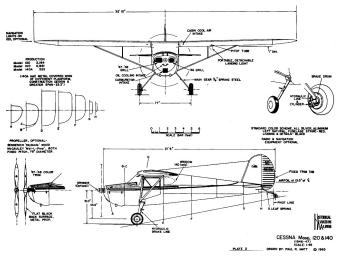
GROUND SCHOOL

AIRCRAFT GENERAL KNOWLEDGE 2



GROUND SCHOOL

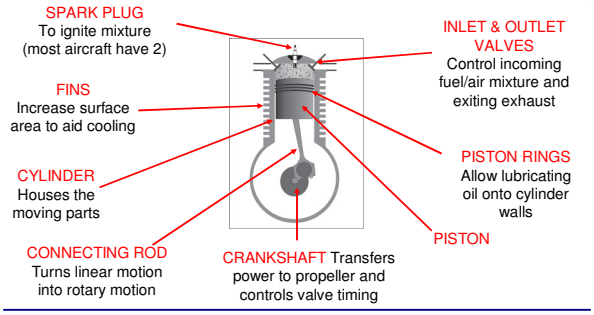
LECTURE TWO: ENGINES

1. Engines – the Four Stroke Cycle
2. Engines – Cooling & Lubrication
3. Ignition Systems

GROUND SCHOOL

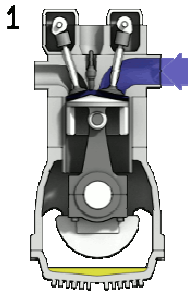
ENGINES: BASIC CONSTRUCTION

Most light aircraft have four-cylinder piston engines



ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL



The 4-stroke cycle consists of 4 strokes of the piston travelling in the cylinder. The four strokes are:

Intake

Compression

Power

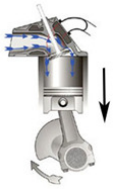
Exhaust

Or... Suck, Squeeze, Bang, Blow!

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

INTAKE STROKE



Piston moves down the cylinder to “bottom dead centre” – its lowest position

Inlet valve opens

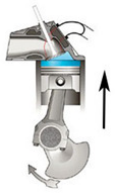
Pressure inside the cylinder decreases

Fuel / Air Mixture is sucked into the cylinder

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

COMPRESSION STROKE



Piston moves up the cylinder to “top dead centre” – its highest position

Pressure inside the cylinder increases

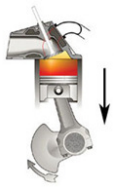
Fuel / Air Mixture is compressed in the gap remaining

Temperature in the cylinder increases

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

POWER STROKE



Spark plug discharges and the spark ignites the mixture

Piston is forced down the cylinder to “bottom dead centre”

Pressure inside the cylinder decreases

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

EXHAUST STROKE

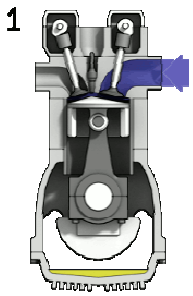
Piston moves back up cylinder to top dead centre

Exhaust valve opens

Burnt gases are moved out through the exhaust system

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL



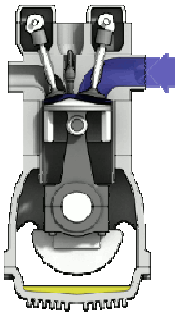
Every completed 4 strokes leads to 2 rotations of the crankshaft

If an engine has 4 cylinders, each cylinder will be on a different stroke at any one time – this leads to smoother running

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

1



The compression ratio of an engine determines which fuel is used and how efficient it is

compression ratio = total volume / clearance volume

Total volume = space left when piston at bottom dead centre

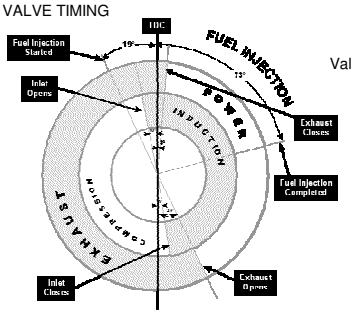
Clearance volume = space left when piston at top dead centre

Swept volume = volume swept by the piston in one stroke

ENGINES: OTTO CYCLE (4 STROKE CYCLE)

GROUND SCHOOL

VALVE TIMING



Valve timing aids the engine's efficiency

The modified Otto Cycle has a high degree of valve overlap – when both valves are open at the same time

ENGINES: PRE-IGNITION & DETONATION

GROUND SCHOOL

PRE-IGNITION

Occurs when ignition of the mixture occurs before the spark

Caused by overheated spark plug tip, carbon deposits, hot spots on the cylinder wall

DETONATION

Occurs when ignition of the mixture occurs after the main spark and burn

Caused by spontaneous combustion of un-burnt mixture

Both cause engine damage!

GROUND SCHOOL

PRACTICE QUESTION!

How many times does each valve open during one cycle of the "Otto" cycle

Once

GROUND SCHOOL

PRACTICE QUESTION!

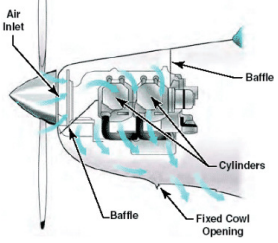
What is the formula for the compression ratio of an engine?

Total volume divided by clearance volume

GROUND SCHOOL

ENGINES: COOLING

Most aircraft engines are air-cooled – it is simpler, cheaper, and easier to maintain



Cowlings and baffles are designed to direct flow of air around to engine to cool it from the outside

Some components have "fins" which increase the surface area and assist with cooling

ENGINES: COOLING

GROUND SCHOOL

Some aircraft have Cylinder Head Temperature (CHT) gauges to monitor engine heat build up

These aircraft often also have cowl flaps which can direct extra air across the engine for cooling

ENGINES: LUBRICATION

GROUND SCHOOL

Engine components require oil-based lubrication for a number of reasons:

To prevent friction between moving surfaces

To cool hot sections of the engine more efficiently than air

To carry contaminants in the system away to a safe area to prevent damage

To provide a seal to certain components (such as the piston and the cylinder wall)

ENGINES: LUBRICATION

GROUND SCHOOL

Oil for engines must have a high flash point so that it does not catch fire easily

Oil must be chemically stable

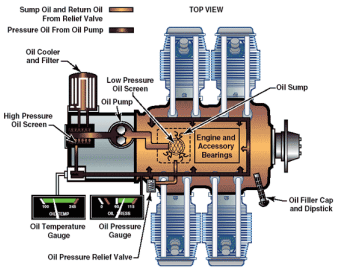
It must be viscous enough to flow easily at all operating temperatures but not so liquid it doesn't coat the surfaces

Lubrication systems will have an oil filter to trap any particles being carried out of the engine – in this way the oil "cleans" the engine

Always check amount and type of oil is sufficient and correct before flight!

ENGINES: LUBRICATION

GROUND SCHOOL



Most light aircraft have "wet sump" oil systems

There is a sump where oil returns to by gravity

In a "dry sump" system scavenge pumps are used to collect oil

An oil cooler ensures that the oil does not get too hot

Oil pressure relief valve will vent oil overboard in the case where the pressure would damage the engine

ENGINES: LUBRICATION

GROUND SCHOOL

OIL TEMPERATURE GAUGE

Measures temperature of oil after the oil cooler and before it enters hot section of engine

OIL PRESSURE GAUGE

Measures pressure of oil after oil pump and before it enters hot section of engine

These gauges can show up malfunctions in the lubrication system:

ENGINES: LUBRICATION: MALFUNCTIONS

GROUND SCHOOL

LOW OIL PRESSURE

a.) insufficient oil
b.) oil leak
c.) failure of oil pump
d.) engine problem (failed bearings)
e.) oil pressure relief valve stuck open

HIGH OIL PRESSURE

a.) oil pressure relief valve inoperative
b.) excess oil in system

HIGH OIL TEMPERATURE

a.) oil quantity is insufficient
b.) prolonged operation at high power settings
c.) oil filter is blocked and oil is bypassing the cooler

FLUCTUATING GAUGE

a.) gauge is broken!
b.) other issue

Remember oil problem can lead to no oil which will lead to no engine! Land as soon as possible

GROUND SCHOOL

ENGINES: LUBRICATION: MALFUNCTIONS

NO OIL PRESSURE INCREASE AFTER 30 SECONDS AFTER ENGINE START

VERY important to check after you start the engine because if there is no oil pressure rise (into the green) after 30 seconds it means that the engine may not have any oil supply!

The engine must be shut down immediately to prevent any further damage

GROUND SCHOOL

PRACTICE QUESTION!

How are excessive engine oil pressures prevented?

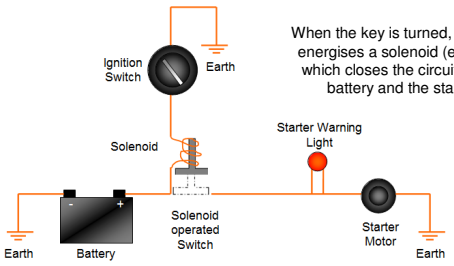
An oil pressure relief valve

GROUND SCHOOL

IGNITION SYSTEMS: CONSTRUCTION

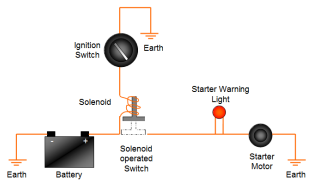
Various components of the aircraft ignition system

When the key is turned, a small current energises a solenoid (electromagnet) which closes the circuit between the battery and the starter motor



IGNITION SYSTEMS: CONSTRUCTION

GROUND SCHOOL



The solenoid allows a much higher current to do the work required

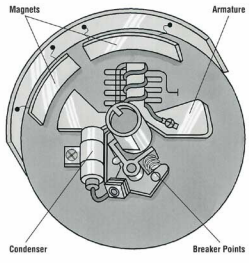
A starter warning light indicates when the starter motor is engaged

Once the key is released, the starter warning light should go out

If it does not – engine must be shut down immediately to avoid damage to the starter motor and to the engine

IGNITION SYSTEMS: MAGNETOS & IMPULSE COUPLING

GROUND SCHOOL



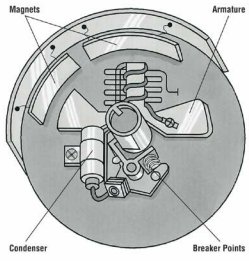
The RAPID collapse of the magnetic field provides the first sparks needed to start the engine

After start the sparks are provided by the engine and the impulse coupling retracts

The impulse coupling can be powered by the battery or by hand-swinging the propeller

IGNITION SYSTEMS: MAGNETOS & IMPULSE COUPLING

GROUND SCHOOL



Only one magneto is needed for engine start – it provides the electricity for the spark - this magneto has an impulse coupling

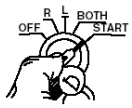
It retards the spark to the engine so that it works at low rpm settings

The impulse coupling rotates the magnet and generates a high voltage

The high voltage is achieved by the magnet being stopped and then released suddenly – this therefore produces the high tension supply required

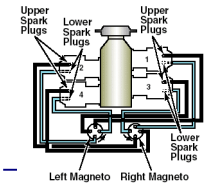
IGNITION SYSTEMS: HOW TO USE

GROUND SCHOOL



The key at “start” position engages the impulse coupling to provide the initial sparks required

When the key is released it springs back to the “both” position so that both magnetos are in use



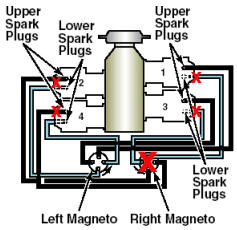
The “right” magneto powers one spark plug in each cylinder

And the “left” does the other spark plug in each cylinder!

If one magneto fails, all cylinders still get a spark

IGNITION SYSTEMS: HOW TO USE

GROUND SCHOOL



DEAD CUT CHECK

Should be done before taxy and just prior to shut down of the engine

When “left” is selected, the right magneto is earthed so that only sparks from the left magneto are generated

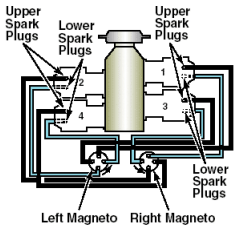
A drop in rpm should be noticed but the engine should continue to run

Repeat for “right” selection

Make sure “both” is selected for taxy

IGNITION SYSTEMS: HOW TO USE

GROUND SCHOOL



POWER CHECK

Should be done prior to take off

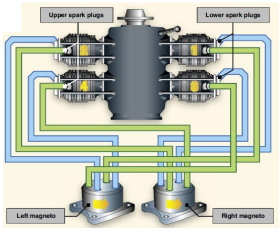
Same check as before but note rpm drop and check it is within limits for your aircraft

For a C152 maximum drop of 125rpm but no more than 50 rpm drop between the two

Ensures that magnetos are providing even sparks and that engine is capable of sustaining with only one working

GROUND SCHOOL

IGNITION SYSTEMS: MALFUNCTIONS



Engine cuts out during "dead cut" check

One magneto is not working. Shut down and inform engineering.

No rpm drop on "dead cut" check

One magneto is not earthing. Shut down and inform engineering. Ensure no-one touches propeller.

Rough running engine during power check

Spark plugs are fouled up. Instructor will show you how to clear or inform engineering

Spark plug fouling is generally caused by an over-rich mixture

GROUND SCHOOL

PRACTICE QUESTION!

When a magneto is switched off is the primary circuit switch open or closed and is it earthed or not earthed?

Circuit is closed and switch is earthed

GROUND SCHOOL

Lecture complete

Any Questions?