

# Flight Instruments

Hanscom FTC- Instrument Pilot Ground School

# Static Pressure

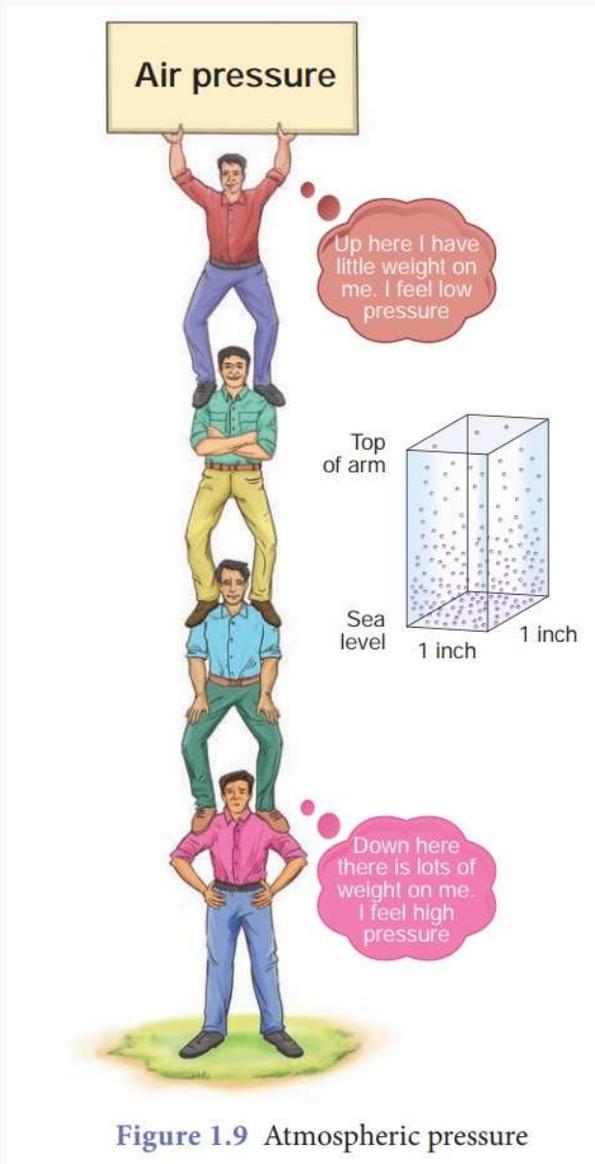
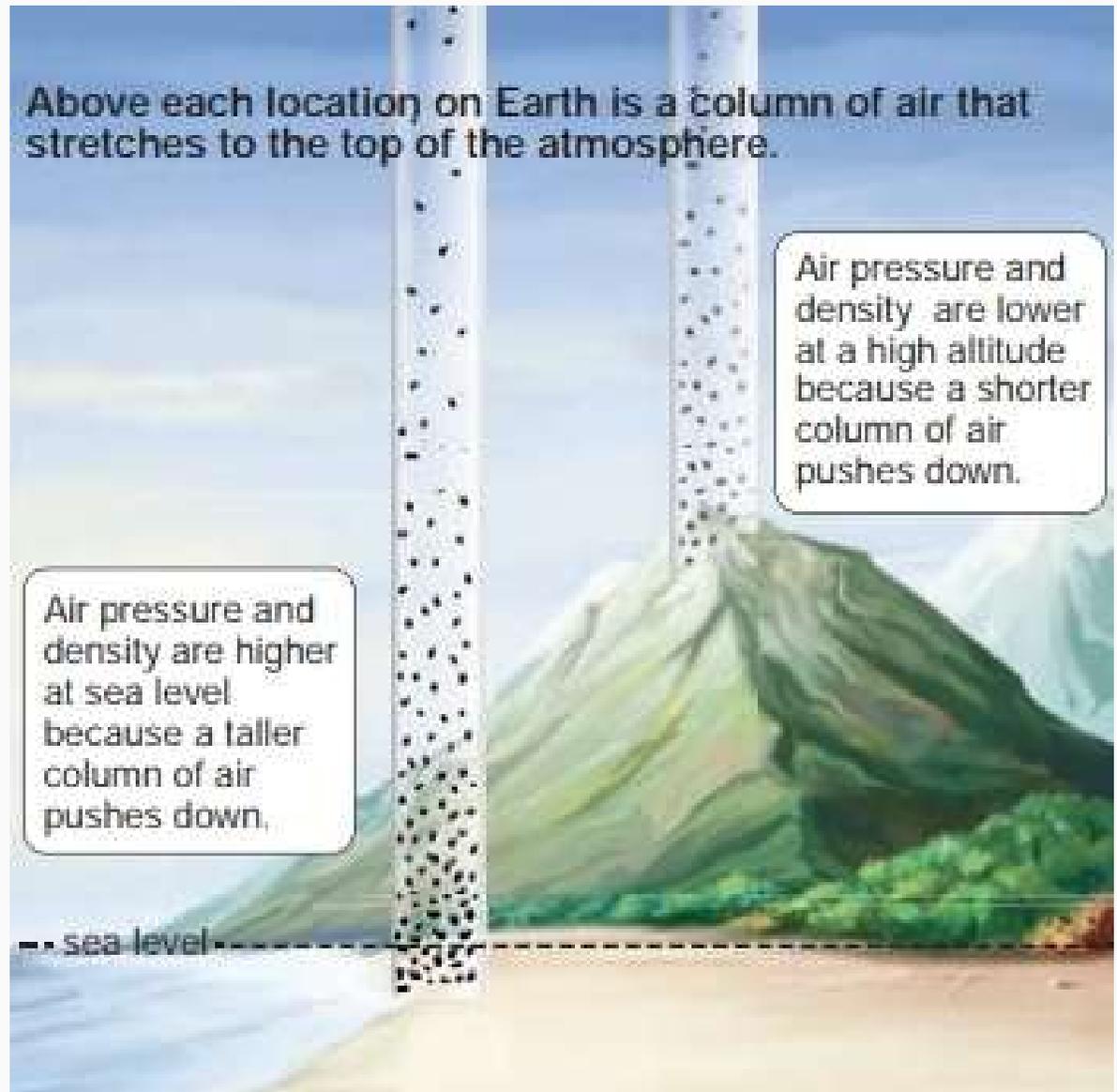
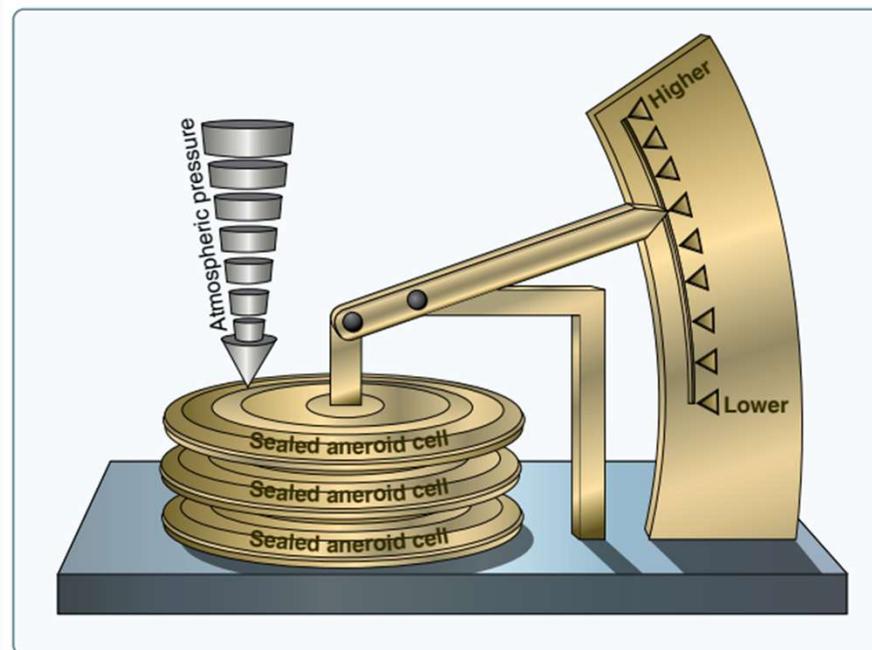
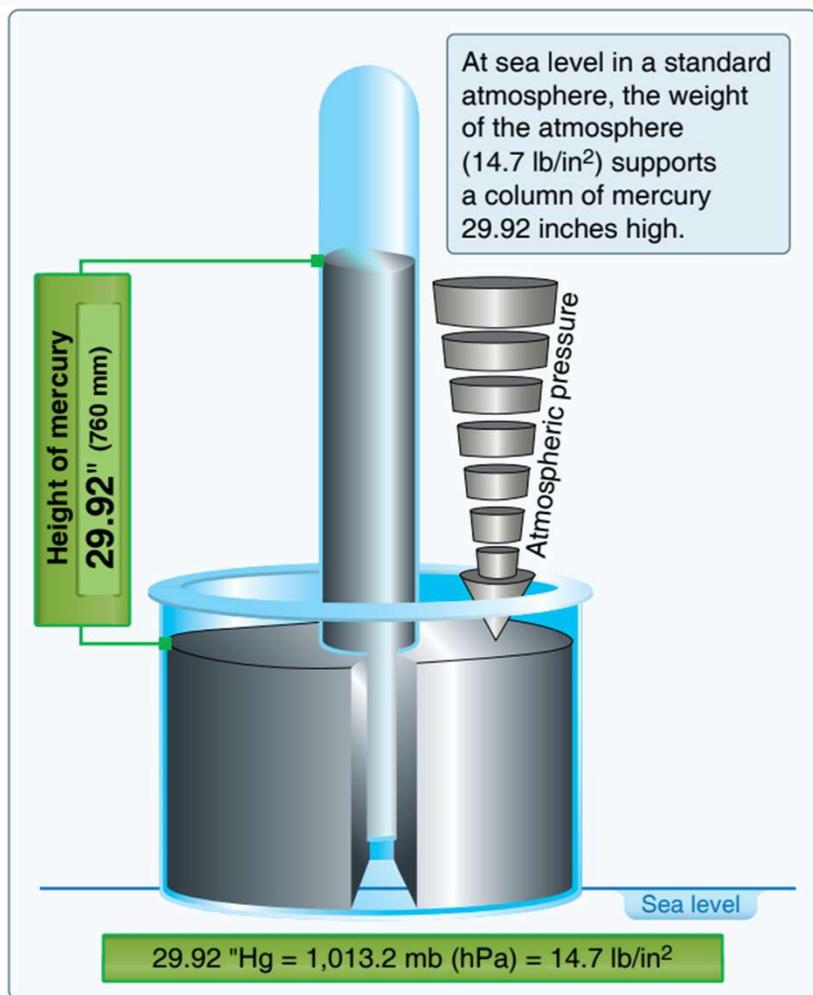


Figure 1.9 Atmospheric pressure

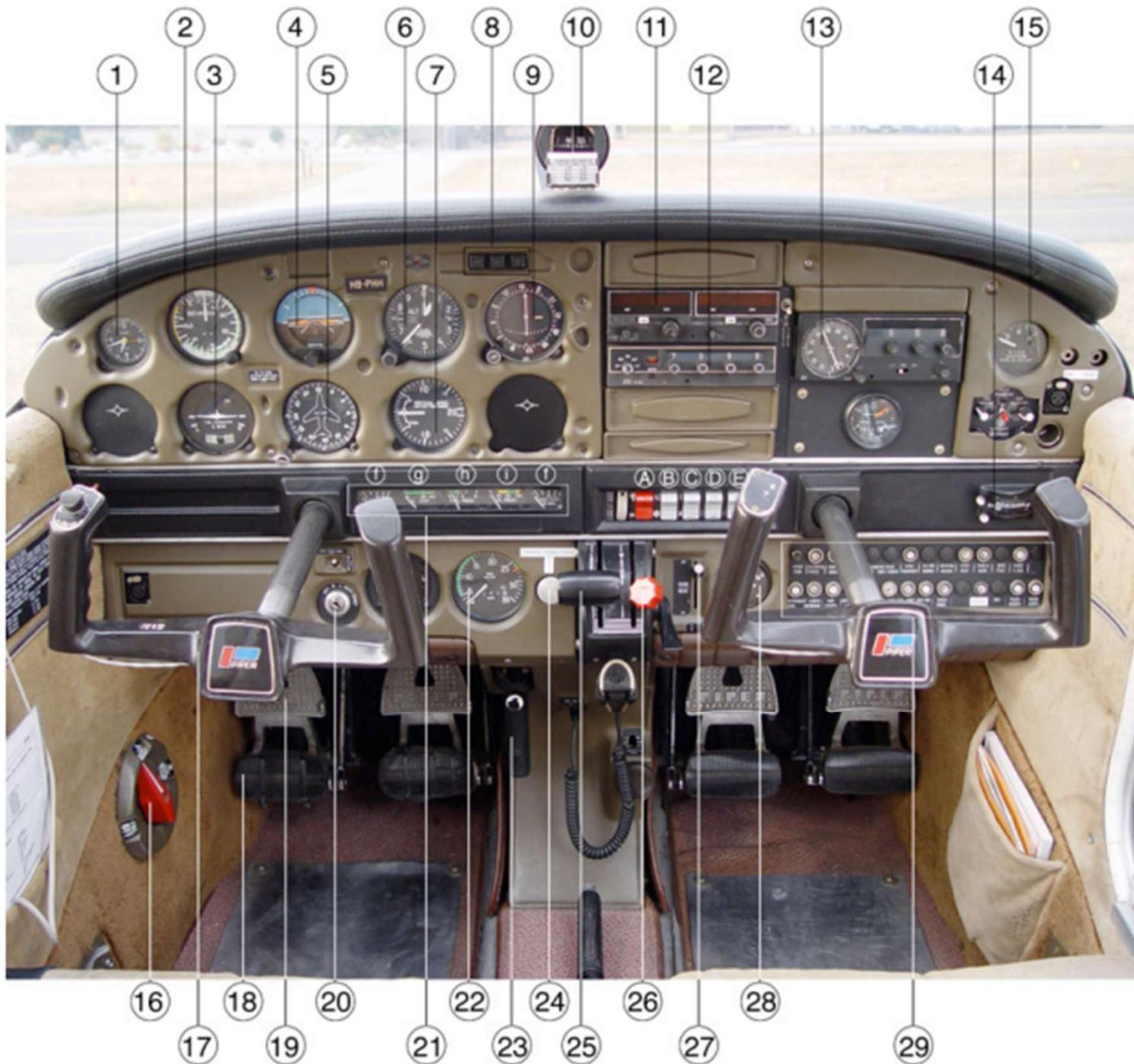


# Measuring Pressure



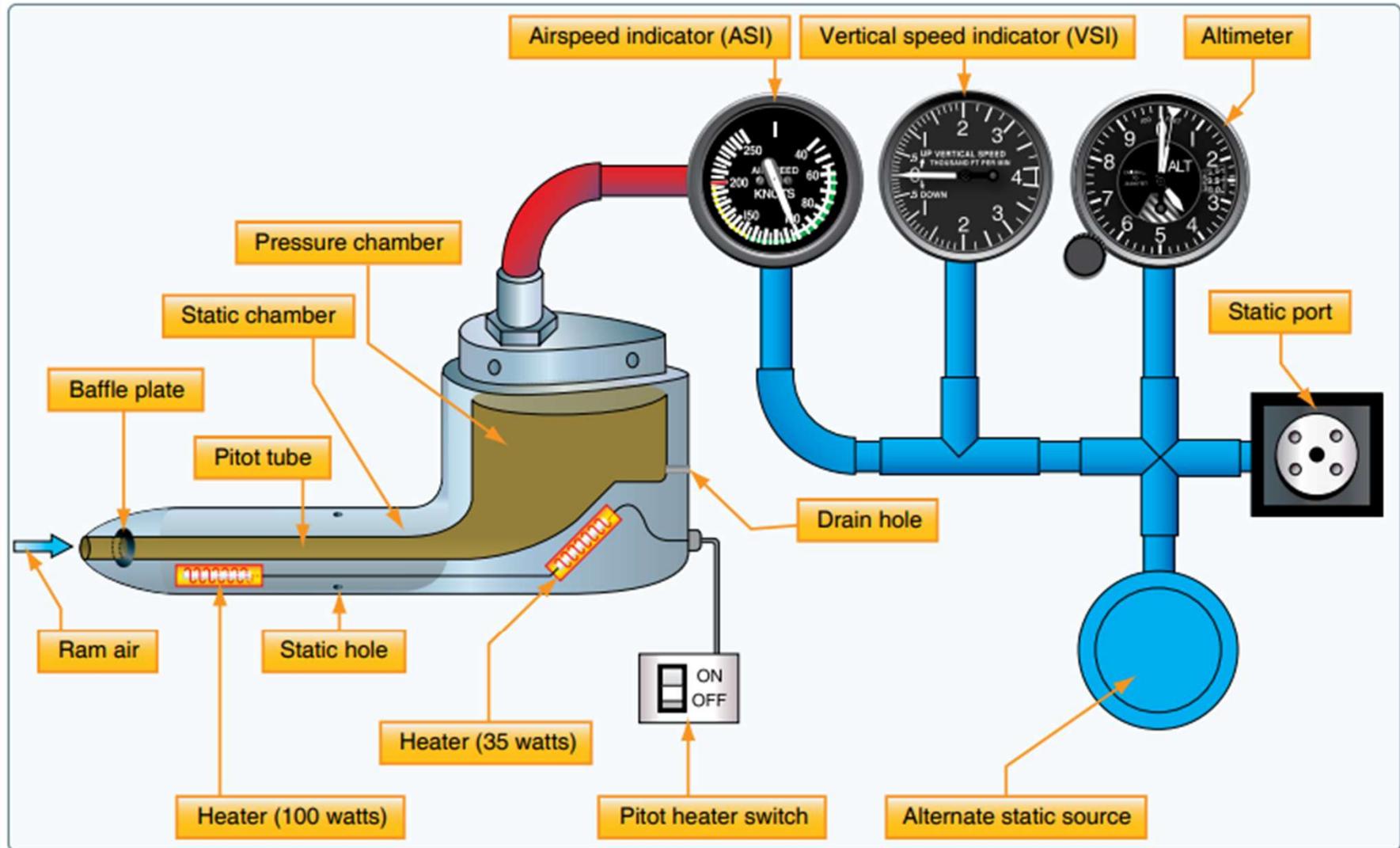
# Pitot-Static Instruments





- 1 Clock
- 2 Airspeed Indicator
- 3 Turn coordinator
- 4 Attitude Indicator
- 5 Directional Gyro
- 6 Altimeter
- 7 Vertical Speed Indicator
- 8 Annunciator Panel
- 9 VOR
- 10 Magnetic Compass
- 11 NAV / COM
- 12 Transponder
- 13 ADF
- 14 Heating
- 15 Gyro Suction
- 16 Fuel Selector
- 17 Yoke
- 18 Rudder Pedals
- 19 Brake Pedals
- 20 Magnetos (Ignition)
- 21 Engine Instruments
- 22 RPM Indicator
- 23 Parking Brake
- 24 Primer
- 25 Throttle (Gas)
- 26 Mixture Control
- 27 Carburetor Heat
- 28 Amp Meter
- 29 Circuit Breakers
- A Master Switch
- B Aux. Fuel Pump
- C Landing Light
- D Strobe Light
- E Pitot Heat
- f Fuel Indicators
- g Oil Temperature
- h Fuel Pressure
- i Oil Pressure

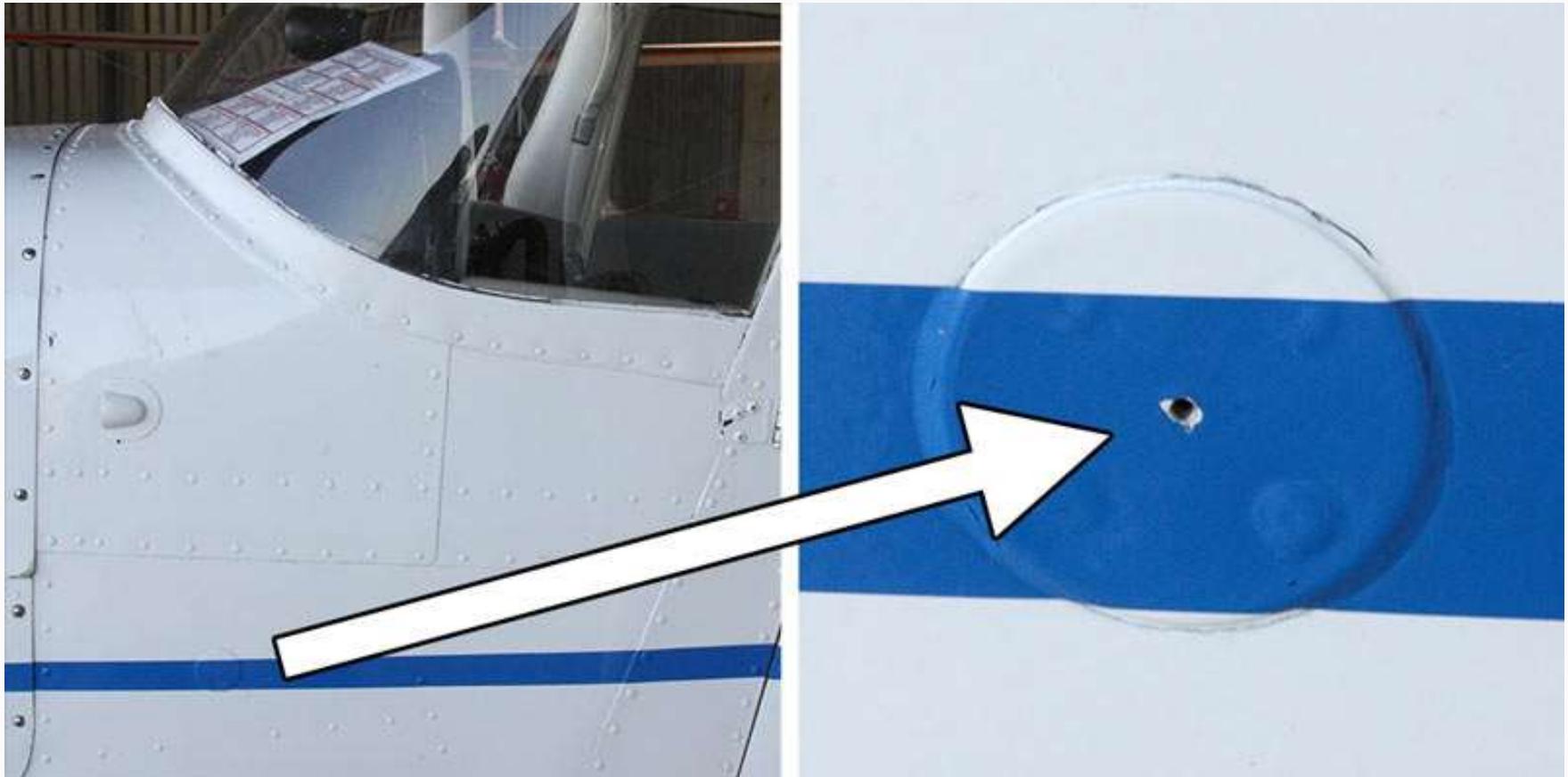
# Pitot-Static System



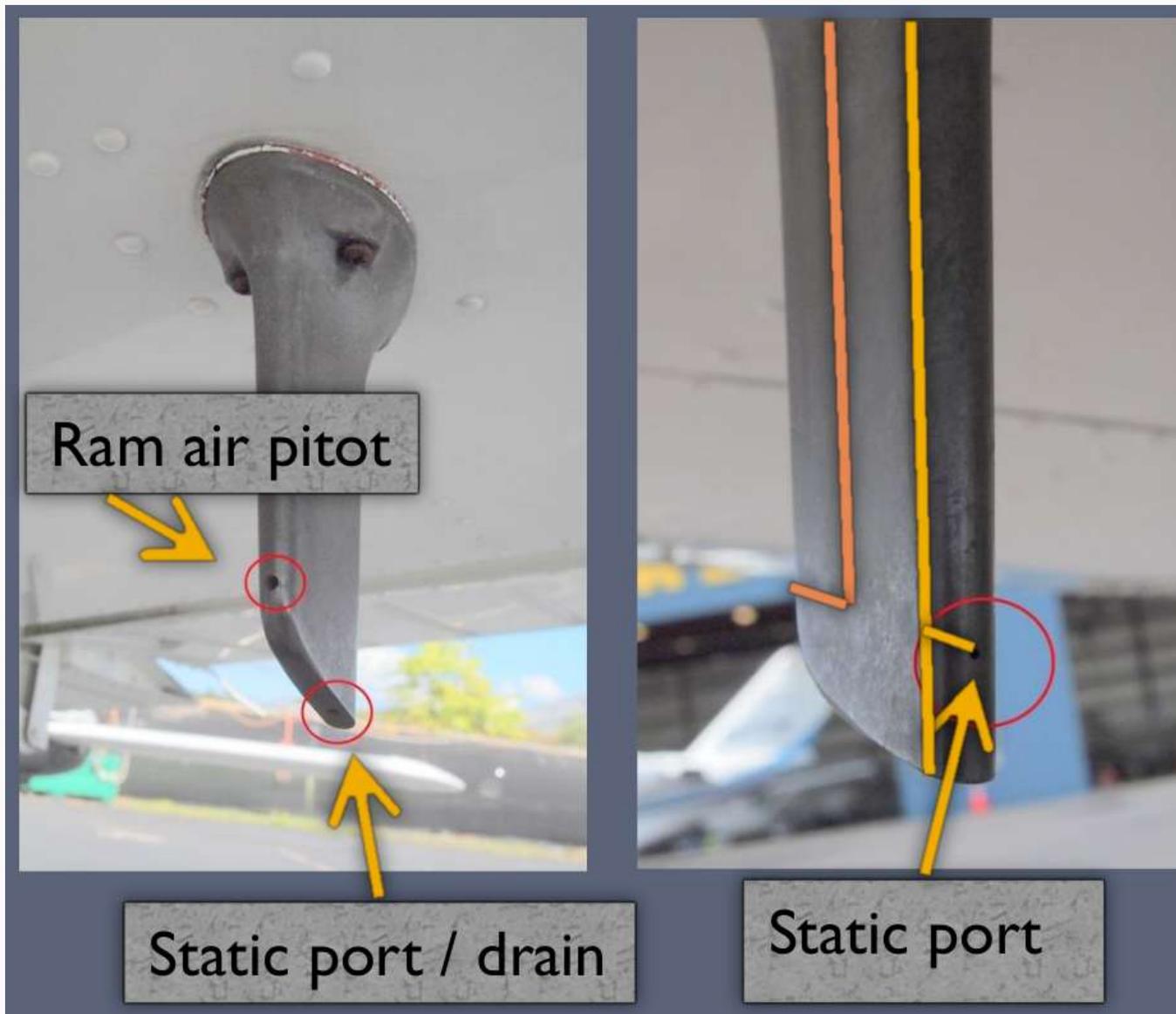
# Pitot Tube



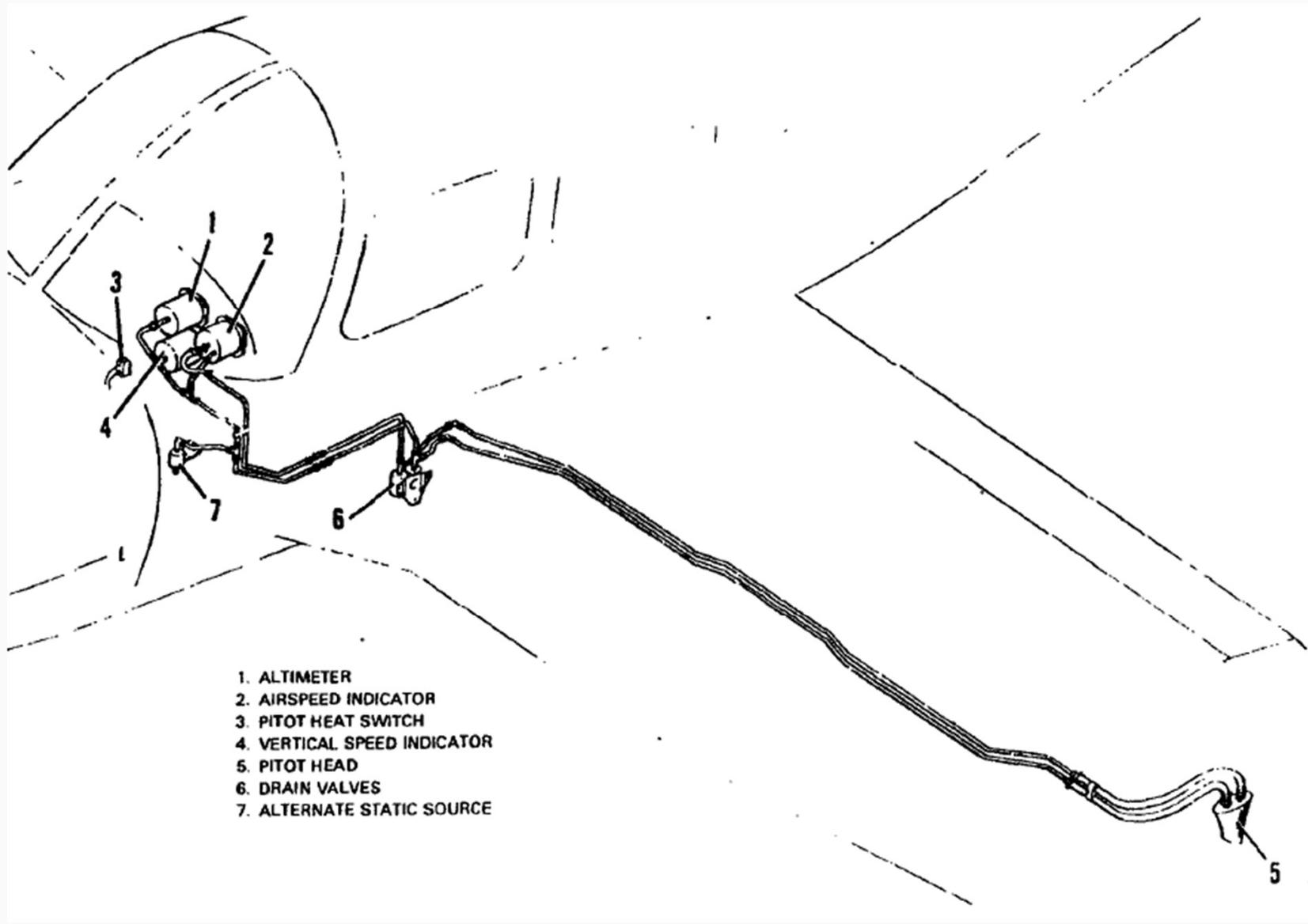
# Static Port



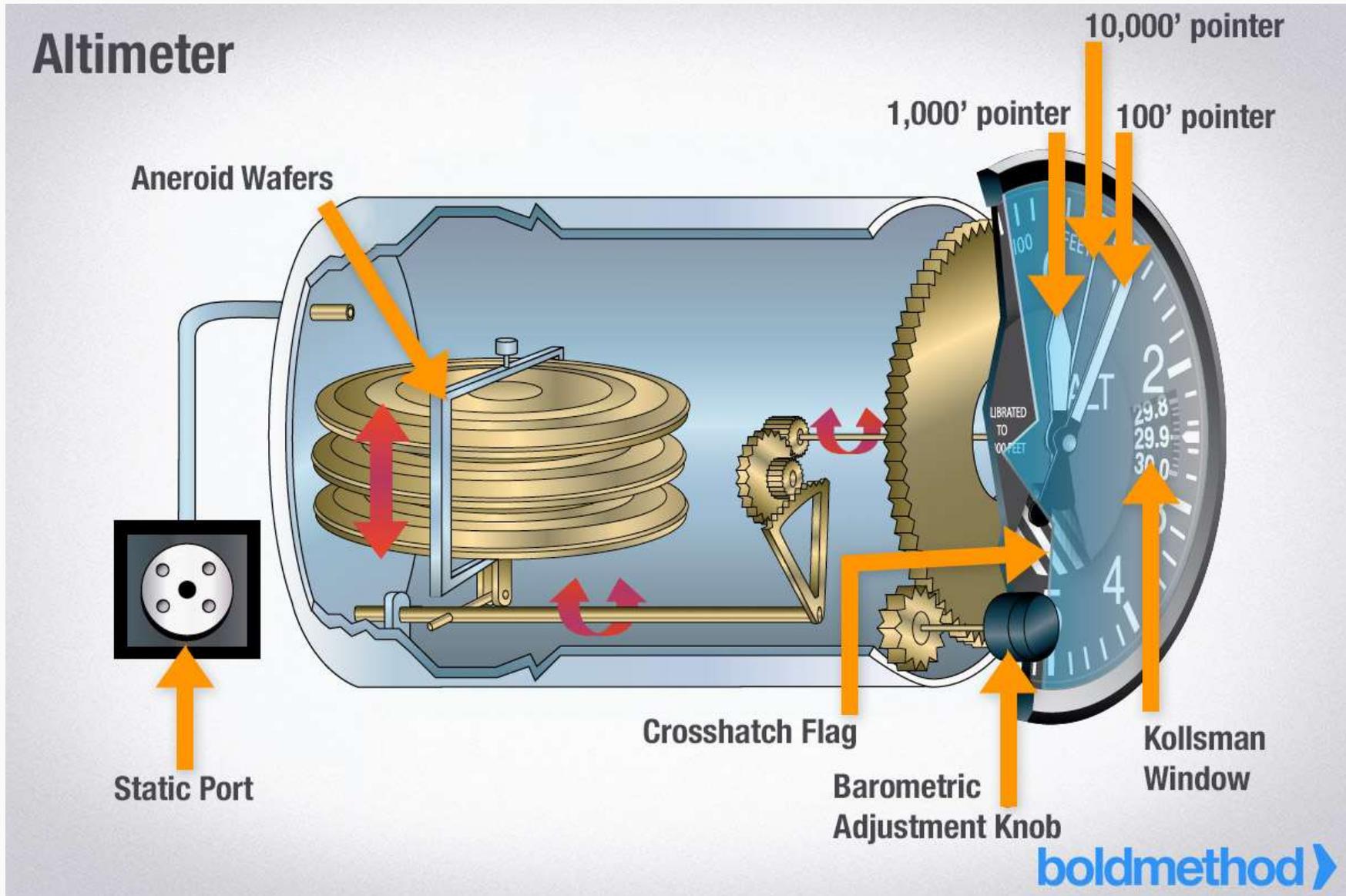
# Pitot-Static Mast (Piper Cherokee)



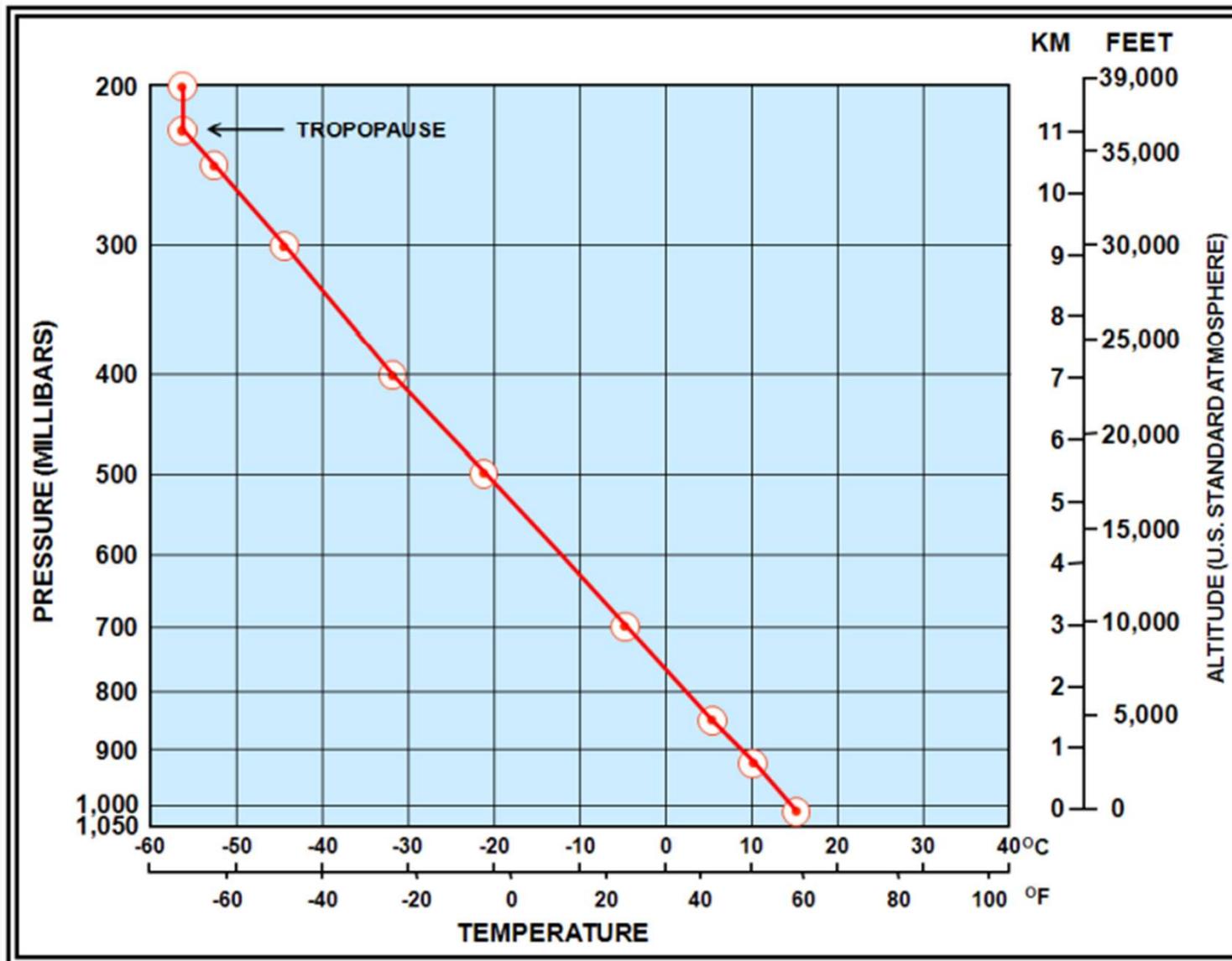
# Pitot-Static System



# Altimeter

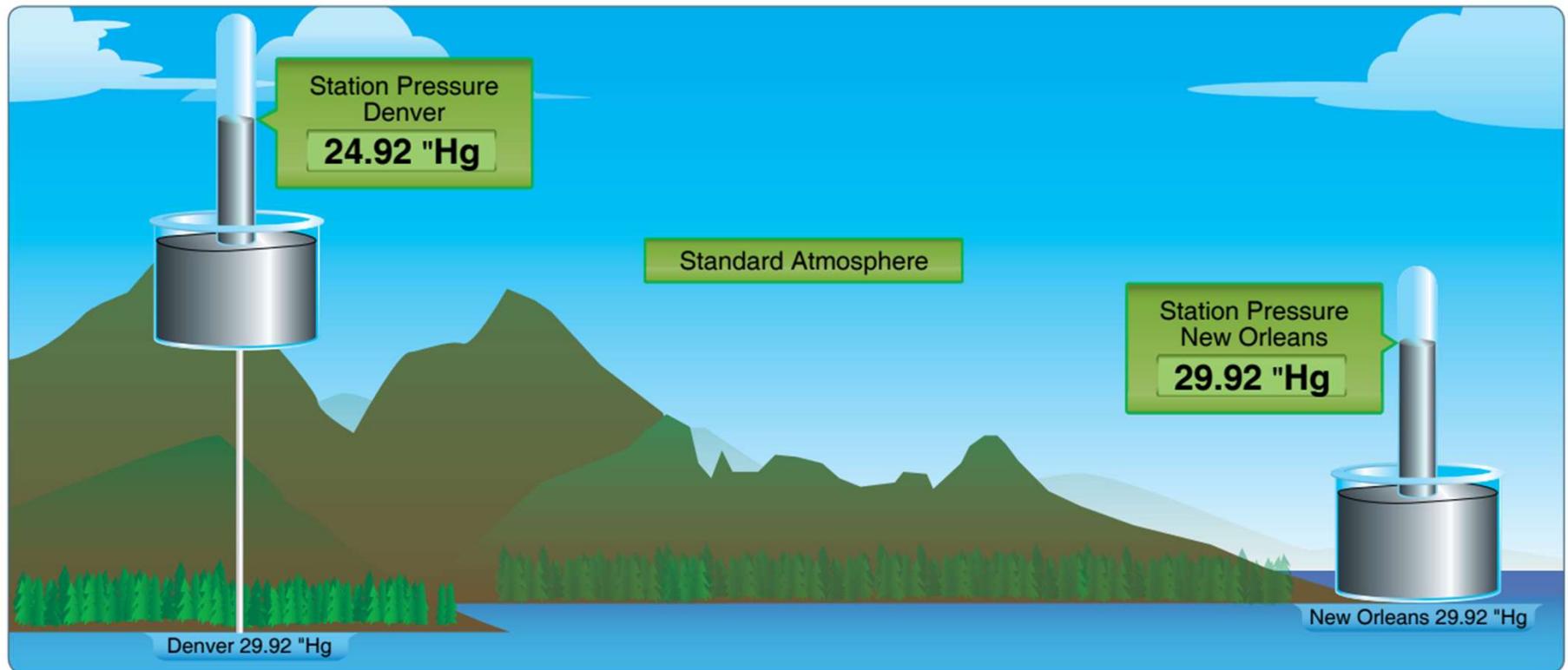


# International Standard Atmosphere (ISA)



Standard Temp and Pressure = 15 degrees C and 29.92 inches at sea level

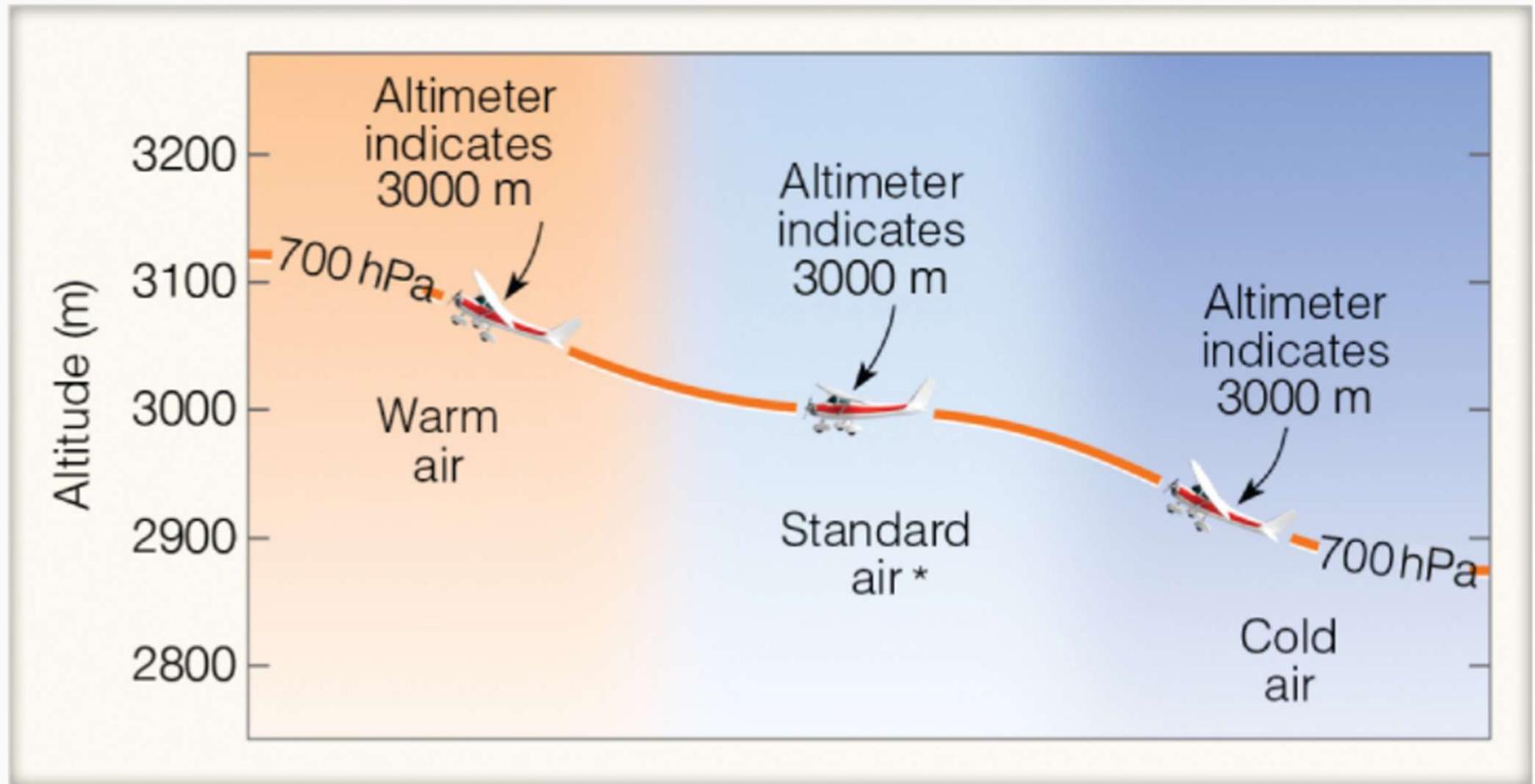
# Altimeter Settings



# Reading Altimeter



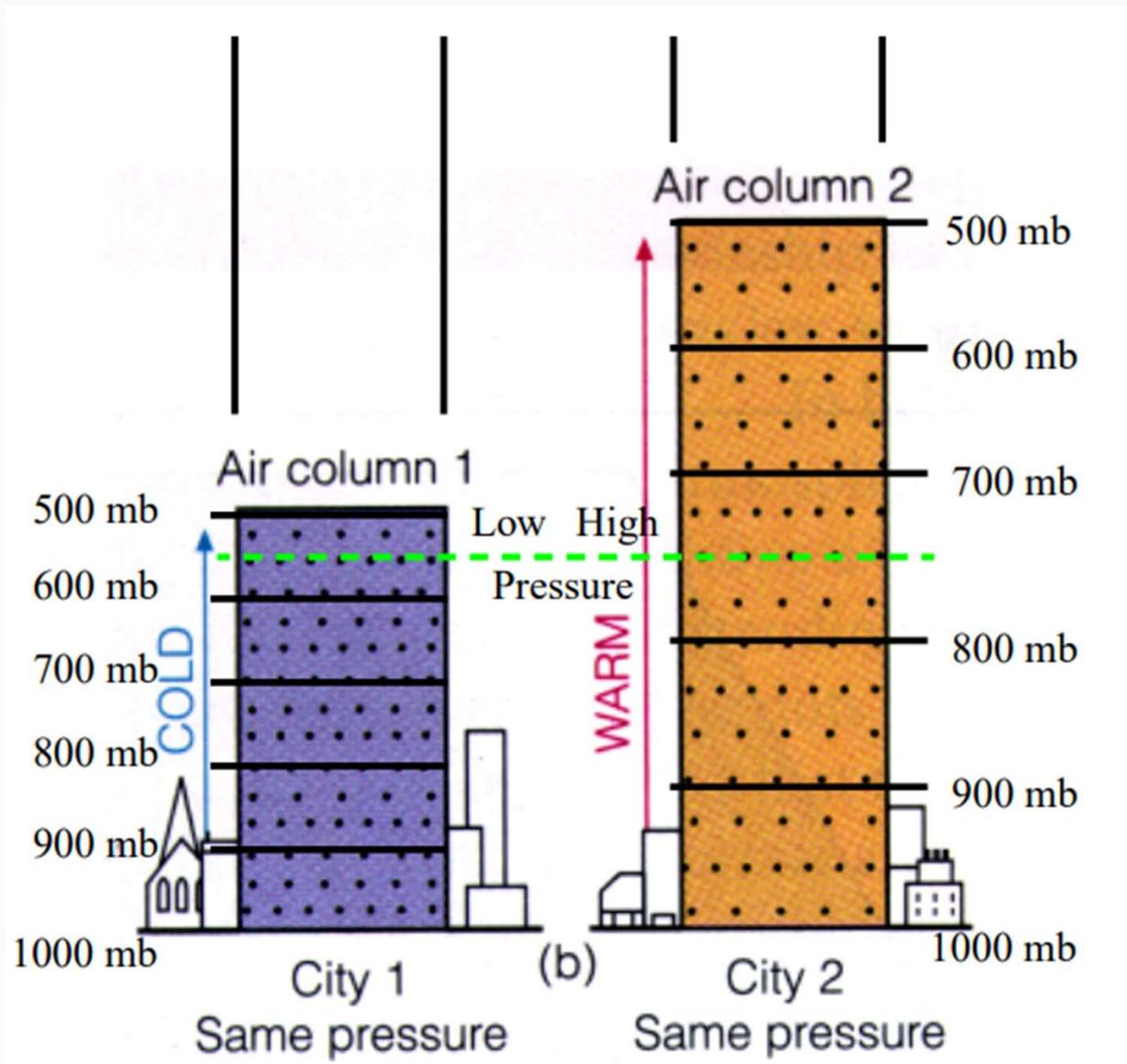
# Look Out Below



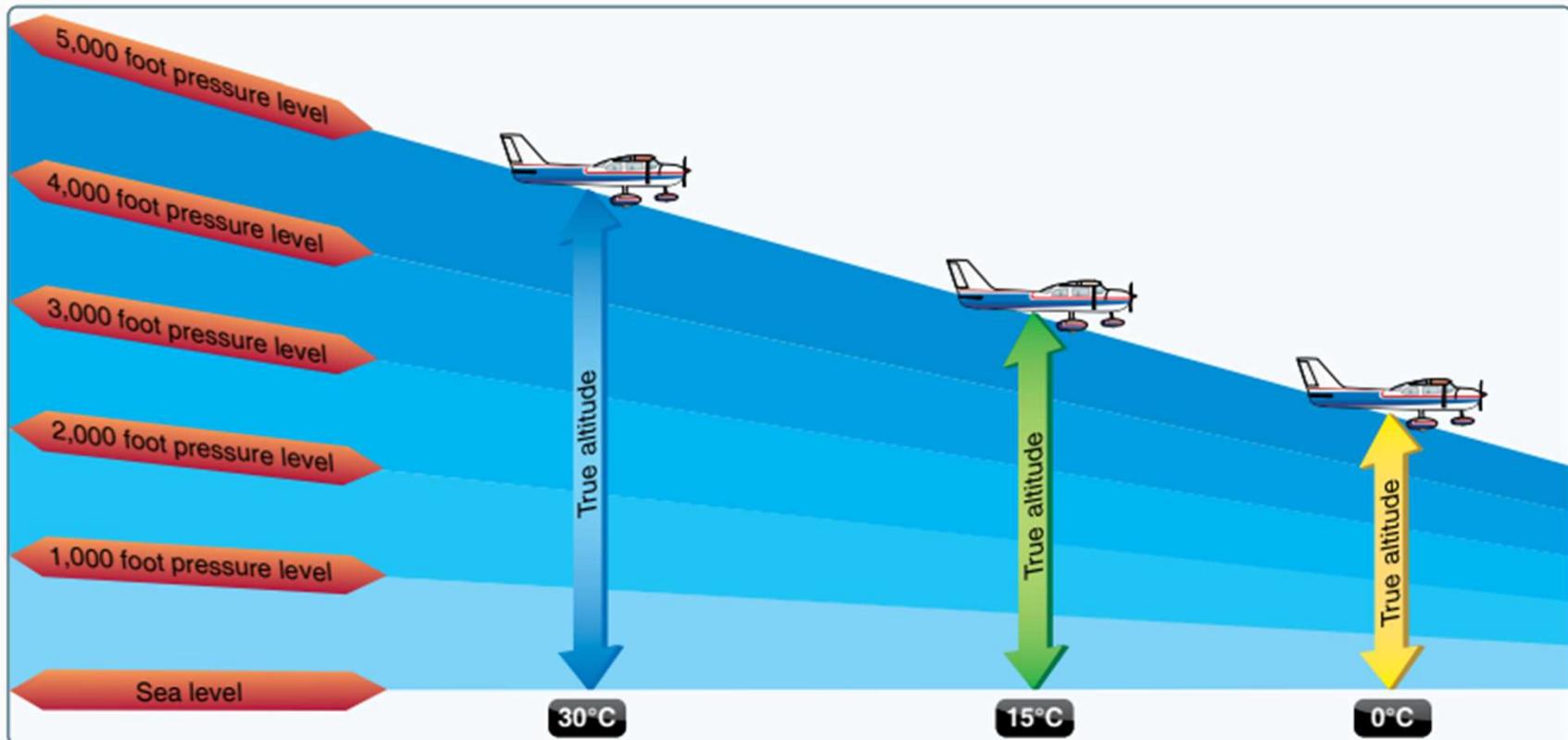
\* Standard air is 15°C, 29.92 inHg at sea level

† 3000 m  $\approx$  9843 ft; 700 hPa  $\approx$  20.67 inHg  $\approx$  0.69 atm

# Scale Height

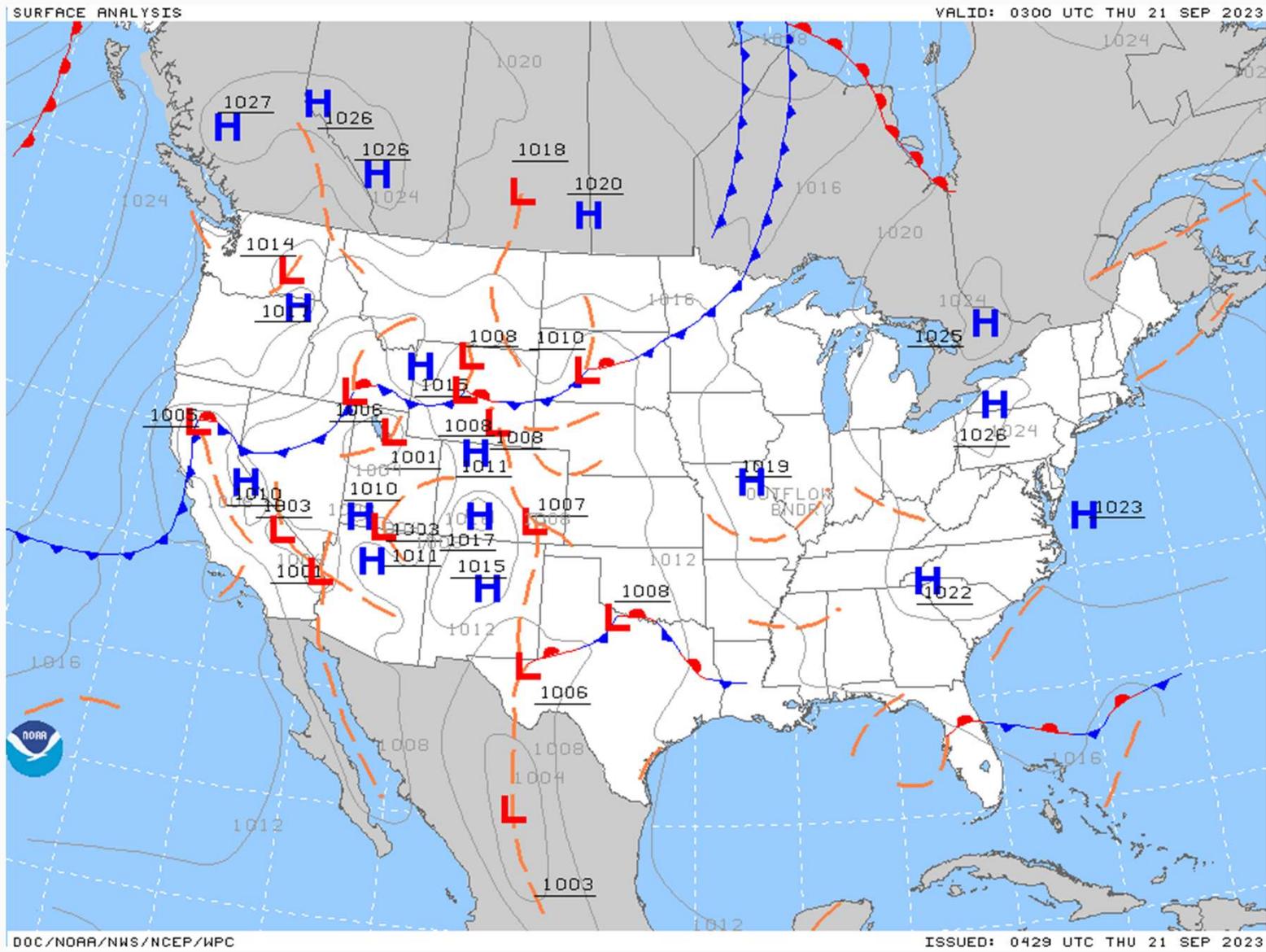


# Non-standard Temperature



From hot to cold and from high to low:  
Look out below!

# Non-standard Pressure



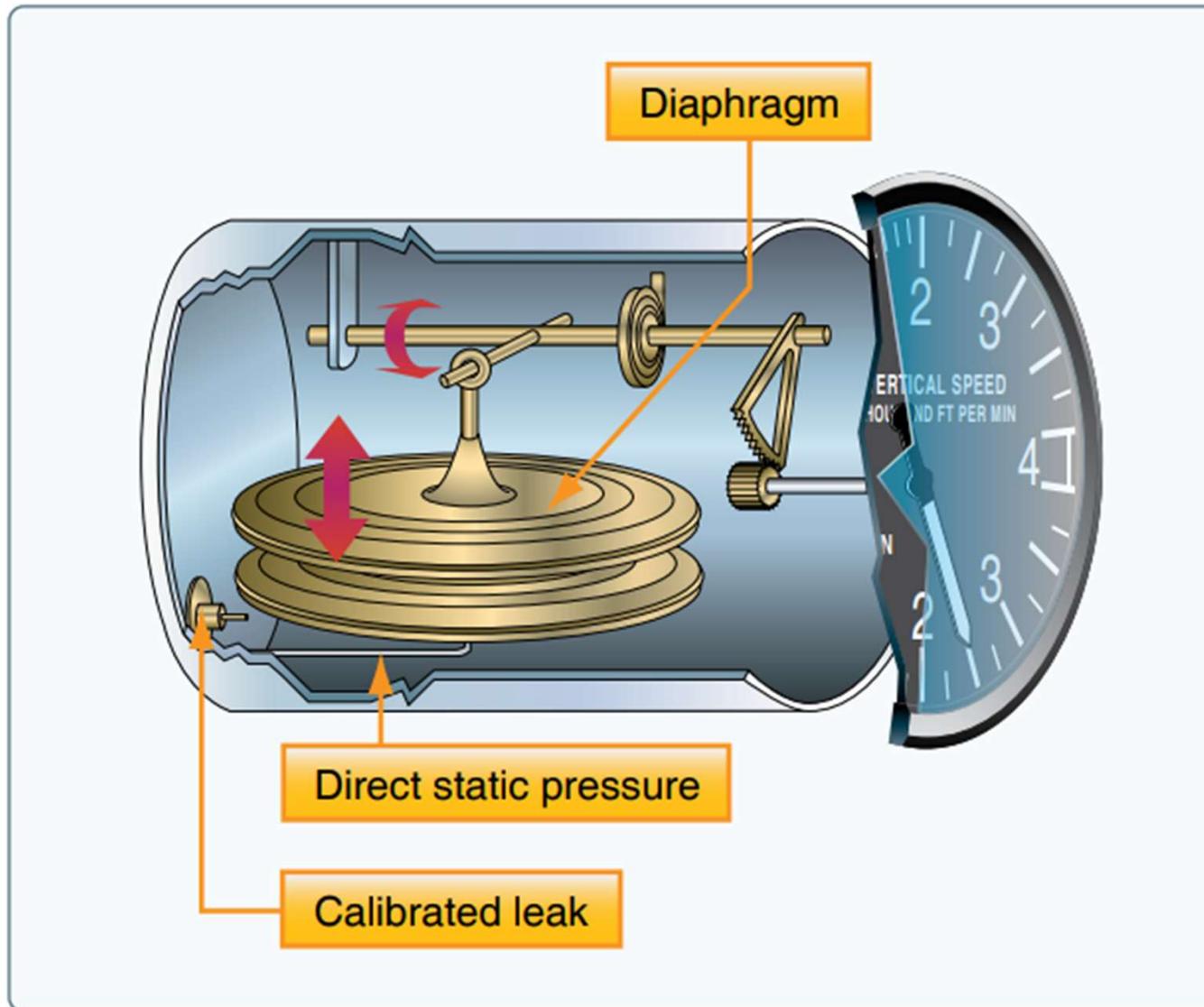
# Types of Altitude

- True Altitude
  - Actual height above mean sea level (MSL)
  - Mean sea level
- Absolute Altitude – height above ground level (AGL)
- Indicated Altitude – MSL *as shown on altimeter*
- Pressure Altitude (PA)
  - Representing air pressure in altitude
  - Would-have-been MSL on a “standard day” (ISA)
  - Instead of saying, “air pressure is 28.92 inHg”, we say “PA is 1,000’”, because the air pressure at 1,000’ in ISA is 28.92 inHg

# Density Altitude

- Representing air density in altitude
  - Instead of saying, “the air density is 0.0565 lbs/cu ft”, we say, “DA is 10,000”, because air density at 10,000” is 0.0565 lbs/cu ft on a standard day (ISA)
- DA increases when
  - Pressure altitude increases
  - Temperature increases
  - Moisture content increases
- Bad idea to take off on a warm day from a high elevation airport without first checking performance

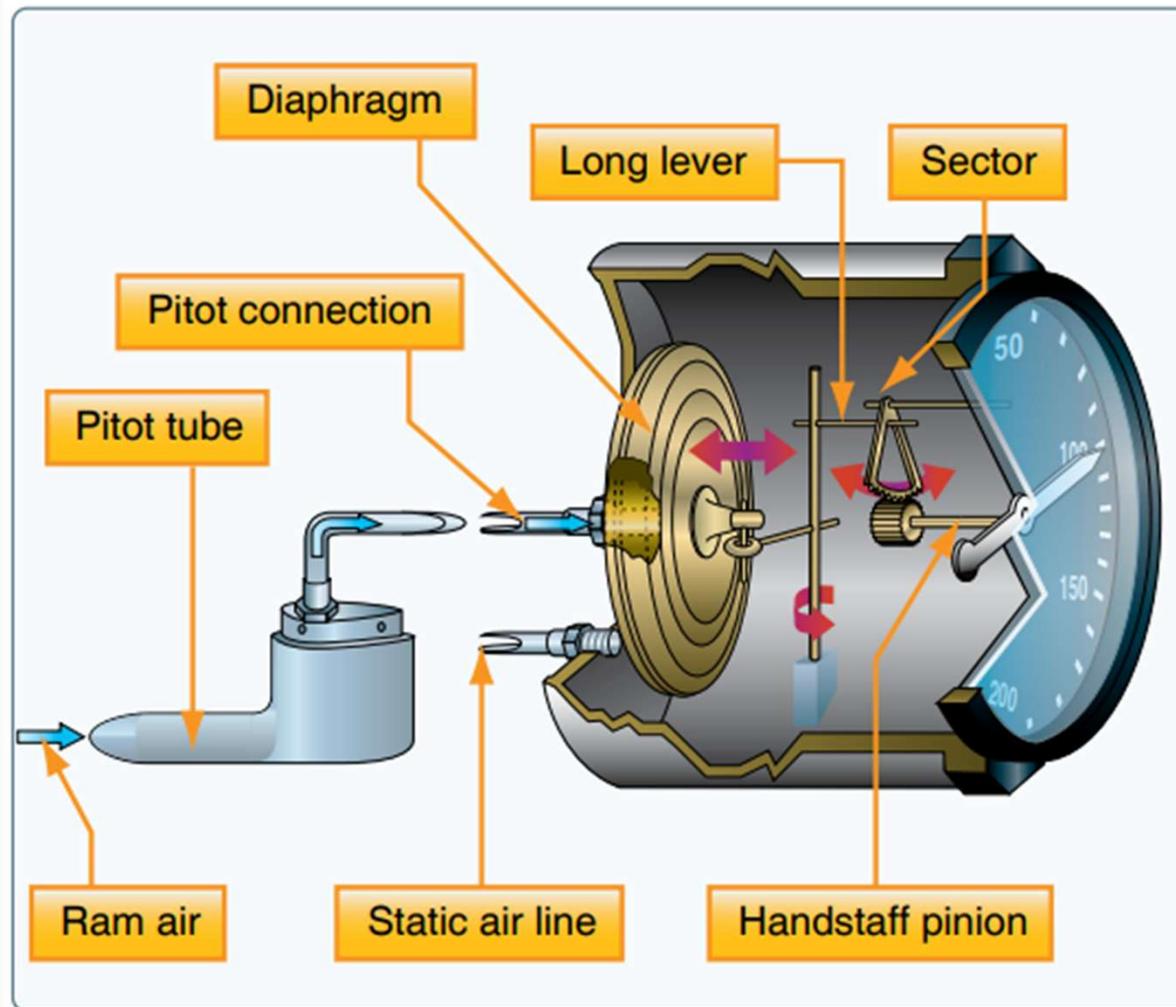
# Vertical Speed Indicator



# Reading VSI



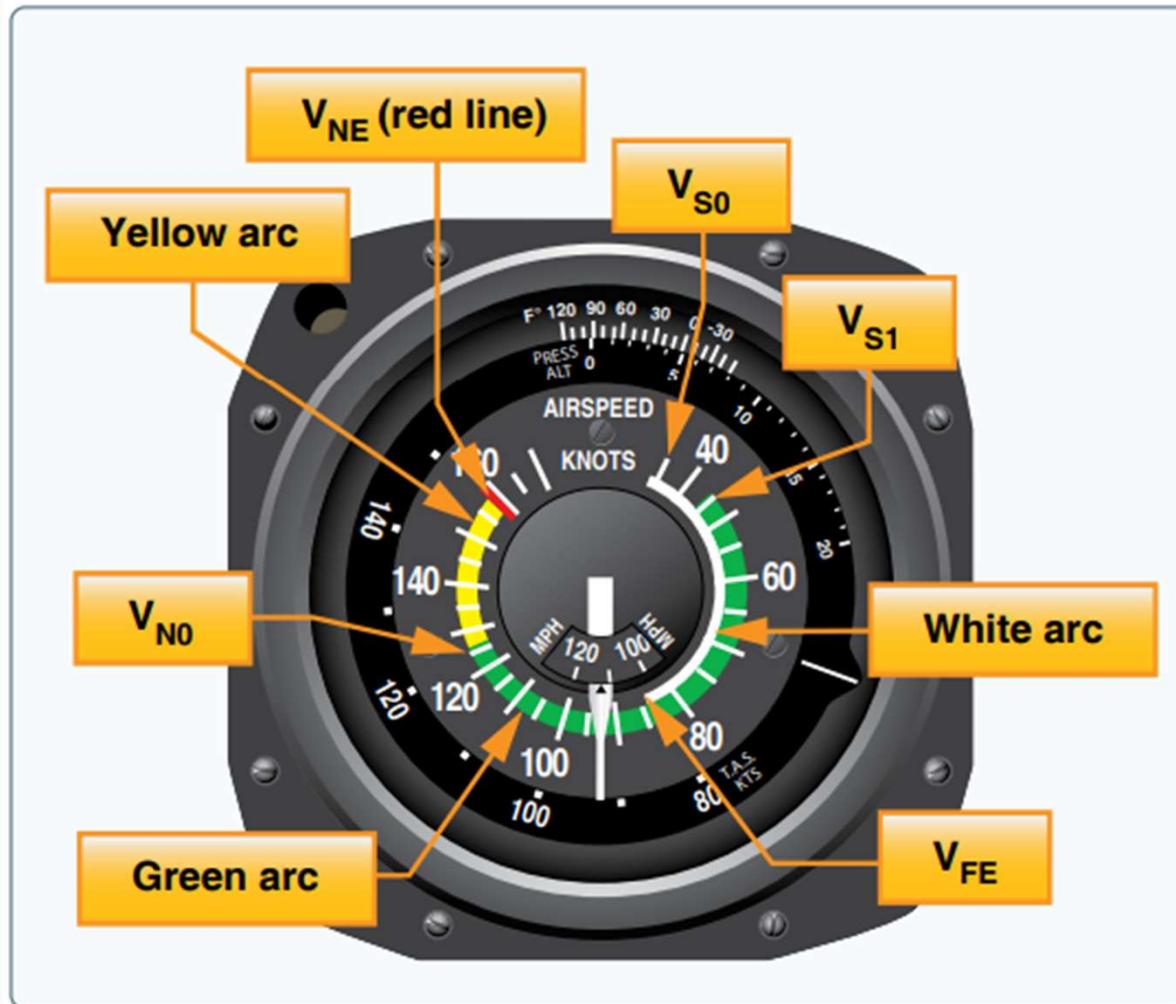
# Airspeed Indicator



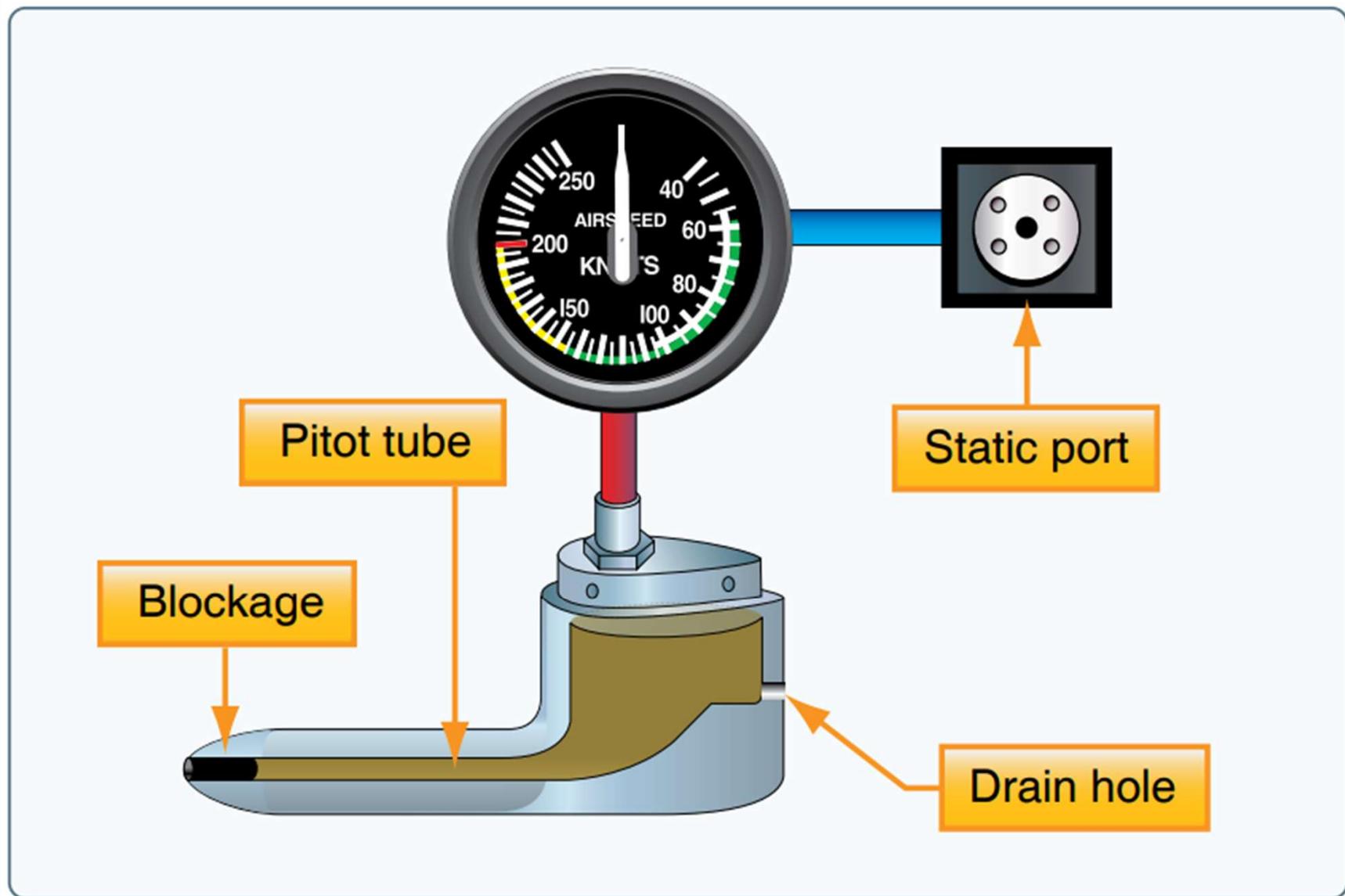
# “I feel the need, the need for speeds.”

- True Airspeed (TAS): relative to the air surrounding aircraft
- Groundspeed (GS): Relative to ground
  - True Airspeed + tail / - head winds
  - Affects time en route – important for fuel planning
- Calibrated Airspeed (CAS): diff. between ram and static pressures
  - 100 knots CAS (KCAS): the pressure differential is the same as if the airplane is flying at 100 KTAS *at sea level, on a standard day*
  - Affected by density altitude – lower the air density, lower the CAS
  - Reflects the aerodynamic forces generated
- Indicated Airspeed (IAS)
  - What is shown on the airspeed indicator
  - CAS + installation error (*e.g.* pitot tube placement)

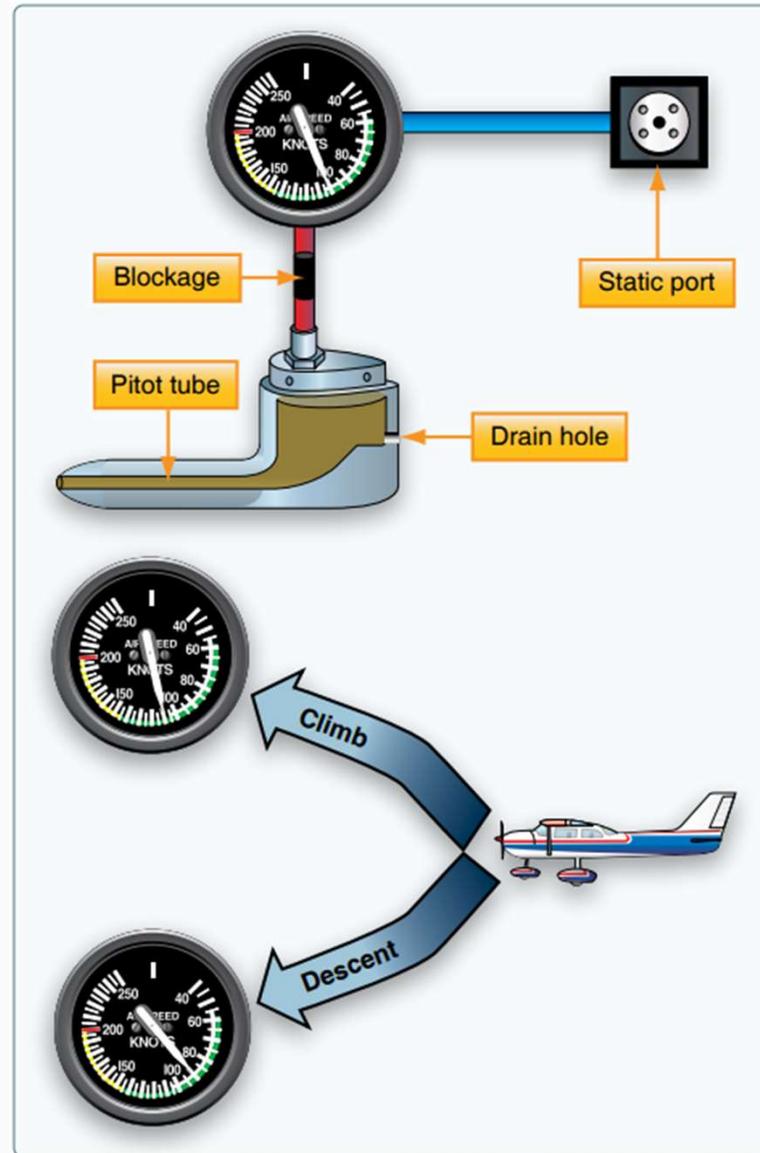
# Markings on ASI



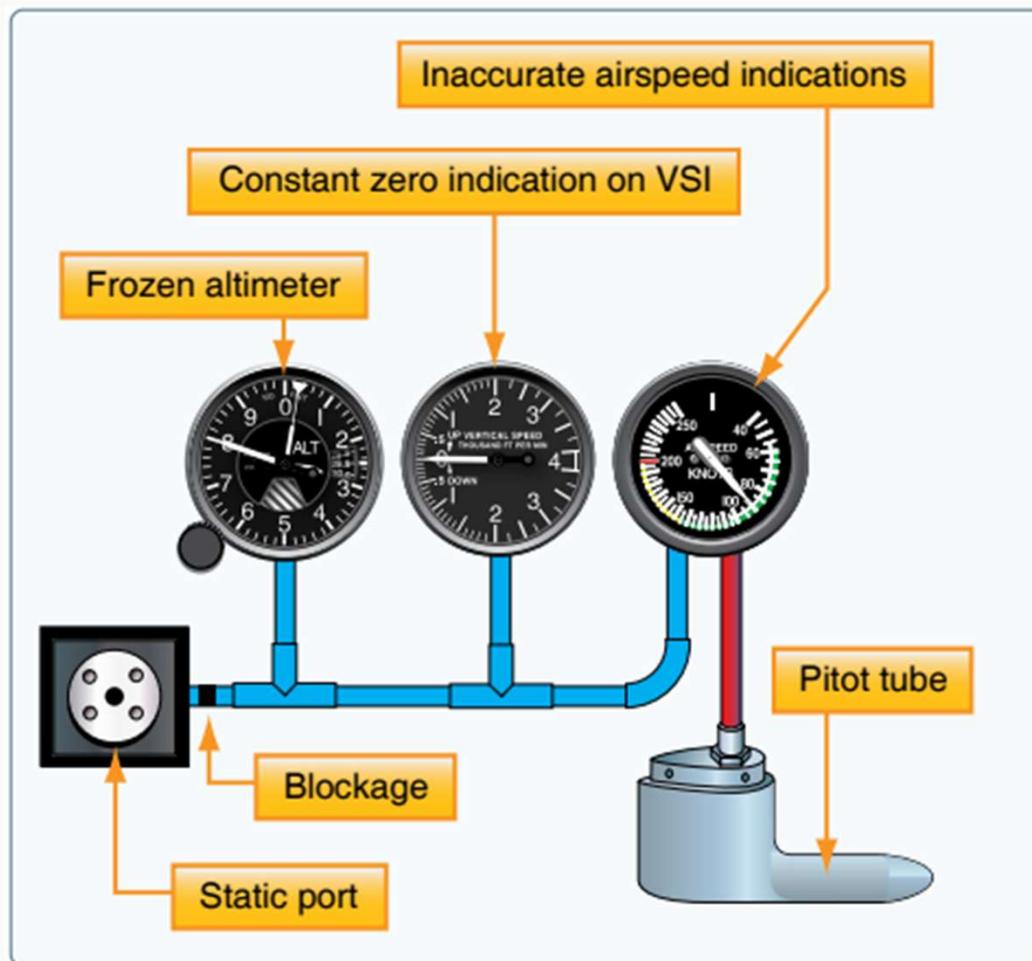
# Blocked Pitot Tube



# Blocked Pitot Tube & Drain Hole



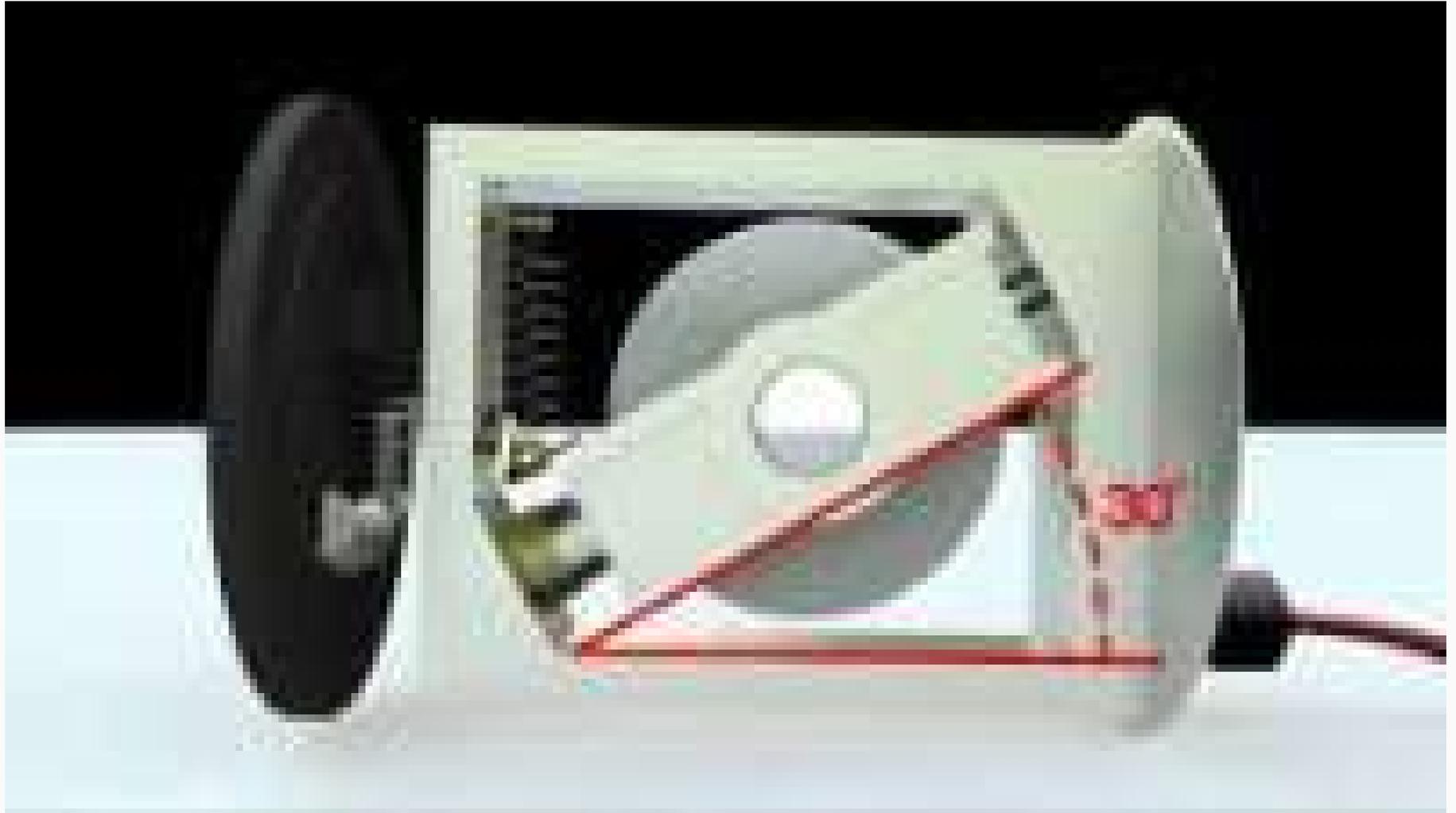
# Blocked Static Port

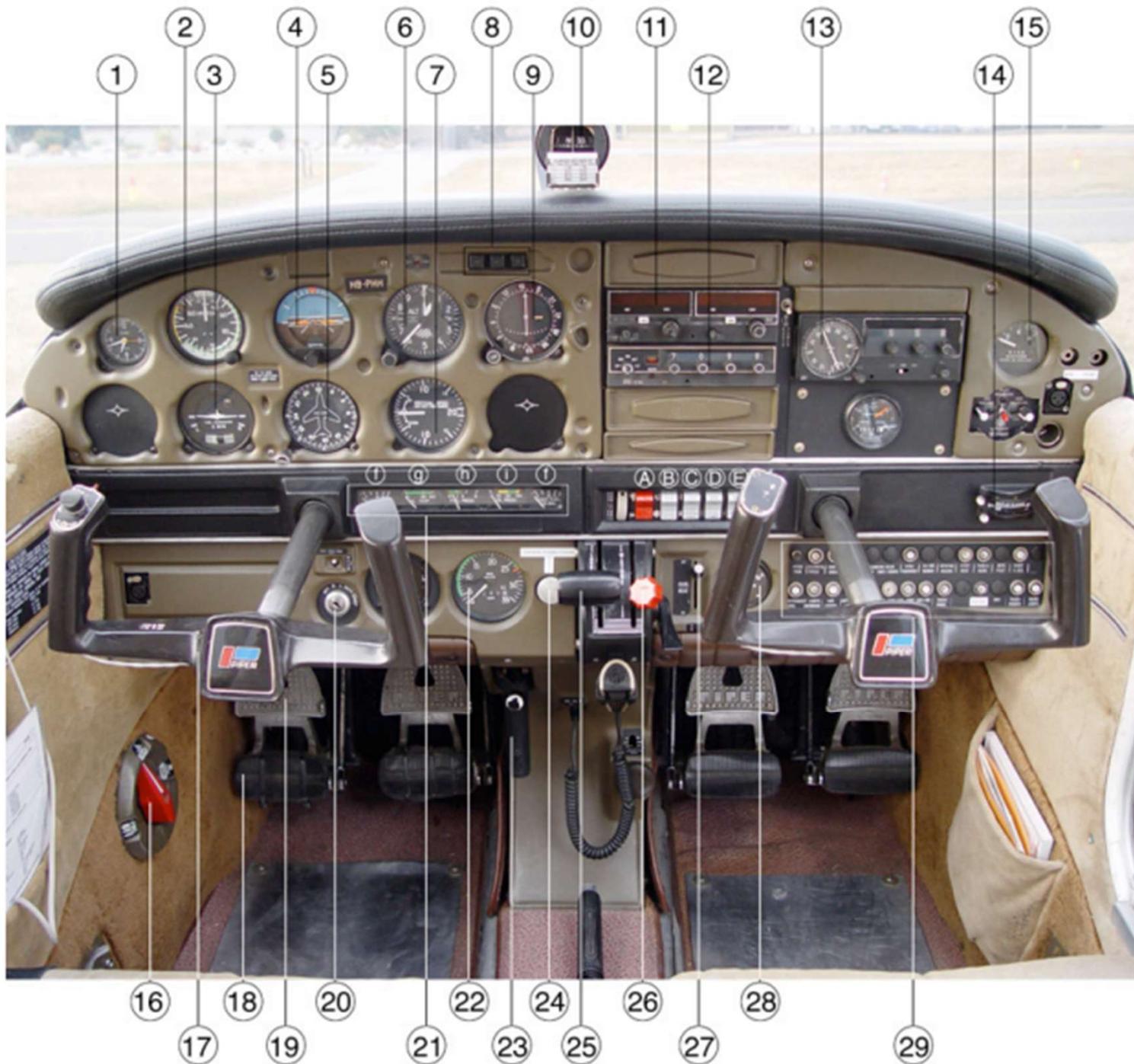


# Table of Contents

- Section A: Airframe
  - Certificates and Documents
  - Fuselage
  - Wings
  - Empennage
  - Landing Gear
  - Ignition System
  - Cooling System
  - Oil System
  - Exhaust System
  - Electrical System
- Section B: Powerplant
  - Reciprocating Engine
  - Propellers & Hazards
  - Fuel System
  - Induction System
- Section C: Instruments
  - Pitot-Static Instruments
  - Gyroscopic Instruments
  - Magnetic Compass

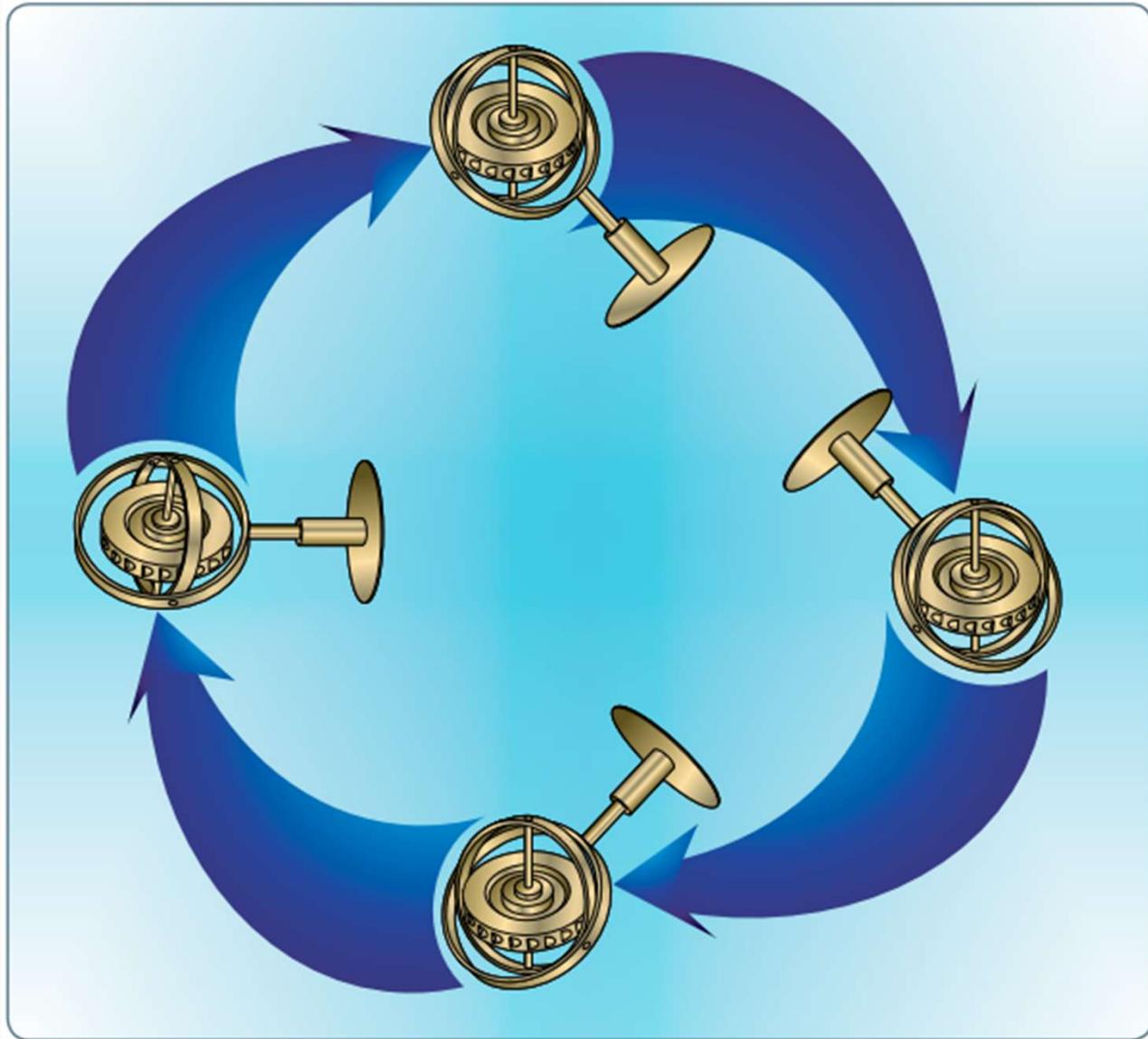
# Gyroscopic Instruments



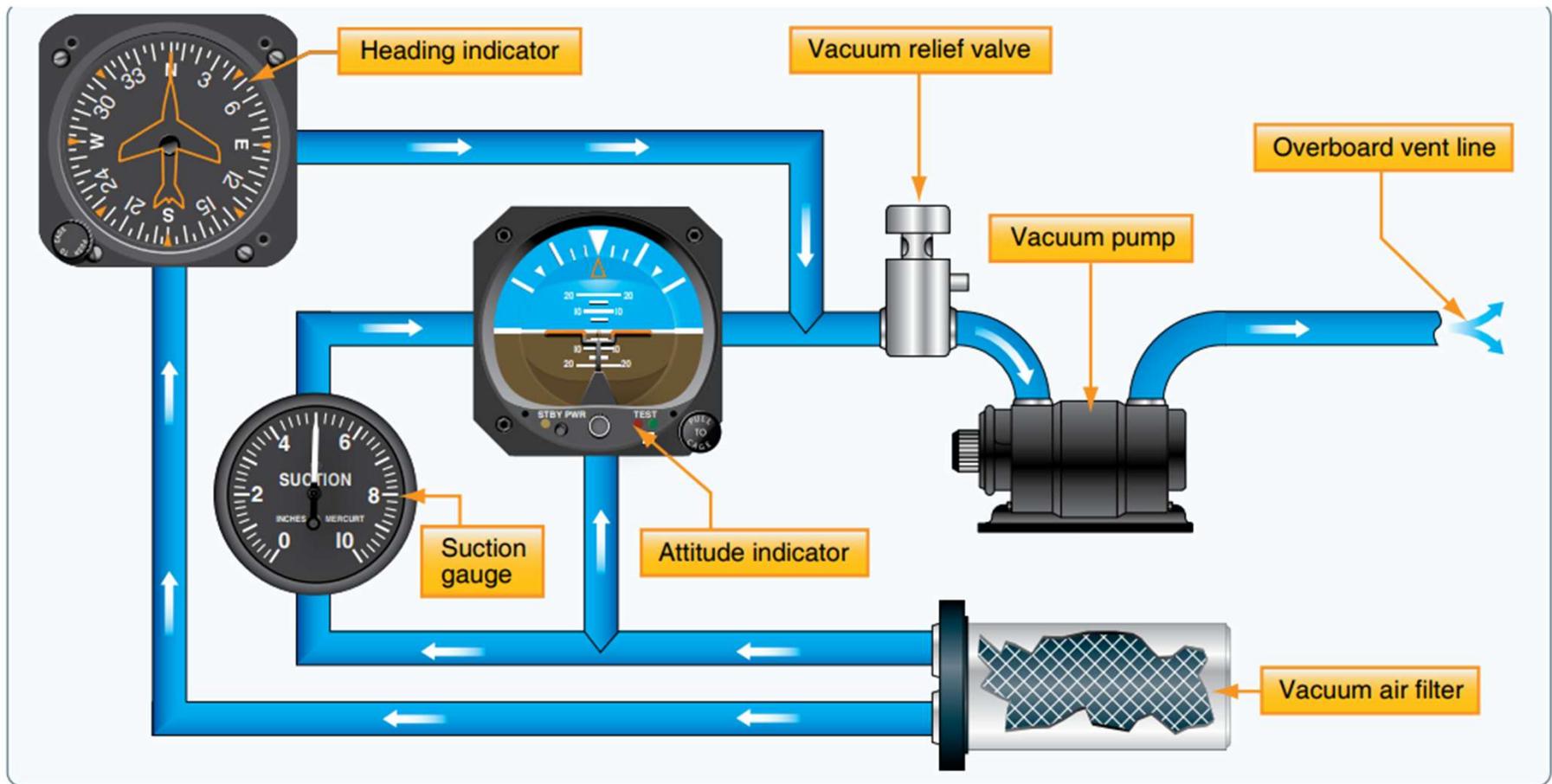


- 1 Clock
- 2 Airspeed Indicator
- 3 Turn coordinator
- 4 Attitude Indicator
- 5 Directional Gyro
- 6 Altimeter
- 7 Vertical Speed Indicator
- 8 Annunciator Panel
- 9 VOR
- 10 Magnetic Compass
- 11 NAV / COM
- 12 Transponder
- 13 ADF
- 14 Heating
- 15 Gyro Suction
- 16 Fuel Selector
- 17 Yoke
- 18 Rudder Pedals
- 19 Brake Pedals
- 20 Magnetos (Ignition)
- 21 Engine Instruments
- 22 RPM Indicator
- 23 Parking Brake
- 24 Primer
- 25 Throttle (Gas)
- 26 Mixture Control
- 27 Carburetor Heat
- 28 Amp Meter
- 29 Circuit Breakers
- A Master Switch
- B Aux. Fuel Pump
- C Landing Light
- D Strobe Light
- E Pitot Heat
- f Fuel Indicators
- g Oil Temperature
- h Fuel Pressure
- i Oil Pressure

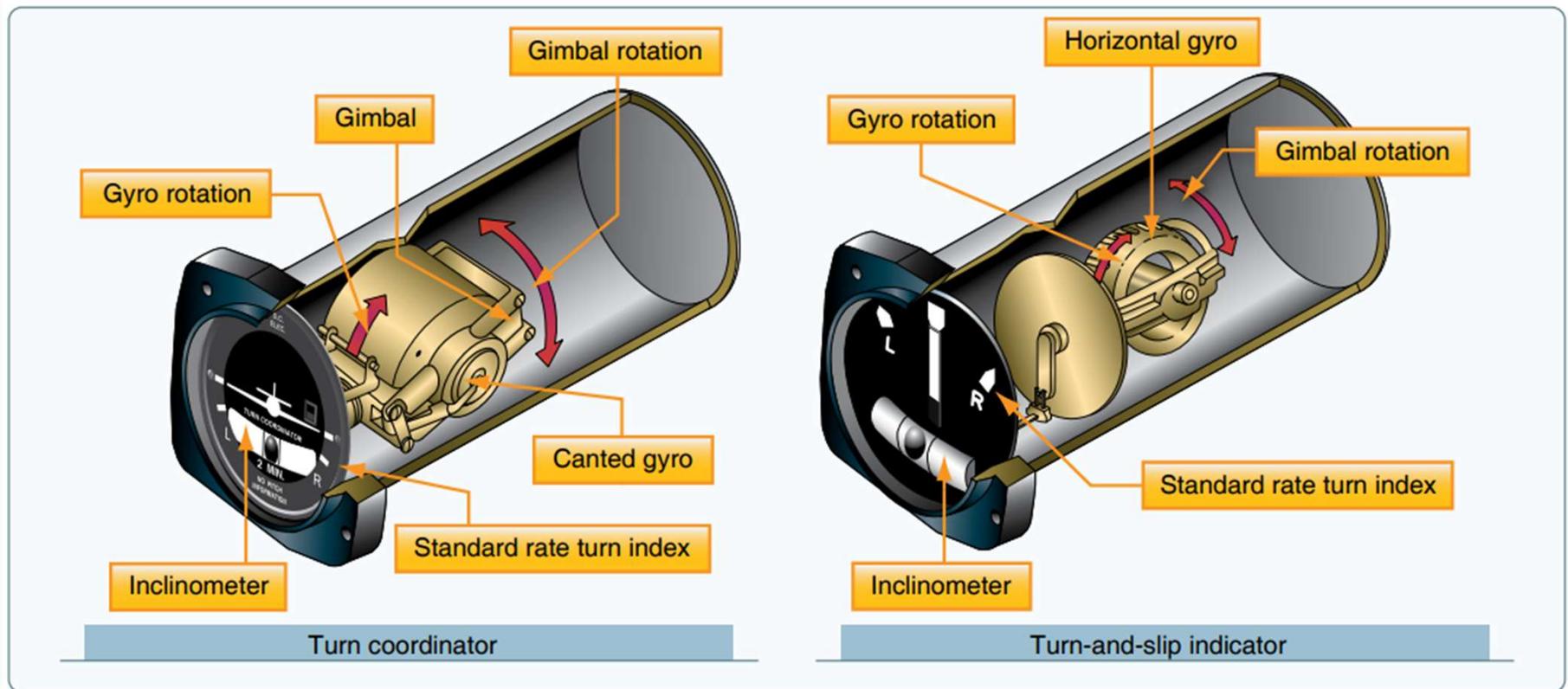
# Gyroscopic Instruments



# Vacuum System



# Turn Indicators



# Inclinometer (“The Ball”)



Slipping turn

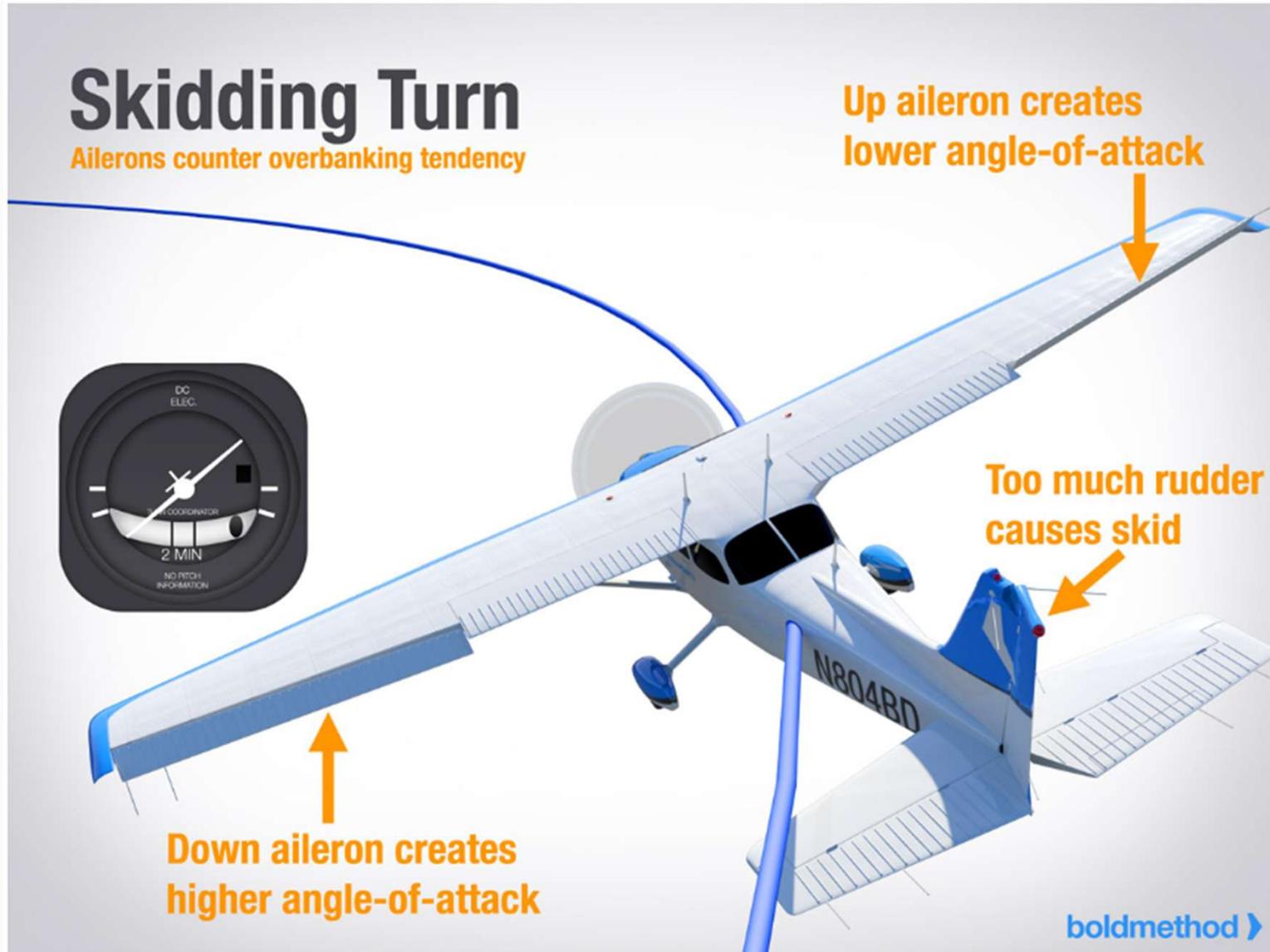


Skidding turn

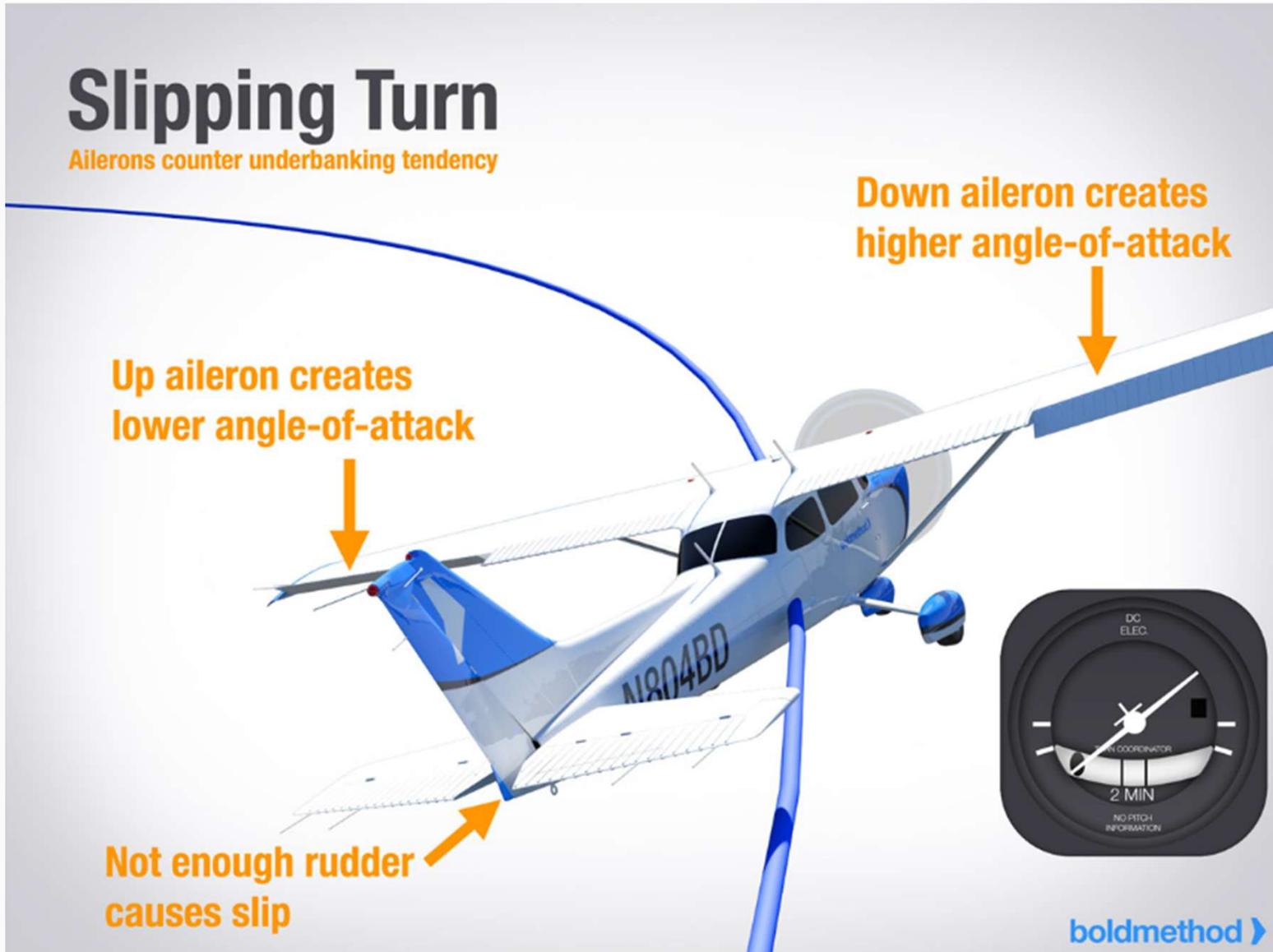


Coordinated turn

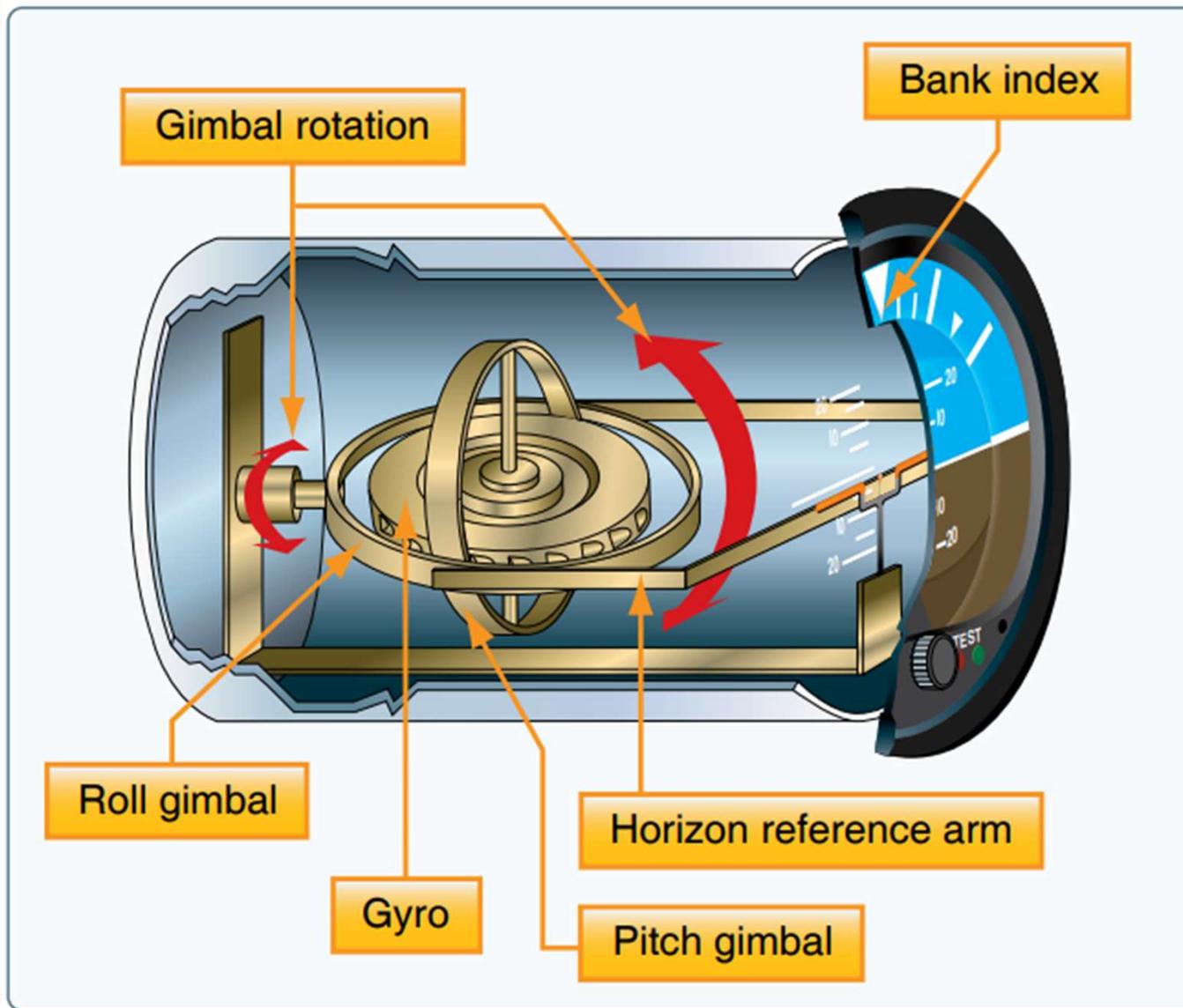
# Skidding Turn



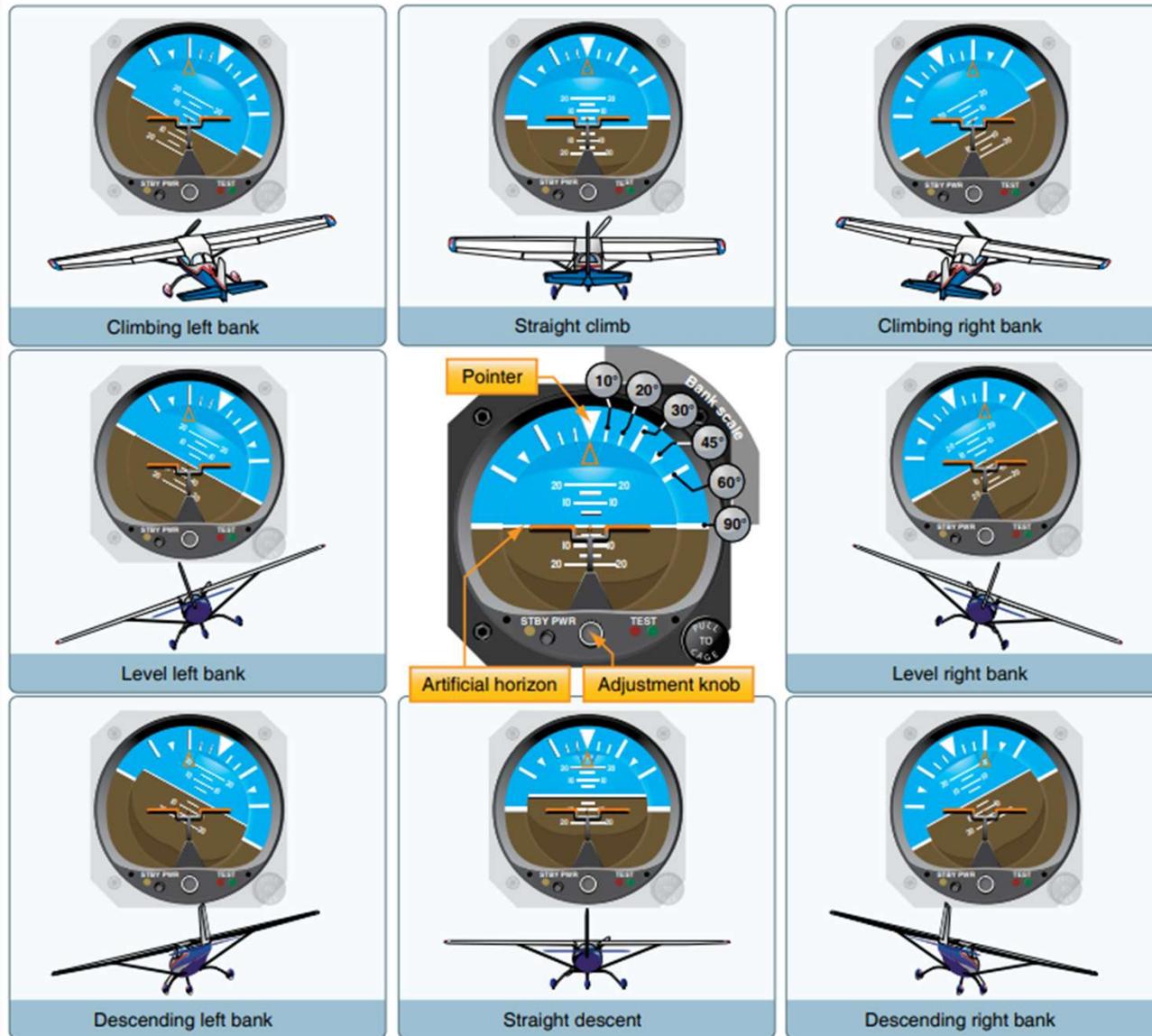
# Slipping Turn



# Attitude Indicator



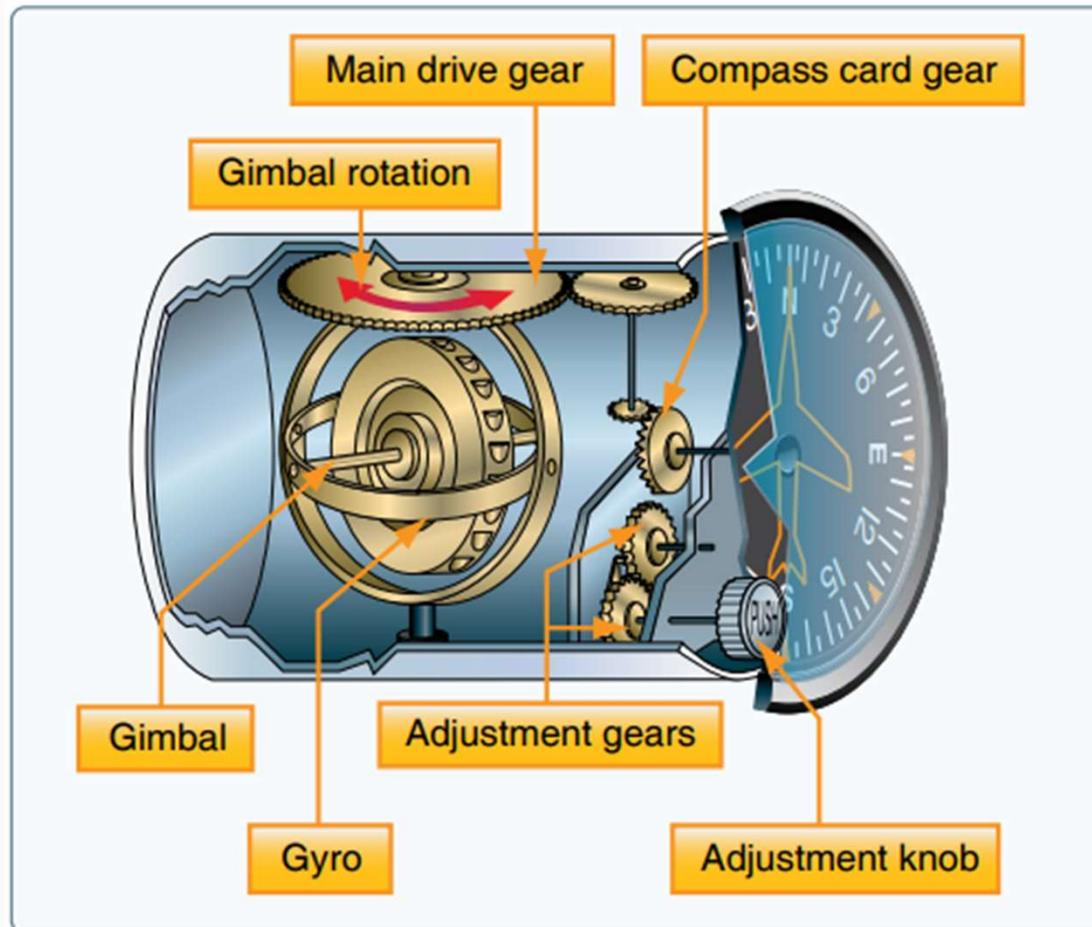
# AI Indications



# What say you?

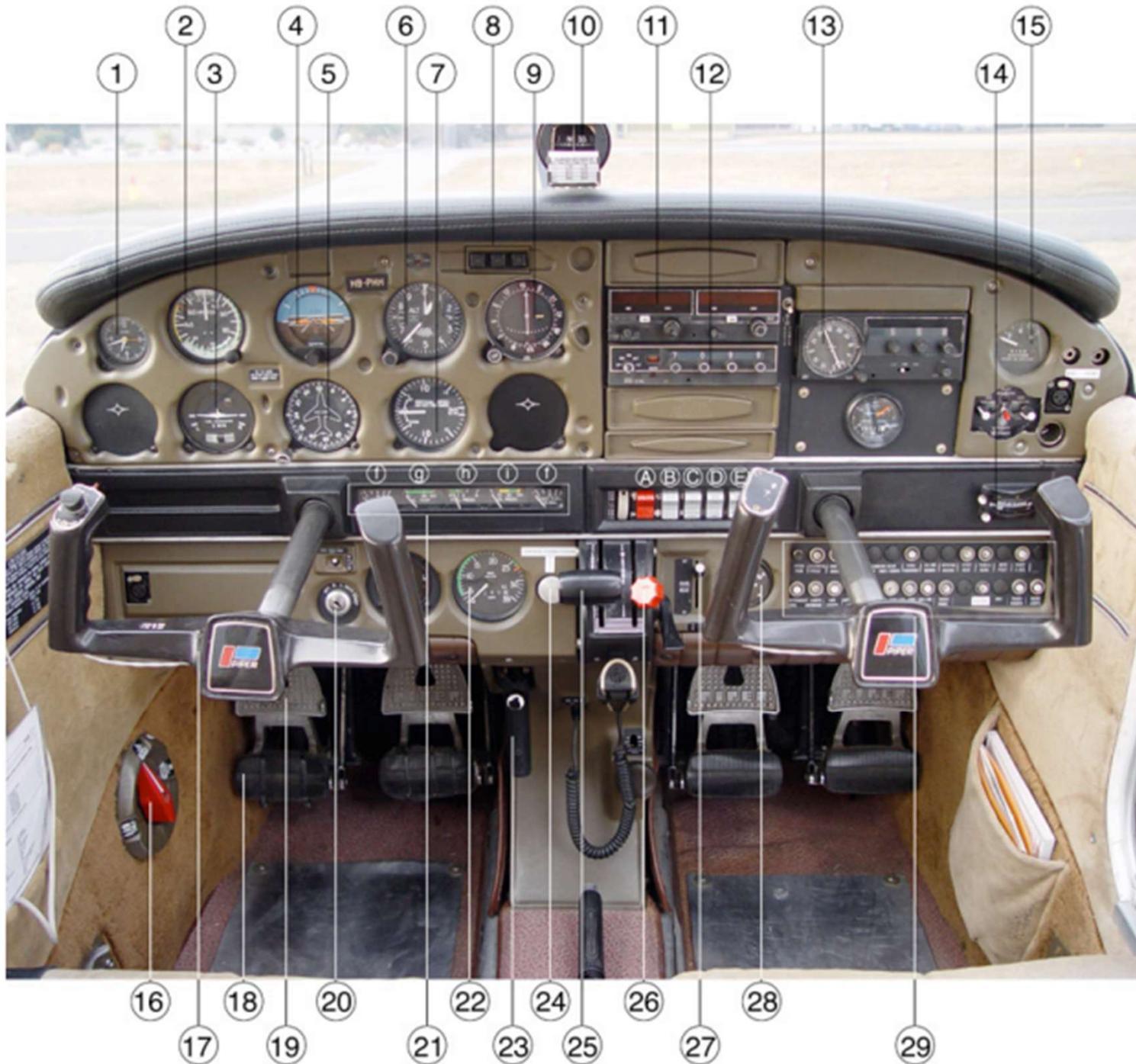


# Directional Gyro



# Table of Contents

- Section A: Airframe
  - Certificates and Documents
  - Fuselage
  - Wings
  - Empennage
  - Landing Gear
- Section B: Powerplant
  - Reciprocating Engine
  - Propellers & Hazards
  - Fuel System
  - Induction System
  - Ignition System
  - Cooling System
  - Oil System
  - Exhaust System
  - Electrical System
- Section C: Instruments
  - Pitot-Static Instruments
  - Gyroscopic Instruments
  - Magnetic Compass



1 Clock

2 Airspeed Indicator

3 Turn coordinator

4 Attitude Indicator

5 Directional Gyro

6 Altimeter

7 Vertical Speed Indicator

8 Annunciator Panel

9 VOR

**10 Magnetic Compass**

11 NAV / COM

12 Transponder

13 ADF

14 Heating

15 Gyro Suction

16 Fuel Selector

17 Yoke

18 Rudder Pedals

19 Brake Pedals

20 Magnets (Ignition)

21 Engine Instruments

22 RPM Indicator

23 Parking Brake

24 Primer

25 Throttle (Gas)

26 Mixture Control

27 Carburetor Heat

28 Amp Meter

29 Circuit Breakers

A Master Switch

B Aux. Fuel Pump

C Landing Light

D Strobe Light

E Pitot Heat

f Fuel Indicators

g Oil Temperature

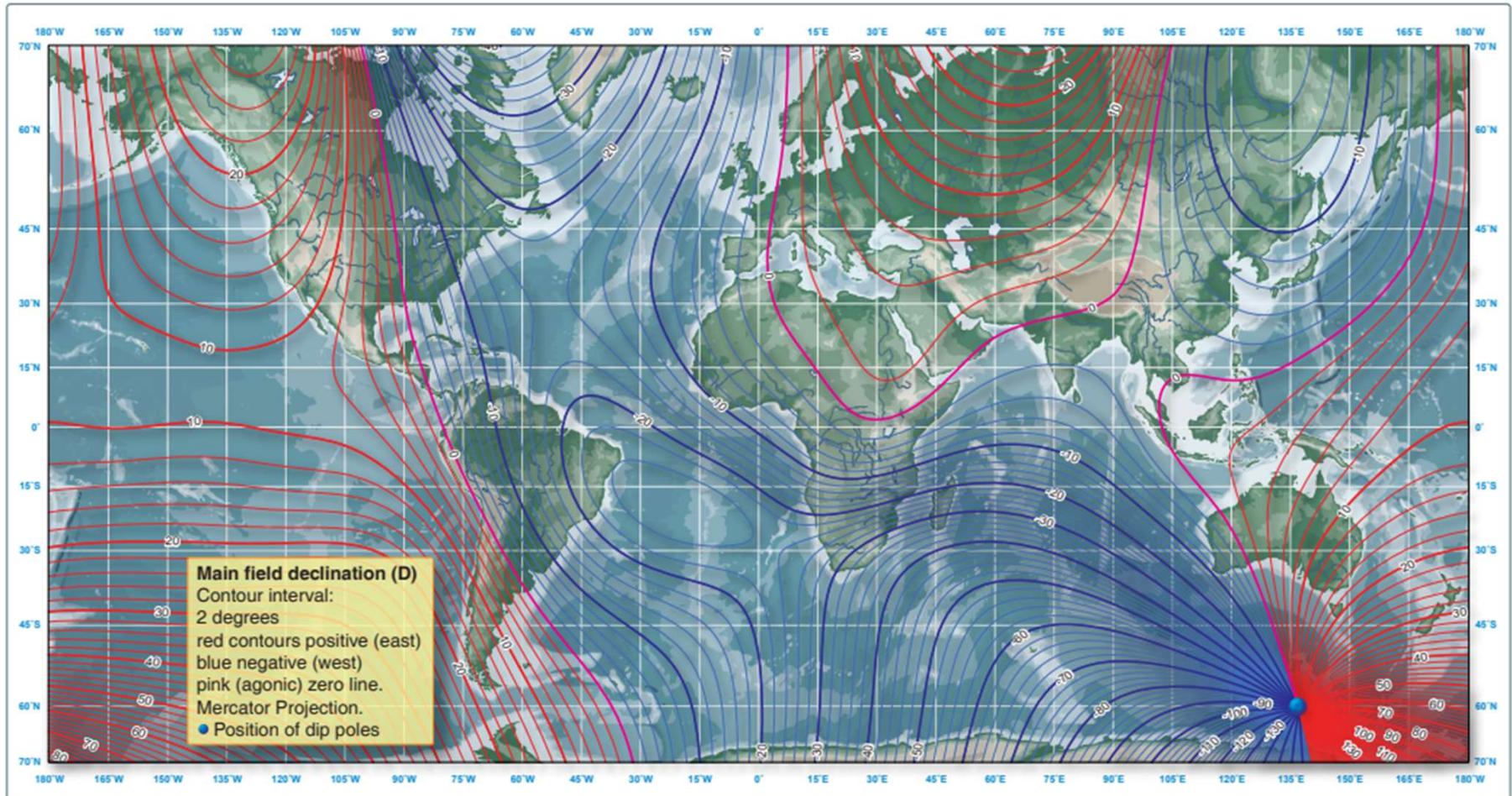
h Fuel Pressure

i Oil Pressure

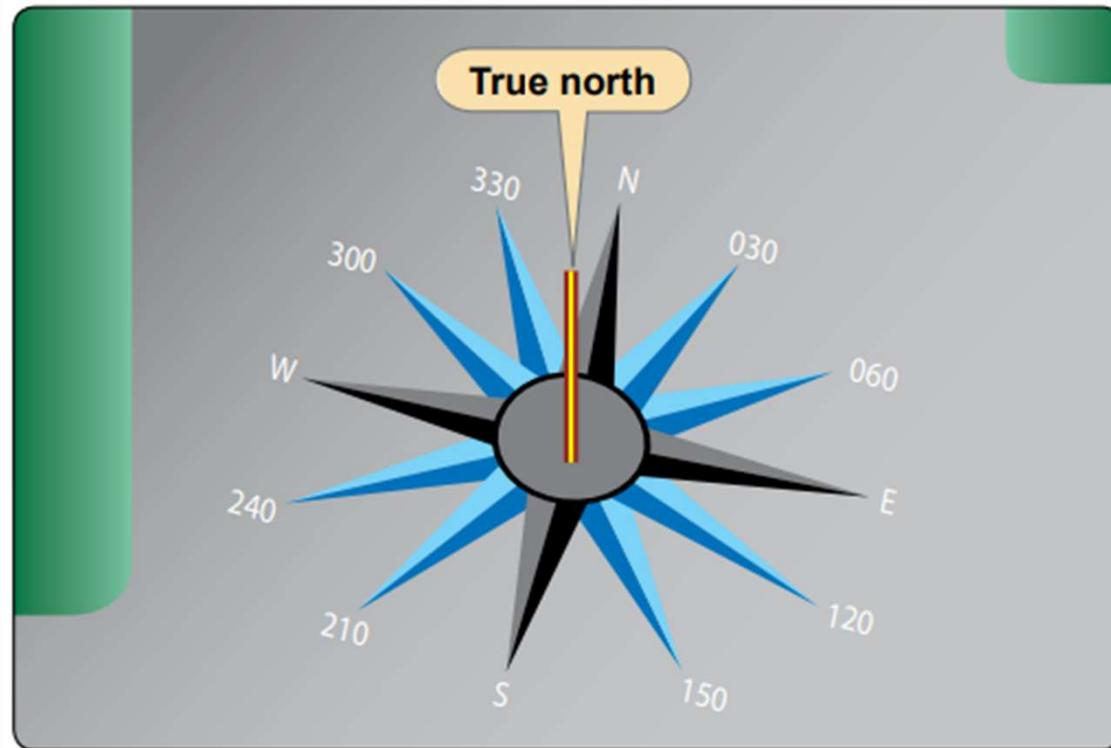
# Magnetic Compass



# Magnetic Variation



# Compass Rose



# Magnetic Deviation

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

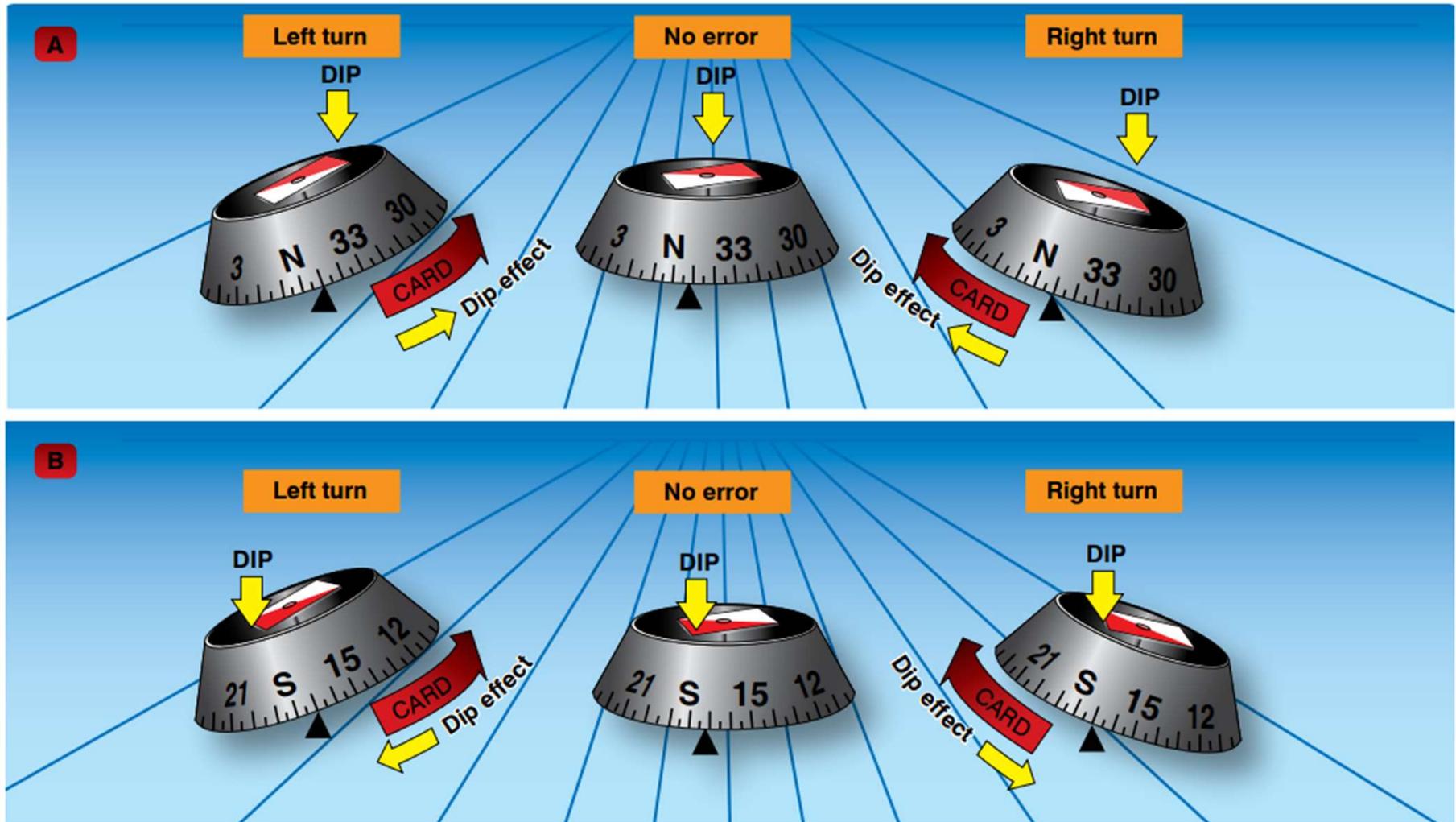
FOR	180	210	240	270	300	330
STEER						
RDO. ON	176	210	243	271	296	325
RDO. OFF	174	210	240	273	298	327



# Compass Turn

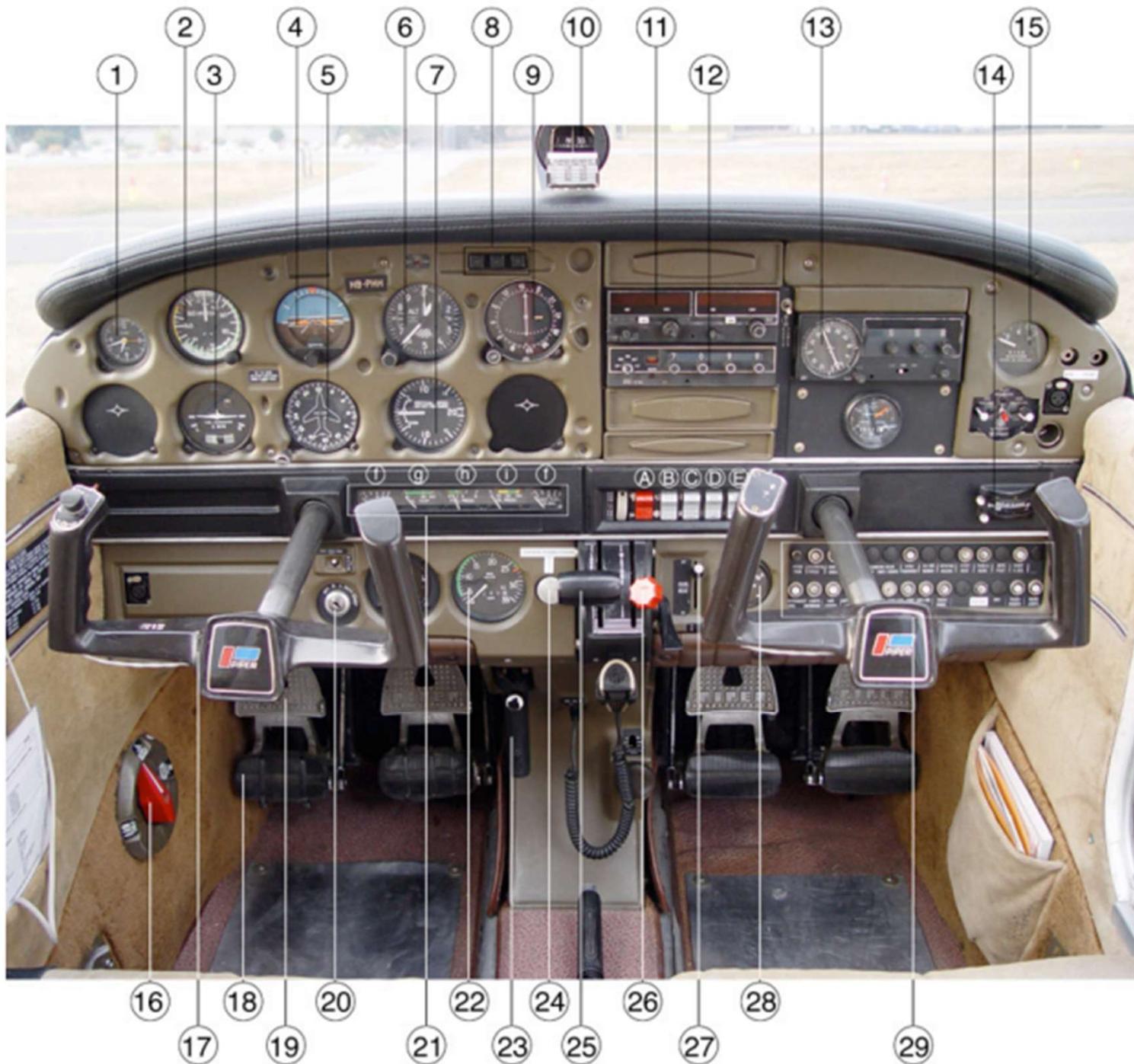


# Magnetic Dip



# Acceleration Error





- 1 Clock
- 2 Airspeed Indicator
- 3 Turn coordinator
- 4 Attitude Indicator
- 5 Directional Gyro
- 6 Altimeter
- 7 Vertical Speed Indicator
- 8 Annunciator Panel
- 9 VOR
- 10 Magnetic Compass
- 11 NAV / COM
- 12 Transponder
- 13 ADF
- 14 Heating
- 15 Gyro Suction
- 16 Fuel Selector
- 17 Yoke
- 18 Rudder Pedals
- 19 Brake Pedals
- 20 Magnetos (Ignition)
- 21 Engine Instruments
- 22 RPM Indicator
- 23 Parking Brake
- 24 Primer
- 25 Throttle (Gas)
- 26 Mixture Control
- 27 Carburetor Heat
- 28 Amp Meter
- 29 Circuit Breakers
- A Master Switch
- B Aux. Fuel Pump
- C Landing Light
- D Strobe Light
- E Pitot Heat
- f Fuel Indicators
- g Oil Temperature
- h Fuel Pressure
- i Oil Pressure

# Electronic Flight Instruments and Displays

