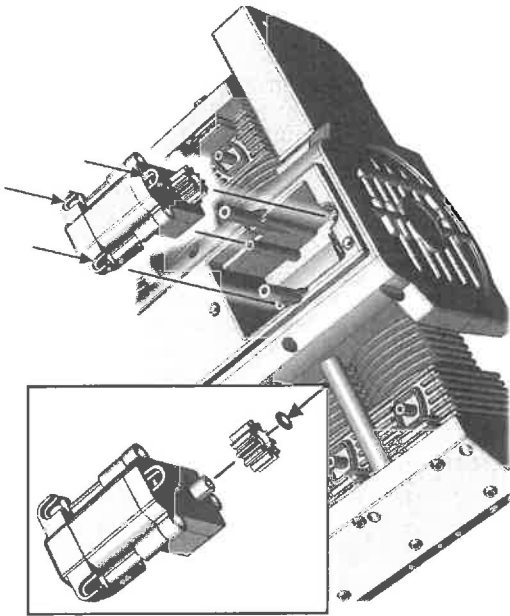


## ASSEMBLING THE ENGINE

### Step 29. Drive motor

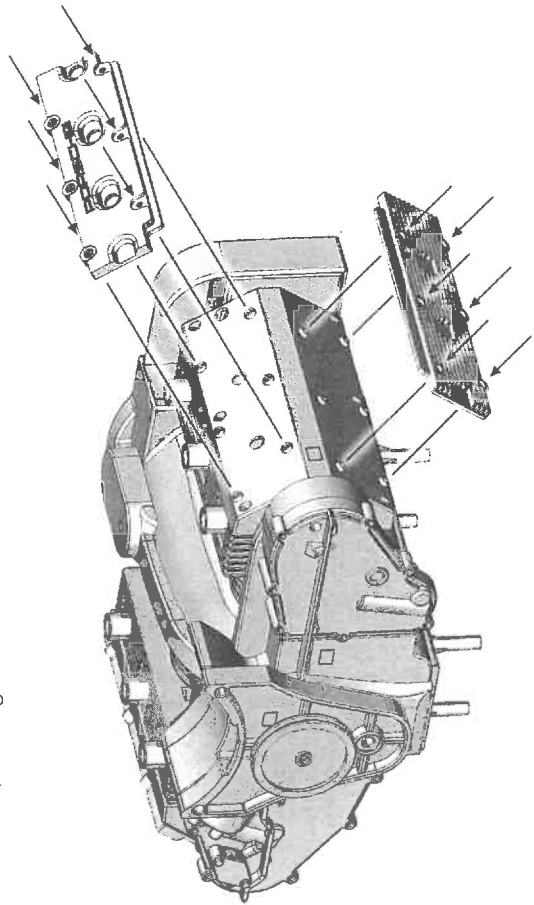
Fit the drive gear (67) to the motor shaft. One side of the gear is recessed; make sure the recess is facing outwards, and secure using one of the metal washers and a screw.

Insert the motor/gearbox assembly into the hole in the lower part of the crankcase and secure with three screws.



### Step 30. Cylinder head covers

Attach the upper (57) and lower cylinder (58) head covers, securing each with six screws.

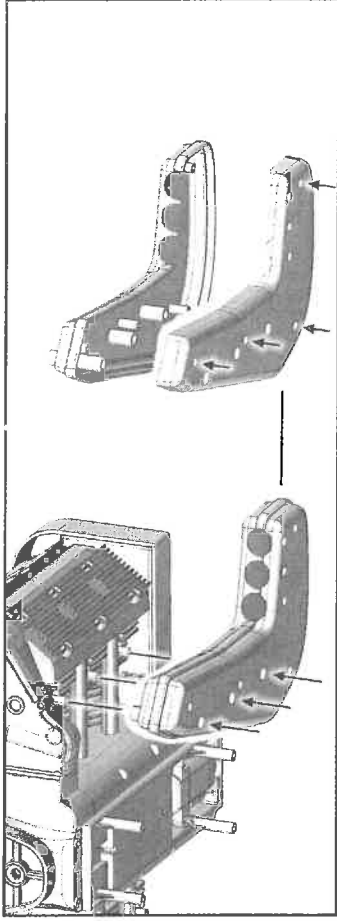


## ASSEMBLING THE ENGINE

### Step 31. Exhaust manifolds

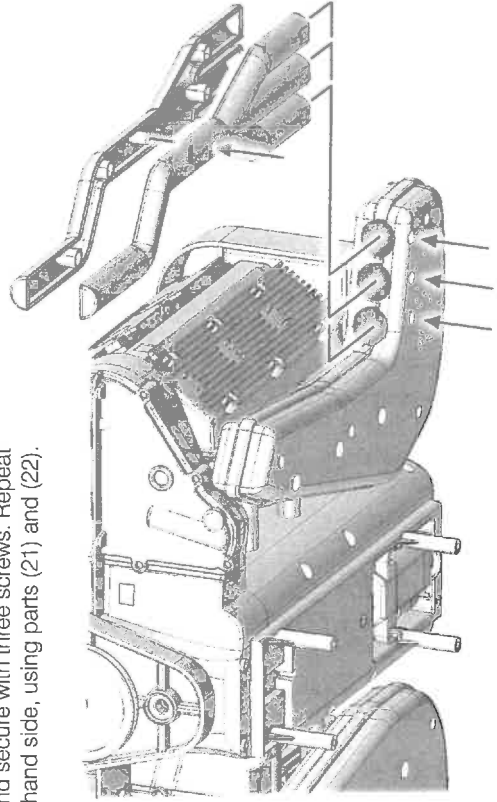
Each exhaust manifold is made up from two parts. Assemble the upper (30) and lower (31) halves of the right manifold and secure

with four screws. Fit the assembled manifold to the underside of the cylinder head and secure with three screws. Repeat for the left hand side, using parts (28) and (29).



### Step 32. Exhaust pipes

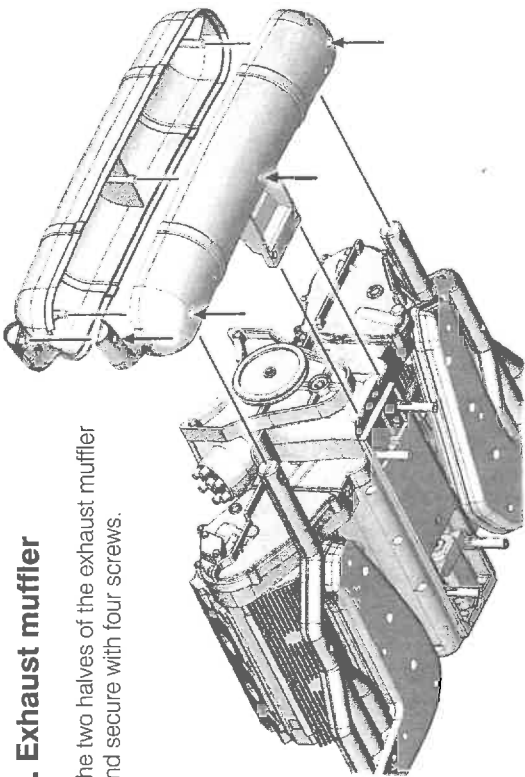
Each set of exhaust pipes is also made up from two parts. Assemble the upper (23) and lower (24) halves of the right exhaust and secure with one screw. Fit the assembled exhaust to the manifold and secure with three screws. Repeat for the left hand side, using parts (21) and (22).



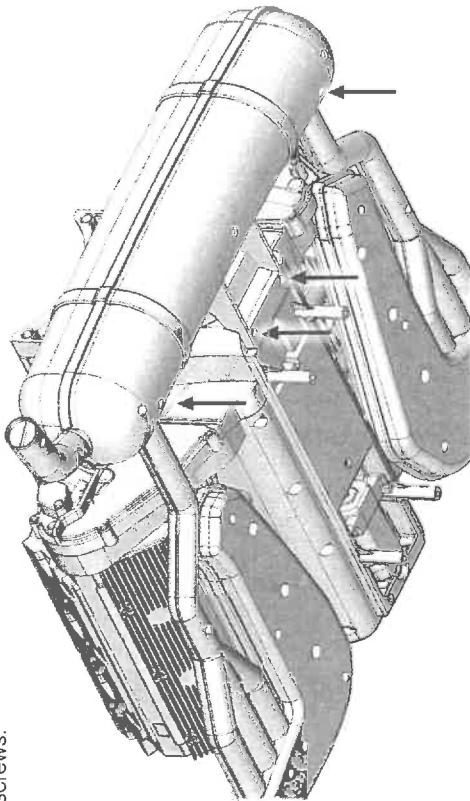
## ASSEMBLING THE ENGINE

### Step 33. Exhaust muffler

Assemble the two halves of the exhaust muffler (19 & 20) and secure with four screws.



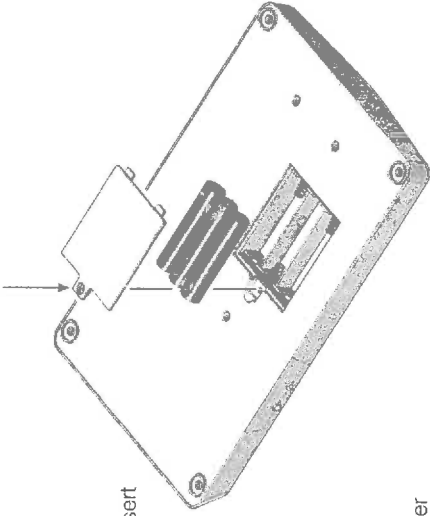
Slide the muffler over the ends of the exhaust pipes. The muffler is secured to each exhaust pipe with a single screw, and to the crankcase with two screws.



## ASSEMBLING THE ENGINE

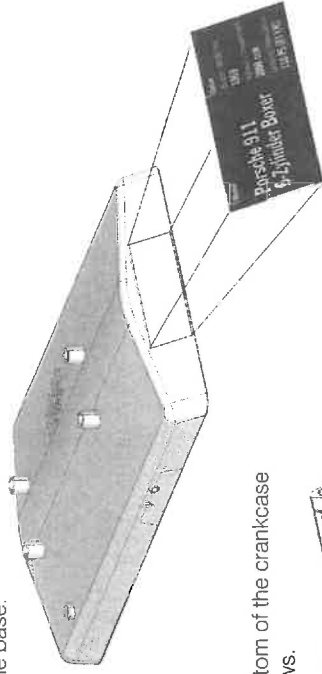
### Step 34. Base - battery installation

Remove the battery compartment cover. Insert 3 x AA batteries in the compartment, taking care to ensure that the battery markings (polarity) match the markings in the compartment. Replace the battery cover.



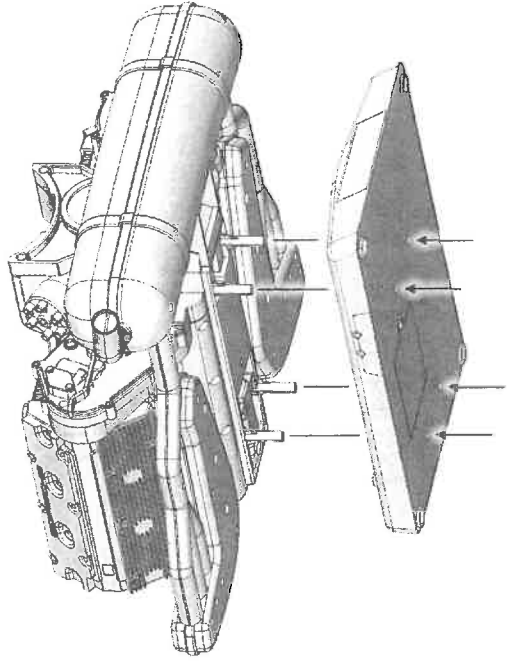
### Step 35. Base label

Remove the foil label from the backing paper and place in position on the base.



### Step 36. Base

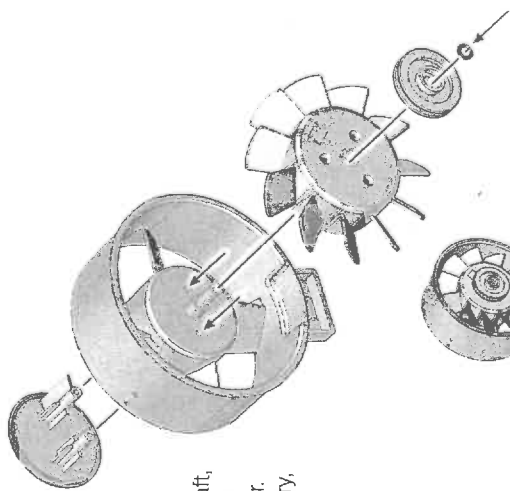
Attach the base to the bottom of the crankcase and secure with four screws.



## ASSEMBLING THE ENGINE

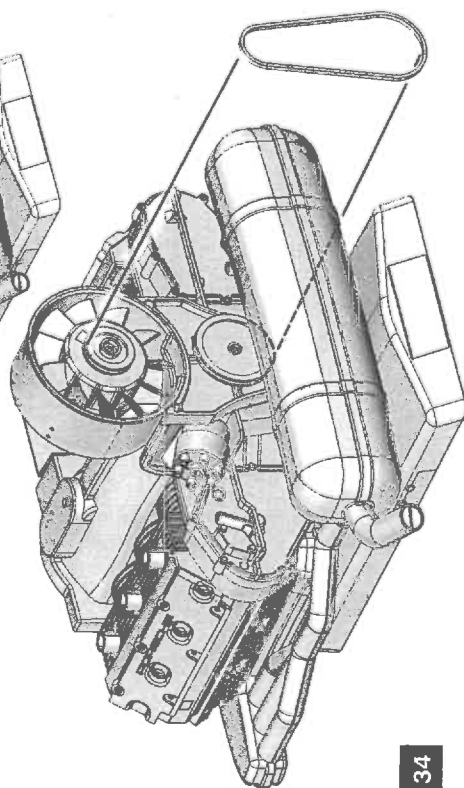
### Step 37. Cooling fan assembly

Assemble the cooling fan components as shown. Attach the rear cover (78) to the fan housing (34) first, and secure with two screws. Slide the fan (42) over the shaft, followed by the fan pulley (26). Secure the pulley to the fan using a screw and washer. Check that the fan spins freely; if necessary, loosen the screw slightly.



### Step 38. Cooling fan installation

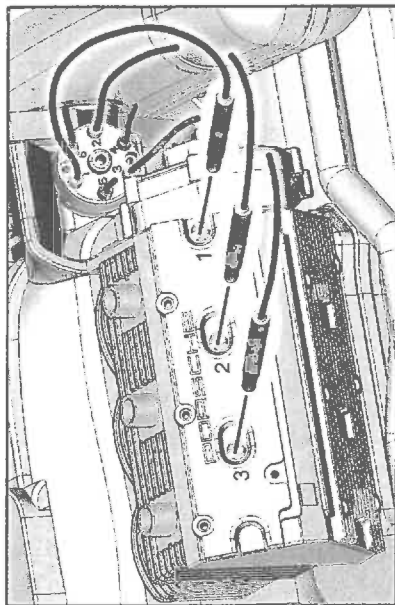
Insert the clip on the bottom of the cooling fan assembly into the slot in the crankcase. Fit the fan drive belt – this fits over the crankcase pulley and the fan pulley.



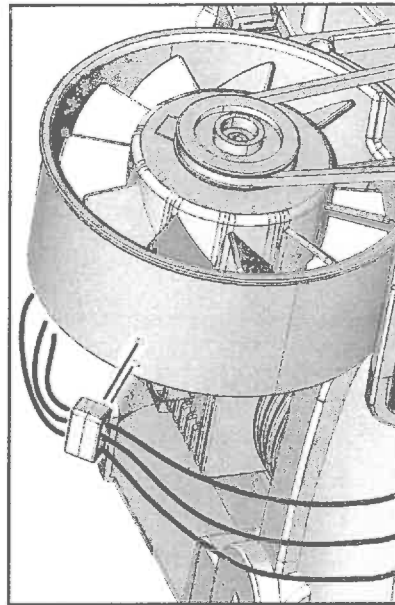
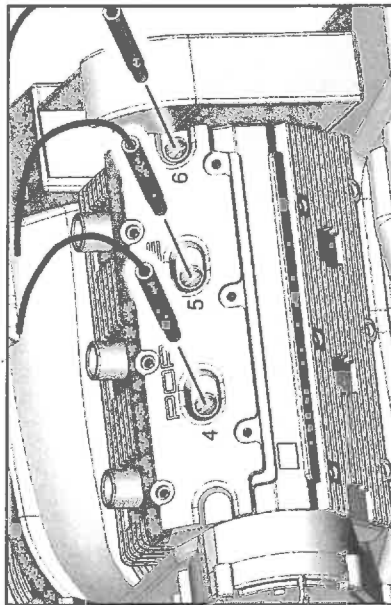
## ASSEMBLING THE ENGINE

### Step 39. Spark plugs

Insert the spark plugs into the holes in the upper part of the cylinder heads. Carefully note the markings on the top of the distributor cap; follow the wire that exits from hole #1 and insert it into cylinder number 1 as shown. Repeat for wires/cylinders 2, 3, 4, 5 and 6.



Use the clip (72) provided to secure the wires for cylinders 4, 5 and 6 so they are routed neatly over the cooling fan.



# HOW AN ENGINE WORKS

## Basic Principles

To explain how a full-size car engine works, we'll use a simplified version of a real engine - our model engine in fact. You can switch on your finished model as you read this explanation and it will help you to understand how a real engine works.

An engine crankshaft is described as such because it is a 'cranked' shaft - the shaft has offset sections, to which the six piston/connecting rod assemblies are connected. In the model, as the crankshaft turns (driven by the electric motor), the cranked sections move around the centreline of the crankshaft, and convert the rotation to the reciprocating (up and down) movement of the pistons. In a real engine, it is the movement of the pistons (driven by the burning of fuel in the cylinders) that causes the crankshaft to rotate.

The engine's crankshaft drives the transmission, which includes various different components connected together whose job it is to drive the car's wheels, making the car move.

Now let's look at how the engine works in more detail. We'll look at just one cylinder of the engine. A cylinder is the hollow cylinder inside the engine in which one piston moves up and down. The piston has seals, called piston rings, around its edge, which aren't shown on our model and these seals stop gases passing round the sides of the piston. Our model has six cylinders.

When you turn the engine to start the car, the starter (a powerful electric motor, powered by the car's battery) turns the crankshaft, moving the pistons up and down.

As a piston moves down from its highest position inside the cylinder (called 'Top Dead Centre' or 'TDC'), a mixture of fuel and air is sucked into the space inside the cylinder above the piston. This is called the intake stroke.

The starter continues to turn the crankshaft and, as the piston moves back up towards the top of its cylinder, the fuel/air mixture is compressed (squashed) in the space above the piston. This is called the compression stroke.

As the piston reaches its highest point, a spark plug creates a spark above the piston and this spark ignites the fuel/air mixture, causing a small controlled explosion above the piston. The explosion pushes the piston downwards and this is called the power stroke.

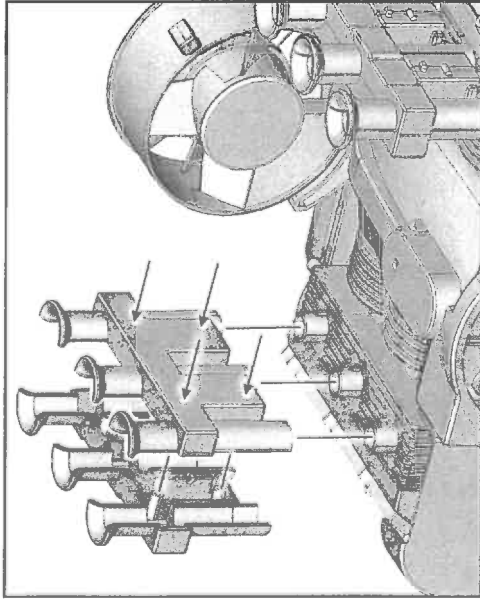
Once the piston has reached its lowest point, it starts to move back up its cylinder, pushing the burnt gases out through the top of the cylinder. This is called the exhaust stroke.

So, the engine has four strokes: intake, compression, power and exhaust, or 'suck', 'squeeze', 'bang' and 'blow' to make it simpler. These four strokes make up the 4-stroke cycle.

# ASSEMBLING THE ENGINE

## Step 40. Carburettors

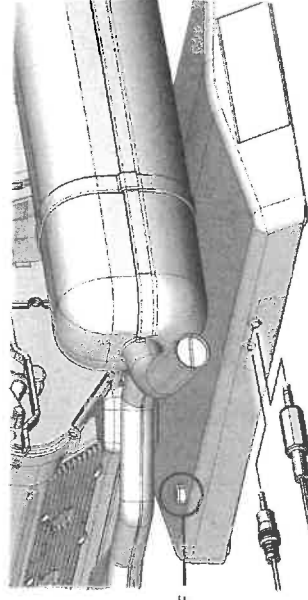
Each set of carburettors is in two halves (15 & 16). Fit each pair together and secure with four screws. Place each in position over the three inlet pipes on the top of the cylinder heads.



## Step 41. Operation

Insert the two electrical plugs into the base - they are two different sizes, and will only fit one way.

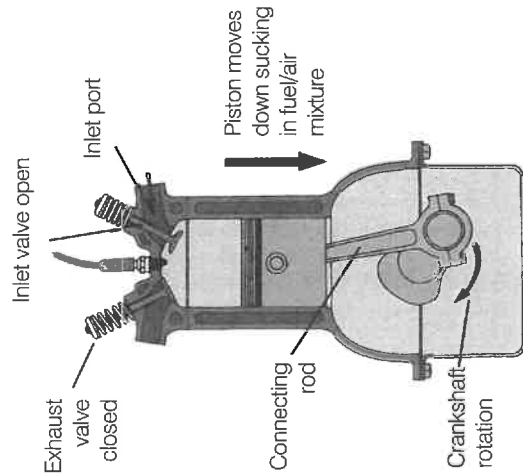
Press the on/off button on the base to begin operating the engine. It will continue to run for 30 seconds and then stop automatically. Press the on/off button while the engine is running to stop it before the end of the 30 second cycle. Pressing the button again will start another 30 second cycle.



## HOW AN ENGINE WORKS

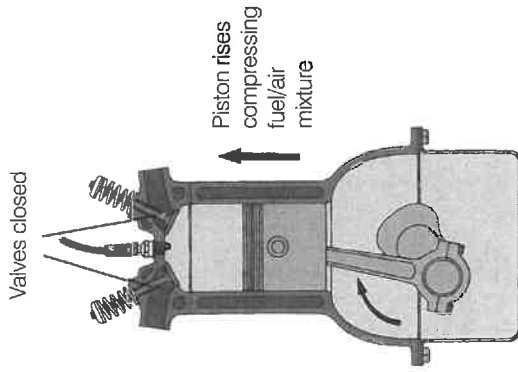
The fuel/air mixture flows into the space above the piston, called the combustion chamber. The mixture flows in through a small hole which is opened and closed by the inlet valve. The burnt gas flows out of the cylinder through another hole which is opened and closed by the exhaust valve. The valves are normally held closed by springs, but as the engine turns the valves are pushed open in the correct order by the rocker arms, which are moved by the camshaft. The rocker arm pushes the valve down against its spring and, as the rocker moves up, the spring pushes the valve closed.

### 4-stroke cycle



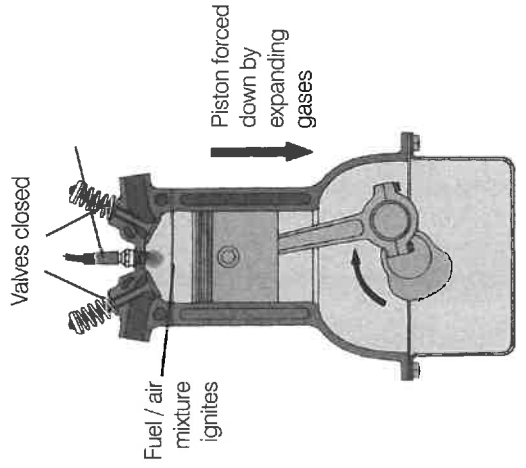
#### The 1st stroke (Intake)

The piston starts off at the top of the cylinder. The exhaust valve is closed and the inlet valve is open. As the crankshaft turns and the piston moves down inside the cylinder, fuel/air mixture is sucked in through the inlet valve. When the piston reaches its lowest point inside the cylinder, the cylinder is filled with fuel/air mixture and the inlet valve closes. This is the end of the intake stroke.



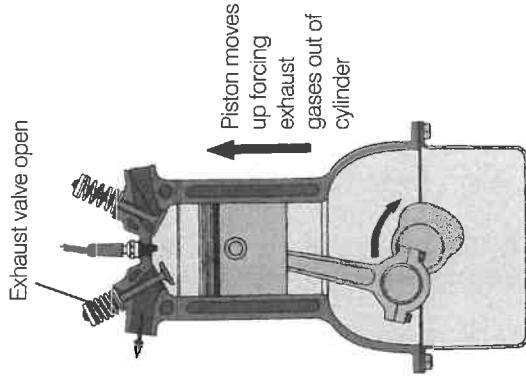
#### The 2nd stroke (Compression)

At the start of the compression stroke, the piston is at its lowest point inside the cylinder and the inlet and exhaust valves are closed. The crankshaft continues turning and the piston moves upwards. As the piston moves upwards it squeezes (compresses) the fuel/air mixture and this increases the temperature of the mixture very quickly. When the piston reaches its highest point the mixture is fully compressed and this is the end of the compression stroke.



#### The 3rd stroke (Power)

The very high pressure and temperature inside the combustion chamber cause the fuel/air mixture to break up into very fine particles, like a mist. These are perfect conditions for burning a gas. All that's needed to start the burning (or 'combustion' - a kind of controlled explosion) is a spark. A very high electrical voltage supplied to the spark plug causes a spark to jump across the gap at the end of the spark plug. This ignites the fuel/air mixture and starts the combustion. The force of the controlled explosion and the expanding gases forces the piston downwards, which pushes the crankshaft round. During the power stroke, three things happen to the fuel/air mixture - it ignites, combusts (burns) and expands. The expansion of the gas pushes the piston down, which transfers power to the crankshaft. When the piston reaches its lowest point inside the cylinder this is the end of the power stroke.



#### The 4th stroke (Exhaust)

As the piston starts to move up inside the cylinder again, the exhaust valve opens to allow the burnt (exhaust) gas to escape from the cylinder and as the piston moves up the cylinder it pushes the gas out through the exhaust valve. As the piston reaches the top of the cylinder the exhaust valve closes, the exhaust stroke ends and the 4-stroke cycle begins again with another intake stroke.

## HOW AN ENGINE WORKS