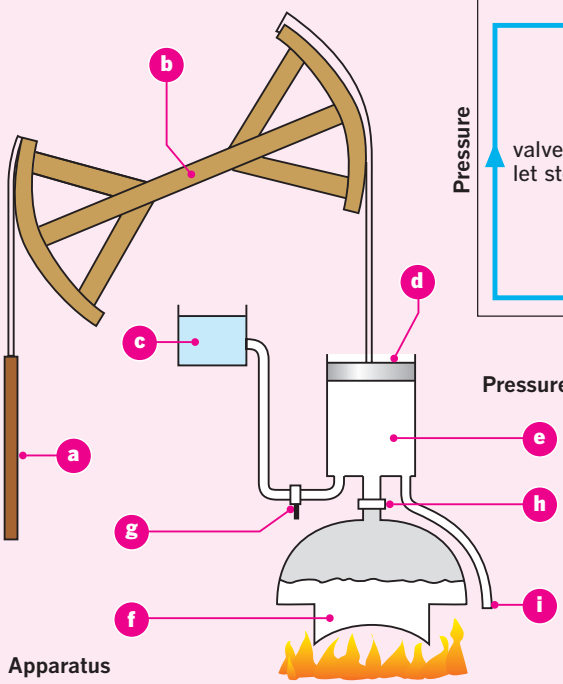
More complicated machines 1

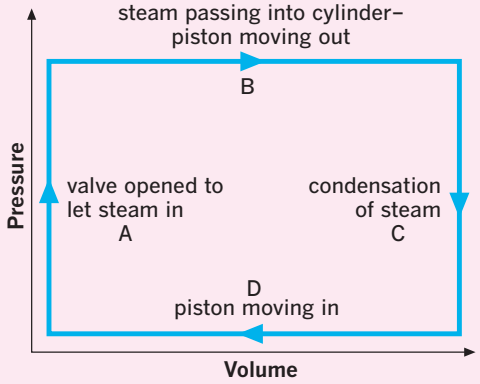
Key words

condense
ignite
internal combustion engine
piston
pivot

1 Newcomen engine



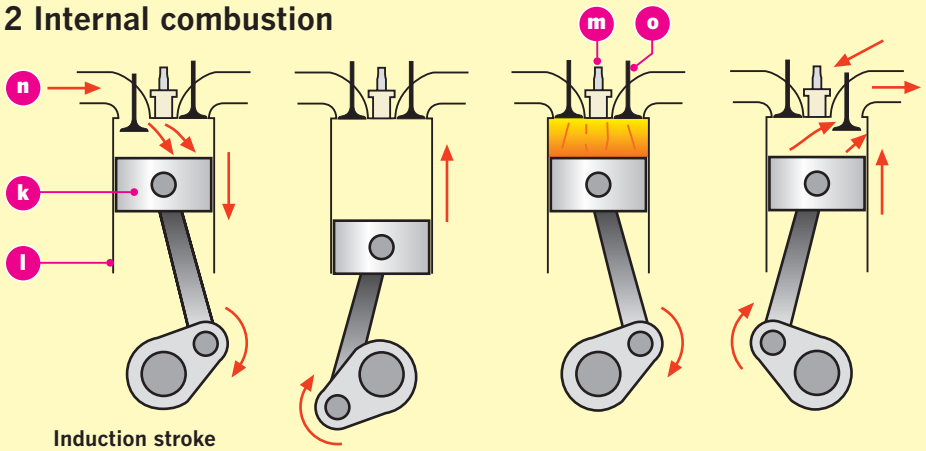
Apparatus



Pressure-volume relation

a load
b pivot
c cold water
d piston
e cylinder
f boiler
g valve to allow cold water to spray cylinder walls
h valve to let steam into cylinder
i pipe to drain water from cylinder

2 Internal combustion

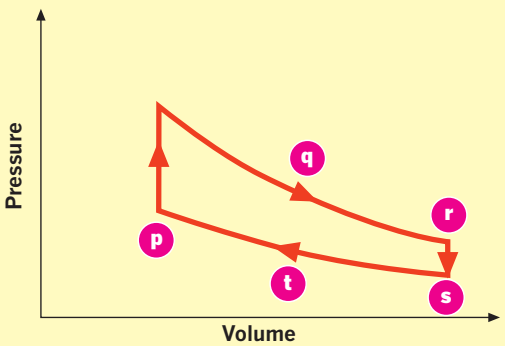


Induction stroke (air and vaporized petrol mixture)

Compression stroke: valves closed

Ignition stroke: valves closed

Exhaust stroke



Pressure–volume relation for Otto cycle

k piston
l cylinder
m spark plug
n inlet valve open
o outlet valve closed
p ignition
q piston moves down
r exhaust
s intake
t compression

1 Newcomen engine

- Newcomen built the first practical engine in the early eighteenth century. Water is heated in the boiler, and turns to steam which is injected into the cylinder under high pressure, forcing the piston upwards. A spray of cold water is injected into the cylinder causing the steam to *condense*, drastically reducing pressure in the cylinder. The *piston* is forced down by atmospheric pressure. Movement is transferred to a load via a *pivot*.
- Pressure volume relation. The pressure in the cylinder rises A) as steam is injected into it and remains constant B) as the piston rises. When a spray of cold water is injected into the cylinder the pressure rapidly falls C) as the steam condenses and remains constant D) as the piston is forced down by atmospheric pressure.

2 Internal combustion

- In a four-stroke *internal combustion engine* a mixture of air and petrol burns within the cylinder.
- During the induction stroke the inlet valve opens and the air-petrol mixture passes into the cylinder.
- During the compression stroke both inlet and outlet valves are closed and the air-petrol mixture is compressed.
- During the *ignition* stroke, still with both the inlet and outlet valves closed, the air-petrol mixture is ignited by an electrical discharge from a spark plug. This causes a rapid increase in pressure within the cylinder as the air-petrol mixture is converted to exhaust gases. This increase in pressure forces the piston down.
- During the exhaust stroke the outlet valve opens allowing the exhaust gases to leave the cylinder.
- The pressure volume changes during the cycle are shown on the diagram.