

NSI INTERNATIONAL, INC.		COLORS
Date	3/27/2010; 11/18, 4/20/12, 2/12/14	 REG 4/11/12 1/1/12 1/1/12
Artist	HK	
Brand	Smithsonian	
Item #	49013	
Item Name	Motorworks Instruction Poster	
Size	580mm x 850mm (22.8" x 34.8")	
Notes	DOUBLE-SIDED	



Smithsonian®



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Internal Combustion Engine



Internal combustion engines were invented in the 1860s, but it was the German engineer Nikolaus August Otto who in 1867 patented the four-stroke "Otto" cycle engine that we use today.



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The power of an internal combustion engine comes from carefully controlled burning of fuel inside the cylinder.

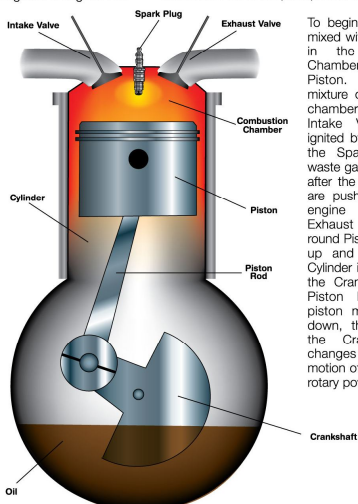
HOW A GAS ENGINE WORKS

INTERNAL COMBUSTION

The Motor-Works model shows the basic parts of a four cycle internal combustion gasoline engine. This is the most common type of gasoline engine and is the kind used in most cars and trucks.

The power of an internal combustion engine comes from the carefully controlled burning of fuel inside the cylinder. That's why it's called an "internal combustion" engine – it literally means "burning inside." Internal combustion engines are generally about twice as efficient as "external combustion" engines, like the old steam engines.

Internal combustion engines were invented in the 1860s, but it was the German engineer Nikolaus August Otto who in 1867 patented the four-stroke "Otto" cycle engine that we use today. This is the kind of engine shown in the Motor-Works model. All "four-stroke" engines work in the same way and have the same basic parts inside. These are shown in the drawing.



Understanding how these parts work will let you understand the basic principles of all engines.

To begin with, gasoline mixed with air is burned in the Combustion Chamber above the Piston. The gas/air mixture comes into the chamber through the Intake Valve and is ignited by a spark from the Spark Plug. The waste gases that remain after the gasoline burns are pushed out of the engine through the Exhaust Valve. The round Piston that moves up and down in the Cylinder is connected to the Crankshaft by the Piston Rod. As the piston moves up and down, the "rod" turns the Crankshaft and changes the up/down motion of the piston into rotary power.

THE FOUR CYCLES

The four cycles – or "strokes" – of an engine are "Intake", "Compression", "Power" and "Exhaust". These repeat again and again in the same order as the piston moves up and down in the cylinder. Since most engines have more than one cylinder, these cycles are alternated in the different cylinders to reduce vibration and make the engine run smoother.

In the **Intake** stroke, the piston is descending and the Intake Valve is open. Since the piston is tightly sealed against the walls of the cylinder, it pulls the gas/air mixture into the cylinder behind it.

1
INTAKE



In the **Power** stroke, the piston has just reached the highest point it can travel when the spark plug ignites the fuel. The gas literally explodes and pushes the piston rapidly down. This provides the engine's power.

3
POWER



In the **Compression** stroke, the piston has gone down as far as it can and is now moving back up. Both valves are closed, so the gas has no place to go and is "compressed" by the piston.

2
COMPRESSION



In the **Exhaust** stroke, the piston has again gone as far down as it can and is now moving back up. The exhaust valve is open and the piston pushes the "exhaust" gases out of the cylinder as it rises. As soon as the piston reaches the top of the cylinder, the exhaust valve closes, the intake valve opens and the cycles begin again.

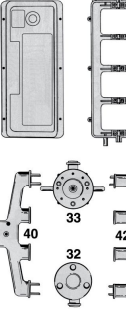
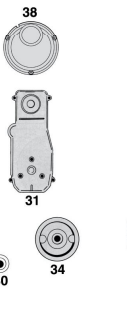
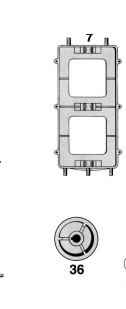
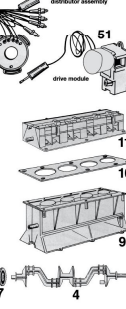
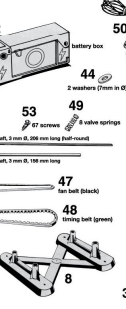
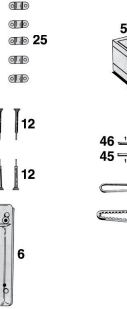
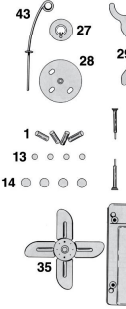
4
EXHAUST



DIAGRAM OF PARTS



Smithsonian Motor-Works™

Ages 8 and up ITEM # 49013
A B C D E F G H


LIST OF PARTS

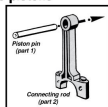
DESCRIPTION	Number
8 timing cams	A-H
4 piston pins	1
4 connecting rods	2
8 piston halves	3
1 crankshaft	4
4 connecting rod keepers (big end)	5
1 oil-pan	6
1 lower crankcase	7
1 engine mounting stand	8
1 cylinder block	9
1 head gasket	10
1 lower cylinder head	11
8 valve stems	12
4 exhaust valves	13
4 intake valves	14
1 upper cylinder head	15
8 rocker arms	16
5 bearings	17
1 rocker arm cover	18
1 timing gear	19
1 timing wheel	20
1 positioning jig	21
1 belt tensioning pulley	22
1 timing belt cover	23
1 rear half of water pump	24
1 front half of water pump	25
1 fan pulley	26
1 fan	27
1 crankshaft pulley	28
1 flywheel clutch	29
1 clutch housing	30
1 carburetor bowl	31
1 intake manifold	32
1 carburetor cover	33
1 exhaust manifold	34
1 dipstick	35
2 washers, 7 mm ø	36
1 shaft, 3 mm ø, 156 mm long	37
1 shaft, 3 mm ø, 206 mm long (half round)	38
1 fan belt	39
1 timing belt (green)	40
8 valve springs	41
1 distributor assembly	42
1 drive module	43
1 battery pack	44
67 screws	45
Requires 2 (1.5V) "AA" Batteries and screwdriver (Not Included.)	46

ASSEMBLING YOUR MOTOR WORKS ENGINE

Adult Supervision required.

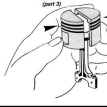
1 Assembling the pistons

Insert a piston pin (part 1) through the small end of the connecting rod (part 2).



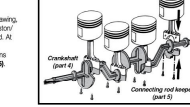
2 Mounting the oil pan on the lower housing

Set the oil pan (part 6) on the four pins protruding from the bottom of the lower crankcase (part 7), as shown in the drawing. Secure the oil pan using four screws.



3 Mounting the pistons on the crankshaft

NOTE! Break off the small lip (marked with a *) on the piston head prior to inserting the piston into the cylinder. Any remaining lip could subsequently interfere with the piston's movement. **NOTE!** Before assembly, make sure the piston is oriented with the pin hole at the top. **NOTE!** Before assembly, make sure the piston is oriented with the pin hole at the top.



4 Mounting the cylinder block assembly on the lower crankcase

Position the oil pan/water pump mounting stand assembly as shown in the drawing. Check the orientation of the oil pan/water pump assembly as shown in the drawing. Turn the assembly upside down so it is positioned as shown in the drawing. Set the cylinder block assembly on the lower crankcase. Make sure the units are aligned as shown in the drawing, and that you have not reversed the orientation of either unit lower crankcase and cylinder block studs should stick out to your left.



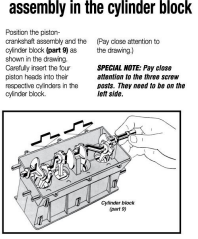
5 Mounting the oil pan on the lower housing

Set the oil pan (part 6) on the four pins protruding from the bottom of the lower crankcase (part 7), as shown in the drawing. Secure the oil pan using four screws.



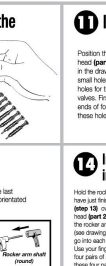
6 Mounting the piston-crankshaft assembly in the cylinder block

Position the piston-crankshaft assembly and the cylinder block (part 9) as shown in the drawing. Carefully insert the four piston heads into their respective cylinders in the cylinder block.



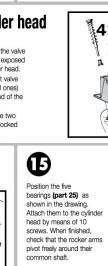
7 Mounting the rocker arms on the rocker arm shaft

Collect the eight rocker arms (part 16) and the rocker arm shaft (part 17). Slide each rocker arm onto the shaft, one by one. Rotate every other rocker arm 180° so that the long and short segments of each arm alternate (see diagram).



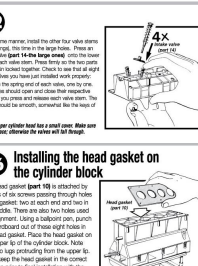
8 Mounting the lower cylinder head on the lower cylinder head

Position the lower cylinder head on the lower cylinder head. Make sure the units are aligned as shown in the drawing, and that you have not reversed the orientation of either unit lower cylinder head and cylinder block studs should stick out to your left.



9 Mounting the upper cylinder head on the upper cylinder head

Position the upper cylinder head on the upper cylinder head. Make sure the units are aligned as shown in the drawing, and that you have not reversed the orientation of either unit upper cylinder head and cylinder block studs should stick out to your left.



10 Mounting the timing gear on the crankshaft

Hold the timing gear (part 19) in the upper cylinder head. Attach them to the cylinder head by means of 10 screws. When finished, check that the timing gear is properly seated around the common shaft.



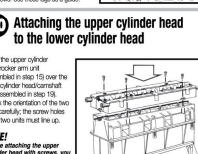
11 Mounting the timing gear on the crankshaft

Hold the timing gear (part 19) in the upper cylinder head. Attach them to the cylinder head by means of 10 screws. When finished, check that the timing gear is properly seated around the common shaft.



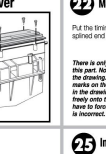
12 Mounting the timing gear on the crankshaft

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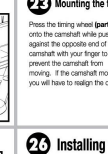
13 Mounting the timing gear on the crankshaft

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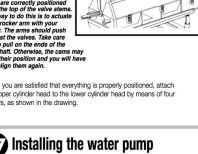
14 Mounting the timing gear on the crankshaft

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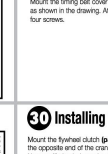
16 Mounting the timing gear on the crankshaft

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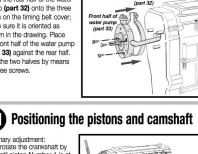
17 Mounting the timing gear on the crankshaft

Hold the timing gear (part 19) in the upper cylinder head. Attach them to the cylinder head by means of 10 screws. When finished, check that the timing gear is properly seated around the common shaft.



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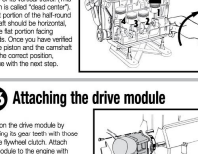
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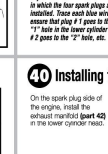
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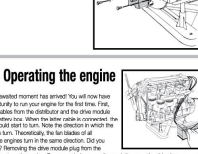
23 Mounting the timing gear on the crankshaft

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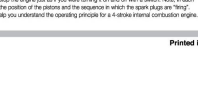
26 Mounting the timing gear on the crankshaft

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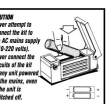
27 Mounting the timing gear on the crankshaft

Hold the timing gear (part 19) in the upper cylinder head. Attach them to the cylinder head by means of 10 screws. When finished, check that the timing gear is properly seated around the common shaft.



37 Installing the clutch cone

Press the rear half of the clutch cone (part 37) into the clutch cone (part 38) using the opening in the clutch cone (part 38).



38 Mounting the carburetor and the intake manifold

Place the carburetor bowl (part 31) on the intake manifold (part 32). Attach the carburetor bowl to the intake manifold using the screws provided.

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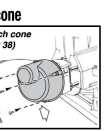
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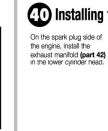
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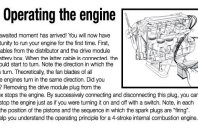
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