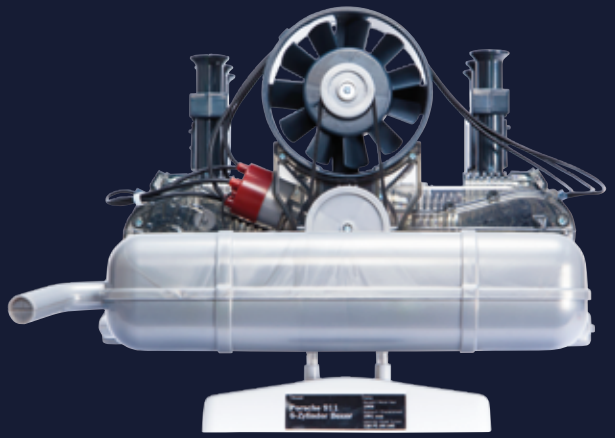
PORSCHE 911



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PORSCHE 911

Flat-Six Boxer engine

Build your own working, classic Porsche 911 flat-six engine model!

FRANZIS

Designed by John Anson for:
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Germany

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Item number:
PE01

CE
Made in China.

FRANZIS

Instruction MANUAL

For Ages 10+

PE01 Porsche Flat-Six Boxer Engine

Printed in China

Please retain the information in this manual for future reference.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference
(2) this device must accept any interference received, including interference that may cause undesired operation.

Caution: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

PORSCHE 911

Flat-Six Boxer Engine

Build your own working, classic Porsche 911 flat-six engine model!

Contents

FRANZIS

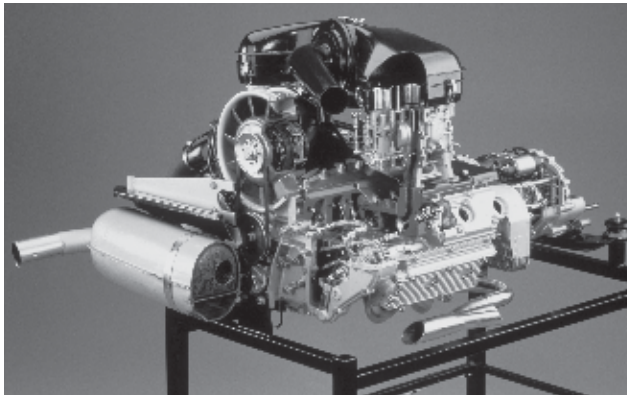
INTRODUCTION

The car that was to become the Porsche 911 was first unveiled at the 1963 Frankfurt motor show, intended as a larger, more comfortable, successor to the legendary 356. As well as a new chassis and suspension, a completely new, six cylinder, overhead cam boxer engine was designed (called the Type 901), to replace the four cylinder, overhead valve unit used in the 356. Design of the new engine was led by Hans Mezger, a German automotive engine who became a key part of Porsche's development programme for 35 years.

The primary reason for using the new 6-cylinder engine was to utilise the inherent smoothness offered by the boxer configuration. Because it consisted of three pairs of pistons moving backwards and forwards in opposite directions, with each pair spaced at 120 degrees of crankshaft rotation, the design minimised first and second order vibrations (vibrations that occur once and twice per engine revolution). In addition, the short length of the engine, low centre of gravity, and effectiveness of air cooling made it ideal for the rear-engine 911.

To meet the high bending stresses at very high revolutions, the forged crankshaft was supported with eight main bearings. The crankcase was split vertically, and like all of the major components, was made from aluminium (even the cooling fins of the cylinders were aluminium, with cast iron sleeves inside them). Each row of three cylinders had an overhead camshaft, these being driven by a duplex chain running around intermediate gears on a layshaft (itself gear driven from the crankshaft). Accurate valve timing and smooth operation were achieved by using a hydraulic cam chain tensioning wheel and rubber guide ramps. The valves were arranged in a V-shape, which allowed the use of a hemispherical combustion chamber with a small, smooth and heat-absorbing surface. Initial versions of the engine used Solex overflow-type carburettors, and although these had the benefit of being relatively insensitive to forces caused by hard cornering, problems with these, including a flat spot at low engine speeds, led to them being changed for Weber carburettors in 1966.

An 11 bladed axial fan, with the alternator inside it, was mounted on top of the engine to improve cooling by helping to ensure the air was more evenly distributed to both sets of cylinders.



An early Porsche 911 engine, with cut-away sections to show the internal components. The engine shown is part of the Porsche museum collection in Stuttgart.

In its original form (Type 901/01), the engine had a capacity of 1,991 cubic centimetres, with a cylinder bore of 80 mm and a stroke of 66 mm. Power output was 130 hp (96 kW) at 6,100 rpm. Subsequent developments led to the 901/02, 901/03 and other versions, each having different specifications depending on the intended use (sports, touring etc). The Carrera six engine (Type 906) was developed simultaneously to the Type 901, the main differences being the use of twin spark plugs per cylinder, higher-compression pistons, and the use of lighter weight (magnesium and titanium) components. A major change came in 1970, with the capacity of the engine being increased to 2,200 cubic centimetres (2.2 litres) by increasing the bore to 84 mm. The original engine configuration was still being used until 1972, when it was superseded by the even larger 2,341 cubic centimetre engine.

The model in this kit is intended as representation of the Type 901 engine used in the early 911. Although it lacks the fine details of the real engine, it includes a realistic crankshaft, a working cooling fan, and accurate valve and ignition timing. Even the distributor works correctly, being driven from the crankshaft using bevel gears, with its red colour closely matched to the real thing.

NOTES AND ADVICE

References to the ***left*** or ***right*** side of the engine mean the left or right side when viewed from the ***fan end***. Cylinders 1-3 are on the left side of the engine and cylinders 4-6 are on the right.

Identify the various parts by looking at the list of components and the corresponding illustrations. Use a sharp knife to trim any excess plastic from the components after they have been removed from their carrier frames.

Take care not to over-tighten the screws as this may permanently damage the plastic.

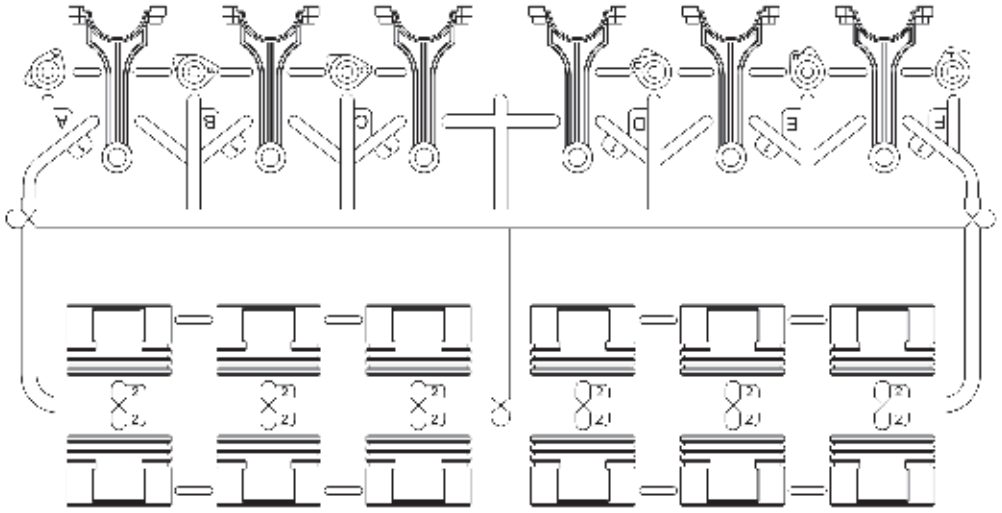
- Non-rechargeable batteries are not to be recharged.
- Rechargeable batteries are only to be charged under adult supervision.
- Rechargeable batteries are to be removed from the toy before being charged.
- Do not mix old and new batteries.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Batteries are to be inserted with the correct polarity.
- Exhausted batteries are to be removed from the toy.
- The supply terminals are not to be shorted-circuited.

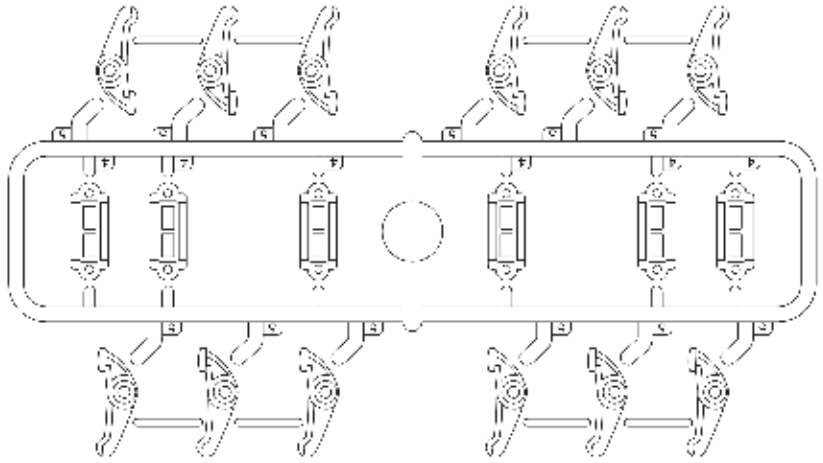
PARTS LIST

No.	Description	Qty
1	Connecting rod	6
2	Piston half	12
	Cams (labelled A – F)	6
4	Bearing cap	6
5	Rocker arm	6
6	Timing tool	1
7	Valve stem	6
9	Valves	12
10	Crankshaft sprocket A	1
11	Crankshaft sprocket B	1
12	Camshaft sprocket	2
13	Gudgeon (piston) pin	6
15	Carburettor outer	2
16	Carburettor inner	2
19	Exhaust muffler upper	1
20	Exhaust muffler lower	1
21	Exhaust pipe left upper	1
22	Exhaust pipe left lower	1
23	Exhaust pipe right upper	1
24	Exhaust pipe right lower	1
25	Crankshaft pulley	1
26	Fan pulley	1
27	Oil return pipes	4
28	Exhaust manifold left upper	1
29	Exhaust manifold left lower	1
30	Exhaust manifold right upper	1
31	Exhaust manifold right lower	1
32	Oil cooler outer	1
33	Oil cooler inner	1
34	Fan housing	1
37	Idler pulley	2
41	Crankshaft	1
42	Cooling fan	1

No.	Description	Qty
47	Crankcase upper	1
48	Crankcase lower	1
49	Cylinder barrels	2
50	Cylinder head left	1
51	Cylinder head right	1
52	Upper cylinder head left	1
53	Upper cylinder head right	1
54	Large cylinder head plate	2
55	Small cylinder head plate	2
56	Crankcase rear	1
57	Cylinder head plate upper	2
58	Cylinder head plate lower	2
59	Cam belt tunnel left inner	1
60	Cam belt tunnel right inner	1
61	Cam belt tunnel left outer	1
62	Cam belt tunnel right outer	1
63	Cam belt tunnel middle	1
67	Drive gear	1
68	Crankshaft gear	1
69	Distributor gear	1
	Cam timing belt	2
72	Spark plug lead mounting clip	1
74	Distributor bushing	1
75	Crankshaft gear B	1
76	Crankshaft gear C	1
77	Timing alignment pin	2
78	Fan housing rear cover	1
	Valve spring	12
	Cam shaft (140 mm)	2
	Rocker shaft (118 mm)	4
	Metal shaft (37 mm)	1
	Head gasket	2
	Base	1
	Distributor/spark plug assembly	1
	Label	1

PARTS LIST





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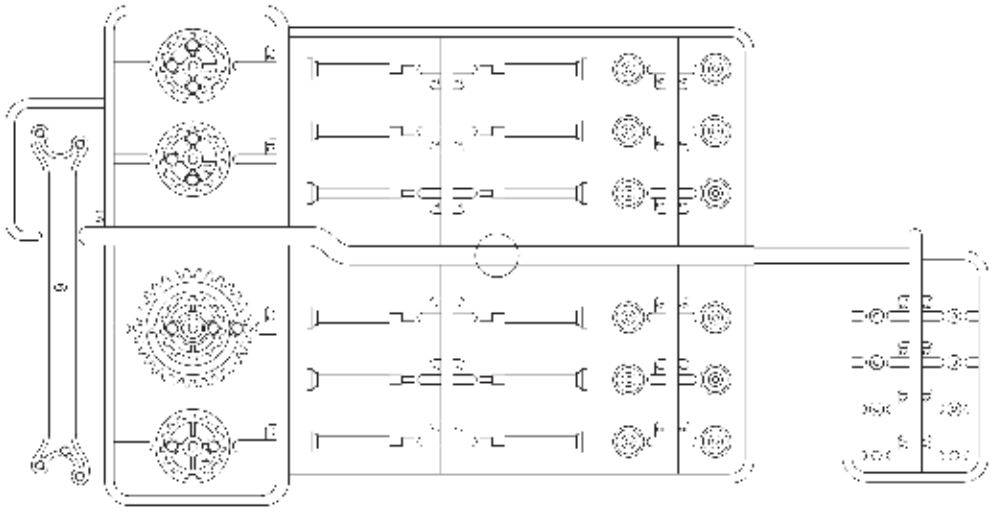

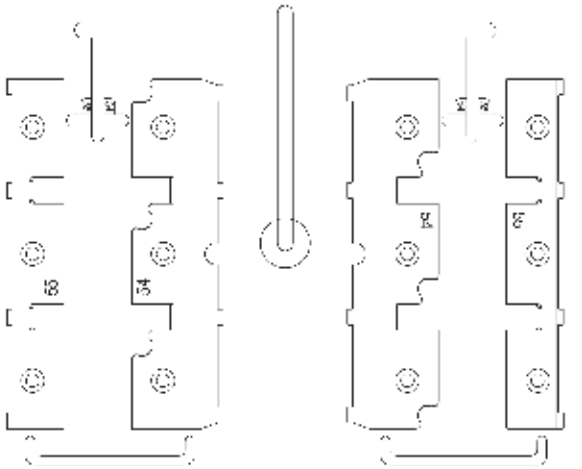

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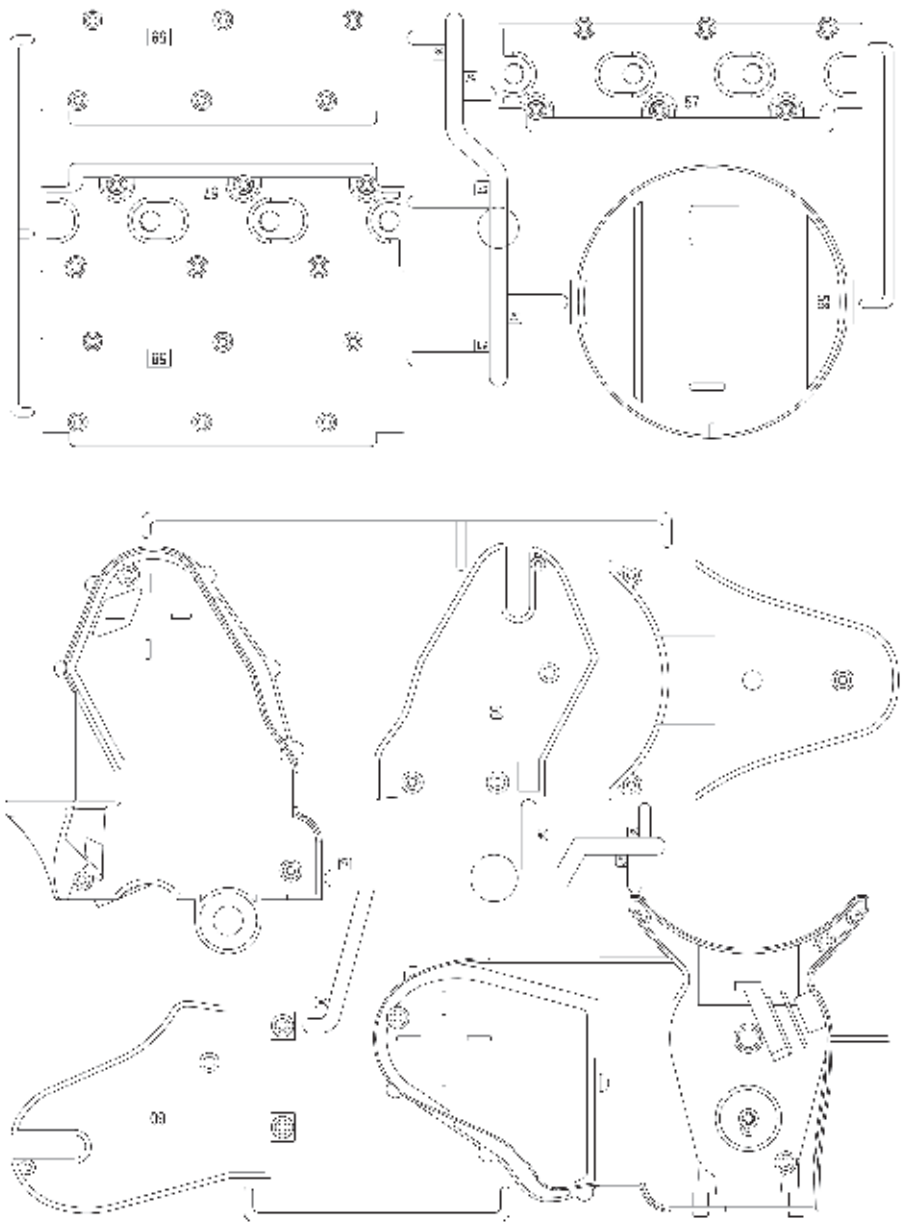

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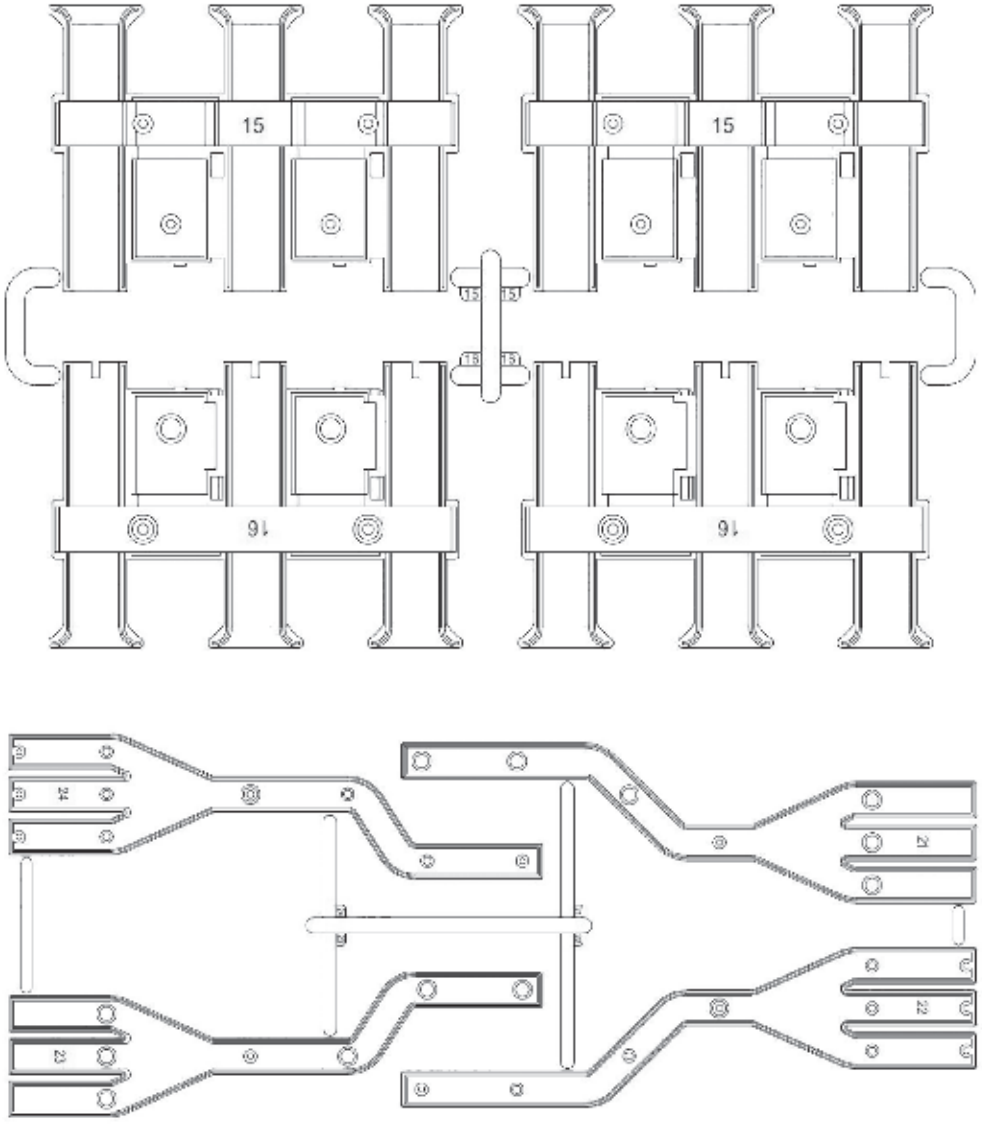
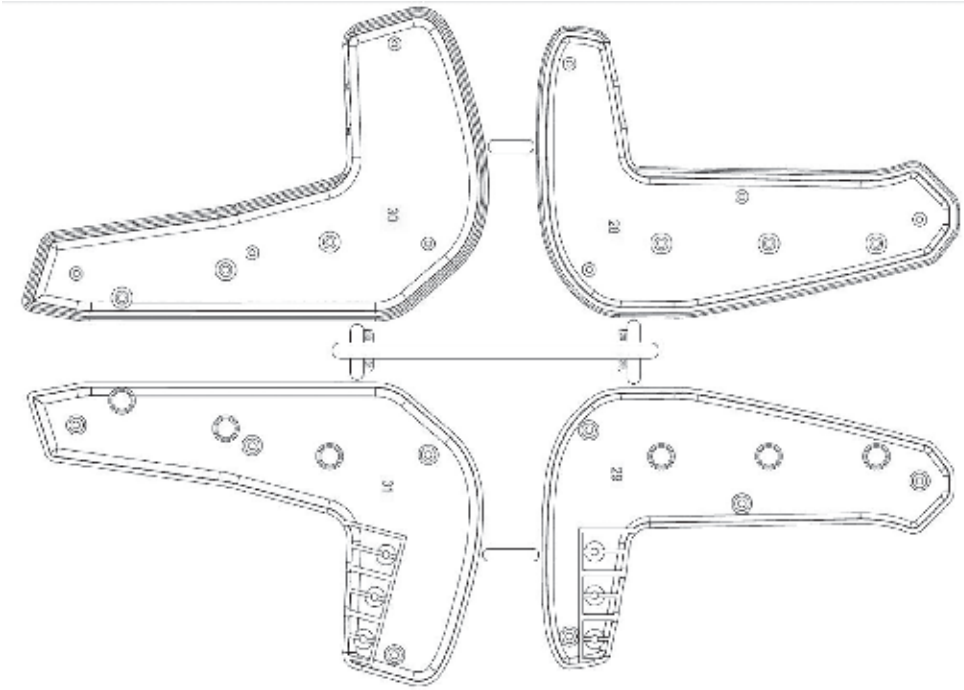
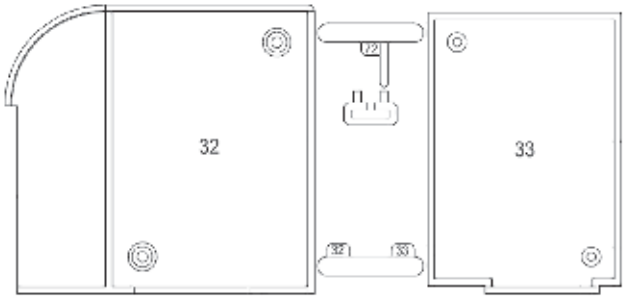






19 Muffler upper

20 Muffler lower

25 Crankshaft pulley

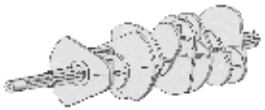
26 Fan pulley

27 Oil return pipes

34 Fan housing

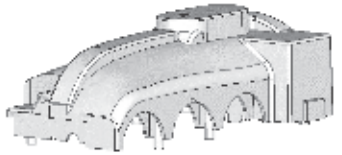
37 Idler pulley

37 mm shaft

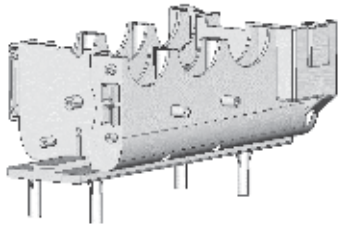


41 Crankshaft

42 Cooling fan



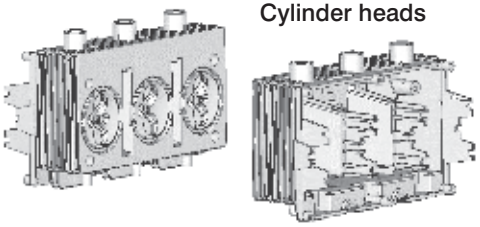
47 Crankcase upper



48 Crankcase lower

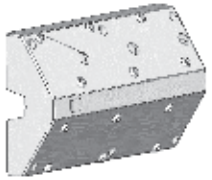
49 Cylinder barrels

50 & 51 Cylinder heads



PARTS LIST

52 & 53 Upper cylinder head



67 Drive gear

68 Crankshaft gear

69 Distributor gear

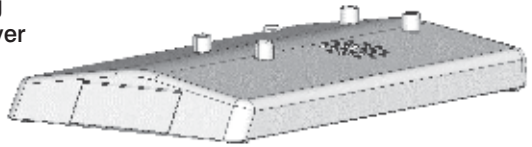
Distributor bush

75 Crankshaft gear B

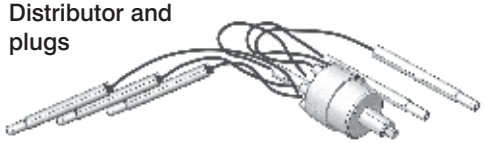
76 Crankshaft gear C

78 Fan housing rear cover

Base



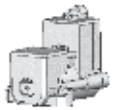
Distributor and plugs



Fan belt

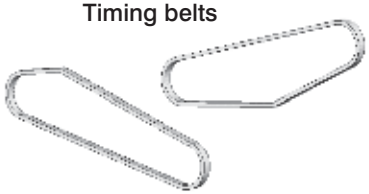
Head gasket

Motor assembly



Rocker and cam shafts

Timing belts



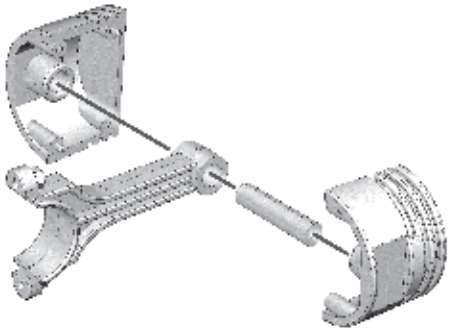
Valve spring

ASSEMBLING THE ENGINE

Step 1. Pistons

Push a gudgeon (piston) pin (13) through the small end of a connecting rod (1). Push two halves of a piston (2) together over the pin and press together firmly.

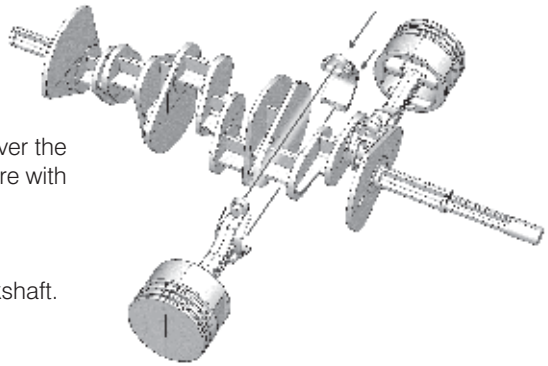
Repeat for the other five piston/rod assemblies.



Step 2. Crankshaft

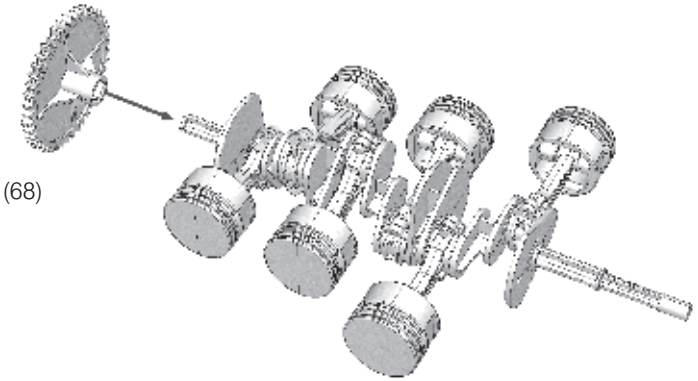
The six connecting rods attach to the crankshaft (41) in the positions shown. In each case, place the connecting rod over the crankshaft, fit a bearing cap (4) and secure with two screws.

Check that the piston/connecting rod assemblies rotate freely around the crankshaft.



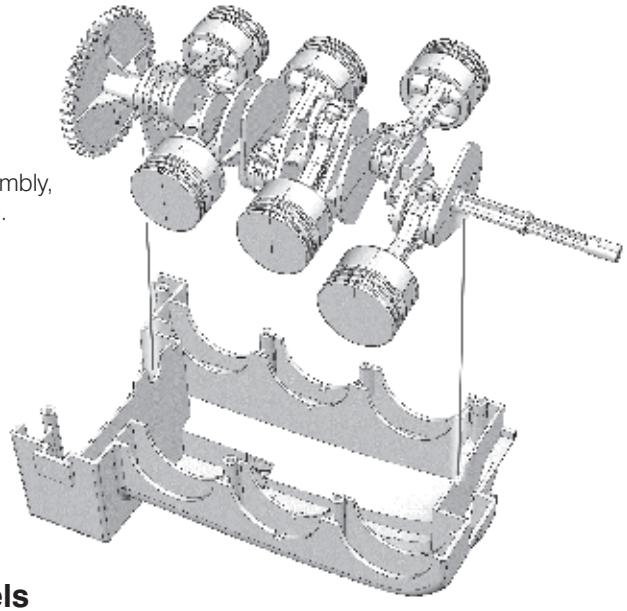
Step 3. Crankshaft drive gear

Fit the crankshaft drive gear (68) to the end of the crankshaft.



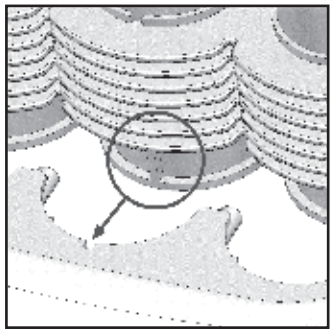
Step 4. Crankshaft assembly

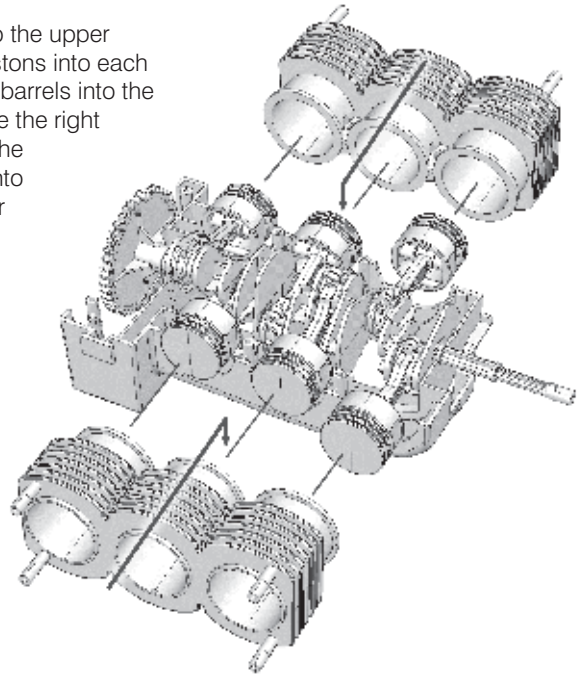
Place the upper crankcase (47) upside down on a table. Hold the piston/crankshaft assembly, and lower it on to the crankcase.



Step 5. Cylinder barrels

Attach the cylinder barrels (49) to the upper crankcase. Carefully slide the pistons into each set of barrels and then lower the barrels into the crankcase. Ensure the barrels are the right way up - note that the barrel for the middle piston has a rib that fits into a corresponding slot in the upper crankcase.

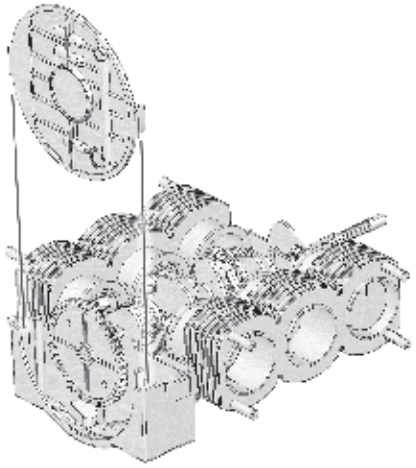


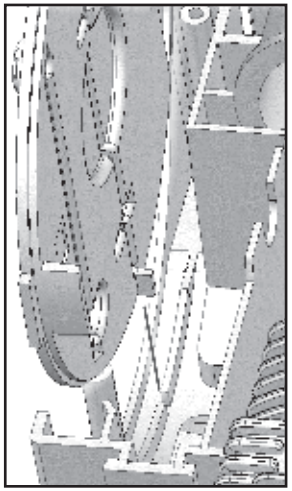


ASSEMBLING THE ENGINE

Step 6. Crankcase rear

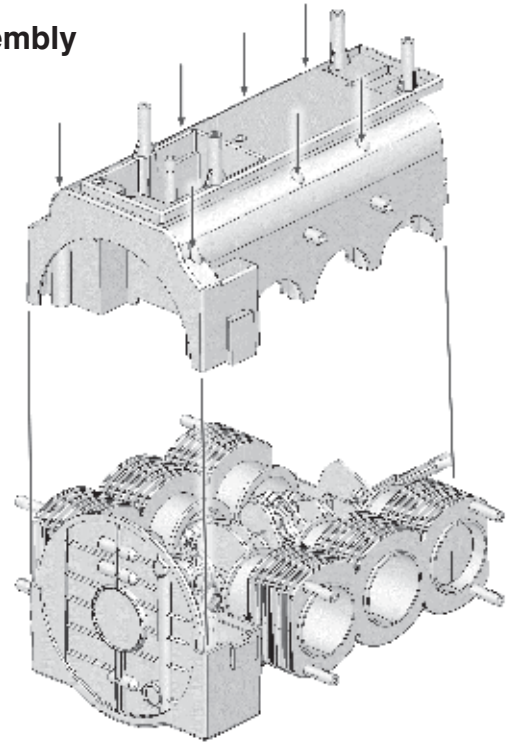
Slide the crankcase rear (56) in to the upper crankcase. There is a rib in the plate that fits into a corresponding slot in the upper crankcase - refer to the inset image (the crankshaft and drive gear have been removed for clarity).



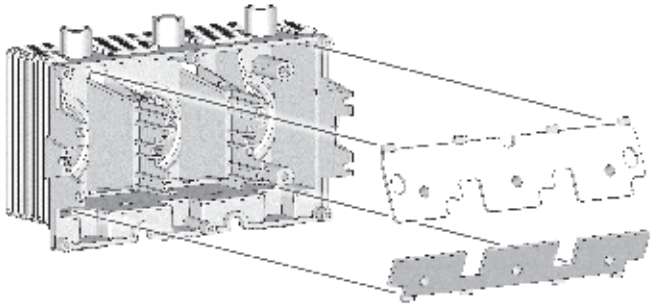


Step 7. Crankcase assembly

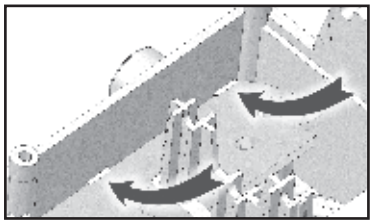
Fit the lower crankcase (48) to the upper crankcase and secure with seven screws.



Step 8. Valve guides

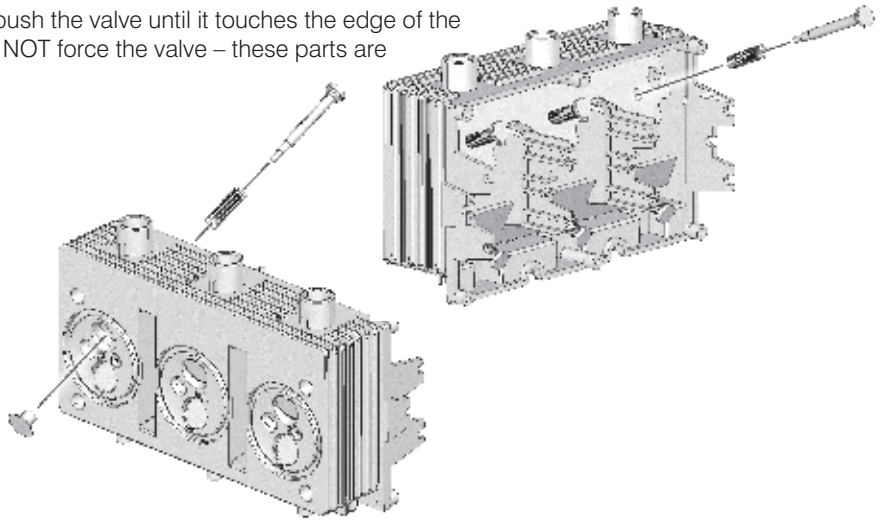


Fit two valve guide plates to each of the lower cylinder heads. Note that each head uses one narrow plate (55) and one wide plate (54). Each plate has three round studs that face downwards into the head. First fit the tabs on the outside of each plate into the corresponding holes in the side of the head, then push the plates down firmly so they clip into position (circled).



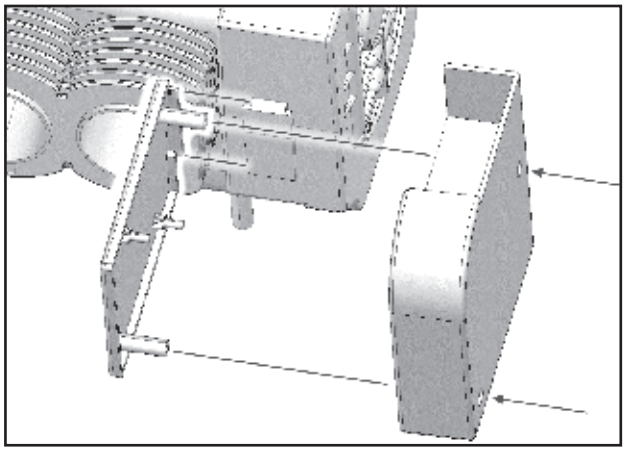
Step 9. Valve assembly

For each cylinder head, you will need six valves (9), valve stems (7) and valve springs. Fit to the head as shown. First slide a spring over a valve stem, and insert into one of the six holes in the valve guide plates. Gently compress the spring until the end of the stem sticks out of the bottom of the head. Carefully push the valve on to the stem. Note that the end of the valve has a step – push the valve until it touches the edge of the step. DO NOT force the valve – these parts are delicate.



Step 10. Oil cooler

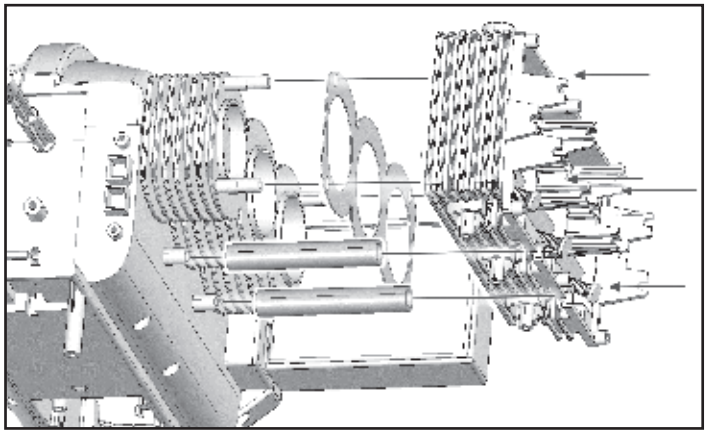
The oil cooler must be fitted at this time. This is in two parts (32 & 33), and should be assembled so that the parts clamp to the T-shaped moulding on the side of the crankcase. Hold the smaller inner part (33) in place, then fit the larger outer part of the cooler (32) to this and secure with two screws.



Step 11. Cylinder head – right side

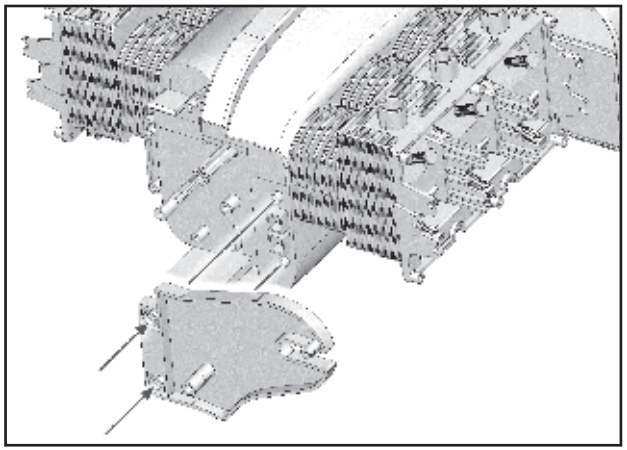
Place a paper cylinder head gasket over the right hand cylinder barrels. Fit two oil return pipes (27) to the moulded lugs on the side of the crankcase, then fit the right cylinder head (51) and secure with four screws.

Repeat for the other (left) side of the engine, using the other gasket, two oil return pipes, and the left cylinder head (50).



Step 12. Camshaft tunnel – right rear

Attach the rear part of the right hand camshaft tunnel (60) to the crankcase and secure with two screws.

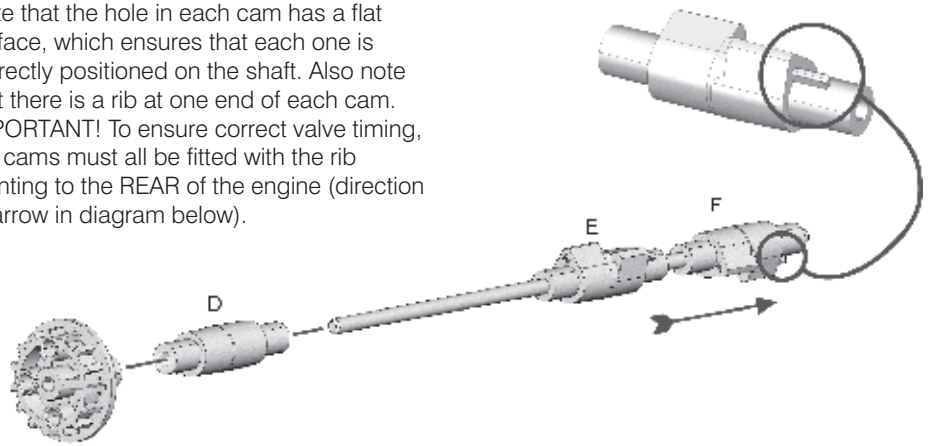


Step 13. Cam and rocker shafts – right side

Assemble the camshaft for the right side of the engine. Slide cams D, E, and F on to a camshaft, IN THIS ORDER.

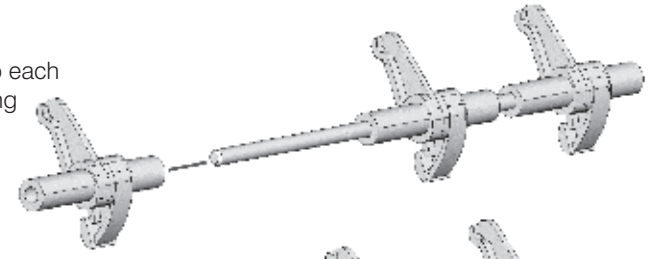
Note that the hole in each cam has a flat surface, which ensures that each one is correctly positioned on the shaft. Also note that there is a rib at one end of each cam. IMPORTANT! To ensure correct valve timing, the cams must all be fitted with the rib pointing to the REAR of the engine (direction of arrow in diagram below).

Fit the sprocket to the end of the camshaft – the hole in this also has a flat surface to ensure it is correctly positioned.

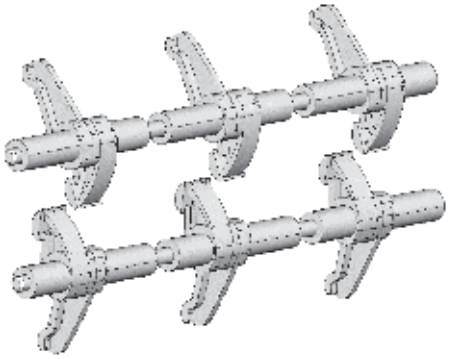


Step 13. continued

Slide three rocker arms (5) on to each of the two rocker shafts, checking that they move freely.

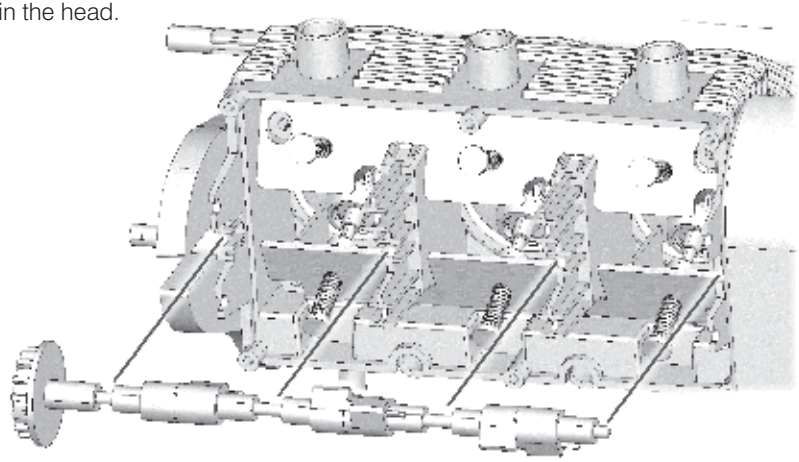


Note the relative position of the inlet (top) and exhaust rockers (bottom).

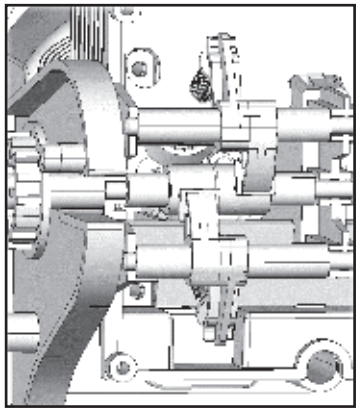


Step 14. Camshaft assembly – right side

Place the camshaft assembly in position on the cylinder head. This is easiest if the engine is held on its side between your legs, with the cylinder head horizontal. Ensure that the cams are separated so that each sits between the bearing surfaces in the head.

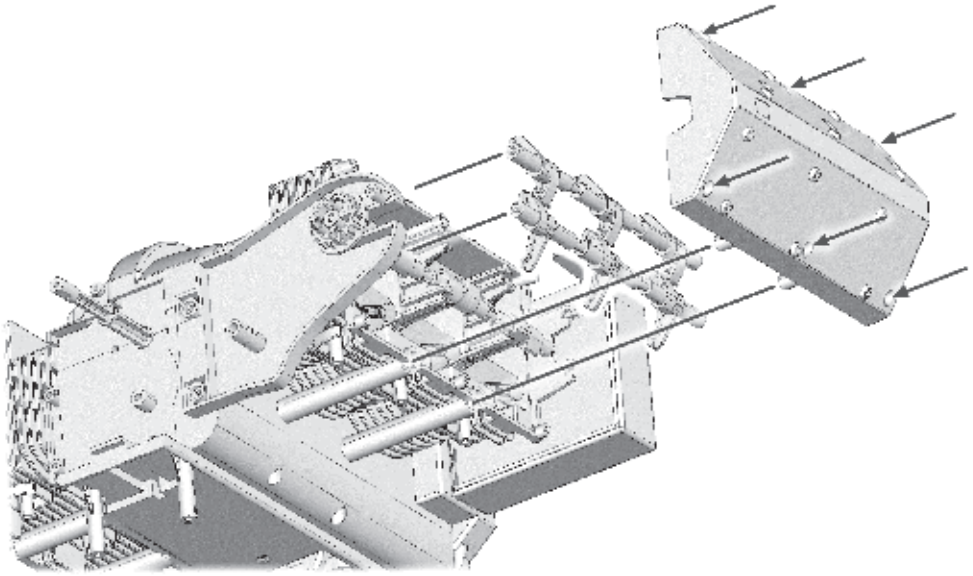


Step 15. Rocker shaft assembly – right side



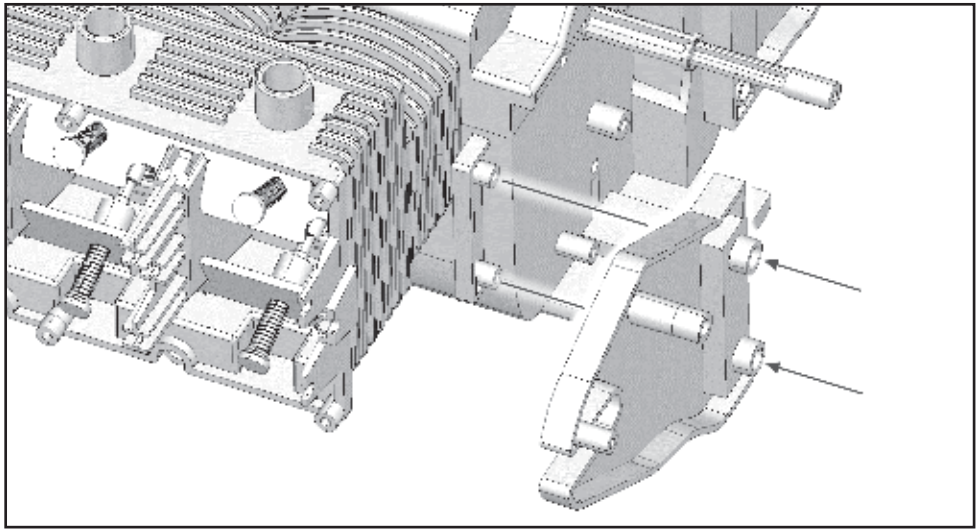
Place the rocker shaft assemblies for the inlet and exhaust valves on to the cylinder head (refer to the inset picture for guidance). Use your fingers to separate the rockers so that each sits between the bearings that hold the shaft. The ends of each rocker shaft should be level with the end of the cylinder head.

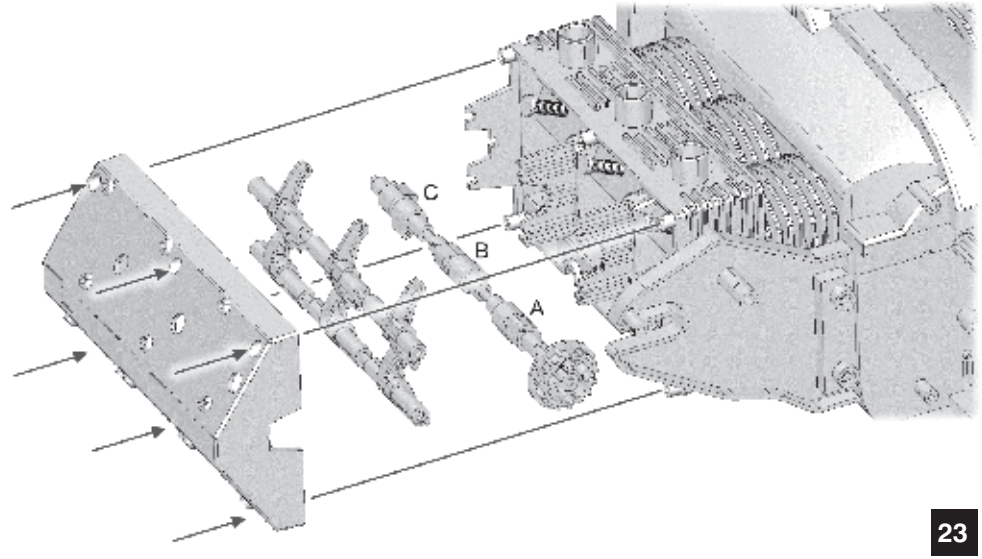
Place the cylinder head cover (53) in position. Note the correct orientation - the two tubes moulded into the bottom edge should be inserted into the ends of the oil return pipes. Secure with six screws.



Step 16. Cylinder head – left side

Repeat steps 11 to 14 for the left hand side of the engine. Note the position of cams A, B and C, making sure the ribs on each point towards the rear of the engine.

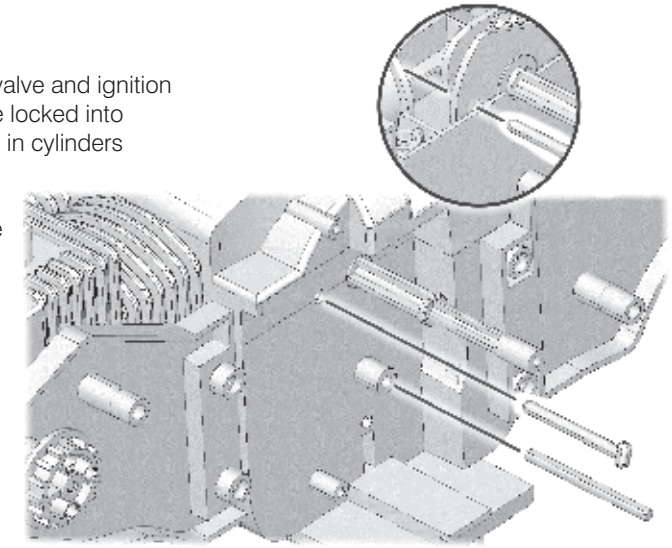




Step 17. Timing pin

In order to accurately set the valve and ignition timing, the crankshaft must be locked into position. Note that the pistons in cylinders 1 and 4 must be at Top Dead Centre (TDC). Insert a timing alignment pin (77) through the holes in the crankcase and crankshaft counterweight.

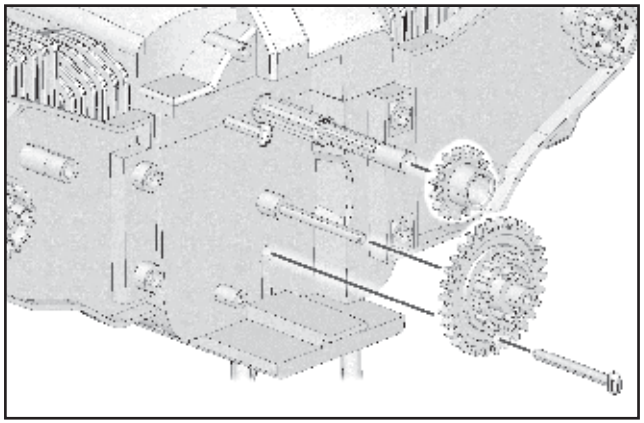
Insert the metal shaft for the cam chain sprocket into the crankcase.



Step 18. Crankshaft sprocket

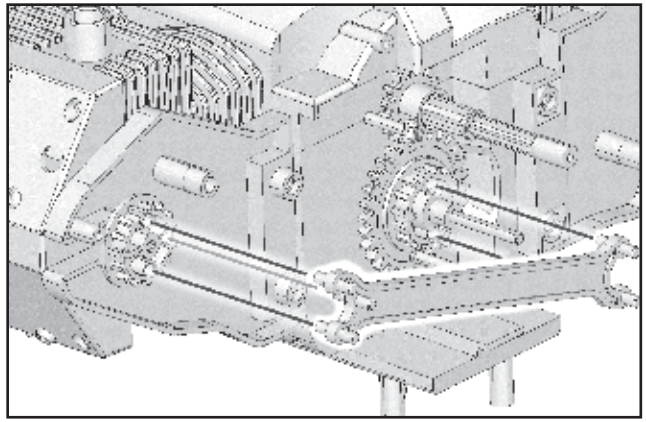
Slide the crankshaft gear B (75) on to the end of the crankshaft. Note that there is a slot in the inside surface of the sprocket that engages with a rib on the crankshaft.

Fit the crankshaft sprocket A (10) to the metal shaft. Note that the shaft has a flat surface on one side that matches a flat surface on the inside of the sprocket. IMPORTANT! There is a hole on one side of the sprocket through which the second timing alignment pin (77) must be inserted to fit into a hole in the crankcase. This ensures that the sprocket is correctly aligned. You may need to reposition the sprocket to allow the pin to be inserted.



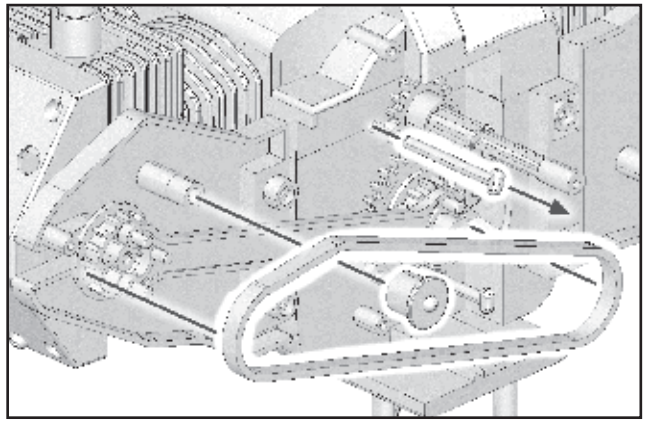
Step 19. Valve timing tool

Fit the valve timing tool (6) to the left hand side of the engine. There are two pins at one end that fit into the holes in the sprocket beneath the crankshaft, and three at the other end that fit into holes in the camshaft sprocket.



Step 20. Cam belt – left side

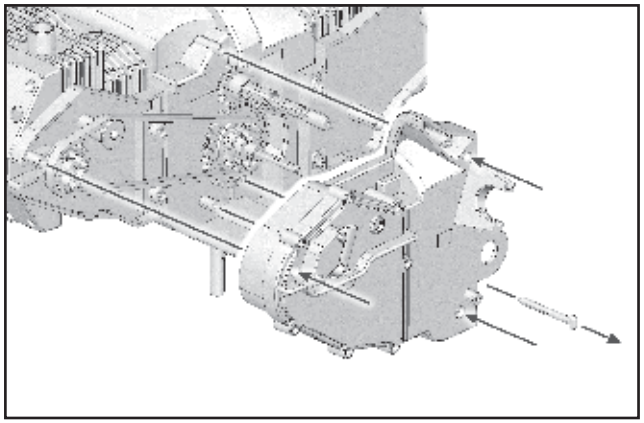
Remove the timing alignment pin as shown (but do not remove the one in the lower sprocket). Place one of the cam timing belts in position over the cam and drive sprockets. Install the idler pulley (37), making sure the cam belt goes up and over this.



Step 21. Cam belt cover – left side

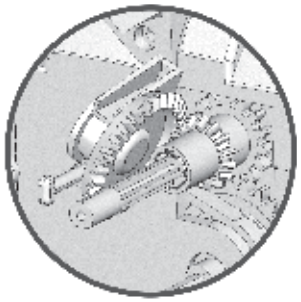
Remove the valve timing tool, and the timing alignment pin from the lower sprocket.

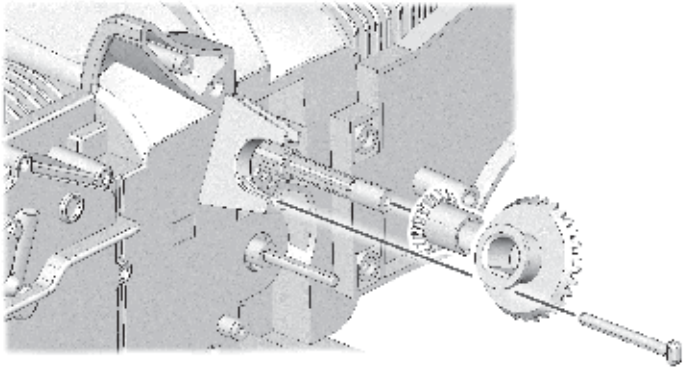
Fit the cam belt tunnel cover (61) and secure with three screws.



Step 22. Distributor drive gears

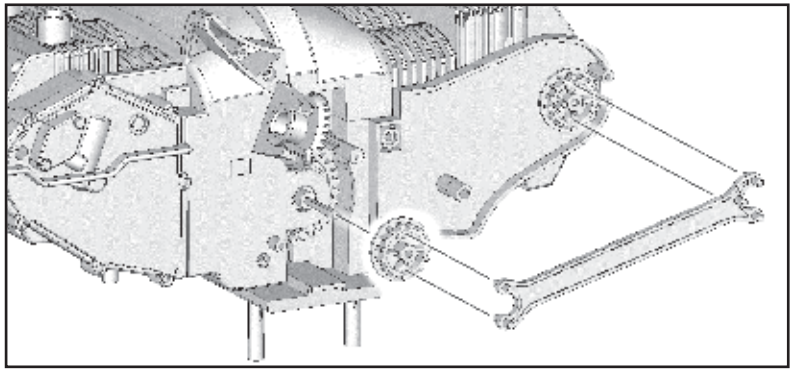
Install the distributor drive bevel gears. Fit the smaller crankshaft gear C (76) first - it has a slot that engages with the rib on the crankshaft. When fitting the larger gear (69), note the round groove in one side. To achieve correct ignition timing, this gear MUST be installed with the flat section facing downwards as shown. Slide a timing pin under the gear and into the bracket in the front of the crankcase to ensure the gear is correctly positioned.





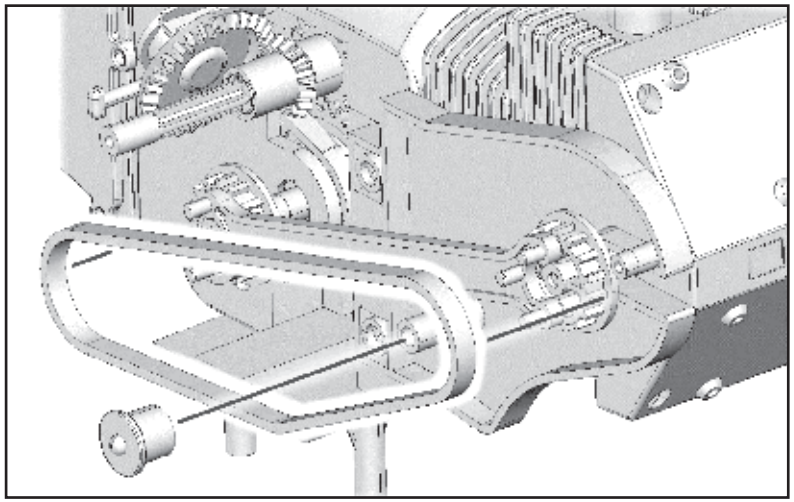
Step 23. Cam drive sprocket – right side

Fit the crankshaft sprocket B (11) to the metal pin, followed by the valve timing tool.



Step 24. Cam belt – right side

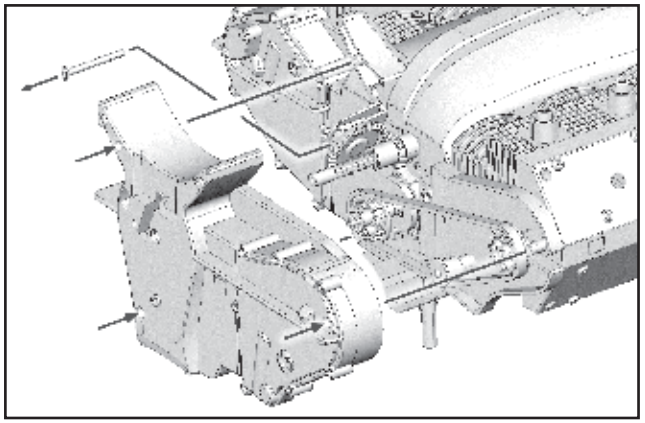
Install the second cam belt and idler pulley.



Step 25. Cam belt cover – right side

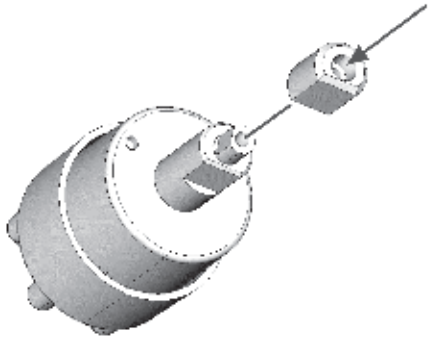
Remove the valve timing tool and the bevel gear locking pin.

Place the right hand cam belt cover in position and secure with three screws.

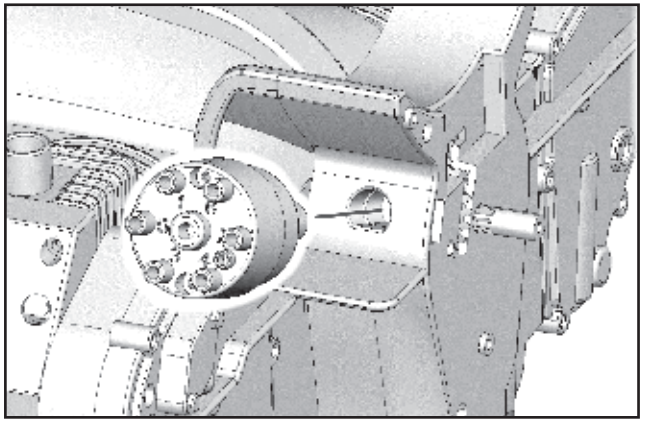


Step 26. Distributor

Fit the distributor bush (74) to the end of the shaft and secure with a screw. One end of the bush has a recess for the screw; this must face outwards, as shown.

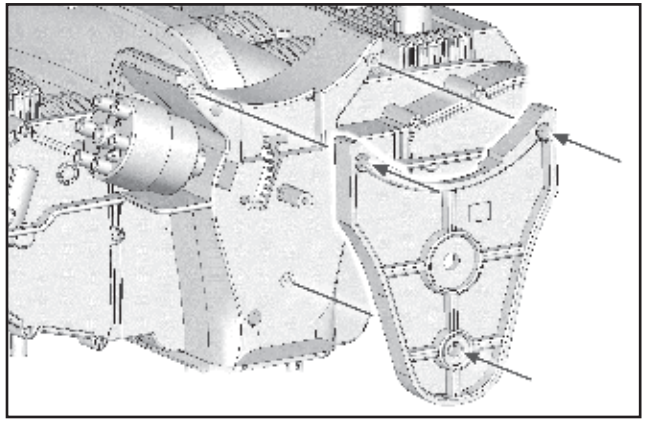


Fit the distributor – it is a friction fit in the crankcase. The flat surface on the distributor shaft and bush match the flat surfaces of the crankcase and bevel gear. The bevel drive gear for the distributor MUST be in the correct position in order for the distributor shaft to be fully inserted.



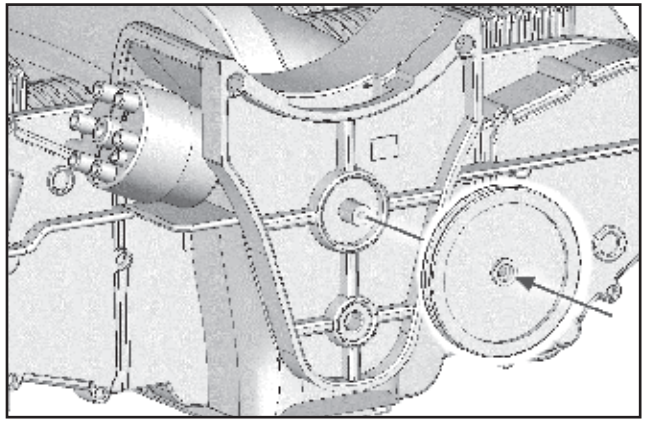
Step 27. Engine front

Attach the engine cover plate and secure with three screws.



Step 28 Crankshaft pulley wheel

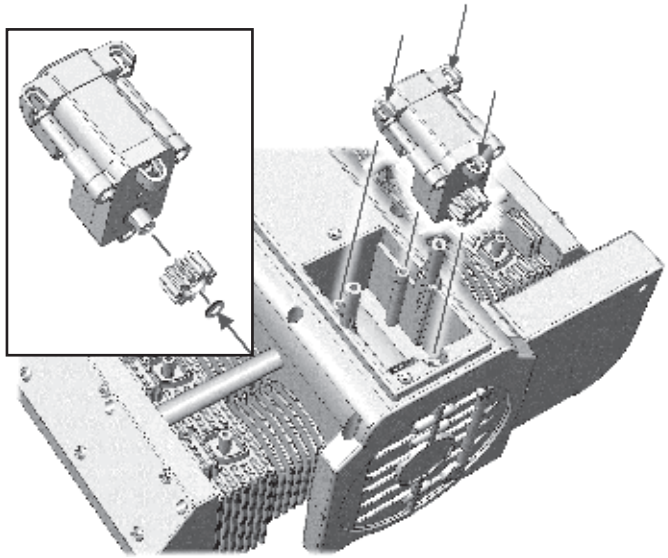
Fit the pulley to the end of the crankshaft and secure with a screw.



Step 29. Drive motor

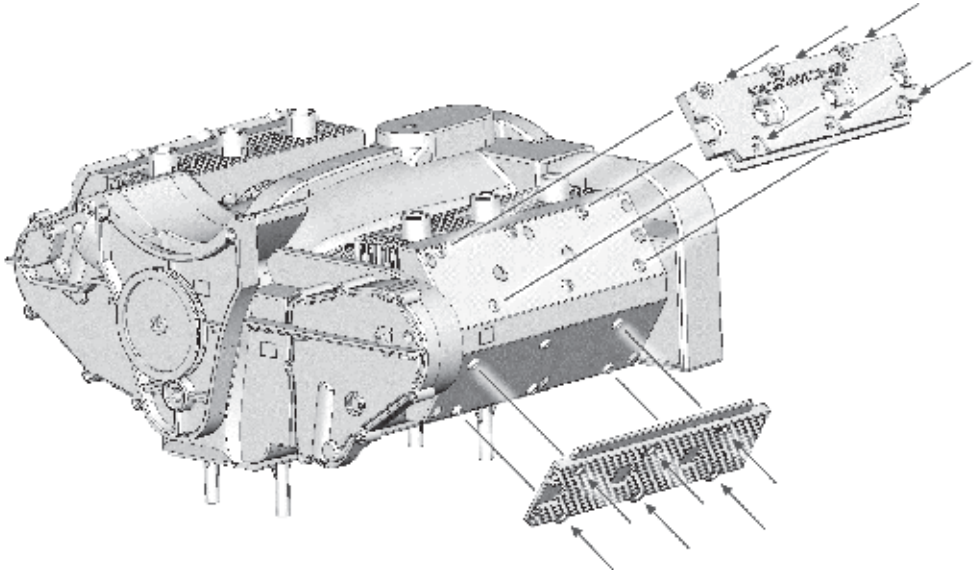
Fit the drive gear (67) to the motor shaft. One side of the gear is recessed; make sure the recess is facing outwards, and secure using one of the metal washers and a screw.

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



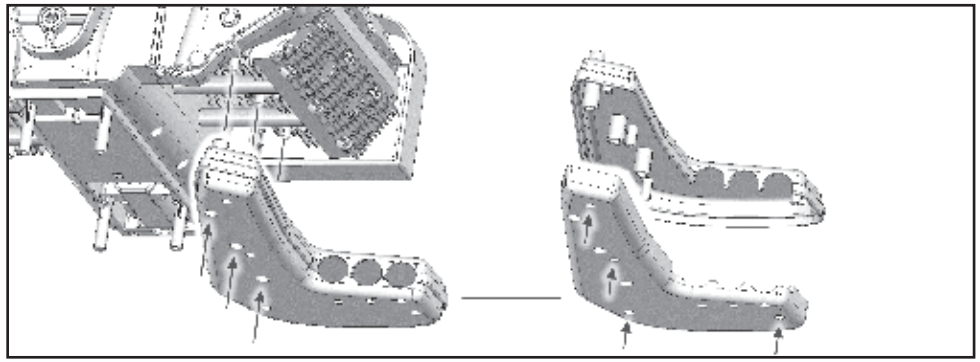
Step 30. Cylinder head covers

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



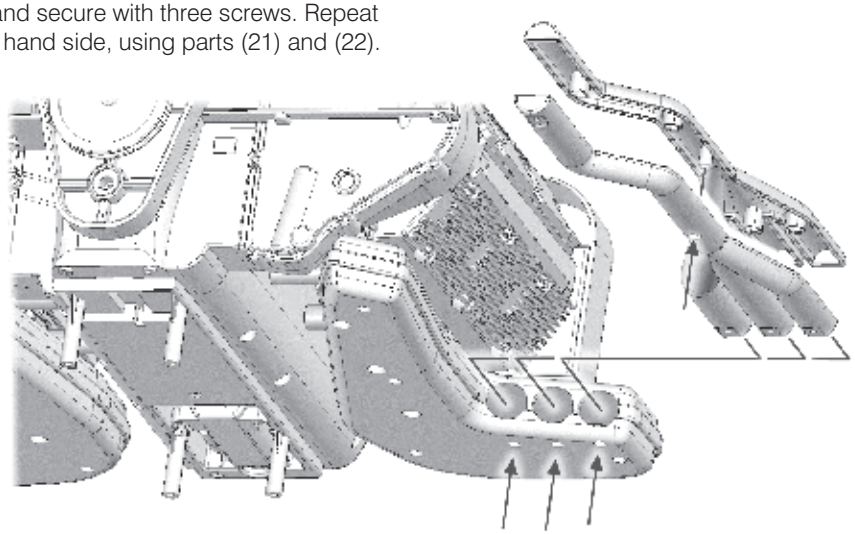
Step 31. Exhaust manifolds

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).



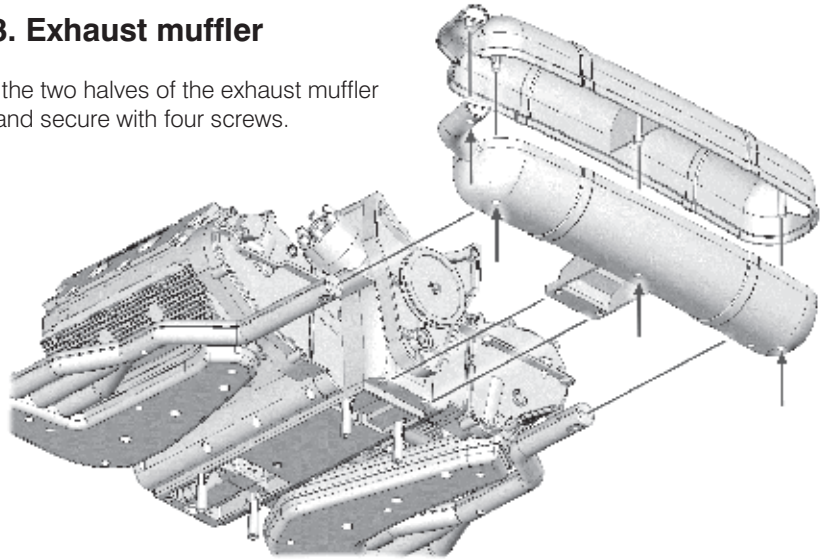
Step 32. Exhaust pipes

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).

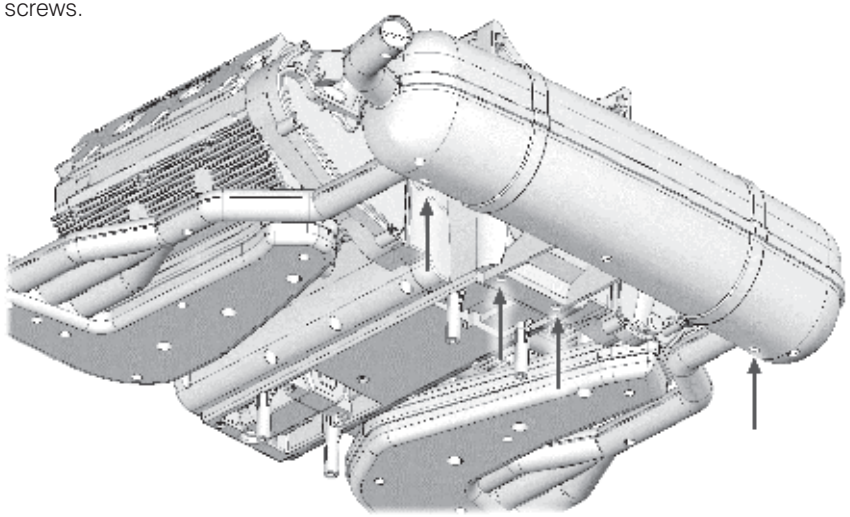


Step 33. Exhaust muffler

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

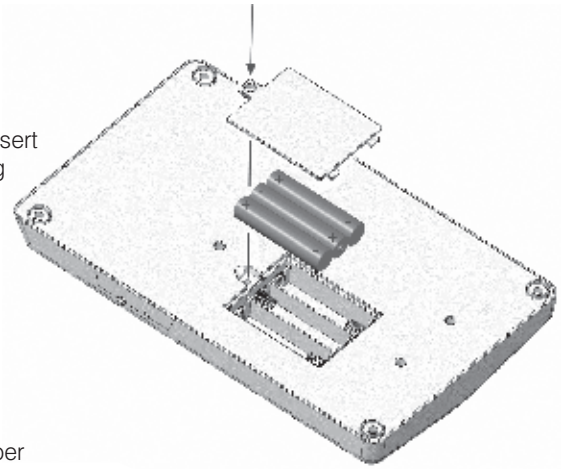


Slide the muffler over the ends of the exhaust pipes. The muffler is secured to each exhaust pipe with a single screw, and to the crankcase with two screws.



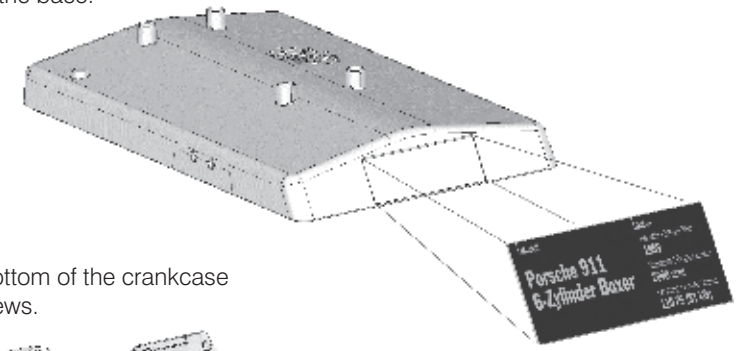
Step 34. Base - battery installation

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.



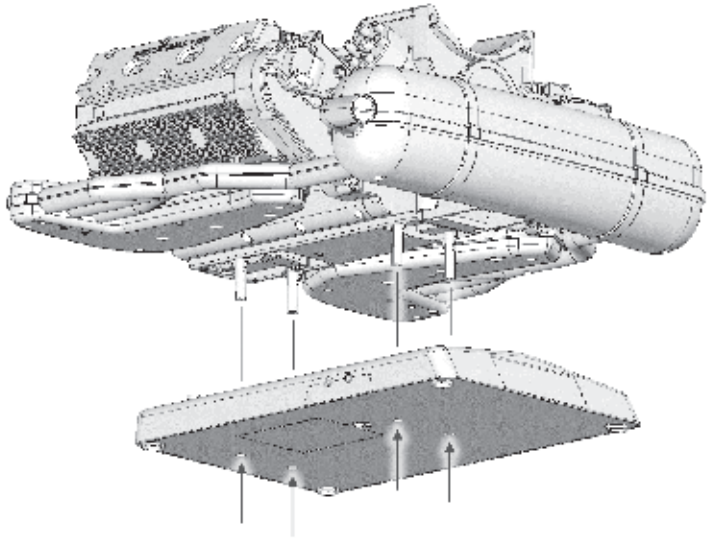
Step 35. Base label

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



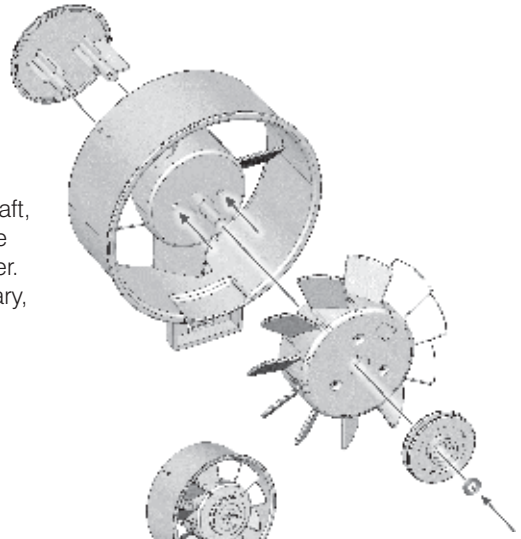
Step 36. Base

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



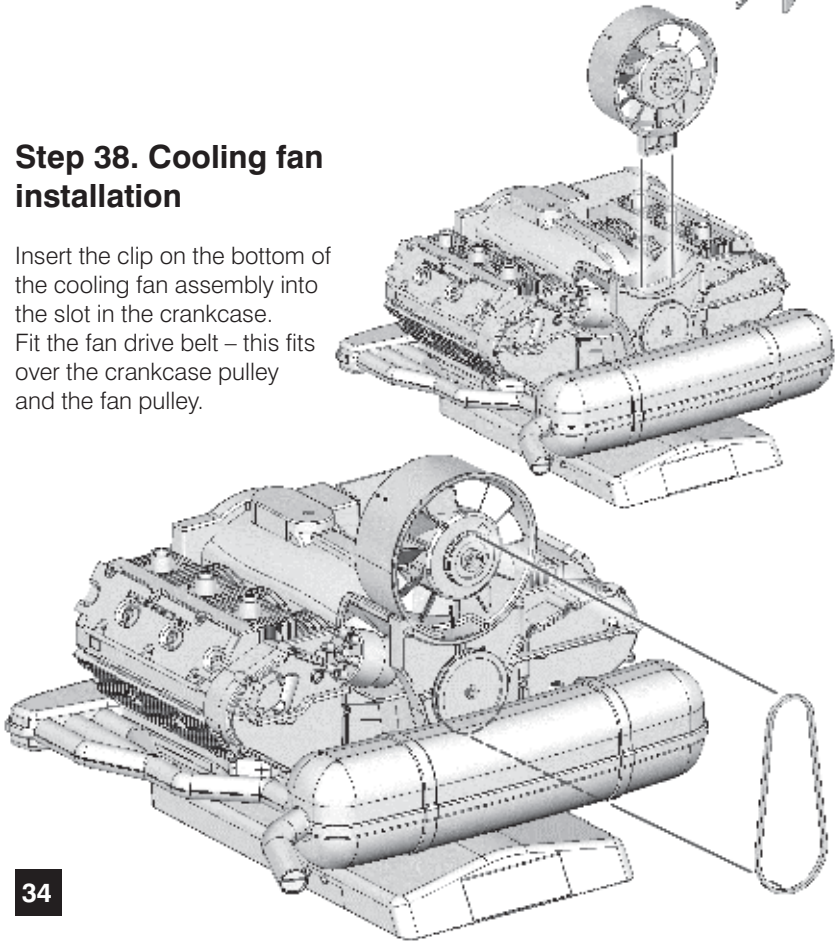
Step 37. Cooling fan assembly

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

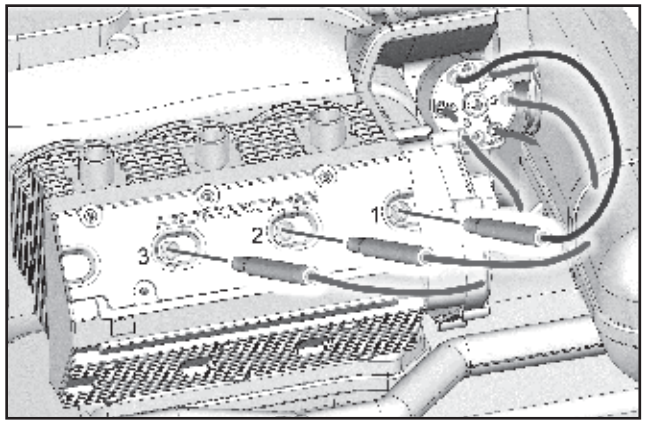
Insert the clip on the bottom of the cooling fan assembly into the slot in the crankcase.
Fit the fan drive belt – this fits over the crankcase pulley and the fan pulley.

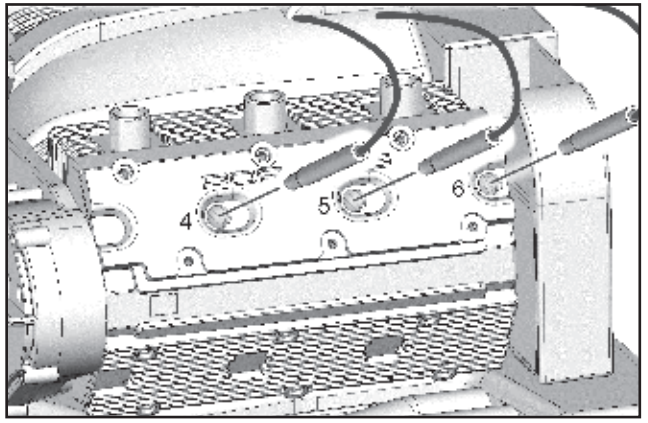


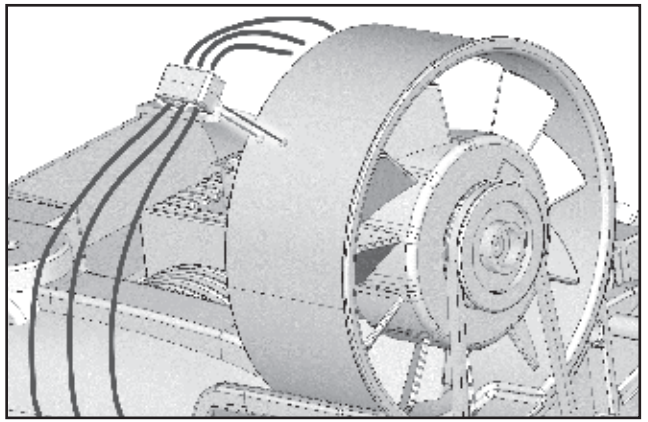
Step 39. Spark plugs

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.



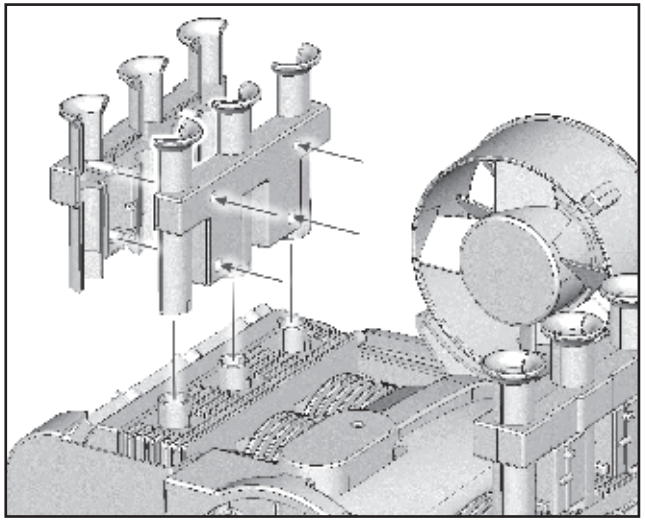




ASSEMBLING THE ENGINE

Step 40. Carburettors

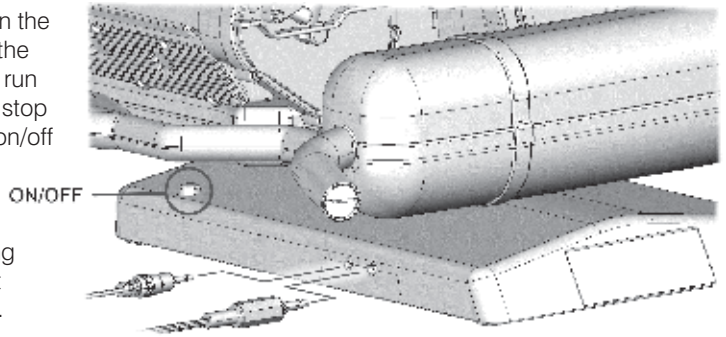
Each set of carburettors is in two halves (15 & 16). Fit each pair together and secure with four screws. Place each in position over the three inlet pipes on the top of the cylinder heads.



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

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.

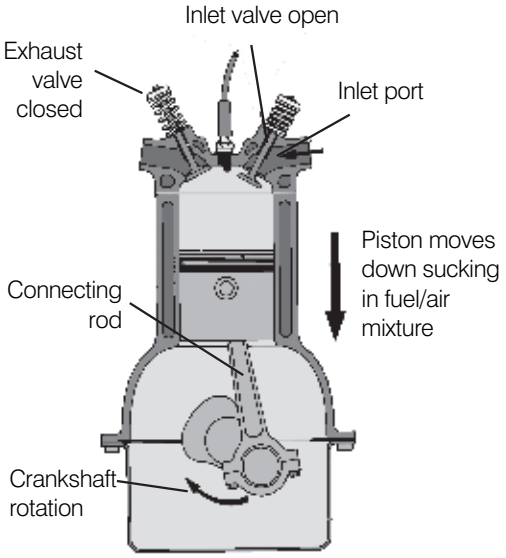
As the piston reaches its highest point, a spark plug creates a spark above the piston and this spark ignites the fuel/air mixture, causing a small controlled explosion above the piston. The explosion pushes the piston downwards and this is called the power stroke.

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.

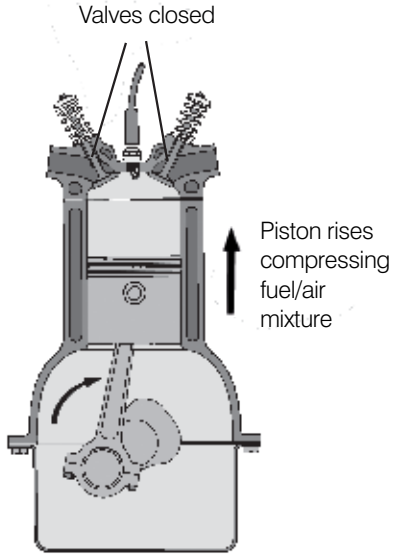
So, the engine has four strokes; intake, compression, power and exhaust, or 'suck', 'squeeze', 'bang' and 'blow' to make it simpler. These four strokes make up the 4-stoke cycle.

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

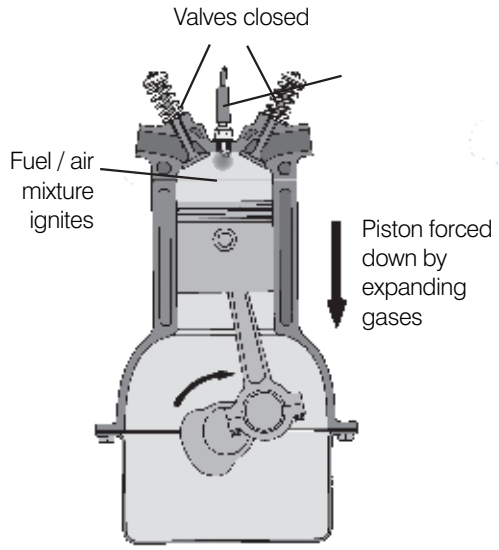


The 1st stroke (intake)
The piston starts off at the top of the cylinder. The exhaust valve is closed and the inlet valve is open. As the crankshaft turns and the piston moves down inside the cylinder, fuel/air mixture is sucked in through the inlet valve. When the piston reaches its lowest point inside the cylinder, the cylinder is filled with fuel/air mixture and the inlet valve closes. This is the end of the intake stroke.

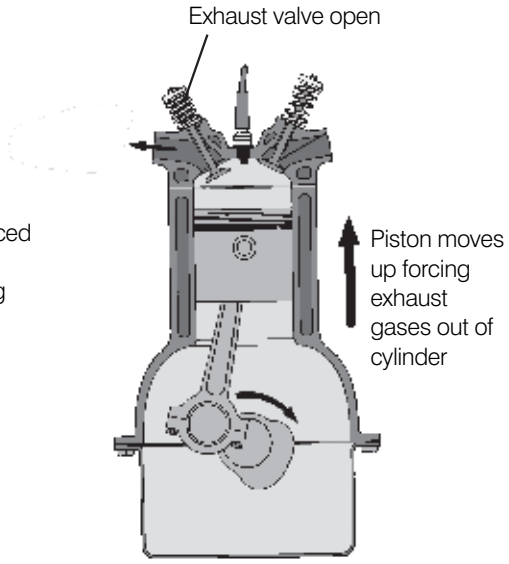


The 2nd stroke (Compression)
At the start of the compression stroke, the piston is at its lowest point inside the cylinder and the inlet and exhaust valves are closed. The crankshaft continues turning and the piston moves upwards. As the piston moves upwards it squeezes (compresses) the fuel/air mixture 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.

HOW AN ENGINE WORKS



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.