E230 Aircraft Systems

Unusual Attitude

6th Presentation

School Of Engineering

Artificial Horizon (AH)

- Indicate aircraft pitch and roll attitudes
- Do not indicate climb or descend

Angle of Bank markers

Pitch attitude markers

Horizon Line

Aircraft Symbol

Quick Erection Knob

Reading Artificial Horizon


Level left bank


Climbing left bank


Straight climb


Climbing right bank


Level right bank

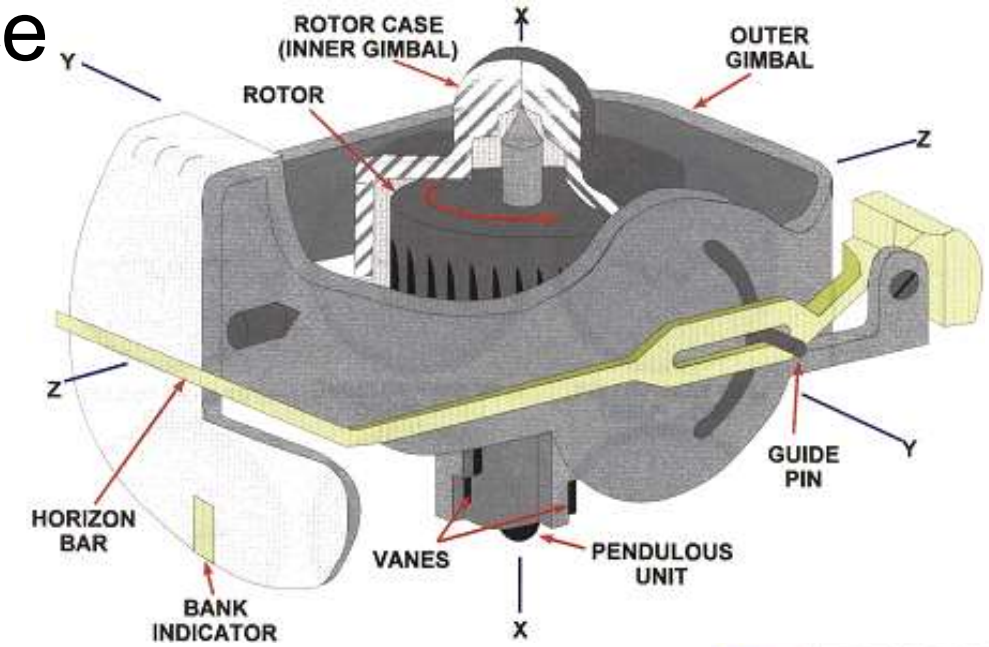

Descending left bank


Straight descent


Descending right bank

Air-driven AH

- Utilizes a type of vertical axis displacement gyro known as Earth gyro
- Earth gyro – Rotor axis is perpendicular to the earth's surface



Effects of movement on AH

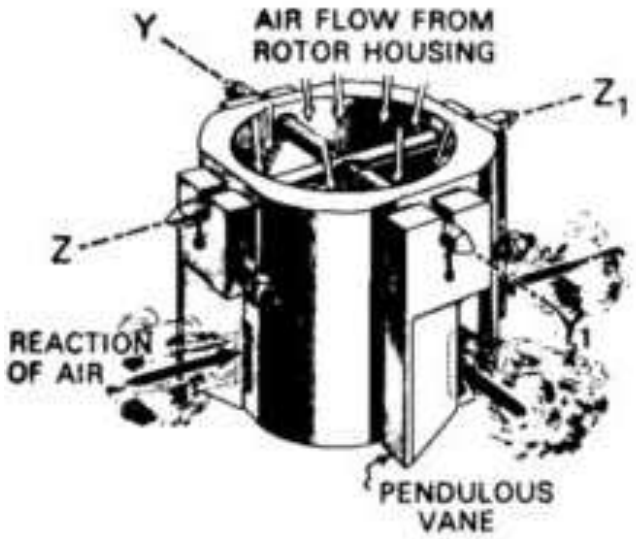
- Pitch
  - Outer gimbal pitches up because it is attached to casing
  - Horizon bar is pivoted downward
  - Aircraft symbol is now above horizon line, indicating pitch up attitude
- Roll
  - Both inner and outer gimbals are stabilised
  - Shows aircraft bank angle
- Yaw
  - Both inner and outer gimbals move with aircraft

Pendulous unit

- Use to keep the rotor axis vertical if it wanders away from vertical position
- Vanes always hang in vertical direction due to gravity, even when rotor is tilted
- Air flow into the unit from the top
- Reaction force is created from the air coming out from the ports at the bottom

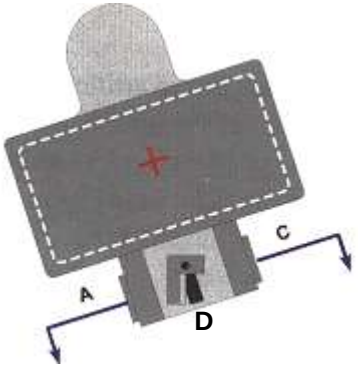
How Pendulous units work

- When spin axis is vertical:
  - Equal amount of air comes out from all 4 ports at the bottom
  - 4 reaction forces equal and opposite and cancel one another out

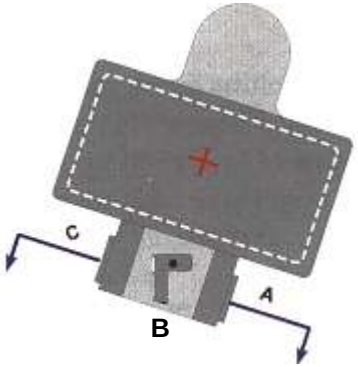


How Pendulous unit works

- If spin axis wanders away from vertical:
  - Port B will be fully covered by the vane
  - Port D will be fully opened
- Unbalanced air creates a force at the base (directed into viewing plane)
- This force will create another precession force that rotates the spin axis back to vertical.



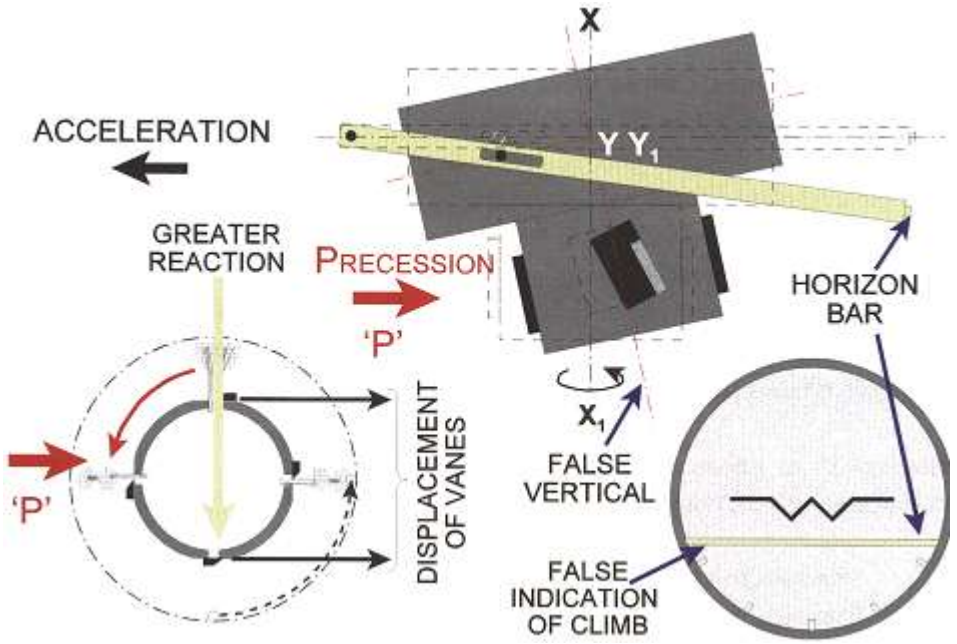
View from Left
(Port D opened)



View from Right
(Port B covered)

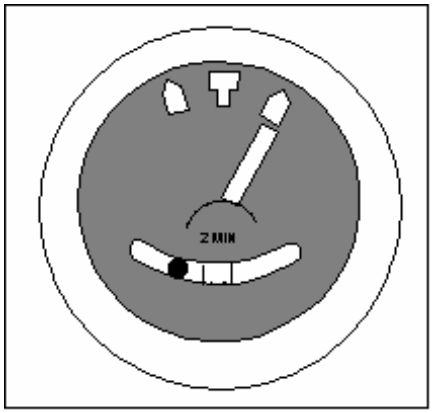
Acceleration error in AH

- AH indicate nose-up during straight and level acceleration because vanes are moved by the acceleration force

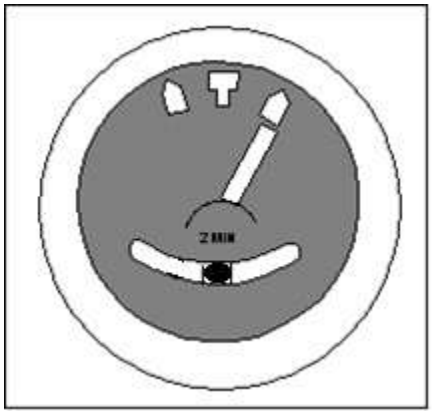


Turn-and-slip Indicator

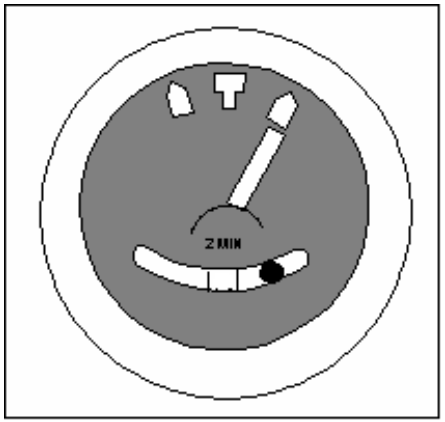
- Provides information on
  - Rate of turn
  - Whether there is slipping or skidding
- Do not indicate bank angle



Skidding

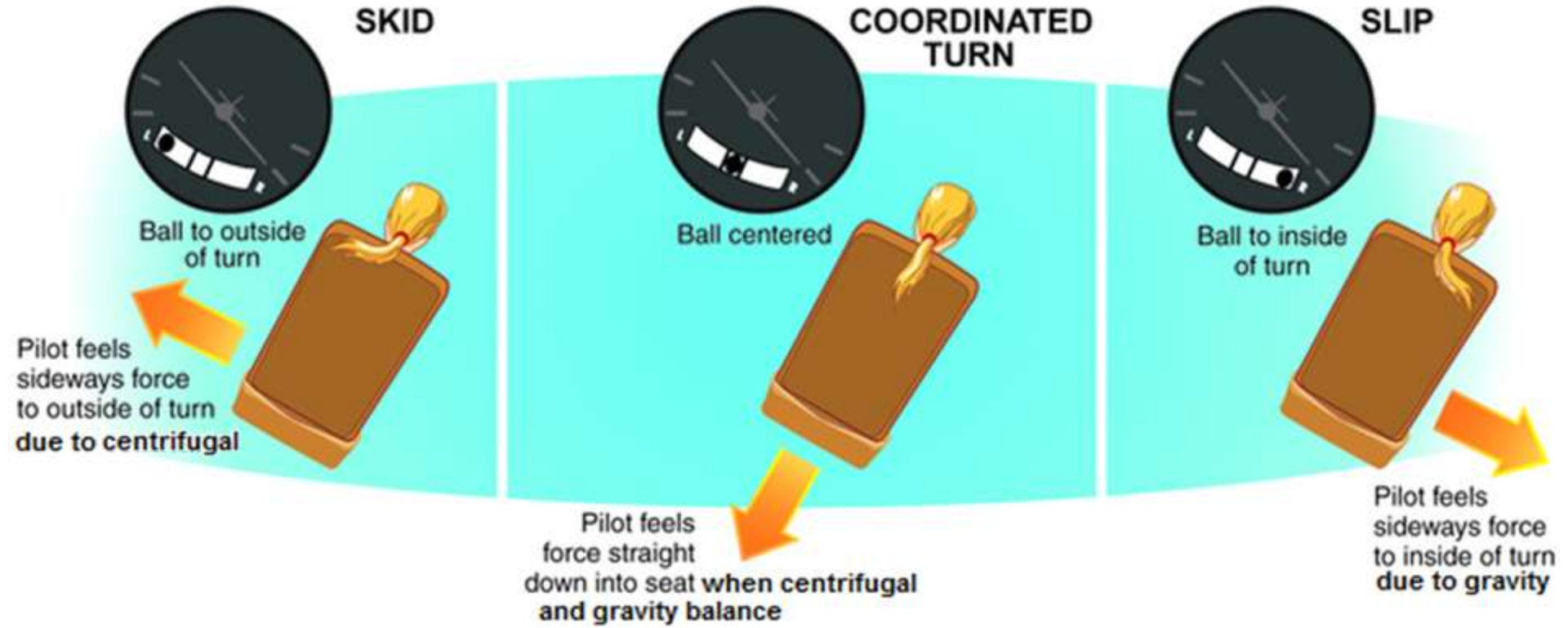


Coordinated



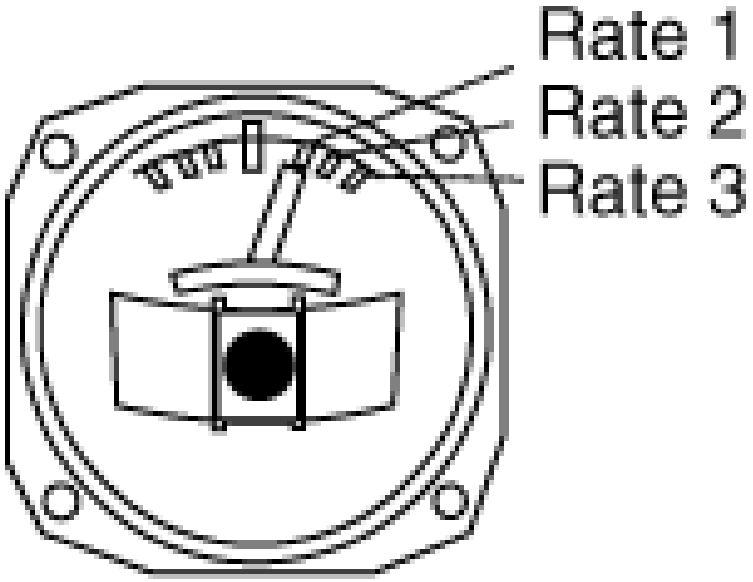
Slipping

Inclinometer



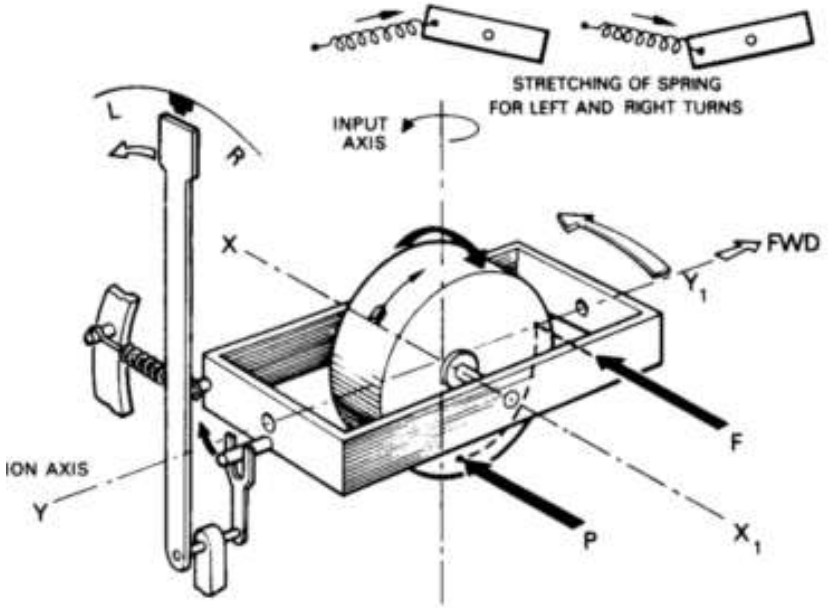
Rate of turn

- Rate One turn is a turn with a rate of 3°/s
- During a rate one turn, indicator will point to the first marking:

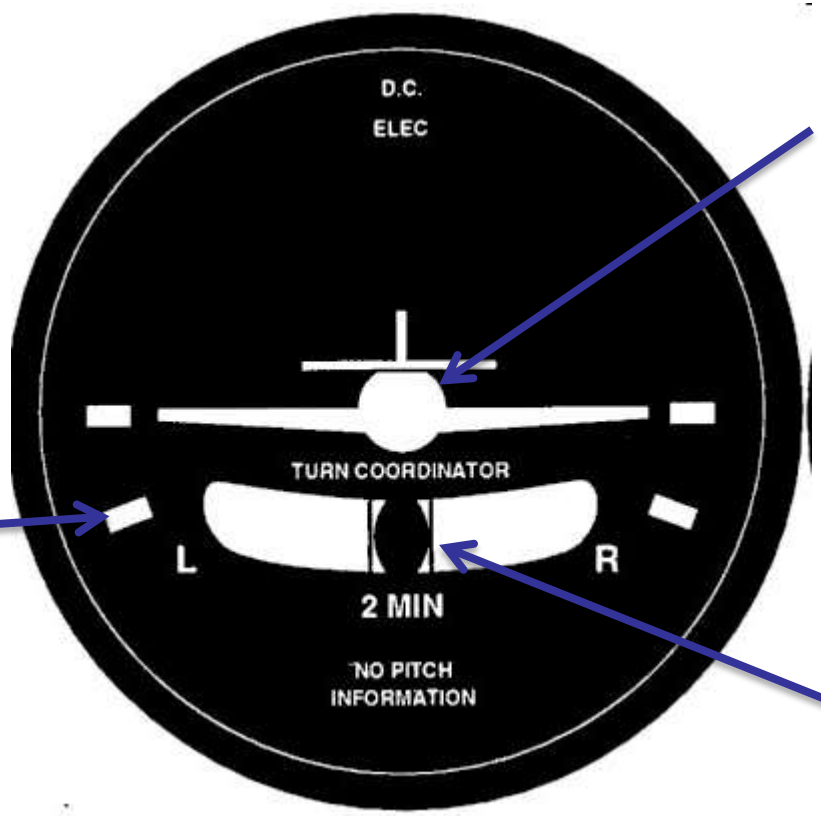


Operation principle

- F is centripetal force experienced by aircraft during a left turn
- P is the resulting precession that deflects the needle



Turn Coordinator



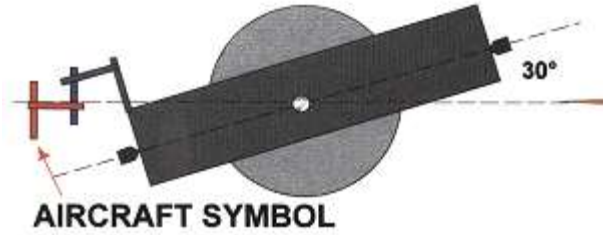
Shows the roll attitude of the aircraft

Indicates standard 2-min turn when wings level at this point

inclinometer

Turn Coordinator

- Gimbal is mounted 30° from aircraft longitudinal axis



- Sensitive to bank as well as yaw
- During a turn,
  - Shows rate of banking initially
  - Once stabilised, shows the rate of turn

Learning objectives

- Attitude Indicator/Artificial Horizon (AH)
  - Describe the components of an AH
  - Explain how the AH makes use of the gyroscopic property of rigidity to serve its function.
  - Describe how the pendulous unit keeps the spin axis vertical
  - Explain the cause of acceleration errors in AH
- Turn and slip Indicator/Turn coordinator
  - Describe the components of a turn-and-slip indicator
  - Explain how the turn-and-slip indicator makes use of the gyroscopic property of precession to serve its function
  - Identify differences between turn-and-slip indicator and turn coordinator