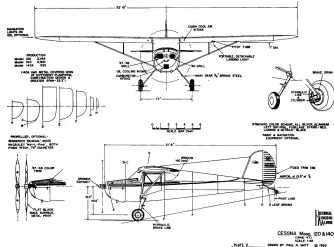


## AIRCRAFT GENERAL KNOWLEDGE 6




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### LECTURE SIX: GYROSCOPES

1. Gyroscopes – basics
2. Attitude Indicator
3. Directional Indicator
4. Turn Co-ordinator

REST  
TAXI




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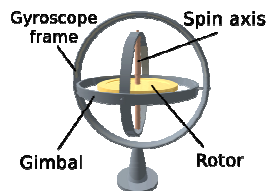
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### INSTRUMENTS: GYROSCOPES BASICS



A gyroscope is a rotating wheel mounted so that it can turn freely in one or more directions

It is capable of maintaining a fixed position in space

The aircraft will move around the gyroscope while the gyroscope remains effectively "stationary"




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## INSTRUMENTS: GYROSCOPES BASICS

GROUND  
SCHOOL

Gyroscopes have two basic properties:

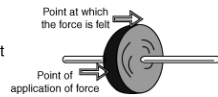


### RIGIDITY

The gyro's ability to maintain its fixed position in space  
Dependent upon mass of the rotor and the speed at which it is rotating

### PRECESSION

When a force is applied to the gyroscope the effect is displaced by 90° in the direction of rotation



## INSTRUMENTS: DIRECTIONAL INDICATOR

GROUND  
SCHOOL



Displays heading information  
(ONLY if aligned to the magnetic compass!)

Used in place of compass because  
more steady to read and not subject to  
errors of the compass

Known as Direction Indicator (DI),  
Directional Gyro (DG) or Heading  
Indicator (HI)



## INSTRUMENTS: DIRECTIONAL INDICATOR

GROUND  
SCHOOL

Heading  
currently  
indicated

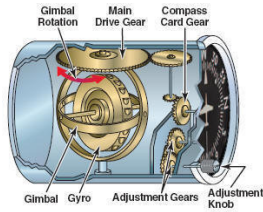


Setting knob (releases gyro so that compass card can be rotated)



## INSTRUMENTS: DIRECTIONAL INDICATOR

GROUND  
SCHOOL



The DI is an "tied gyro" – it maintains a fixed position in space

The aircraft turns around the gyro and the gyro stays in the same place

Most DIs in light aircraft are spun by the suction / vacuum system




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## INSTRUMENTS: DIRECTIONAL INDICATOR: ERRORS

GROUND  
SCHOOL



### INSTRUMENT ERROR

Known errors caused by manufacture of the instrument

### MECHANICAL DRIFT

Friction in the workings of the instrument which will cause it to drift off the set heading

### APPARENT DRIFT

Explanation coming up!

### TRANSPORT WANDER

DI is adjusted to oppose apparent drift at a particular latitude, large distances from this latitude will cause inaccuracies until adjusted




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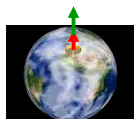
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## ENGINE INSTRUMENTS: DIRECTIONAL INDICATOR: ERRORS

GROUND  
SCHOOL

### Apparent Drift



The gyro remains effectively aligned to the north star

This is initially the same as for magnetic north on earth

As the earth turns, the two points diverge from each other



This is even seen if the aircraft is on the ground and stationary

The DI will need to be manually realigned about every 15 minutes




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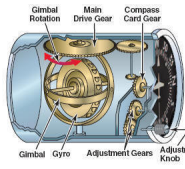
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## INSTRUMENTS: DIRECTIONAL INDICATOR: CHECKS

GROUND  
SCHOOL



### Before taxi check:

Glass is clear and unbroken  
Align DI to compass (with engine running)  
Check suction is in the green

### During taxi check:

Aircraft turning right, DI increasing  
Aircraft turning left, DI decreasing

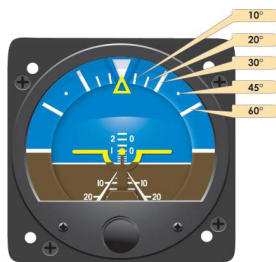
### During flight check:

Aircraft in straight, level & unaccelerated flight  
Re-align DI with compass



## INSTRUMENTS: ATTITUDE INDICATOR

GROUND  
SCHOOL



Displays aircraft pitch and roll attitude

Does NOT necessarily indicate a climb or a descent

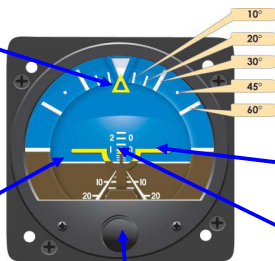
Does NOT necessarily indicate a turn



## INSTRUMENTS: ATTITUDE INDICATOR

GROUND  
SCHOOL

Roll indicator  
"Rabbits ears"



Roll markers

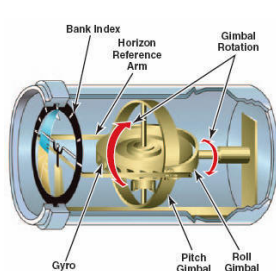
Pitch markers

Adjustment for aircraft datum



## INSTRUMENTS: ATTITUDE INDICATOR

GROUND  
SCHOOL



The AI is an "earth" gyro which maintains its position relative to earth vertical

Some AIs can be "caged" during aerobatics to prevent damage as the instrument tries to keep up!




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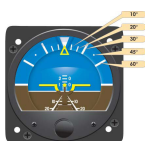
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## INSTRUMENTS: ATTITUDE INDICATOR: ERRORS

GROUND  
SCHOOL

### INSTRUMENT ERROR

Known errors caused by manufacture of the instrument



### ACCELERATION / DECELERATION ERRORS

The pendulous nature of the gyro will cause an indication of pitch during a rapid change of speed

### TOPPLE

All gyros can "topple" if their limits of movement are exceeded. Some time will be needed to allow the gyro to then realign itself




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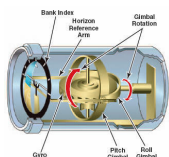
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## INSTRUMENTS: ATTITUDE INDICATOR: ERRORS

GROUND  
SCHOOL

### Before taxi check:

Glass is clear and unbroken  
Mini aircraft is aligned to the horizon lines



### During taxi check:

When aircraft turns, the AI shows no movement (it shouldn't show yaw)




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## INSTRUMENTS: TURN CO-ORDINATOR

GROUND  
SCHOOL



Turn co-ordinator is a "rate" gyro

Two elements – one to show balance indication, one to show yaw

The mini aeroplane does not necessarily show wings banked or level in reality

Usually powered by electric system to provide redundancy against AI failure




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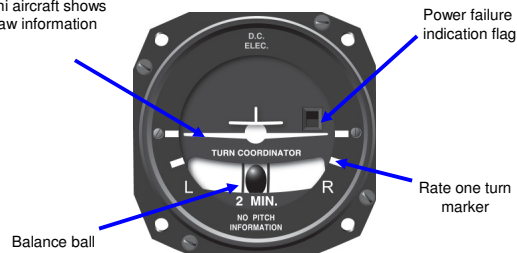
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## INSTRUMENTS: TURN CO-ORDINATOR

GROUND  
SCHOOL

Mini aircraft shows yaw information




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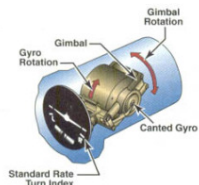
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## INSTRUMENTS: TURN CO-ORDINATOR

GROUND  
SCHOOL



The gyro rotates up and away from the pilot's perspective and is slanted by a 30° angle

This allows instrument to show both yaw and rate of roll

If the aircraft yaws, the gyro stretches a spring which causes precession until the forces match

The instrument then indicates a "rate 1" turn (3° / second)




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## INSTRUMENTS: TURN CO-ORDINATOR

GROUND  
SCHOOL



### CO-ORDINATED RATE 1 TURN

"needle" shows rate 1 indication  
Balance ball in the centre



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## INSTRUMENTS: TURN CO-ORDINATOR

GROUND  
SCHOOL



### SKIDDING TURN

Aircraft in right turn, but trying to "skid" right (into the turn)  
Needs more left rudder applied



### SLIPPING TURN

Aircraft in right turn, but trying to "slip" left (out of turn)  
Needs more right rudder applied



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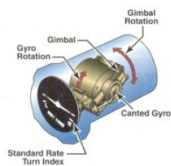
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## INSTRUMENTS: TURN CO-ORDINATOR: ERRORS

GROUND  
SCHOOL



### INSTRUMENT ERROR

Due to imperfections in manufacture

### TOPPLE

If limits are exceeded – gyro will realign itself with time



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### PRACTICE QUESTIONS

GROUND  
SCHOOL

How does the aircraft nose wheel steering work?

- (a) Electric motors
- (b) Push-pull rods
- (c) Hydraulics
- (d) Accumulators

Why are cowlings fitted to an air-cooled engine?

- (a) To control cylinder head temperatures
- (b) To retain lubrication for cooling
- (c) To control airflow to dissipate heat
- (d) For design purposes



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### PRACTICE QUESTIONS

GROUND  
SCHOOL

The piece of the engine which converts linear to rotary motion is the

- (a) Crankshaft
- (b) Piston
- (c) Camshaft
- (d) Reduction Gear

If carrying out a check on the voltmeter...

- (a) There should be no load on the battery
- (b) The load condition is unimportant
- (c) The battery should be isolated
- (d) Load should be applied



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### PRACTICE QUESTIONS

GROUND  
SCHOOL

On the airspeed indicator, the green arc represents

- (a) Flap limiting speed
- (b) Caution Range
- (c) Stall Speed
- (d) Normal Operating Range

Gyroscope rigidity depends upon:

- (1) Rotor Mass, (2) Rotor Speed of Rotation, (3) Radius of the location of the mass

The correct combination of statements is:

- (a) 1 & 2
- (b) 1, 2, & 3
- (c) 2 & 3
- (d) 1 & 3



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## PRACTICE QUESTIONS

GROUND  
SCHOOL

Compass deviation cards are used to:

- (a) Indicate difference between compass reading and true heading
- (b) Show corrections required to magnetic heading to get true heading
- (c) Show corrections to be made to the compass reading to get magnetic heading
- (d) Correct the compass for removable load

So that the turn co-ordinator can give both yaw and roll information the gimbal axis of the gyroscope is:

- (a) Vertical
- (b) Horizontal
- (c) Tilted at  $30^\circ$  to the vertical
- (d) Tilted at  $30^\circ$  to the horizontal



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Lecture complete  
Any Questions?



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