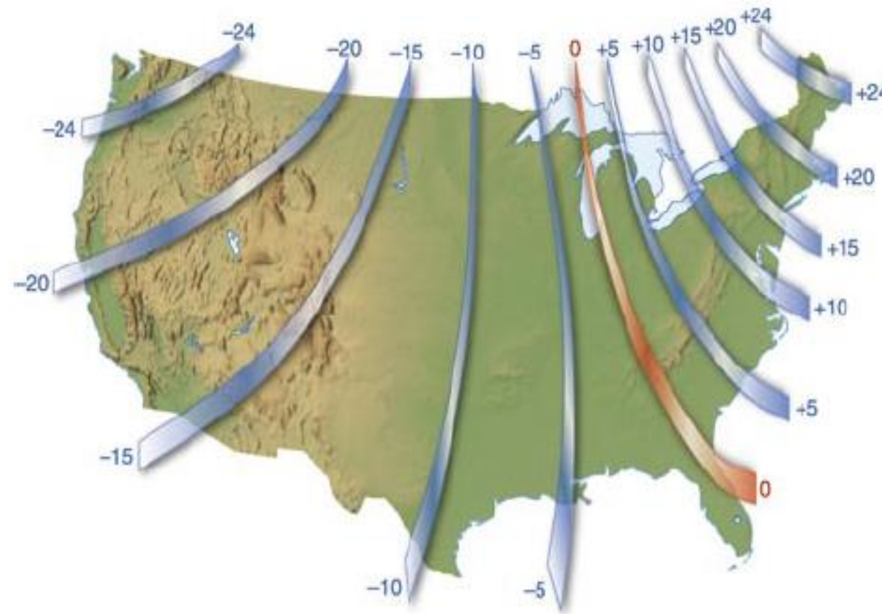
"FROM HOT TO COLD
WATCH OUT BELOW"

Reported Temp 0 °C	Height Above Airport in Feet													
	200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
+10	10	10	10	10	20	20	20	20	20	30	40	60	80	90
0	20	20	30	30	40	40	50	50	60	90	120	170	230	280
-10	20	30	40	50	60	70	80	90	100	150	200	290	390	490
-20	30	50	60	70	90	100	120	130	140	210	280	420	570	710
-30	40	60	80	100	120	140	150	170	190	280	380	570	760	950
-40	50	80	100	120	150	170	190	220	240	360	480	720	970	1210
-50	60	90	120	150	180	210	240	270	300	450	590	890	1190	1500

The Earth's Magnetism

- A magnet attracts ferrous (iron) materials by producing an external magnetic field. The force of attraction is greatest at the poles of the magnet and least in the area halfway between the two poles. Lines of force flow from each of these poles, then bend around and flow toward the opposite pole, thus forming a magnetic field.
- The earth is a huge magnet, with lines of force oriented approximately with the north and south magnetic poles. Because the aircraft compass is suspended to swing freely, it tends to align with the earth's magnetic lines of force.

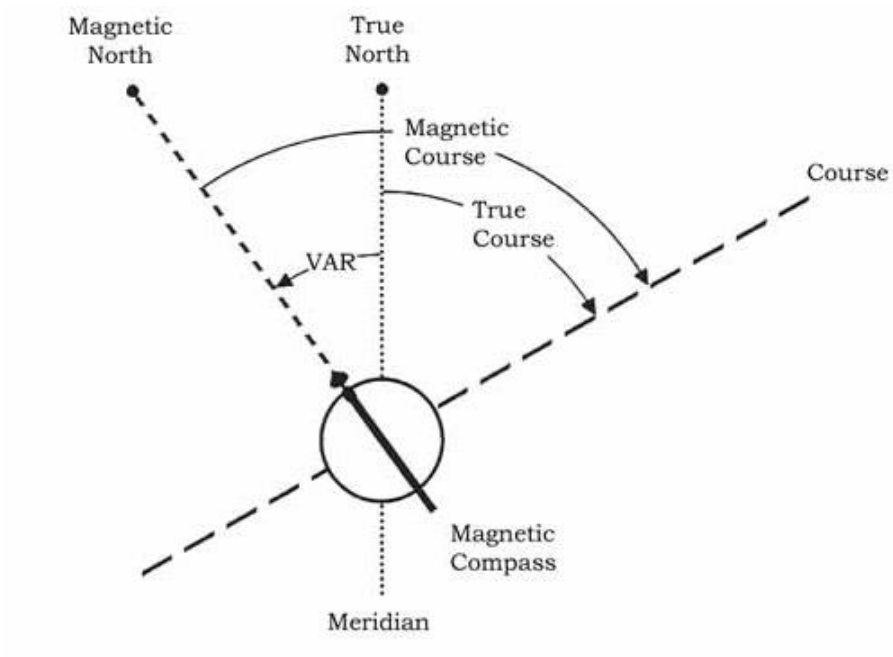




Variation

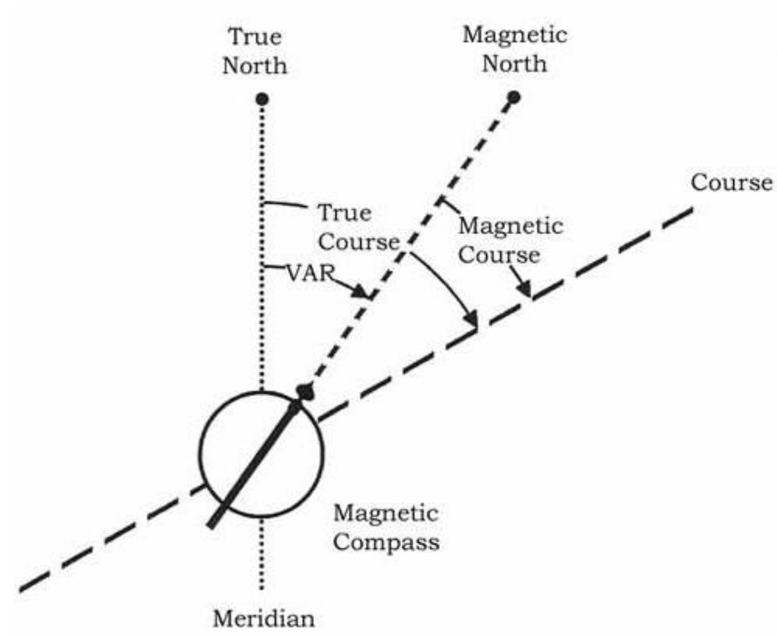
– The earth's magnetic poles are some distance from the geographic or "*true*" poles. The magnetic lines of force do not pass over the surface in a neat geometric pattern because they are influenced by the varying mineral content of the earth's crust. For these reasons, there is usually an angular difference, or *variation*, between true north and magnetic north from a given geographic location.

Calculation of Magnetic Heading from True Heading



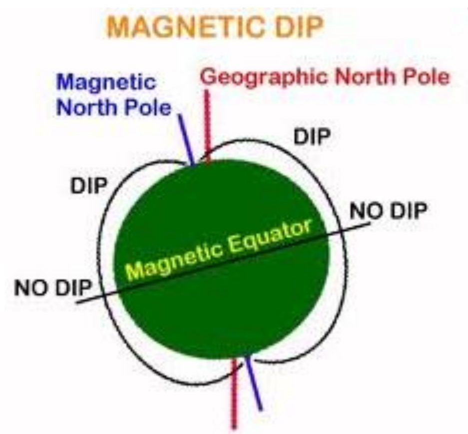
When the variation is westerly it is added to the true heading to find the magnetic heading:
030° True + 10° W variation = 040° Magnetic

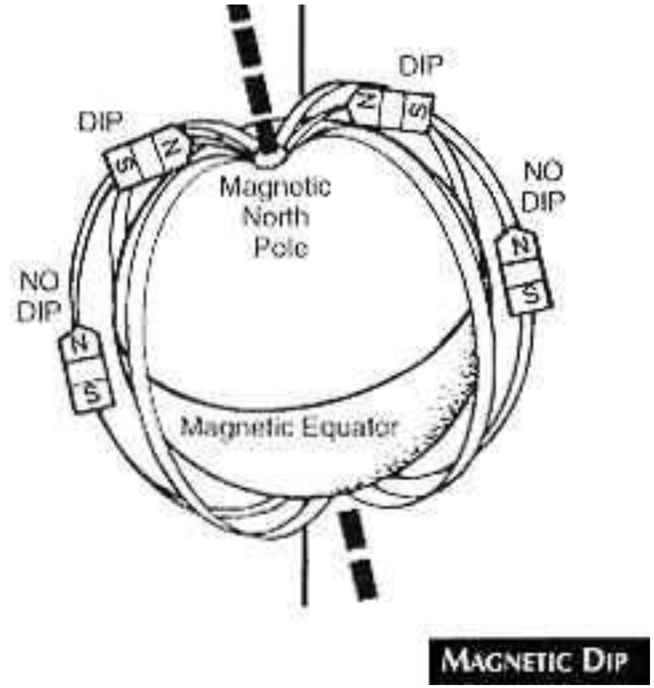
WEST is BEST



When the variation is easterly it is subtracted from the true heading to find the magnetic heading:
030° True - 15° W variation = 015° Magnetic

EAST is LEAST





Magnetic Dip

- The lines of force in the earth's magnetic field pass through the center of the earth, exit at both magnetic poles, and bend around to re-enter at the opposite pole.
- Near the Equator, these lines become almost parallel to the surface of the earth. However, as they near the poles, they tilt toward. the earth until in the immediate area of the magnetic poles they dip rather sharply into the earth.
- Because the poles of a compass tend to align themselves with the magnet lines of force, the magnet within the compass tends to tilt or dip toward the earth in the same manner as the lines of force.

Instrumentation – Direct Reading Magnetic Compass

TP 876 – Section 6

Principles of Operation

– The aircraft's magnetic compass is a simple, self-contained instrument. It consists of a sealed outer case within, which is located, a pivot assembly and a float containing two or more magnets. A *compass card* is attached to the float with the cardinal headings (north, east, south and west) shown by corresponding letters. The pilot may think of the compass card as a soup bowl turned upside down and balanced precisely on the point of a pencil. It rotates freely and can tilt up to 18°.

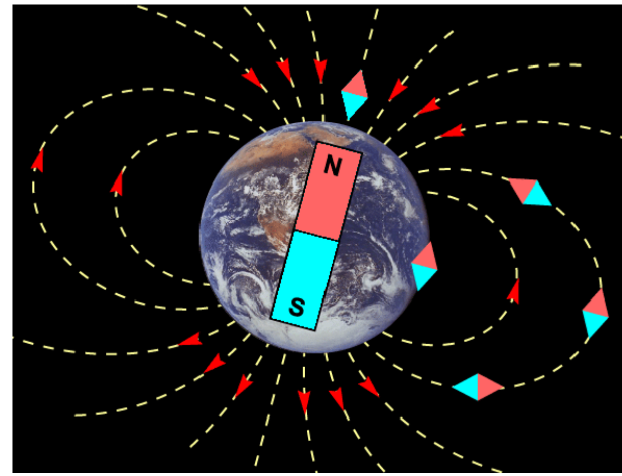
Principles of Operation (continued)

– The case is typically filled with an acid-free white kerosene that helps to dampen oscillations of the float and lubricate the pivot assembly. The pivot assembly is spring-mounted to further dampen aircraft vibrations so that the compass heading may be read more easily. A glass face is mounted on one side of the compass case with a lubber, or reference, line in the center. Compensating magnets are located within the case to correct the compass reading for the effects of small magnetic fields generated by components of the aircraft.

Factors Adversely Affecting Operation

FOR STEER	000	030	060	090	120	150
RDO. ON	001	032	062	095	123	155
RDO. OFF	002	031	064	094	125	157

FOR STEER	180	210	240	270	300	330
RDO. ON	176	210	243	271	296	325
RDO. OFF	174	210	240	273	298	327



Location of "Ferrous" Materials in the Instrument Panel/Cockpit

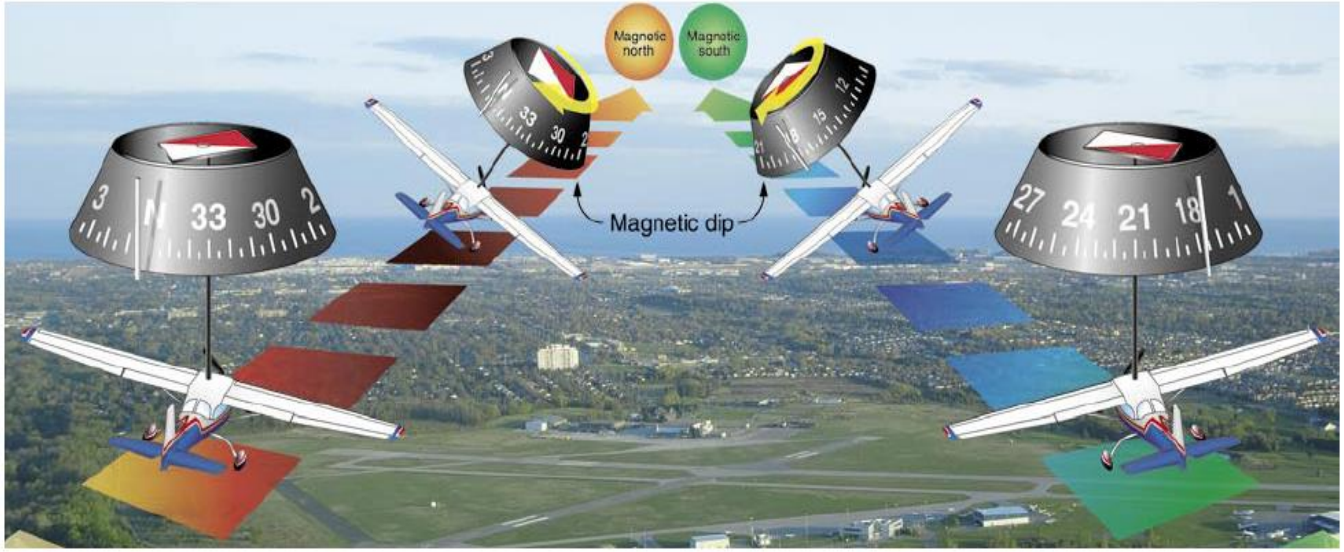
- Compensated by using an attached correction card

Magnetic "Dip" Errors

- Turning errors
- Acceleration errors

Instrumentation – Direct Reading Magnetic Compass

TP 876 – Section 6

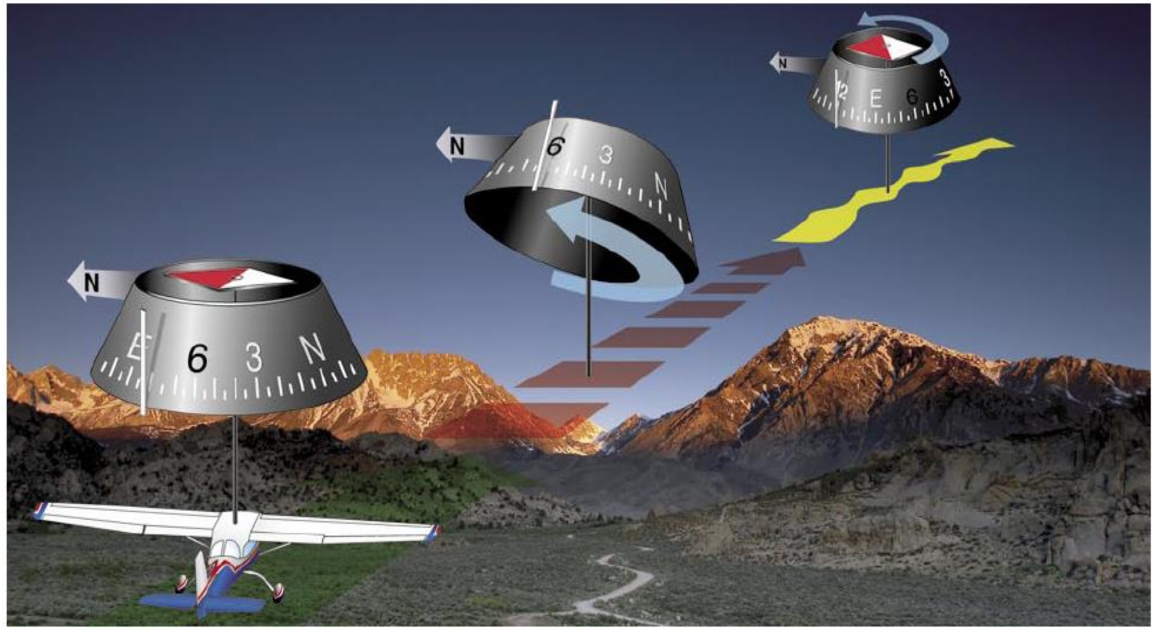


Turning Errors

- The compass card is mounted so that its center of gravity is well below the pivot point on the pedestal. When the aircraft is in a banked turn, the card also banks because of centrifugal force. While the card is in the banked attitude, the vertical component of the earth's magnetic field causes the compass to dip to the low side of the turn.
- The error is most apparent when turning through headings close to north and south.
- When the aircraft makes a turn from a heading of north, the compass briefly indicates a turn in the opposite direction.
- When the aircraft makes a turn from a heading of south, the compass indicates a turn in the correct direction but at a considerably faster rate than is actually occurring.

Instrumentation – Direct Reading Magnetic Compass

TP 876 – Section 6



Acceleration & Deceleration Errors

- *Acceleration error* occurs during airspeed changes and is most apparent on headings of east and west. It is caused by a combination of inertia and magnetic dip. As the aircraft accelerates, the compass card, acting like a pendulum, tilts slightly during the acceleration because of the card's inertia.
- This momentary tilting displaces the compass card from its normal alignment with magnetic north; therefore, when the aircraft accelerates in either an easterly or westerly direction, the compass card momentarily indicates a turn toward the north
- The reverse is true when the aircraft decelerates.
- Pilots should remember the acronym ANDS: *accelerate north, decelerate south*.

Checking Compass Heading on Ground and in Flight

- On the ground, the pilot can verify heading by reading directly off the compass (including the compensation card).
- After rolling the aircraft out on the new heading in flight, the pilot must wait a few seconds for the compass to settle down. Then he or she can check the new heading (remembering to use the compensation card).
- In both cases it is crucial to ensure that no ferrous items are positioned near the compass (sunglasses, headsets)

End of Part 1