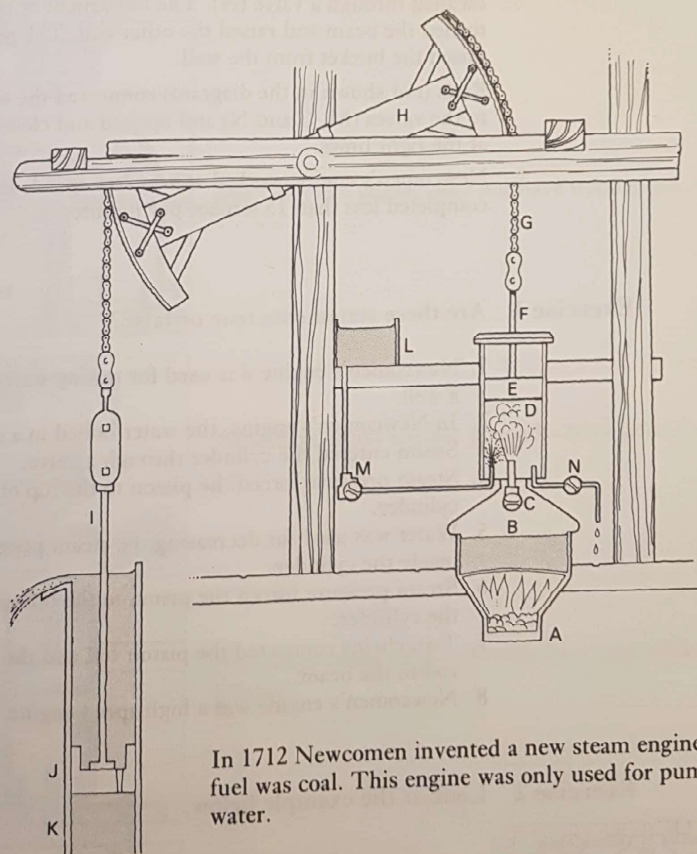


UNIT TWO

Steam Engines

SECTION A: NEWCOMEN'S ENGINE



In 1712 Newcomen invented a new steam engine. The fuel was coal. This engine was only used for pumping water.

The Up Stroke

A furnace (A) heated water in a copper boiler (B). The water evaporated into steam. The steam entered a cylinder (D) through a valve (C). Inside the cylinder the steam pressure forced the piston (E) to the top of the cylinder. A chain (G) connected the piston rod (F) to one end of a heavy beam (H). The beam turned on its centre point. A pump rod (I) lowered a bucket (J) into a well (K).

The Down Stroke

Water entered the cylinder from a tank (L) through a valve (M). The steam in the cylinder condensed. Therefore the pressure below the piston decreased considerably. The pressure above the piston (i.e. normal air pressure) was then much greater than the pressure below the piston. The air pressure forced the piston to the bottom of the cylinder. The water inside the cylinder escaped through a valve (N). The movement of the piston turned the beam and raised the other end. The pump rod raised the bucket from the well.

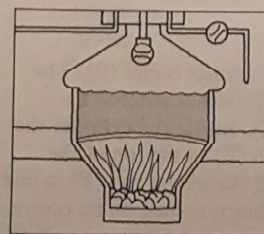
Rods (not shown in the diagram) connected the beam (H) to the valves (M, C and N) and opened and closed them at the right times.

Newcomen's engine worked at very low speed. It completed less than 15 strokes per minute.

Exercise 1 Are these statements true or false?

1. Newcomen's engine was used for raising water from a well.
2. In Newcomen's engine, the water boiled in a cylinder.
3. Steam entered the cylinder through a valve.
4. Steam pressure forced the piston to the top of the cylinder.
5. Water was used for decreasing the steam pressure inside the cylinder.
6. Steam pressure forced the piston to the bottom of the cylinder.
7. Two chains connected the piston rod and the pump rod to the beam.
8. Newcomen's engine was a high speed engine.

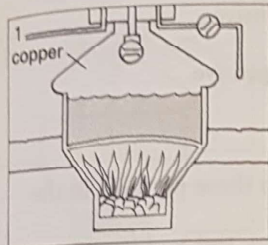
Exercise 2 Look at the example below.



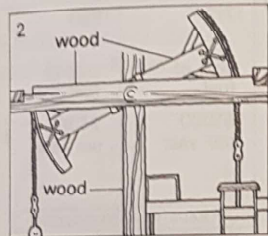
Nowadays a steam engine has a high pressure boiler.

Newcomen's engine had a low pressure boiler.

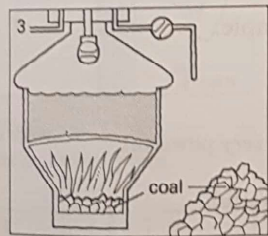
Now make a sentence about Newcomen's engine from each picture.



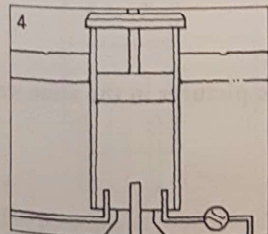
Nowadays an engine has a steel boiler.
Newcomen's



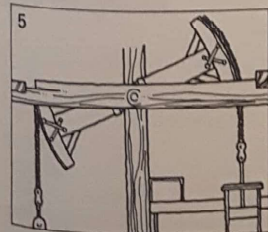
Nowadays an engine does not have wooden parts.
.....



Nowadays steam engines generally have an oil furnace.
.....



Nowadays steam engines usually have more than one cylinder.
.....



Nowadays engines do not have a beam.
.....

| 1712 | 1750 |
|------------------------------|------------------------------|
| construction cost— \$2000 | construction cost— \$1100 |
| expensive | |

Look at the next example.

Newcomen's engine was expensive.

Later engines were not as expensive.

Now make sentences from these pictures in the same way.

6

| 1712 | 1800 |
|-------|------|
| | |
| large | |

7

| 1712 | 1800 |
|--|---|
| engine speed— 5–12 strokes per minute | engine speed— 15–20 strokes per minute |
| slow | |

8

| 1712 | 1850 |
|-------------------------------------|------------------------------------|
| cost of fuel— \$1000 per year | cost of fuel— \$400 per year |
| expensive to operate | |

Now look at the final example.

| 1712 | 1850 |
|-------------------------------------|----------------------------------|
| engine power— 750– 1500 watts | engine power— 15 kW –25 kW |
| powerful | |

Newcomen's engine was *not* very powerful.

Later engines were *more* powerful.

Make sentences from these pictures in the same way.

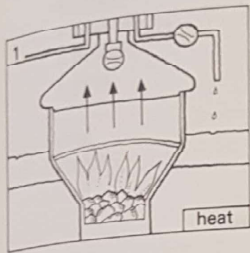
9

| 1712 | 1850 |
|---------|------|
| | |
| complex | |

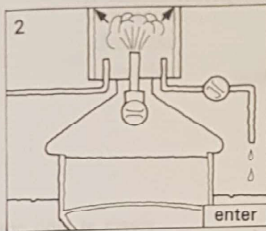
10

| 1712 | 1850 |
|--------|------|
| | |
| strong | |

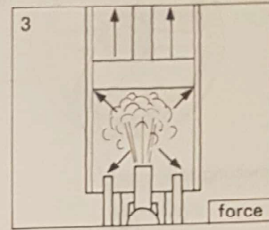
Exercise 3 Describe how Newcomen's engine worked from the pictures below. The first sentence has been done for you.



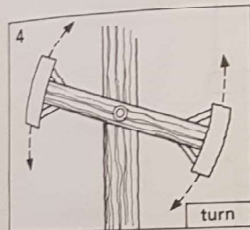
A furnace heated the water in the boiler.



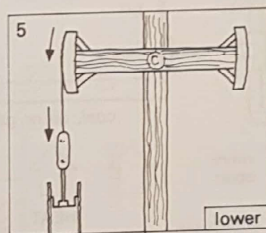
Steam through a valve.



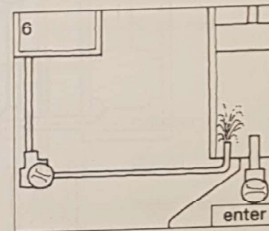
Steam pressure up the cylinder.



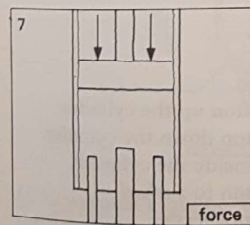
The beam on its centre point.



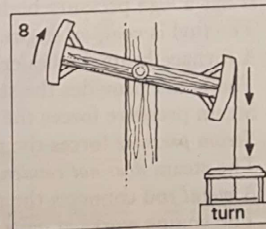
The movement of the beam into a well.



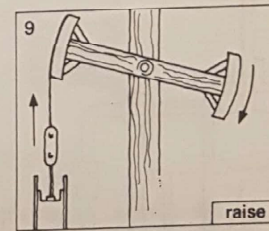
Water through a valve.



The pressure down the cylinder.

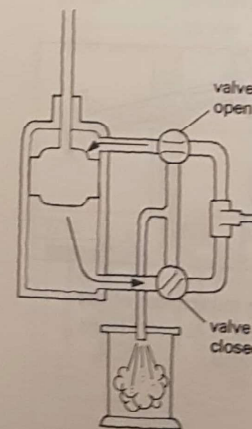
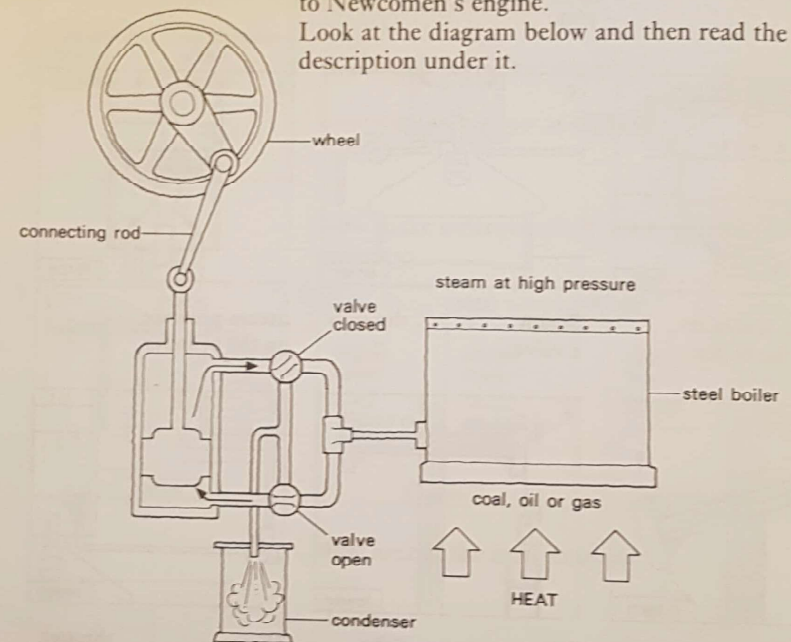


The movement of the piston on its centre point.



The movement of the beam from the well.

Exercise 4 Later steam engines worked in a very similar way to Newcomen's engine. Look at the diagram below and then read the description under it.



1. The boiler is made of *steel*.
2. It has a *high pressure* boiler.
3. The fuel is *coal, oil or gas*.
4. A furnace heats the boiler.
5. The boiler provides the steam.
6. Steam pressure forces the piston up the cylinder.
7. *Steam pressure* forces the piston down the cylinder.
8. The steam *does not condense* inside the cylinder.
9. A *metal rod* connects the piston to a *wheel*.
10. The engine works at quite *high speeds*.

The words in *italics* show the differences between later steam engines and Newcomen's engine. Describe how Newcomen's engine worked. The first sentence has been done for you. Write nine more sentences.

Newcomen's First Steam Engine (1712)

1. The boiler *was* made of *copper*.

a boiler
a piston
a design
a centre
a movement
a minute
a year

coal
steam

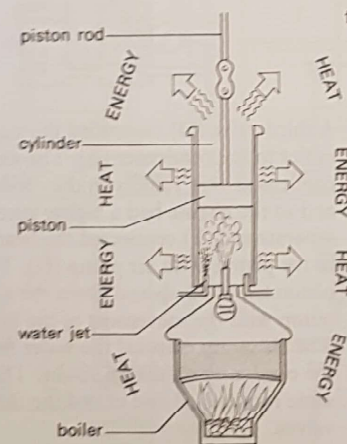
invent
pump
enter
force
condense
decrease
complete

similar
complex
early
late(r)
powerful
slow

up
down

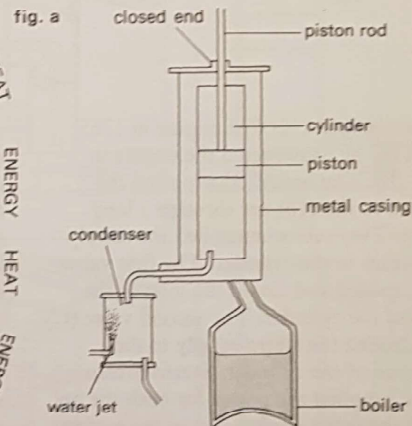
(the) top of . . .
nowadays

SECTION B: WATT'S ENGINES



NEWCOMEN (1712)

In Newcomen's engine, the steam heated the cylinder and then the condensing water cooled it. Therefore heat energy escaped and the engine was not very efficient. In his engine, Watt fitted a steam jacket around the cylinder and so the cylinder remained hot. He also fitted a separate condenser to avoid spraying water into the cylinder.



WATT (1765)

In Newcomen's engine, a water jet condensed the steam inside the cylinder and so the temperature inside the cylinder went up and down over a wide range. Therefore a large amount of steam was used for raising the cylinder temperature at each up stroke. Watt fitted a separate condenser to his engines. Thus it was possible to condense the steam outside the cylinder and so the cylinder remained at a steady temperature.