

STEMnEX[®]

CONNECTS
TO FUTURE
SCIENTISTS!



INLINE 6 MODEL ENGINE

AMAZING STEMNEX® SERIES

Welcome to the AMAZING world of the STEMNEX® series in the 21st century. Our vision in this series is to open door to a world of new possibilities and imagination in our STEMNEX® products, so to educate the future generation to become successful in their own ways.

STEMNEX® integrates Science, Technology, Engineering and Mathematics through hands on fun learning activities! **Science** stimulates our curiosity and can increase creativity. **Technology** focuses on turning theories into reality and empowers inventions. **Engineering** improves hand-eye coordination skills and gives opportunity to connect things together. Whereas **Mathematics** helps to promote problem solving skills. All of these are important life skills for growing and learning in this fast-growing society.

STEMNEX® is our modern learning toys preparing and motivating the future generation to adapt skills in problem solving, creativity and imagination through building experiment to enrich intelligence and stimulate the minds to enhance knowledge. Future generation can learn how science is applied to daily life and how things work around us through embracing STEM learning – it is everywhere and everyday connection around us.

Have an amazing future!

WARNING

Adult supervision and assistance is required.

This unit is only for use by children aged 10 years and older.

Not suitable for children under age 3 years old due to small part(s) and component(s)– CHOKING HAZARD.

Read and follow all instructions in the manual before use.

This toy contains small parts and functional sharp points on components.

Keep away from children under age 3 years.

Please retain the information and this manual for future reference.

Follow the instruction manual to perform the circuit connection.

Instructions for parents are included and have to be observed.

Do not lock the motor or other moving parts. Otherwise it may cause overheating.

The toy is not to be connected to more than the recommended number of power supplies.

Warning. Do not use close to the ear! Misuse may cause damage to hearing.

BATTERY INFORMATION

Use 3 x AA size batteries (not included)

Remove batteries when not in use.

Batteries must be inserted with the correct polarity.

Non-rechargeable batteries are not to be recharged.

Re-chargeable batteries are only to be charged under adult supervision.

Re-chargeable batteries are to be removed from the toy before being charged.

Different types of batteries or new and used batteries are not to be mixed.

Only batteries of the same or equivalent types are to be used.

Exhausted batteries are to be removed from the toy.

The supply terminals are not to be short-circuited.

Do not dispose of the batteries in fire.

Do not mix old and new batteries.

Do not mix alkaline, carbon zinc and re-chargeable batteries.

Introduction

Internal combustion engine is a machine that makes use of combustion of a fuel to provide mechanical power and it was not invented by a single person. In fact, various scientists and engineers contributed to its development since the 19th century and nowadays it is a common mechanical unit in many different features. One of the most common places you will find them in is inside the car. Internal combustion engine is like the heart of a vehicle --- it provides the power for the car to run!

What is the difference between an electric motor and an internal combustion engine?

An electric motor makes use of electricity to create rotatory motion. Basically, it consists of magnets and coils. When electricity flows through the coils in the motor, the electro-magnetic force (attraction towards a magnet/repulsive force away from a magnet) drives the coils to move. Actually, the rotatory output of a motion originates from such electro-magnetic force.

An internal combustion engine makes use of the “combustion” of a fuel such as petrol. In simple, first a small amount of petrol is sprayed (in the form of a gas mixture) inside the combustion chamber. Then, a spark ignites the air-fuel mixture. The abrupt combustion of the air-fuel mixture is pretty much like a very small-scale explosion. This small-scale explosion provides the propellent force as the mechanical power output for the internal combustion engine.

Remark:

An important difference between the petrol engine and the diesel engine is, the diesel engine does not need a spark to ignite the diesel spray. The ignition of the diesel spray is triggered by the heat produced by air compression. Anyway, both types of engines make use of the same principle (combustion of fuels like a small-scale explosion) to provide power.

How to differentiate if a vehicle/vessel is using an electric motor or an internal combustion engine?

If the machine needs to fill in liquid fuel for power, then it should be using an internal combustion engine. If the machine needs to charge up for electricity, then it should be using an electric motor.

How many types of internal combustion engine are there?

It depends on what criteria you use to differentiate them. For example, the internal combustion engine for the car is very different from that of the aeroplane. And then, among the car engines, there is spark ignition engine (using spark to ignite the petrol spray) and compression ignition engine (no spark, but by compressing the air to provide heat to ignite the diesel spray). And among them there are engines of 2-stroke cycle, 4-stroke cycle and 6-stroke cycle (6-stroke cycle is for spark ignition engine only).

This Inline 6 Model Engine is a simulation of a 4-stroke-cycle inline 6 petrol engine. It is called Inline 6 because there are a total of 6 cylinders (the combustion takes place in a cylinder) and they are "in a line". In this manual, we will focus on this particular type of internal combustion engine.

The Inline 6 Engine

The main advantage of the Inline 6 Engine over the Flat 6 or V6 Engines lies in the fact that, inline 6 Engine is considerably easier to build because of its straightforward arrangement of the cylinders. This also makes it easier to maintain and repair than the Flat 6 or V6.

The major drawback for Inline 6 Engine is, since all the 6 cylinders are lining up in a straight line, the Inline 6 Engine is significantly longer in length. This makes it hard to fit in an engine bay and therefore it is only applicable for specifically designed cars, such as Jaguar E-Type, BMW M5, Toyota Supra etc.....

What is 4-stroke-cycle and how a 4-stroke engine works

As said earlier, the working principle of an internal combustion engine is like this:

First a small amount of petrol is sprayed (in the form of a gas mixture) inside the combustion chamber. And then, a spark ignites the air-fuel mixture. The abrupt combustion of the air-fuel mixture is pretty much like a very small-scale explosion. This small-scale explosion provides the propellant force as the mechanical power output of the internal combustion engine.

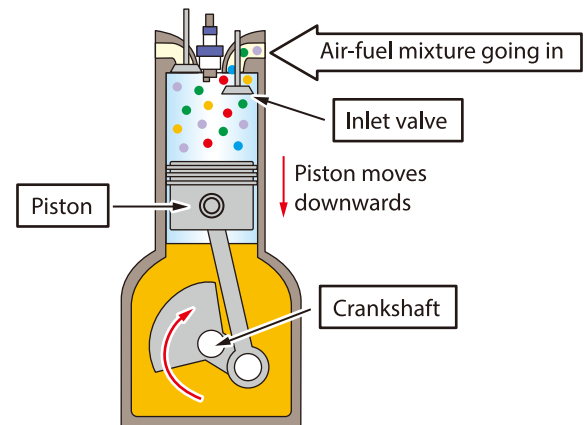
This combustion process, which is pretty much like a very small-scale explosion, takes place in the combustion chamber. The combustion chamber is also called a cylinder. The following diagrams demonstrate the key process inside a particular cylinder during the operation of this type of internal combustion engine.

1. The 1st cycle – Intake

The crankshaft rotates and as a result the piston moves downwards, allowing the air-fuel mixture (air mixed with volatilized petrol) to fill in the cylinder.

* At the top right of the diagram, the inlet valve is opened to let the air-fuel mixture to flow into the cylinder.

[If you wonder "where does the power come from that crank the crankshaft in this cycle?", read through all the 4 cycles first, and the answer can be found in the next section.]

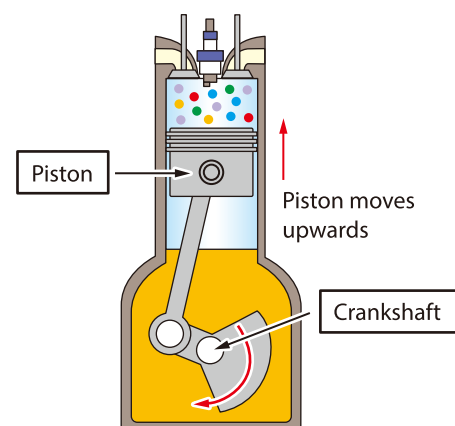


2. The 2nd cycle - Compression

The crankshaft continues to rotate and then the piston moves upward, compressing the air-fuel mixture in the cylinder.

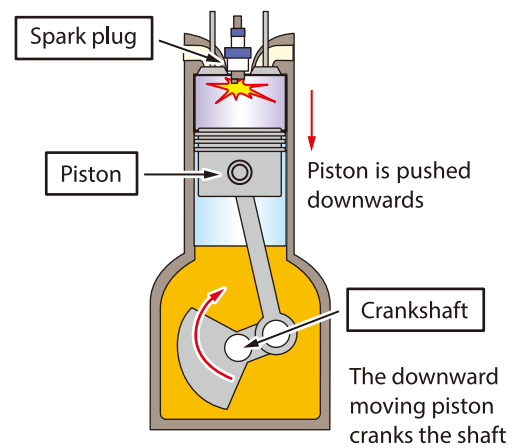
* Note that at the top right of the diagram, the valve is closed so that the air-fuel mixture is trapped inside the cylinder for the compression to take place.

[If you wonder "where does the power come from that crank the crankshaft in this cycle?", read through all the 4 cycles first, and the answer can be found in the next section.]



3. The 3rd cycle - Power

The spark plug is the igniter. It makes a spark, igniting the air-fuel mixture. The air-fuel mixture immediately combusts. This is pretty much like a very small-scale explosion that pushes the piston downwards. When the piston is pushed downwards, it cranks the crankshaft. This is called a power stroke, which is the source of power for the engine.

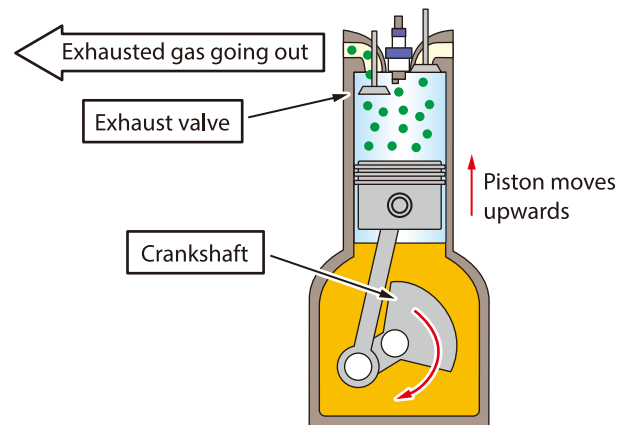


4. The 4th cycle - Exhaust

The crankshaft continues to rotate and the piston moves upward, expelling the exhausted gas completely.

* Note that at the top left of the diagram, the exhaust valve is opened for the exhausted gas to leave.

And then the crankshaft keeps on rotating and back to the 1st cycle and continue the process.



Where does the power come from that cranks the crankshaft to move the piston up and down in the 1st, 2nd and 4th cycle?

In an ordinary 4-stroke cycle engine, there will be several cylinders. They won't be at the same cycle at the same time. In simple, when one of the cylinders is at the 3rd cycle to provide the power, the other cylinders are at different cycles for intaking or compressing or exhausting.

For an engine with 6 cylinders, whenever the crankshafts are cranked by 120°, one of the cylinders will be at the 3rd cycle to provide power. In other words, among the 6 cylinders, there will always be a cylinder that is at the 3rd cycle that provides the power for the other cylinders at the 1st, 2nd and 4th cycle!

Here is a comparison between "engines with 4 cylinders" and "engines with 6 cylinders":

For "engines with 4 cylinders", when the crankshaft completes a cycle of 720°, it has provided power for 4 times. In other words, the crankshaft is cranked by one of the pistons every 180°.

For "engines with 6 cylinders", when the crankshafts complete a cycle of 720°, they have provided power for 6 times. In other words, the crankshafts are cranked by one of the pistons every 120°, which means the power is provided more frequently.

Therefore "engines with 6 cylinders" can have more power and smoother power output.

How to start the engine from stationary?

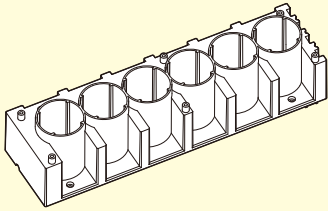
When you understand the working principle of 4-stroke-cycle, naturally a question would come up in the mind: what about at the beginning, when the engine is off, the crankshaft is stationary, no power is there at the moment, and then how to turn it on? How to make it start the process?

The answer is, for modern car engine it will come up with a "starter", which is an electric motor unit to crank the crankshaft at the beginning. Once the crankshaft is spinning, the 4-stroke-cycle can start.

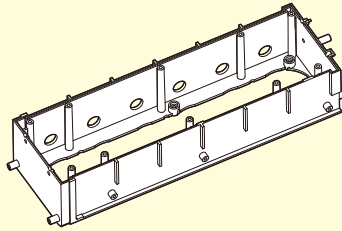
What controls the opening and the closing of the valves?

The opening and the closing of the valves is controlled by the system of "timing belt + camshaft + cams". In simple, when the crankshaft rotates, it also drives the timing belt to move. The timing belt then drives the camshaft and cams to rotate accordingly. The details are difficult to express in words. When you build the Inline 6 engine kit, for the part of "timing belt + camshaft + cams", try turning them a few times to see. You will see how the smart design of such system makes the valves open or close at the proper time automatically.

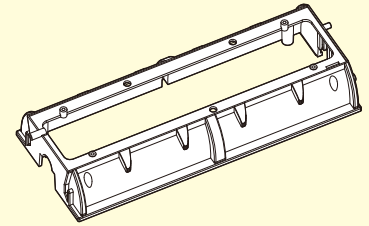
COMPONENT LIST



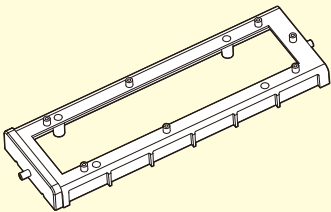
01 Cylinder block



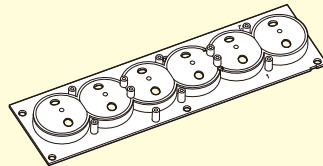
02 Middle cylinder head



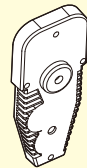
03 Upper crankcase



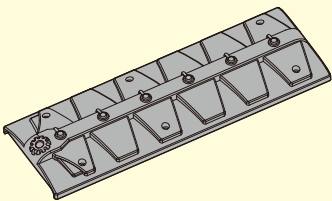
04 Upper cylinder head



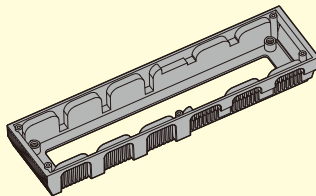
05 Lower cylinder head



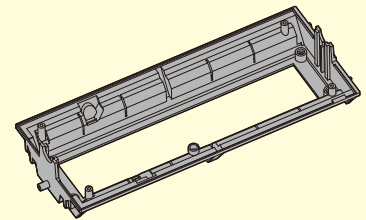
06 Timing belt cover



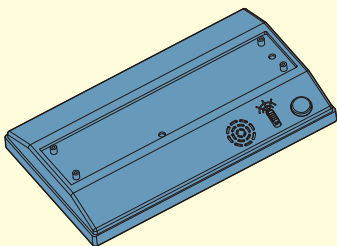
07 Engine cover



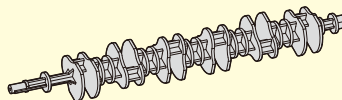
08 Sump pan



09 Lower crankcase



10 Base



11 Crankshaft

12 Camshaft (longer)



13 Camshaft (shorter)





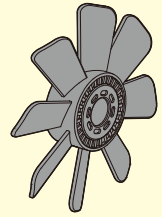
14 Timing alignment pin x 2



15 Fan pulley (halved)



16 Fan pulley (halved)



17 Fan



18 Crankshaft drive gear



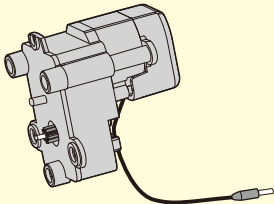
19 LED activator



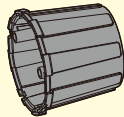
20 Transference gear



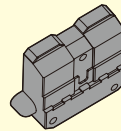
21 Camshaft gear



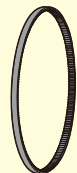
22 Motor



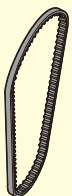
23 Clutch cover



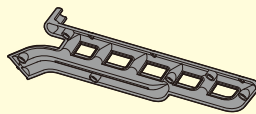
24 Distributor cover



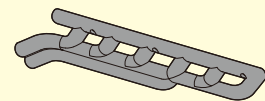
25 Fan belt



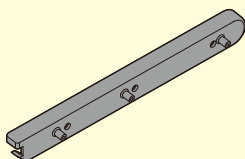
26 Timing belt



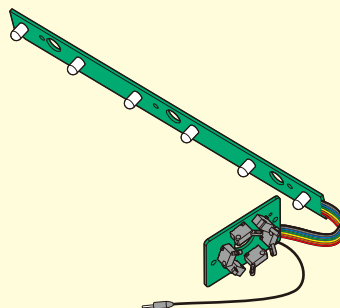
27 Exhaust manifold lower half



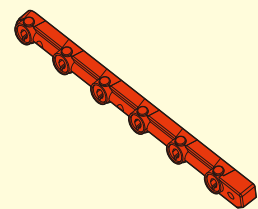
28 Exhaust manifold upper half



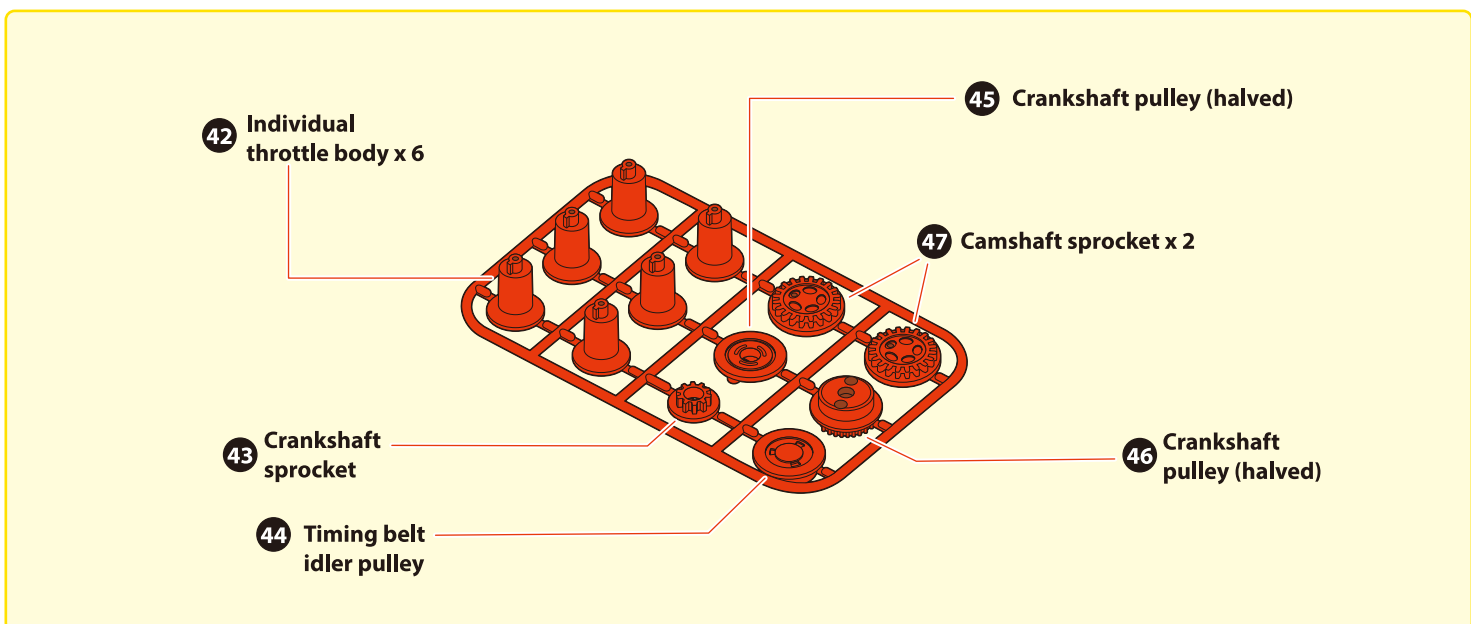
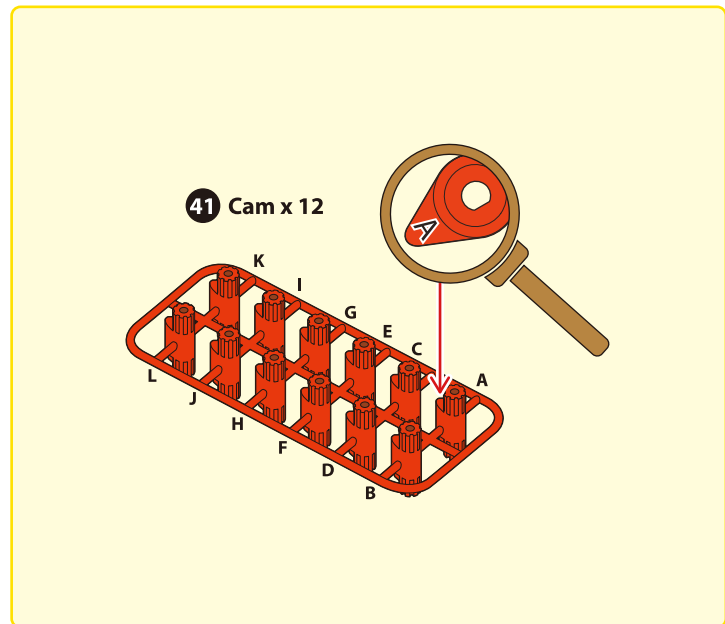
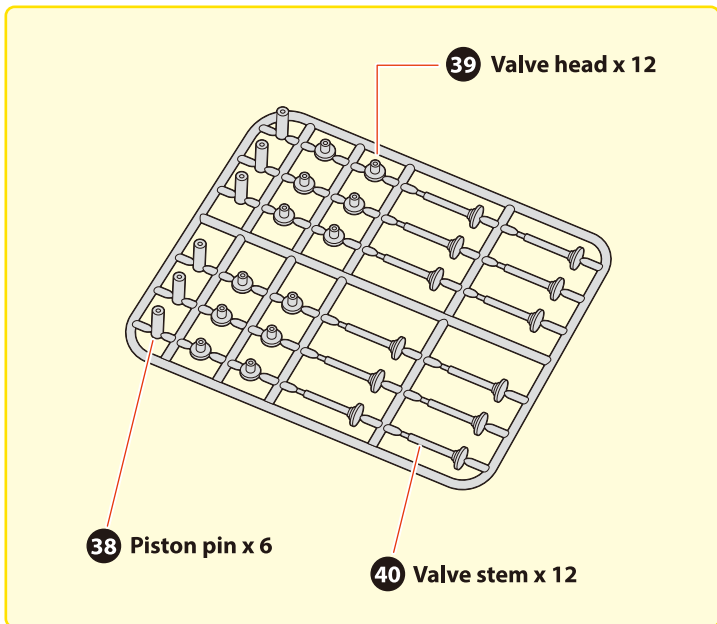
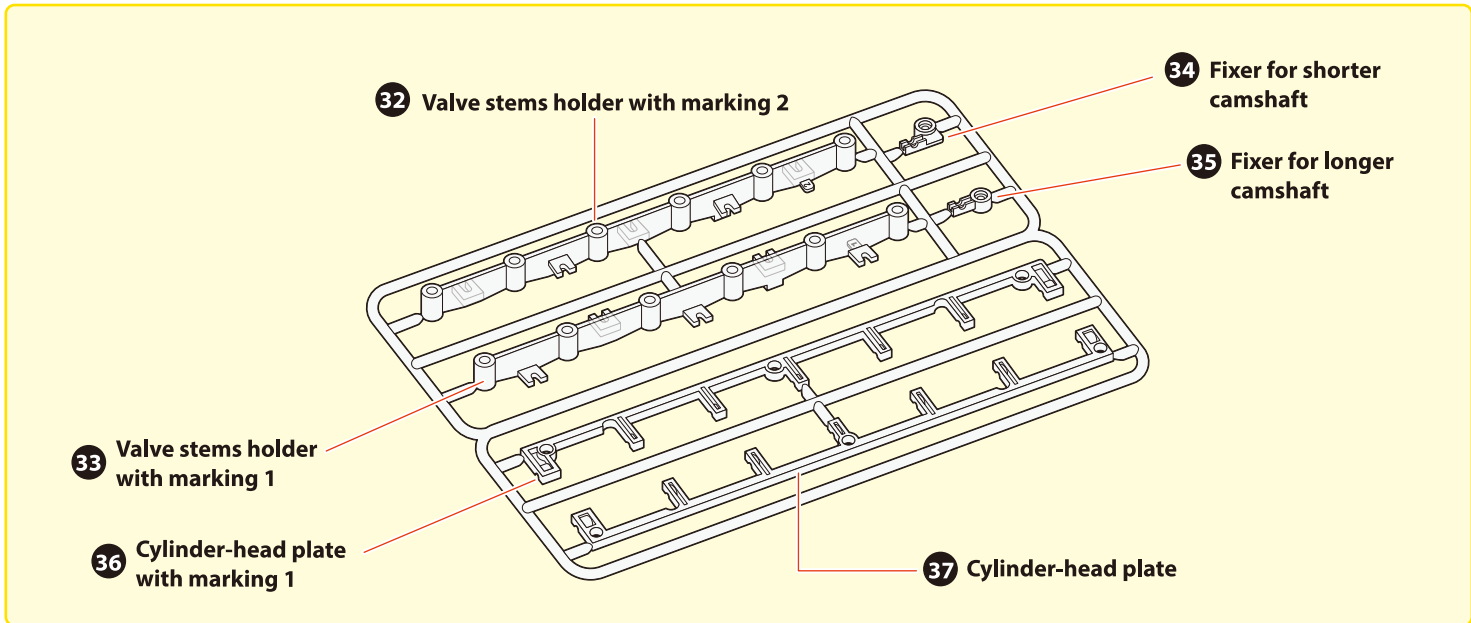
29 Exhaust manifold stem

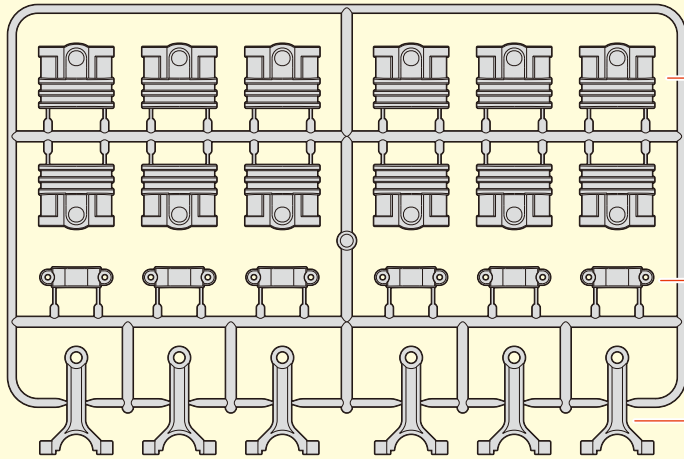


30 Distributor and LED



31 Throttle body stem





48 Piston half x12

49 Connecting rod cap x 6

50 Connecting rod x 6

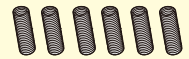


Screwdriver

SCREW A Modified truss head screw (larger plate) x 1

SCREW B Modified truss head screw (smaller plate) x 2

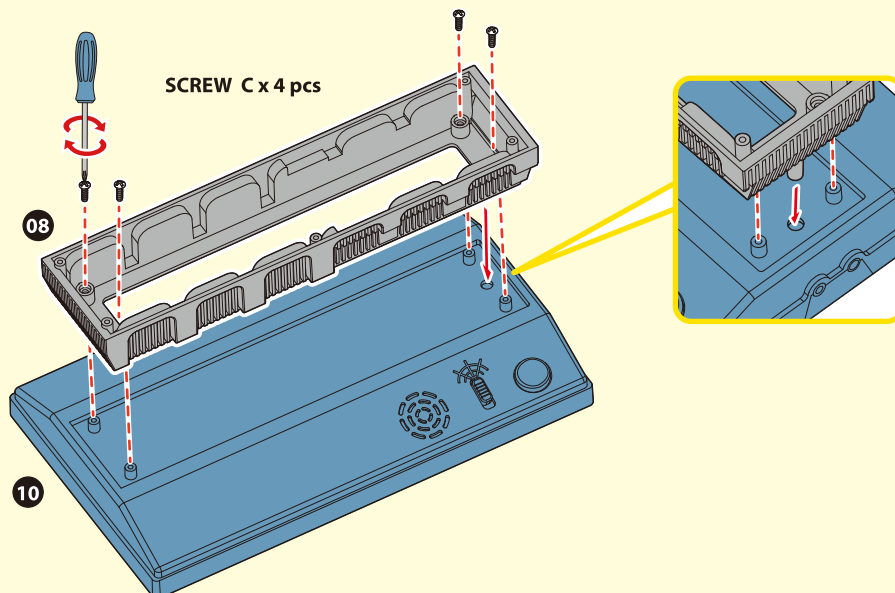
SCREW C Pan head screw x 99



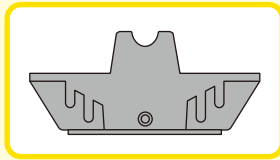
SPRING x 12

ASSEMBLY

1

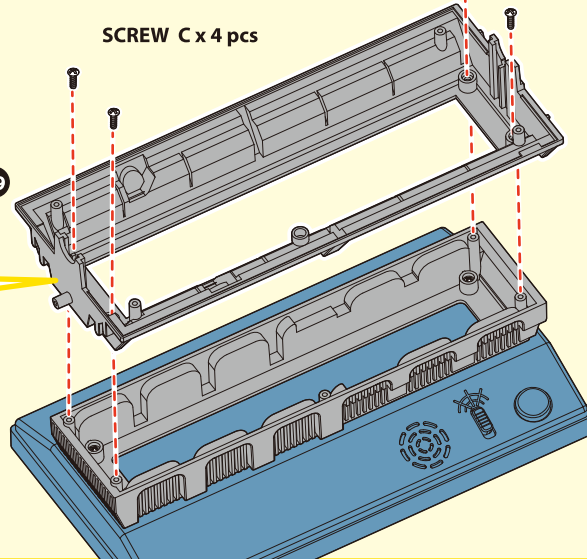


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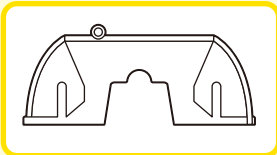


09

SCREW C x 4 pcs



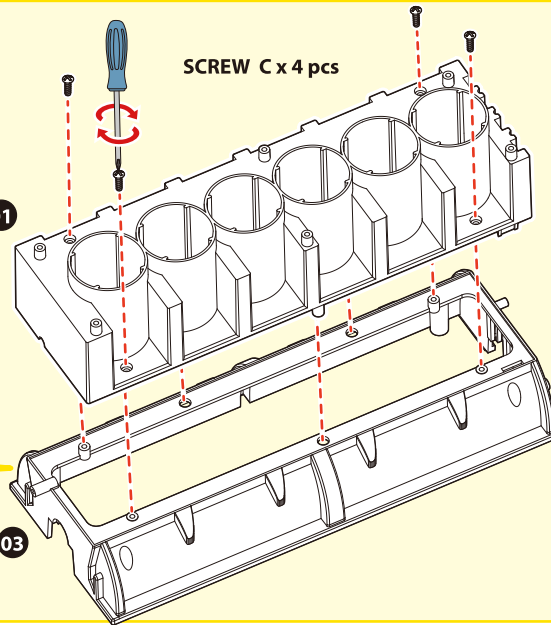
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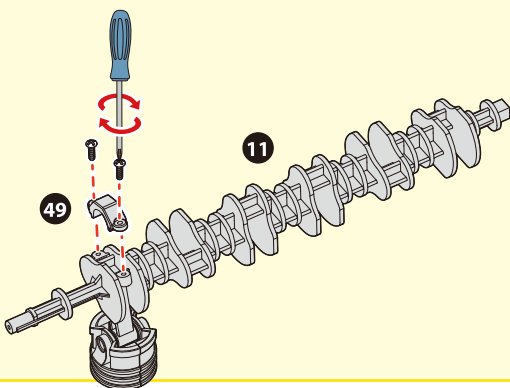
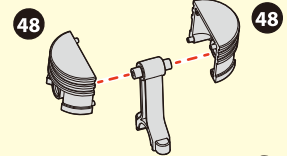
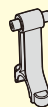
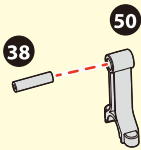
01

SCREW C x 4 pcs

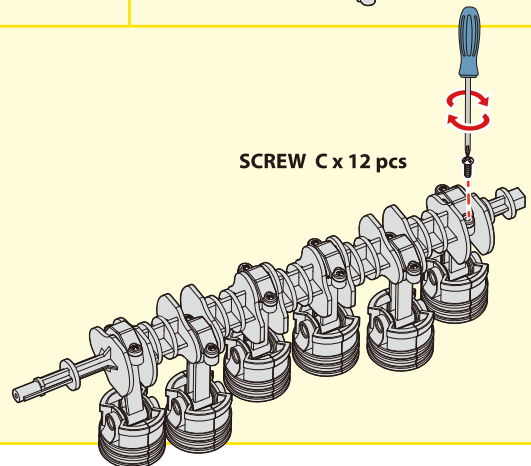
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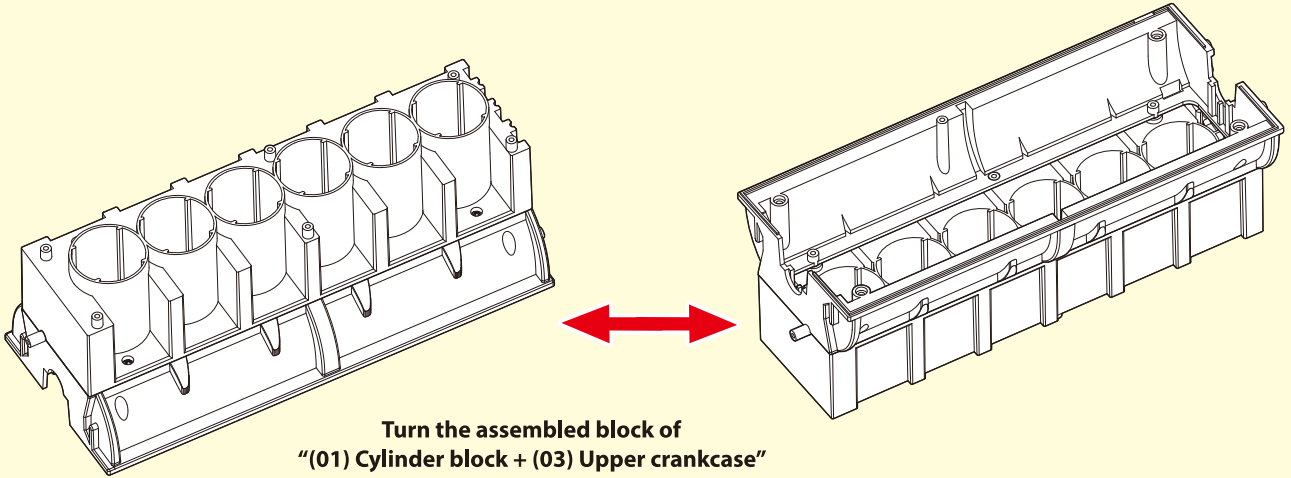
4



SCREW C x 12 pcs

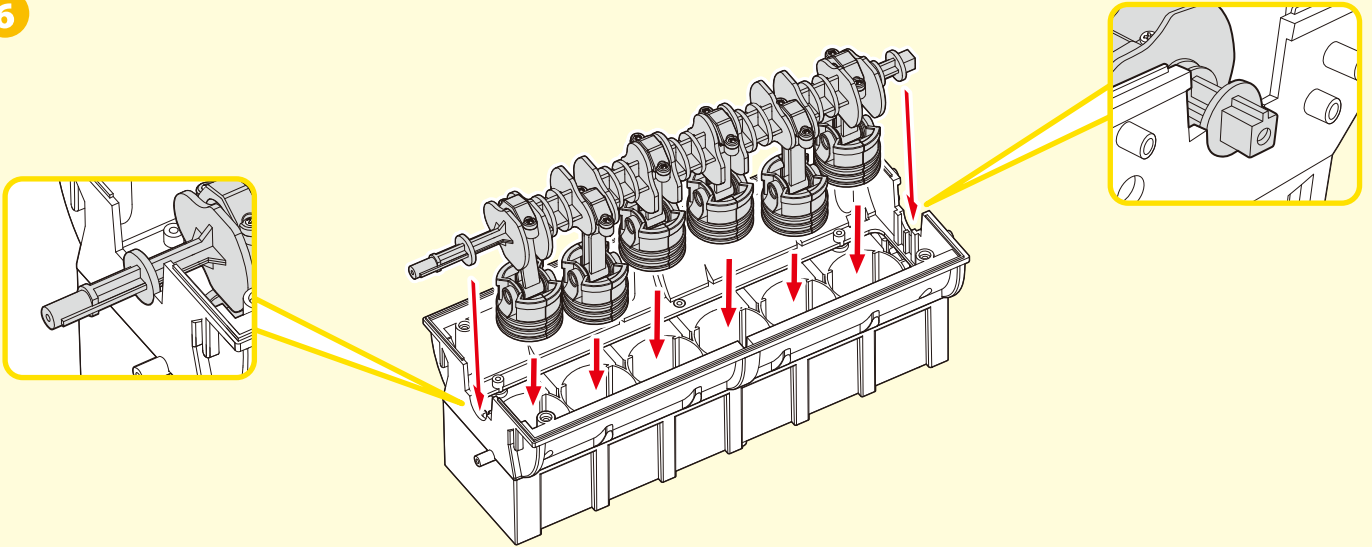


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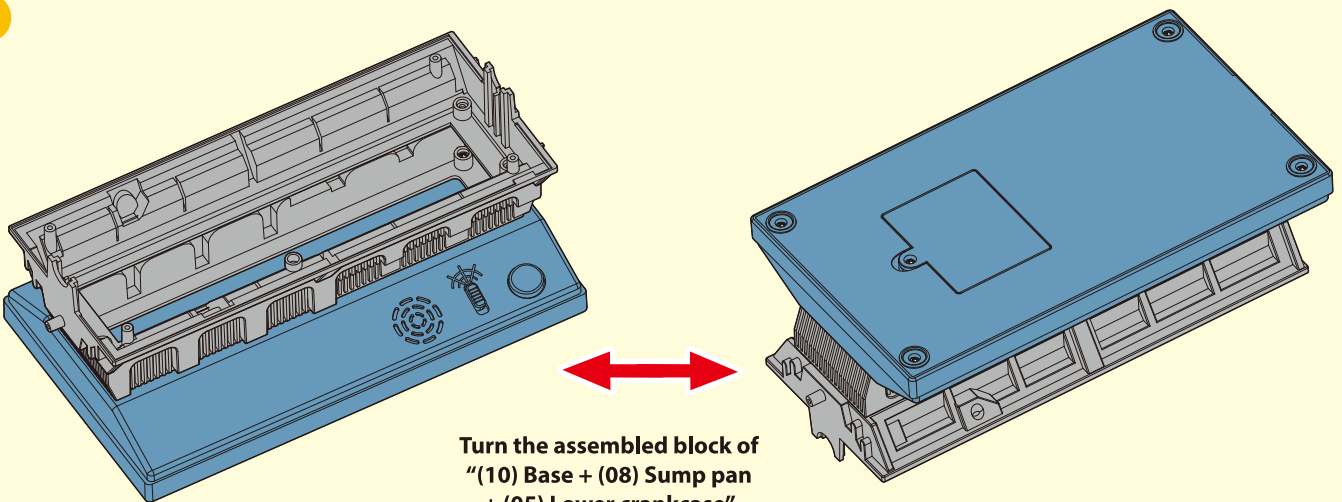


Turn the assembled block of
“(01) Cylinder block + (03) Upper crankcase”
upside down

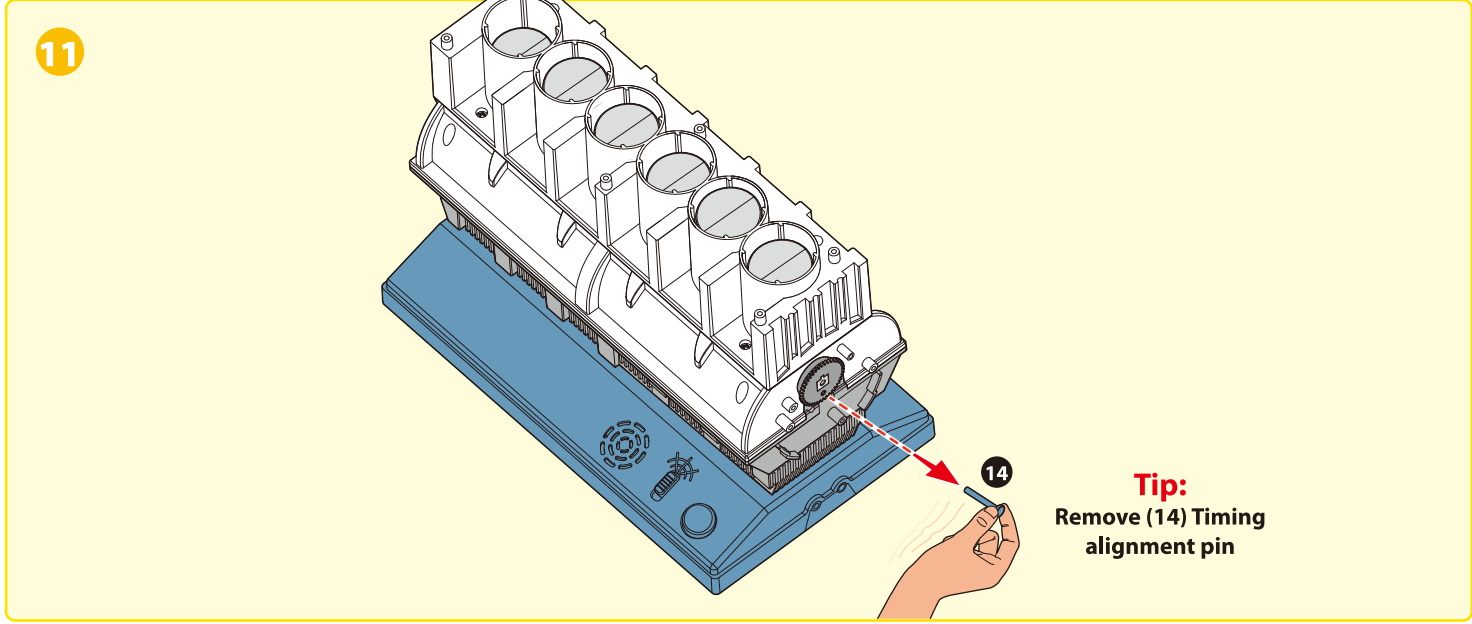
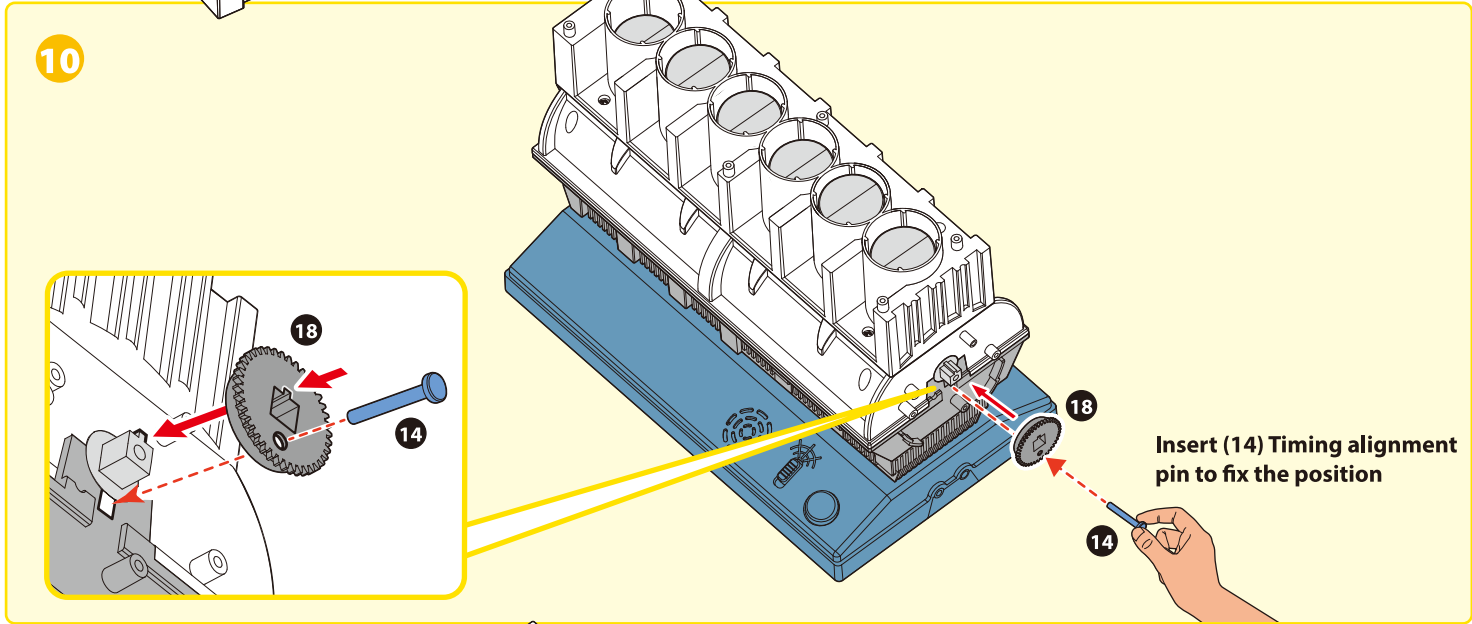
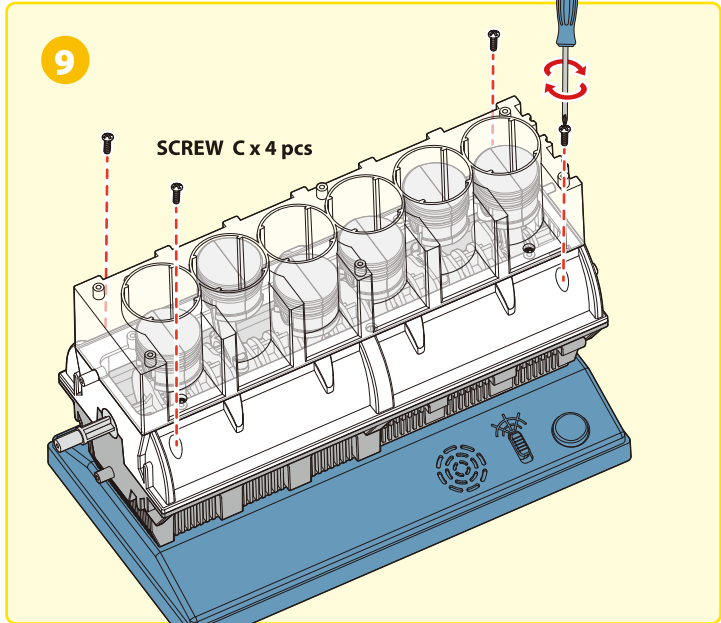
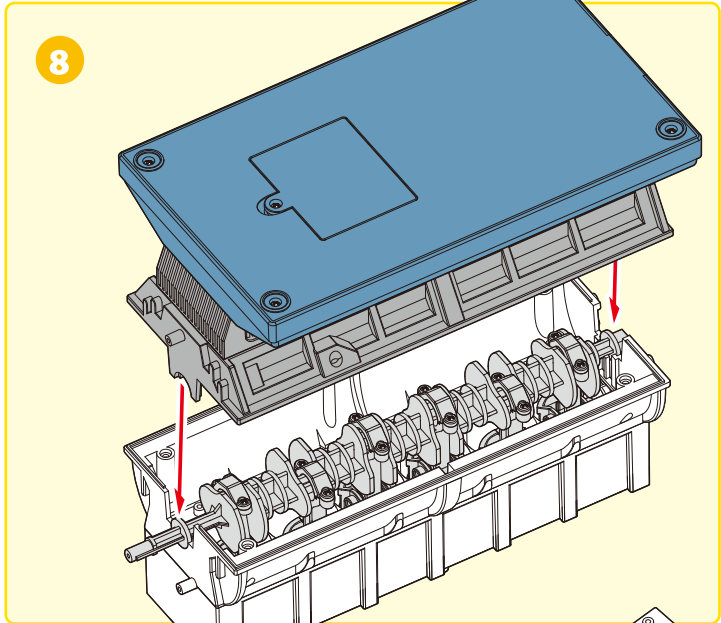
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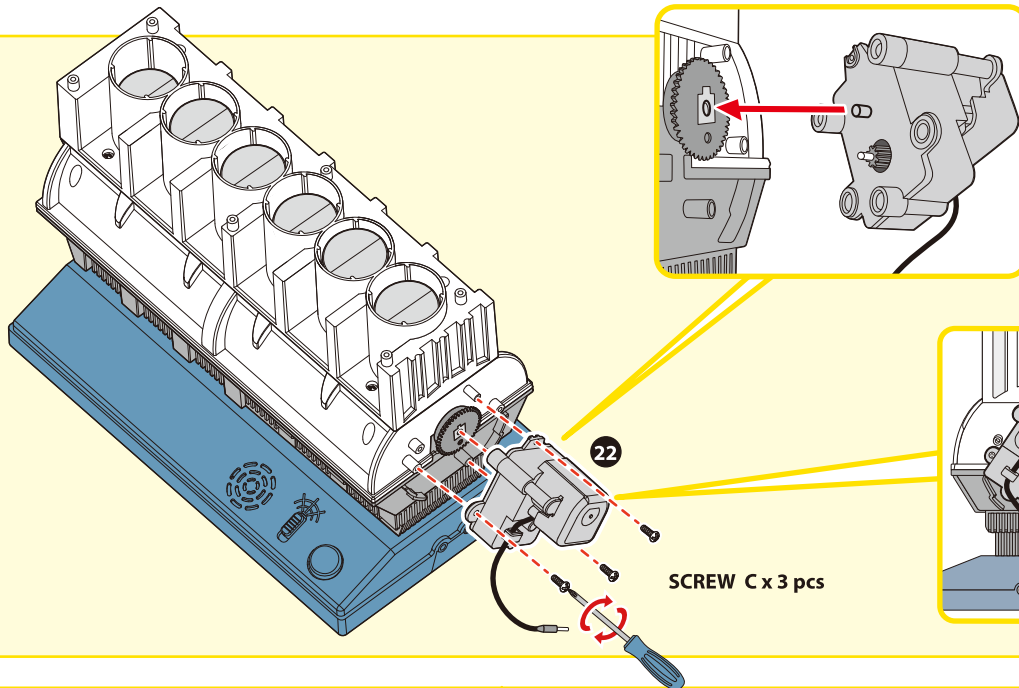
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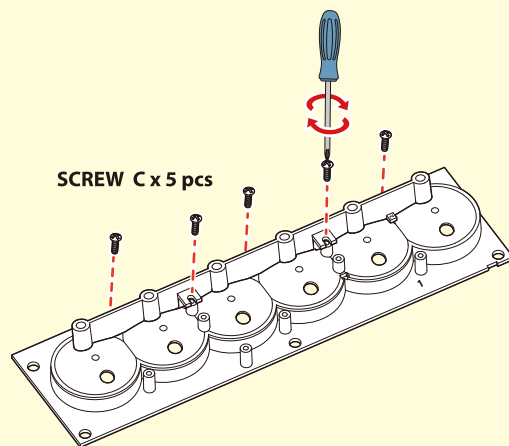
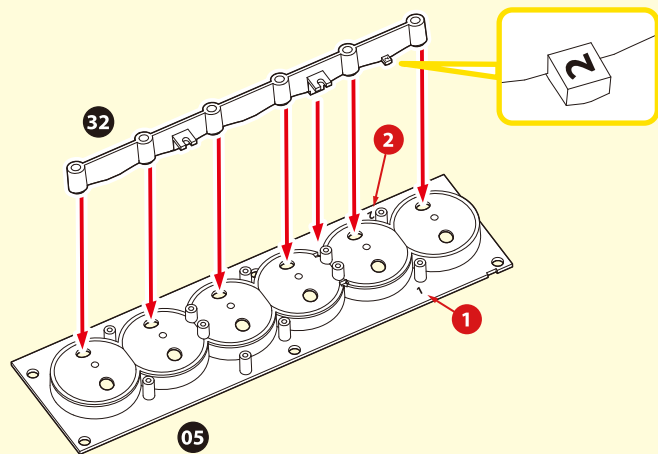
Turn the assembled block of
“(10) Base + (08) Sump pan
+ (05) Lower crankcase”
upside down



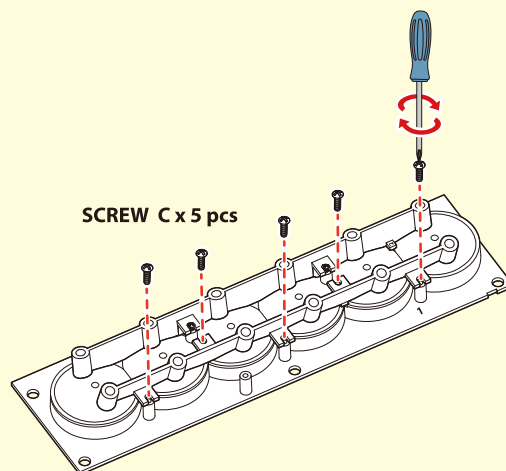
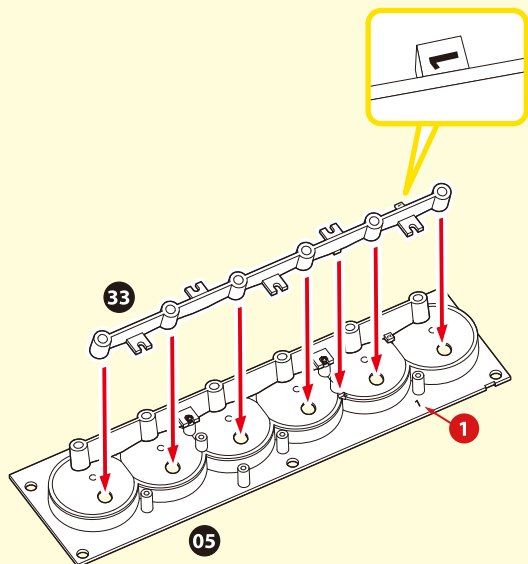
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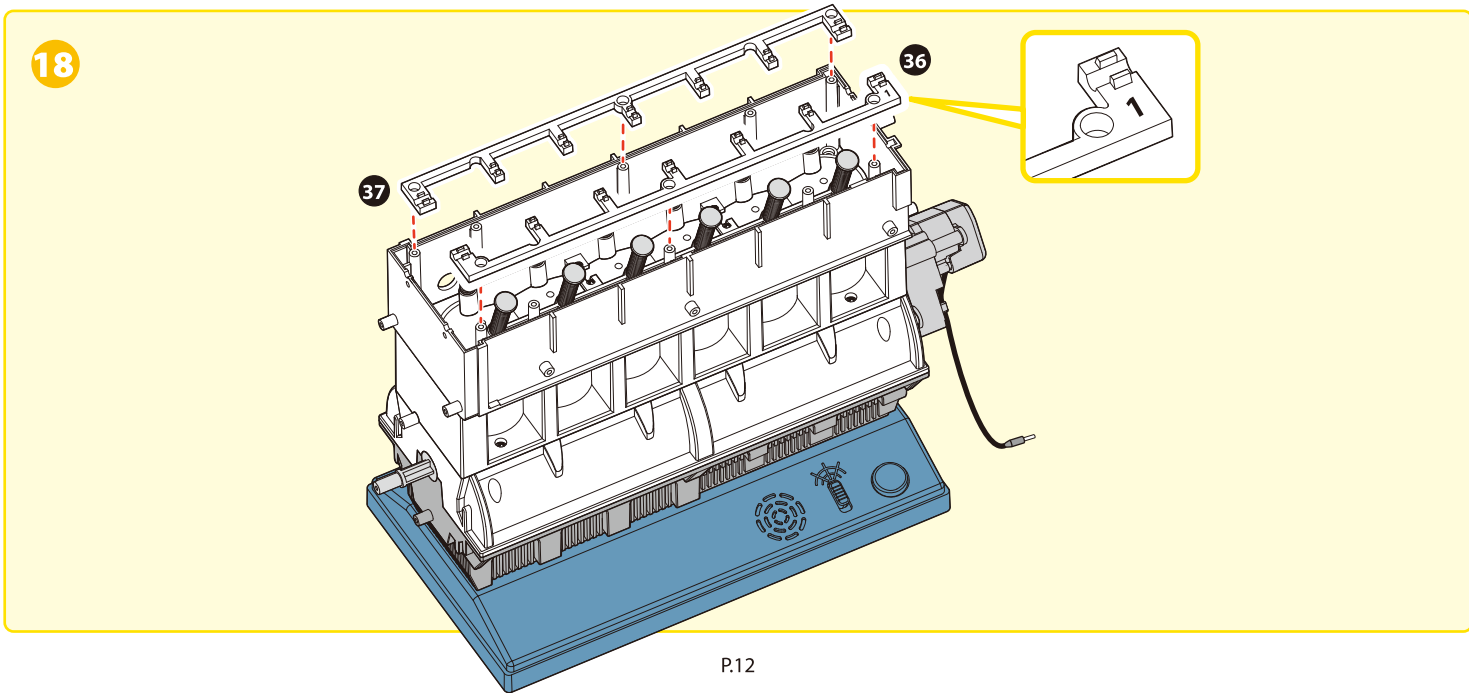
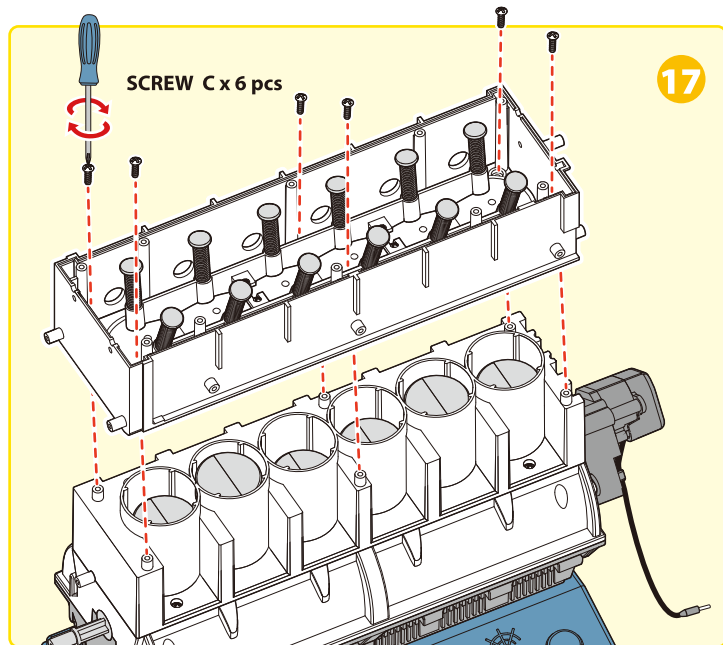
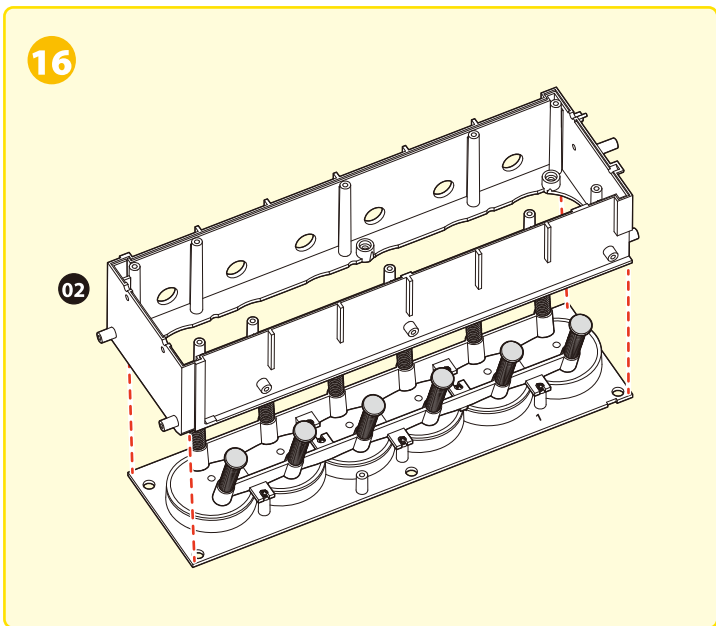
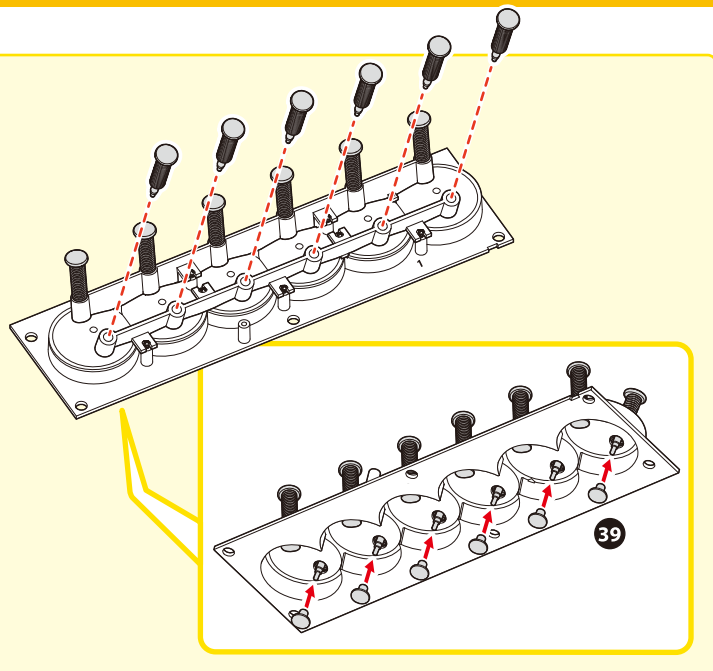
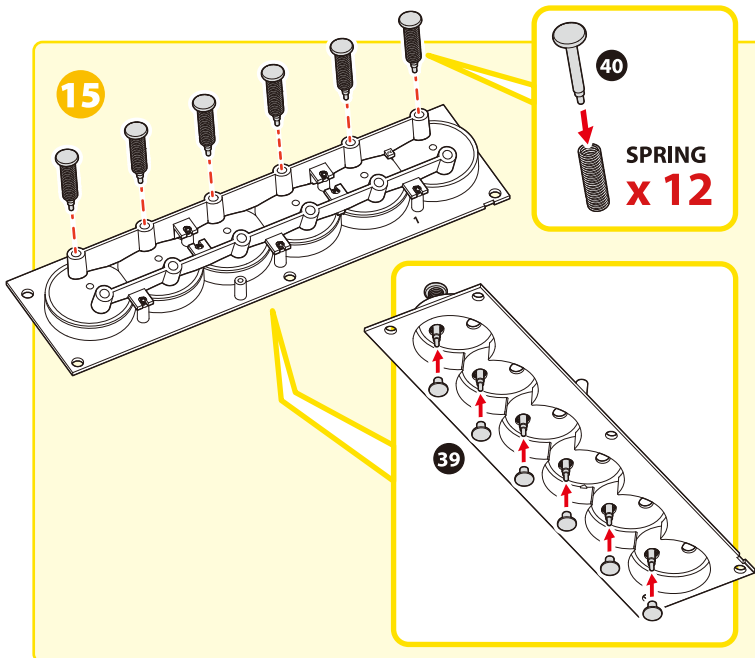


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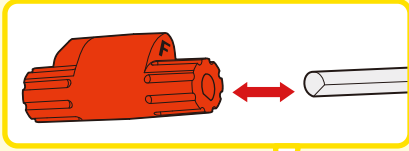


14



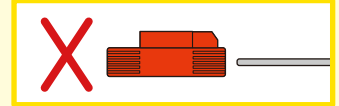
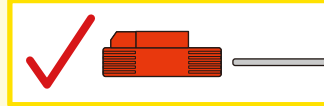
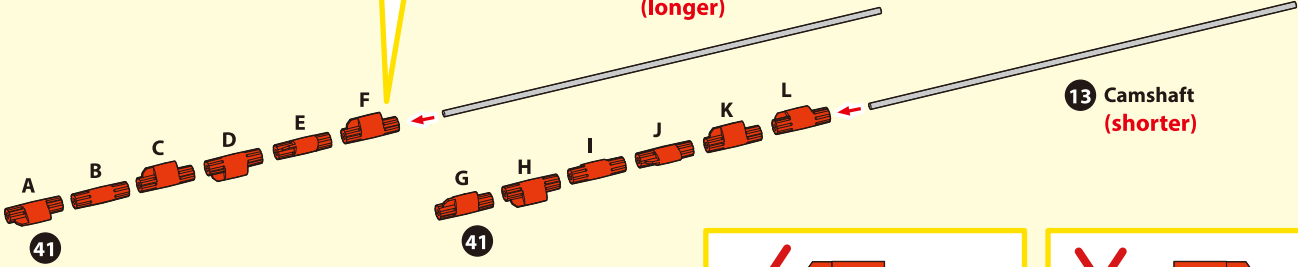


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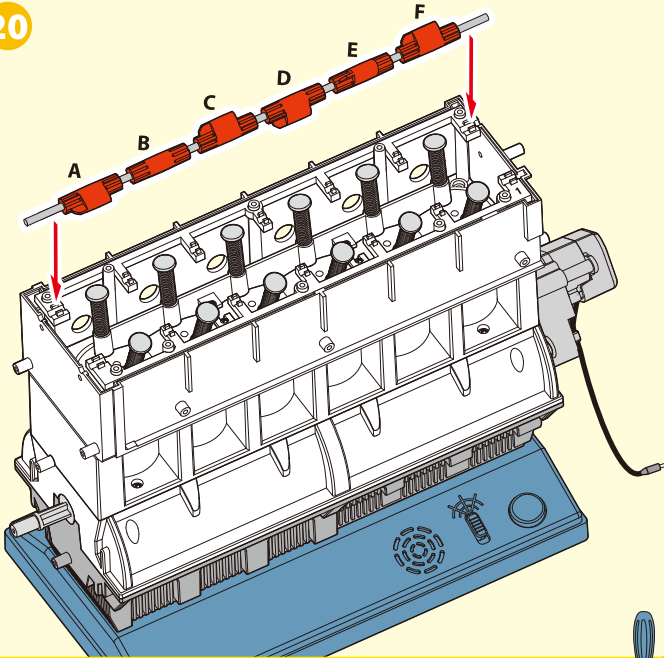


12 Camshaft (longer)

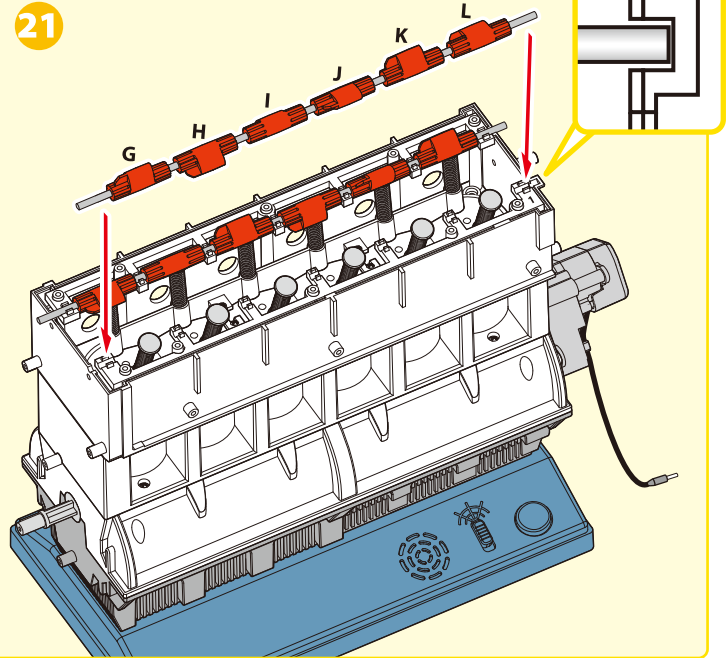
13 Camshaft (shorter)



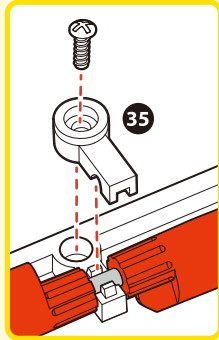
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21



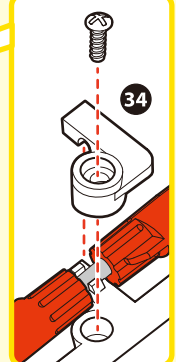
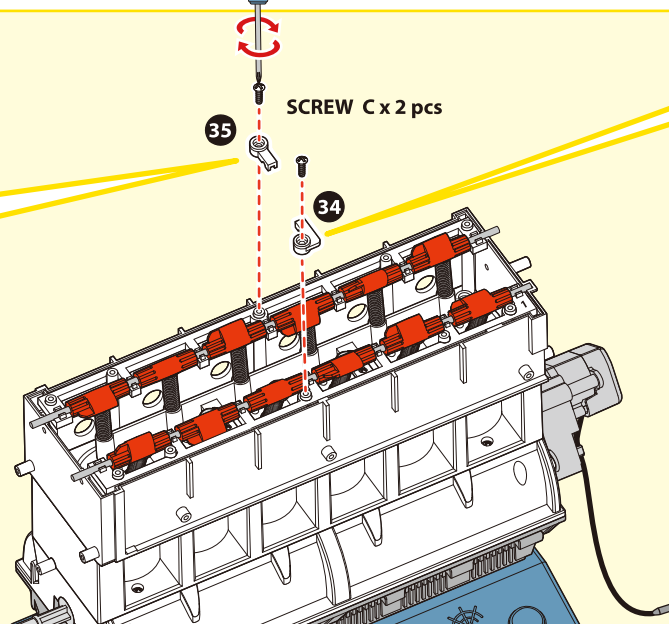
22



SCREW C x 2 pcs

35

34

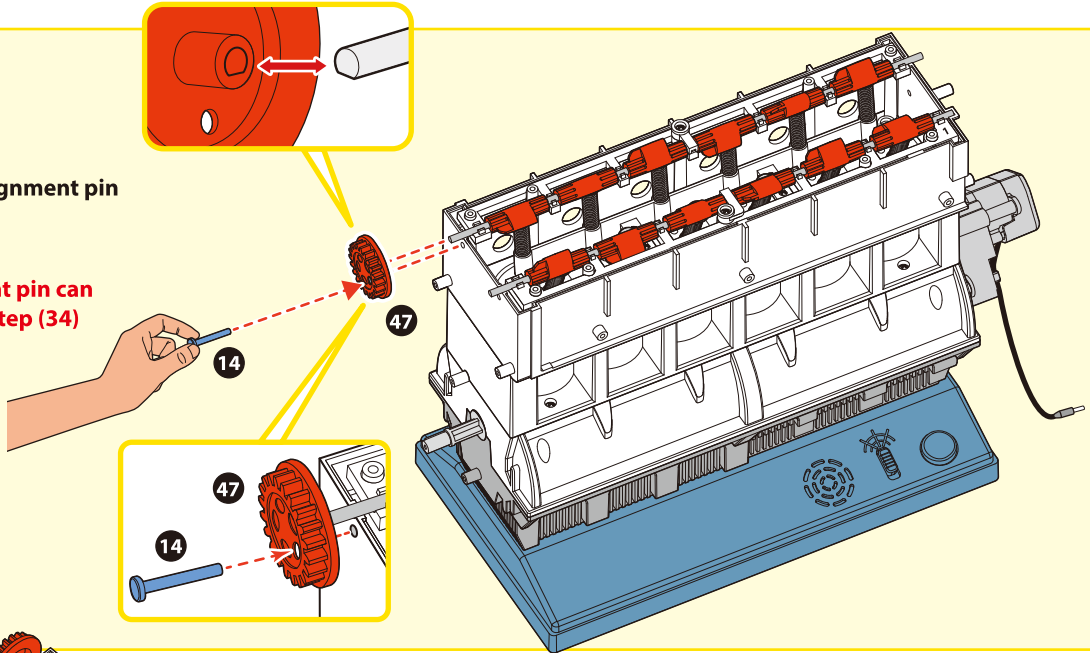


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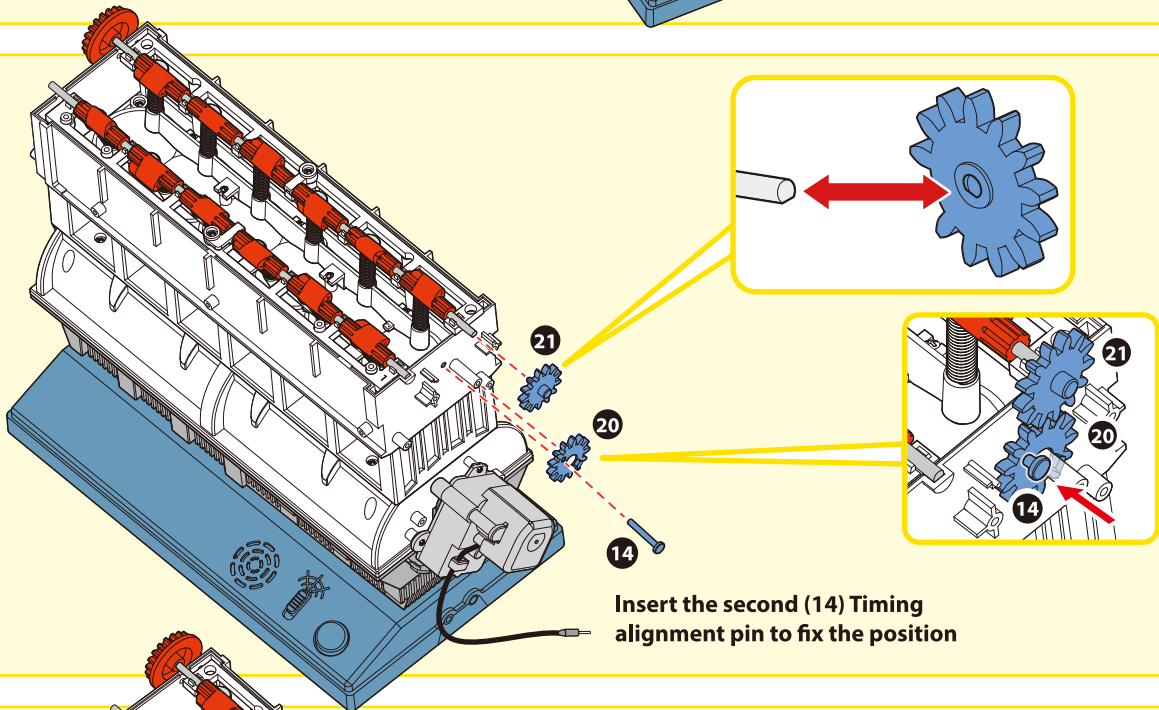
23

Insert (14) Timing alignment pin to fix the position

Attention:
This timing alignment pin can only be removed at step (34)

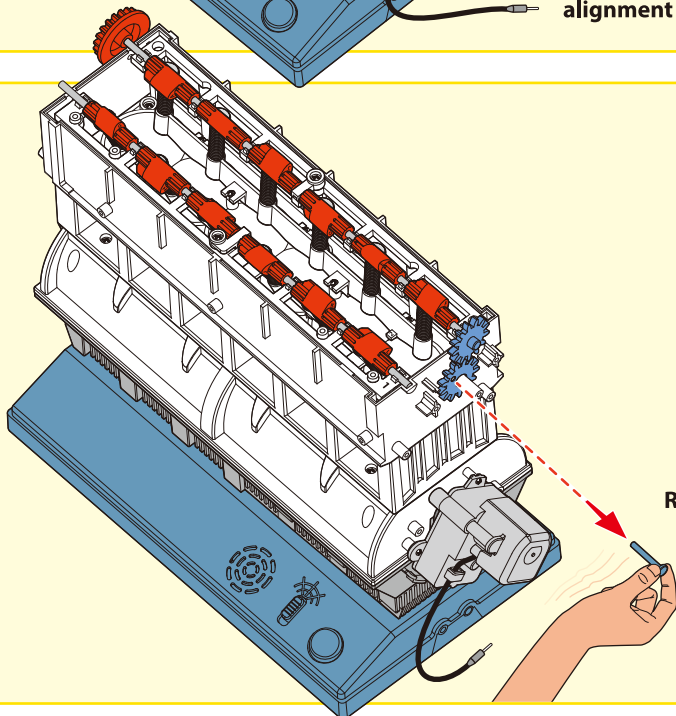


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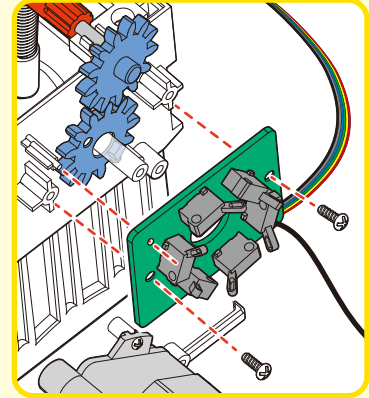
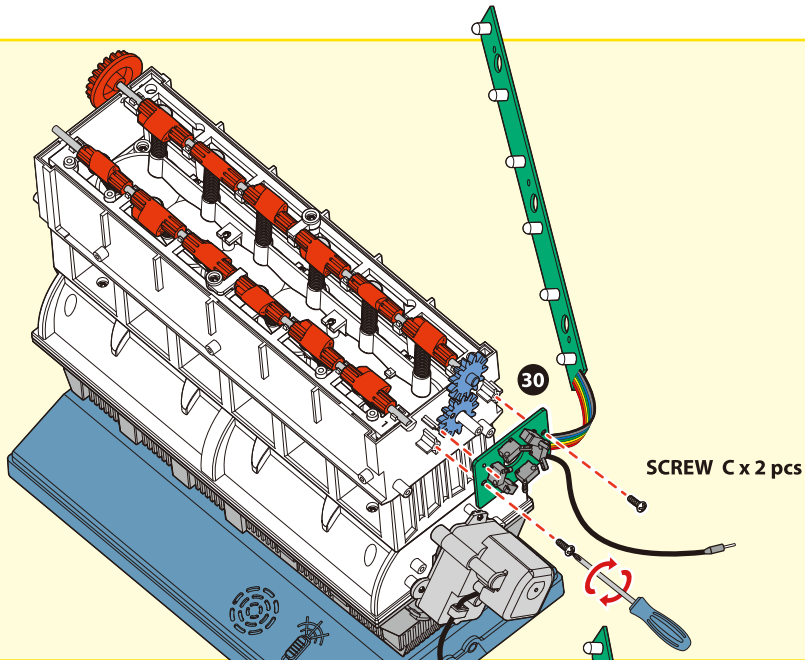
Insert the second (14) Timing alignment pin to fix the position

25

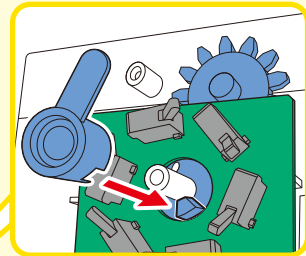
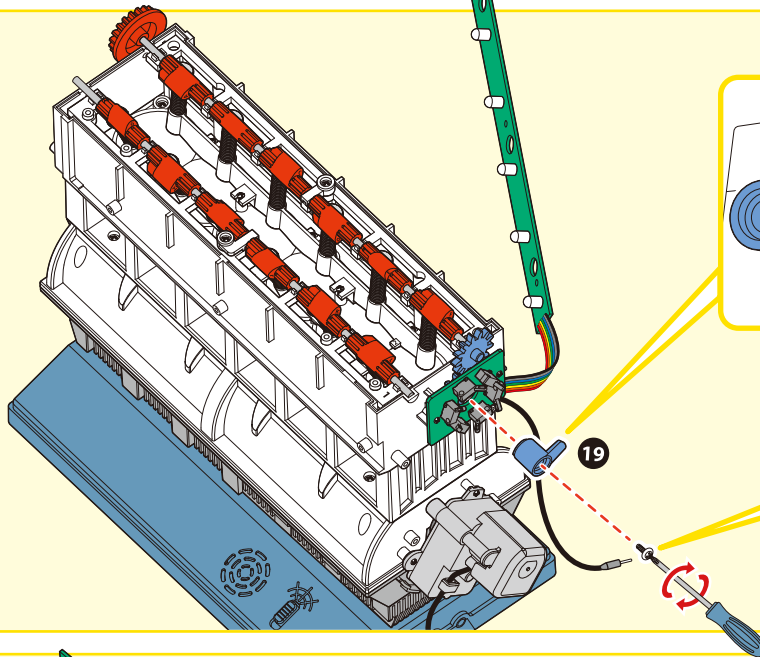


Tip:
Remove the second (14) Timing alignment pin

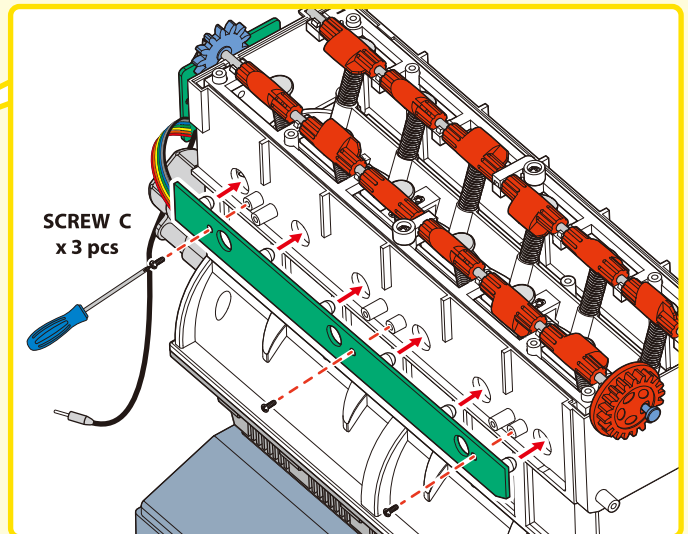
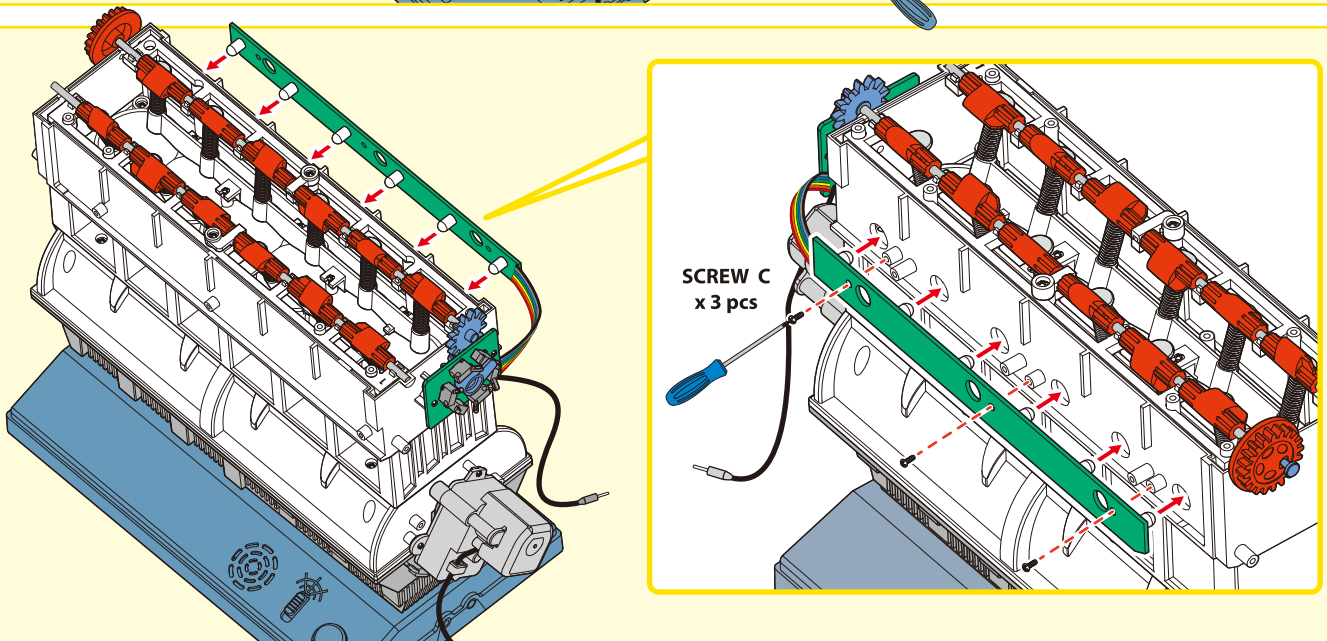
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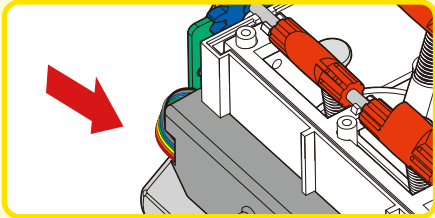
27



28

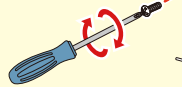


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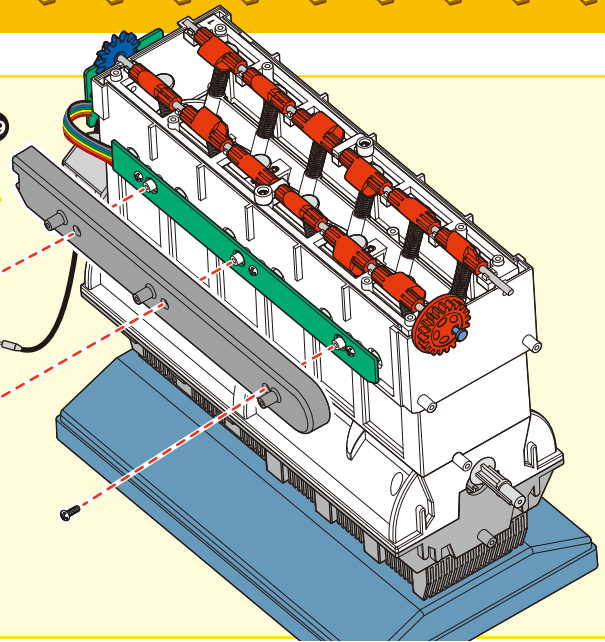


Tip:
Please push the set of cables forward into the black plastic for easier assembly later on.

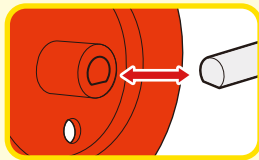
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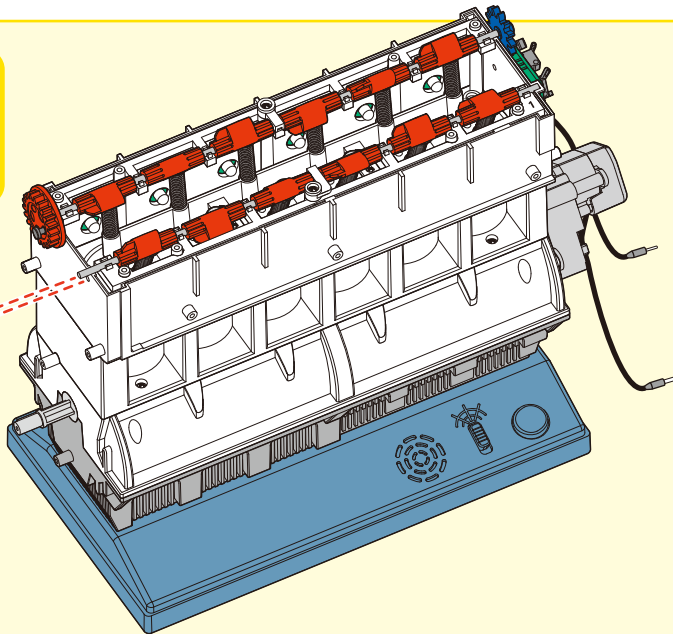
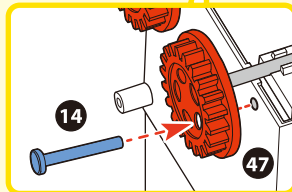
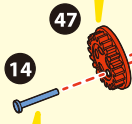
SCREW C x 3 pcs



30



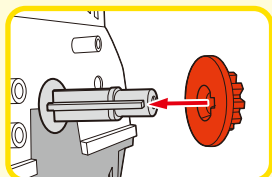
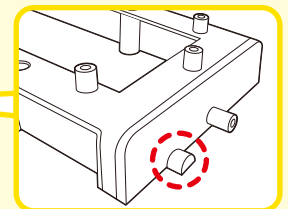
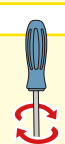
Insert the second (14) Timing alignment pin to fix the position



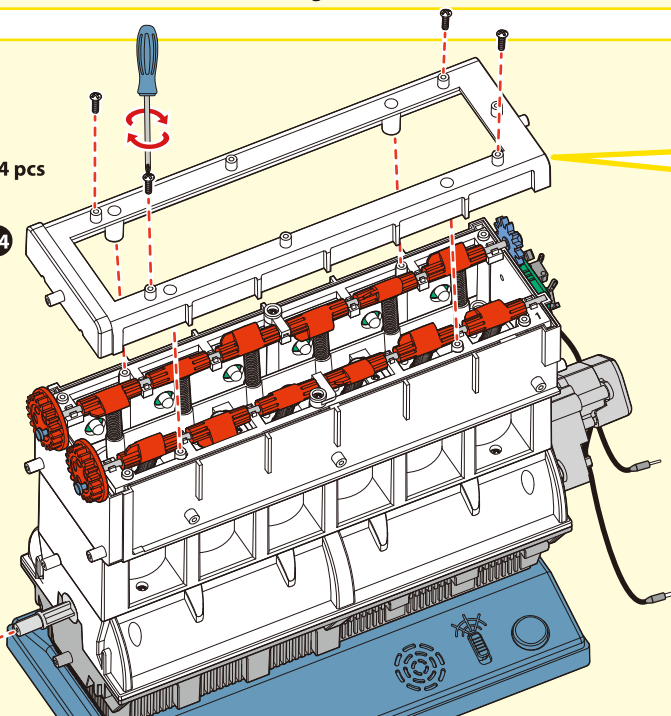
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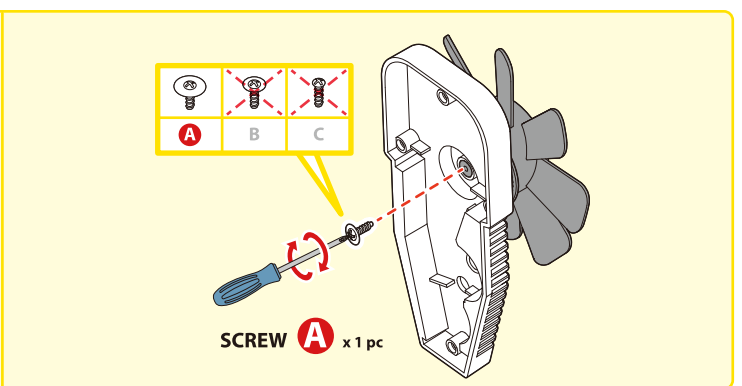
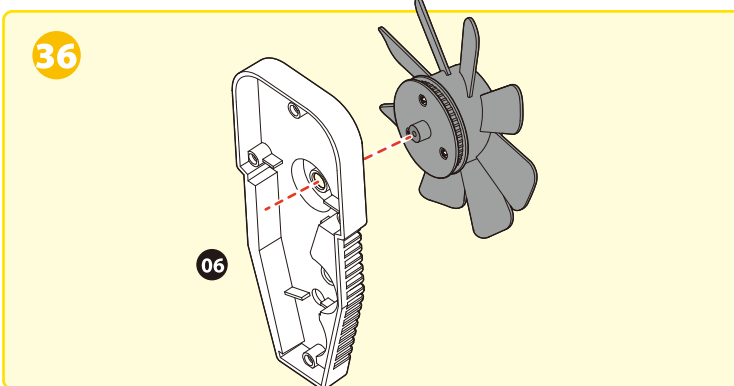
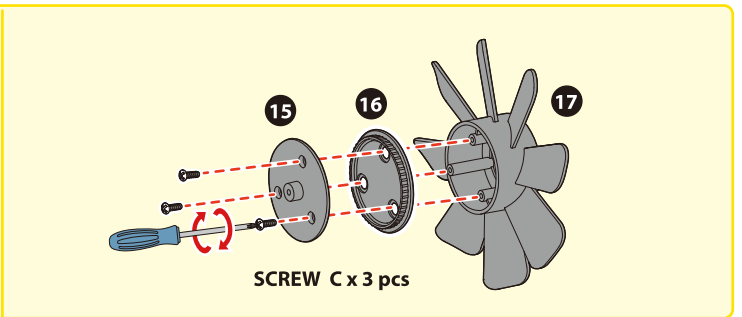
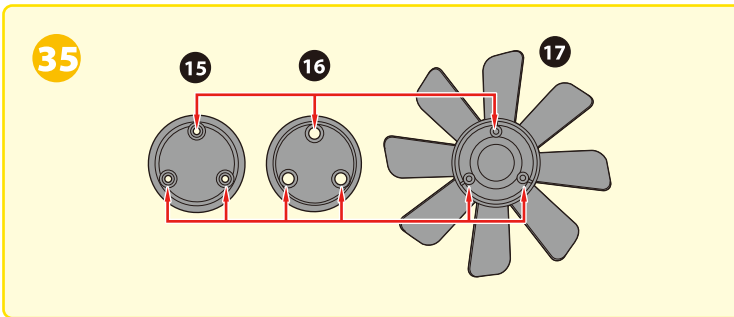
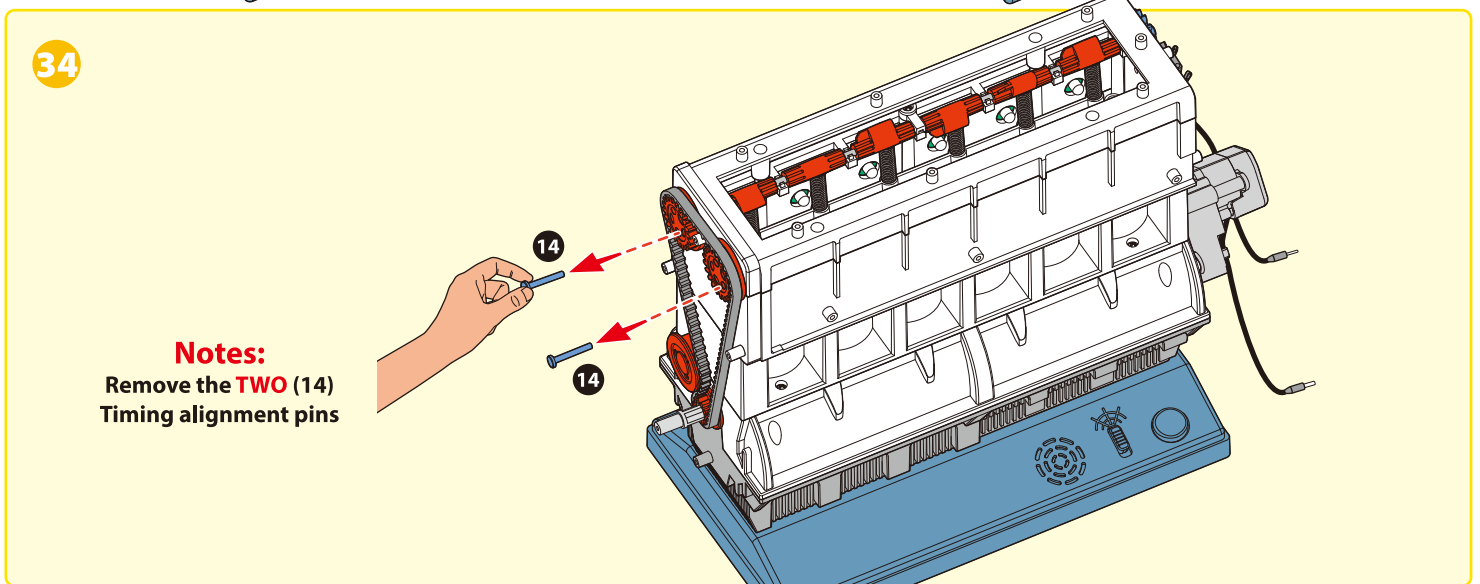
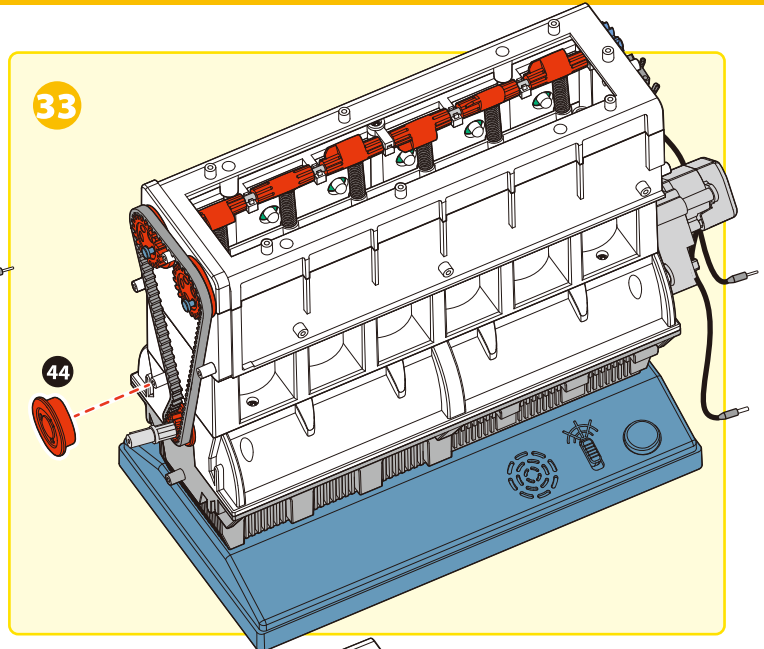
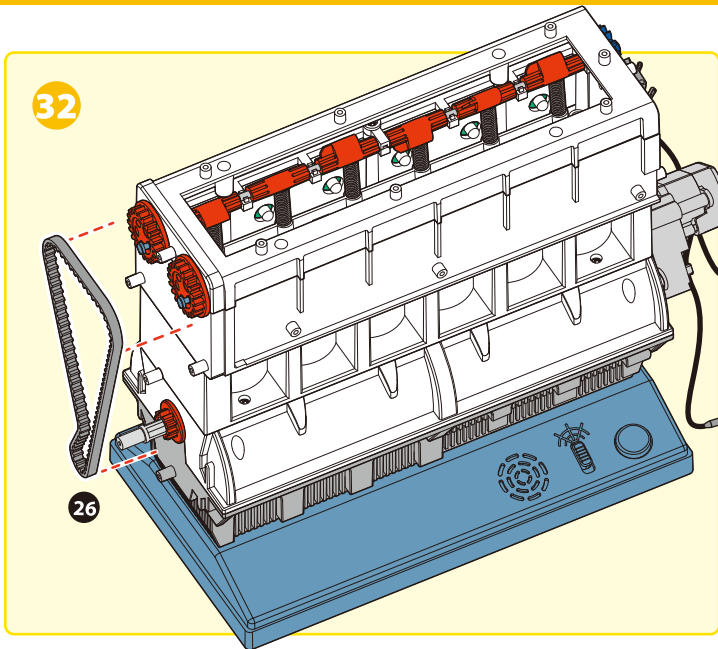
SCREW C x 4 pcs

04

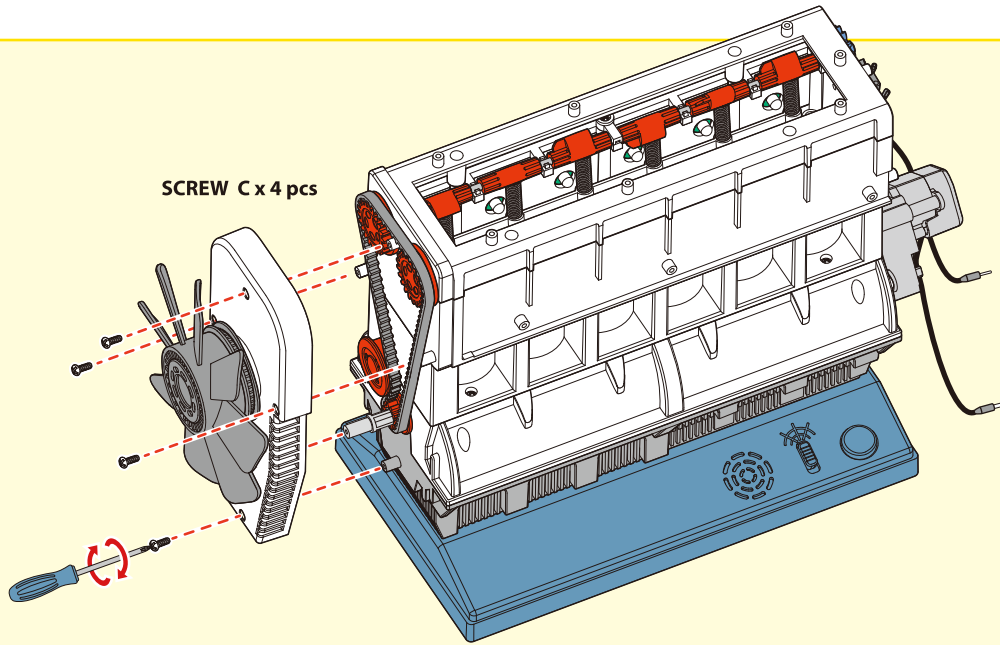


43

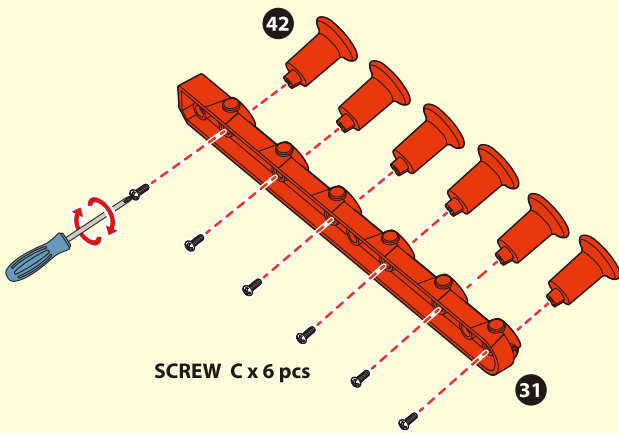




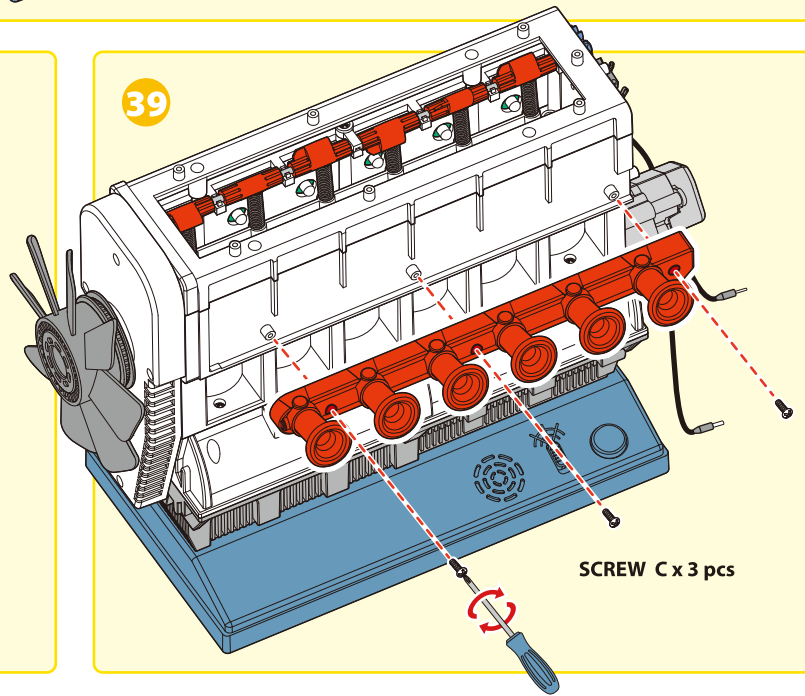
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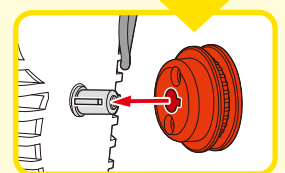
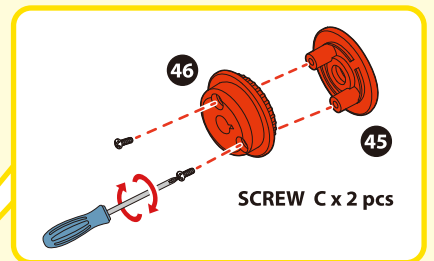
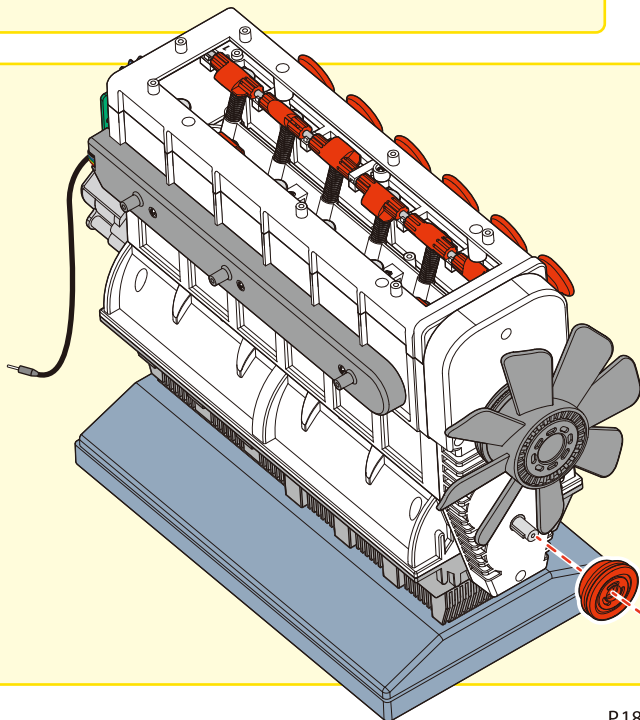
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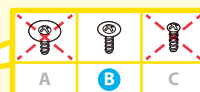
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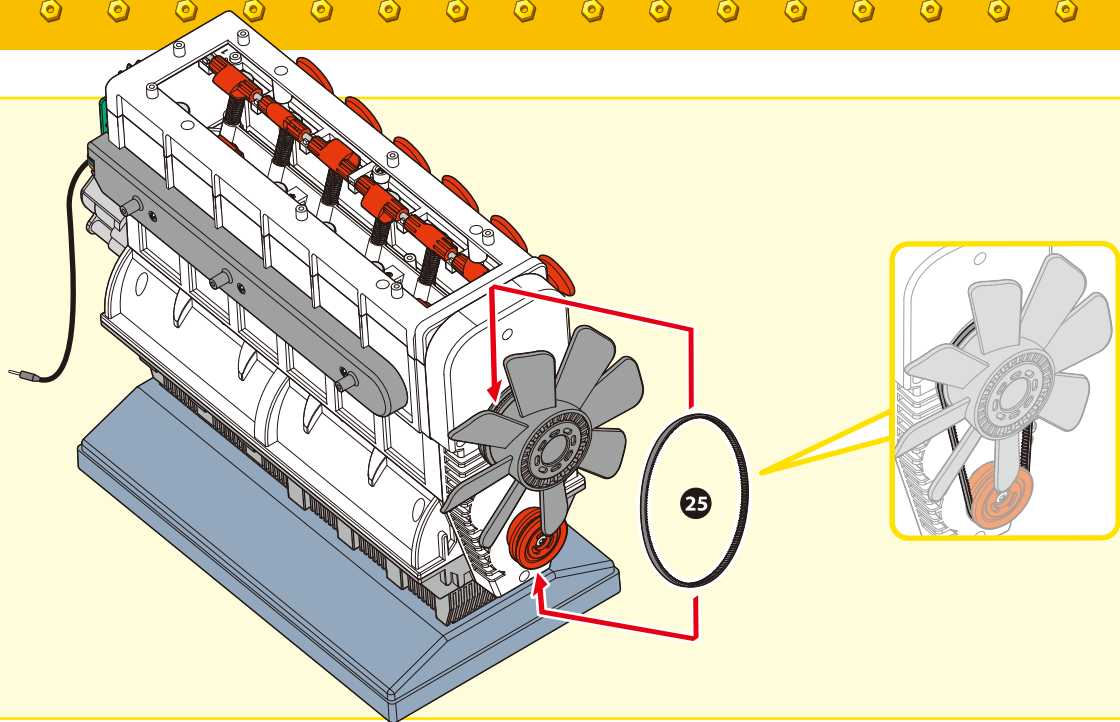
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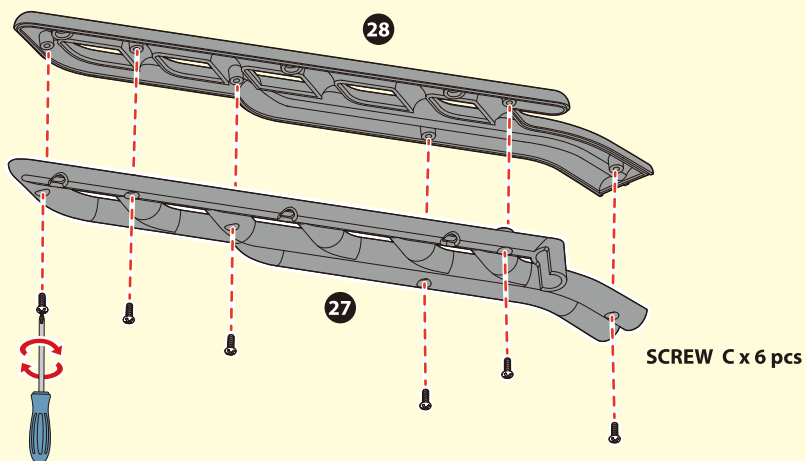
SCREW B x1pc



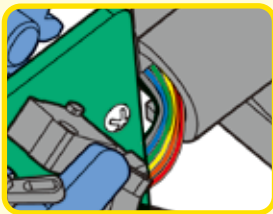
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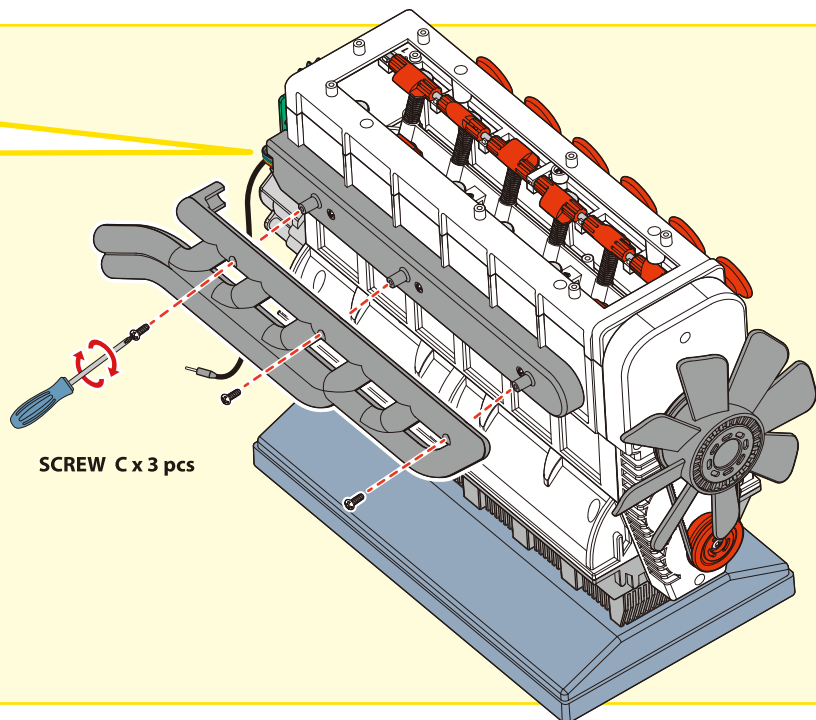
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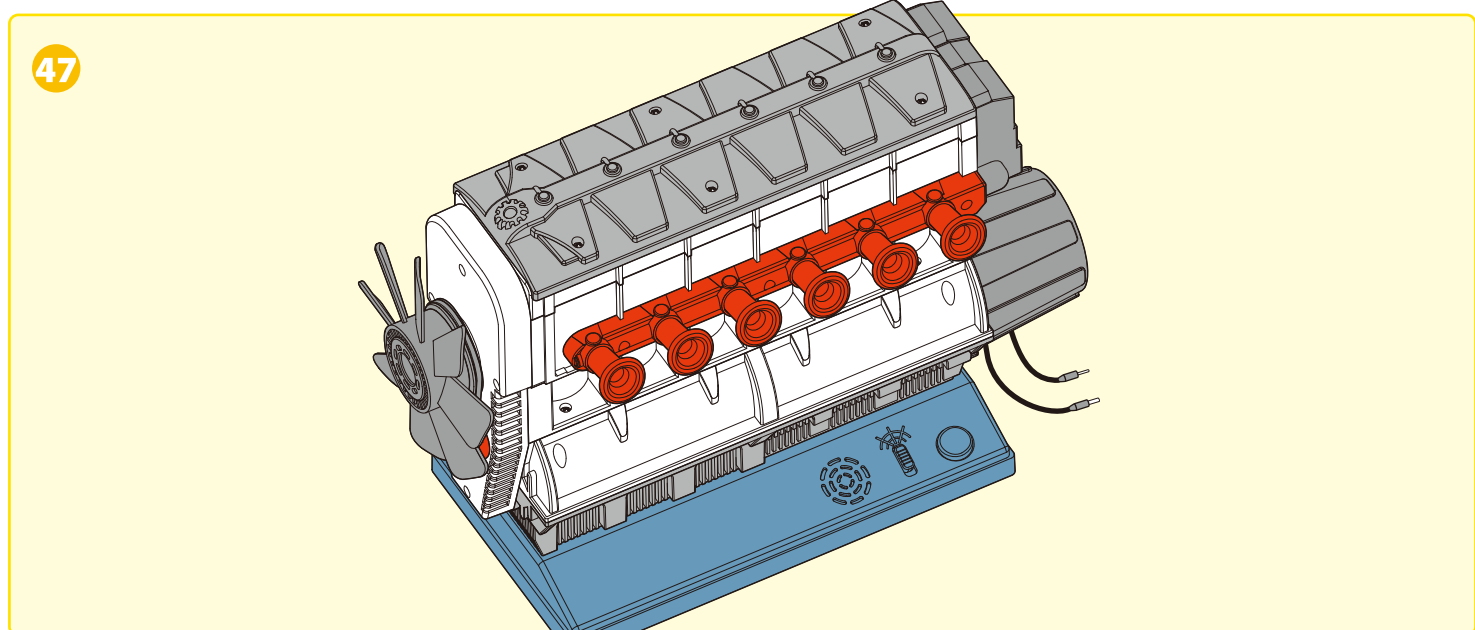
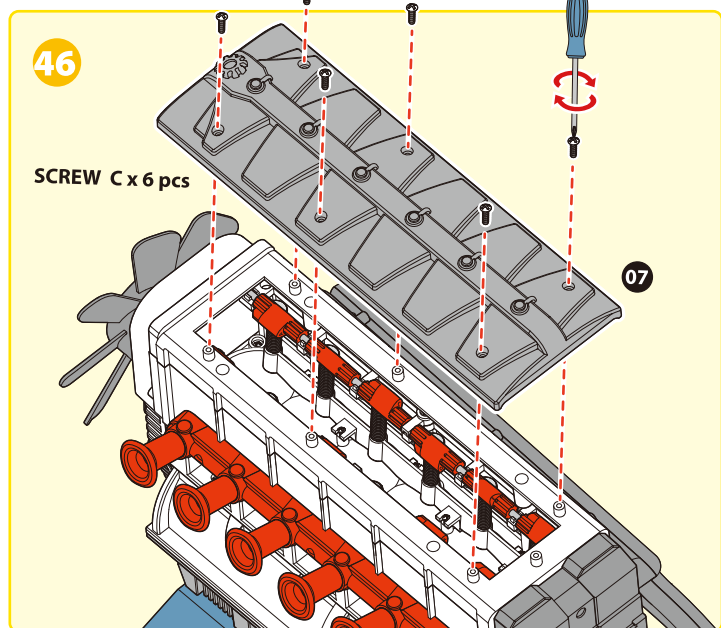
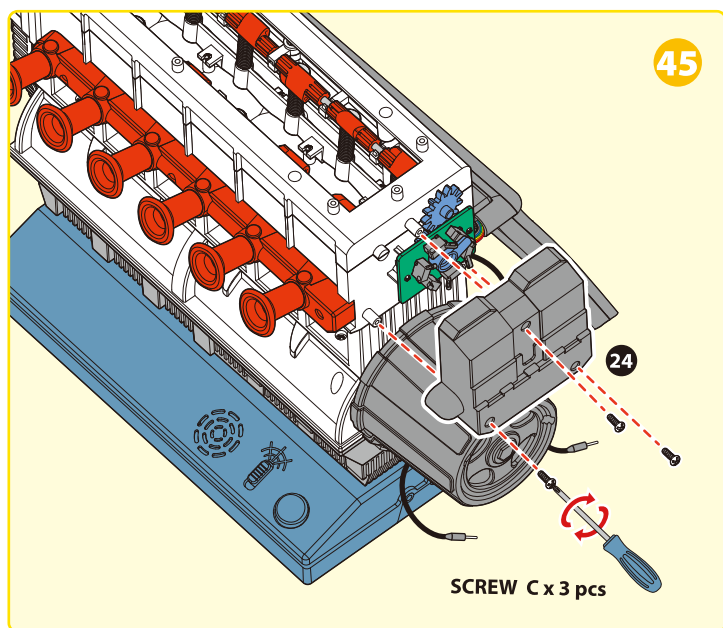
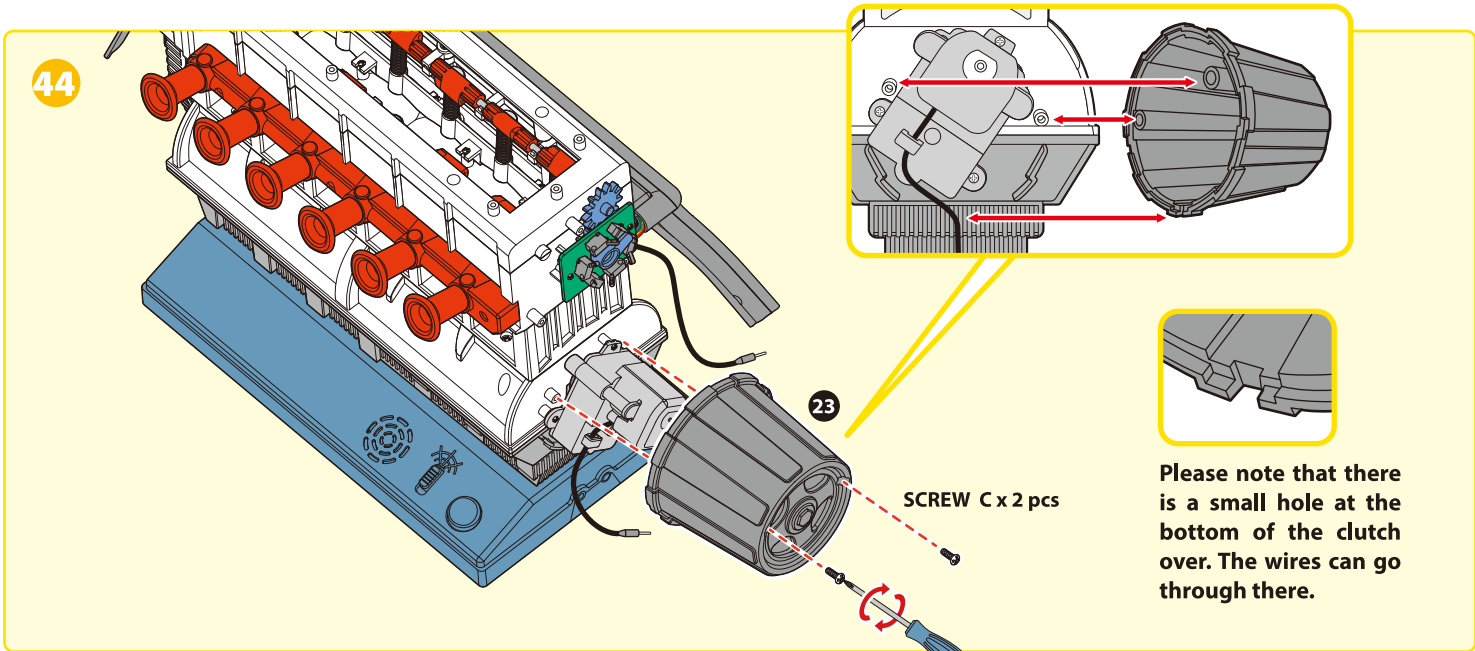


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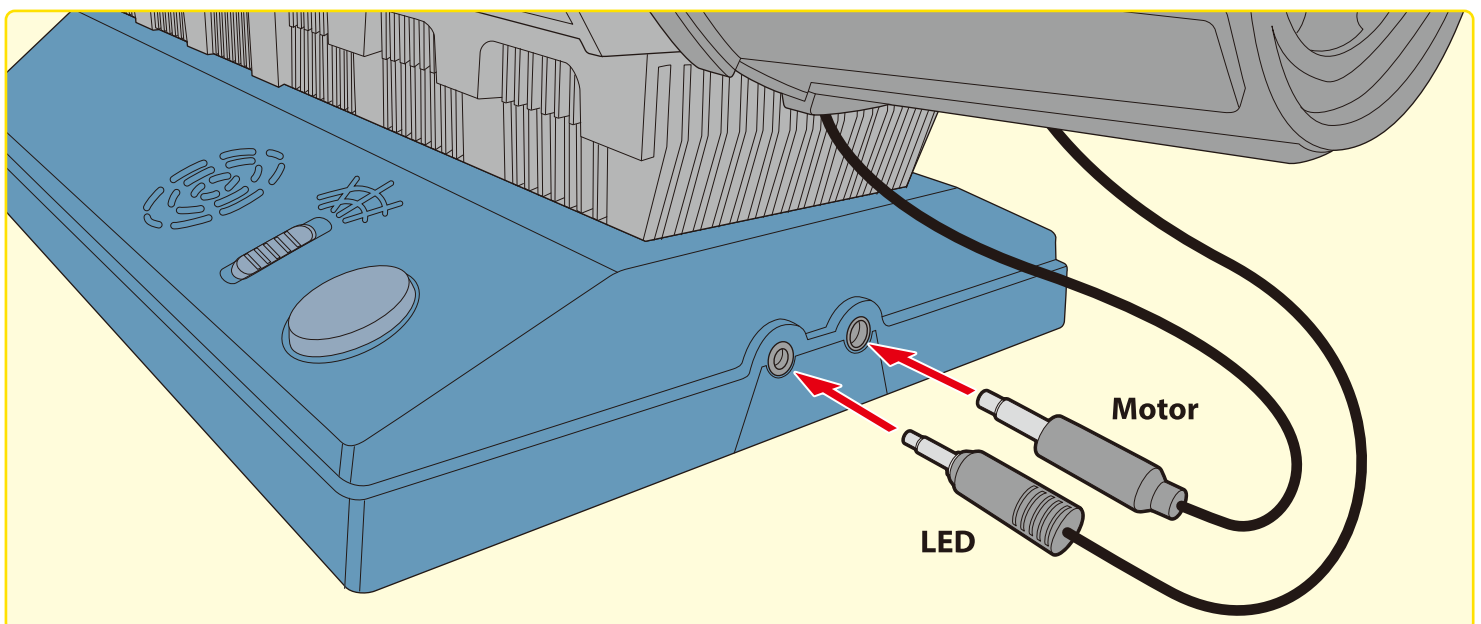
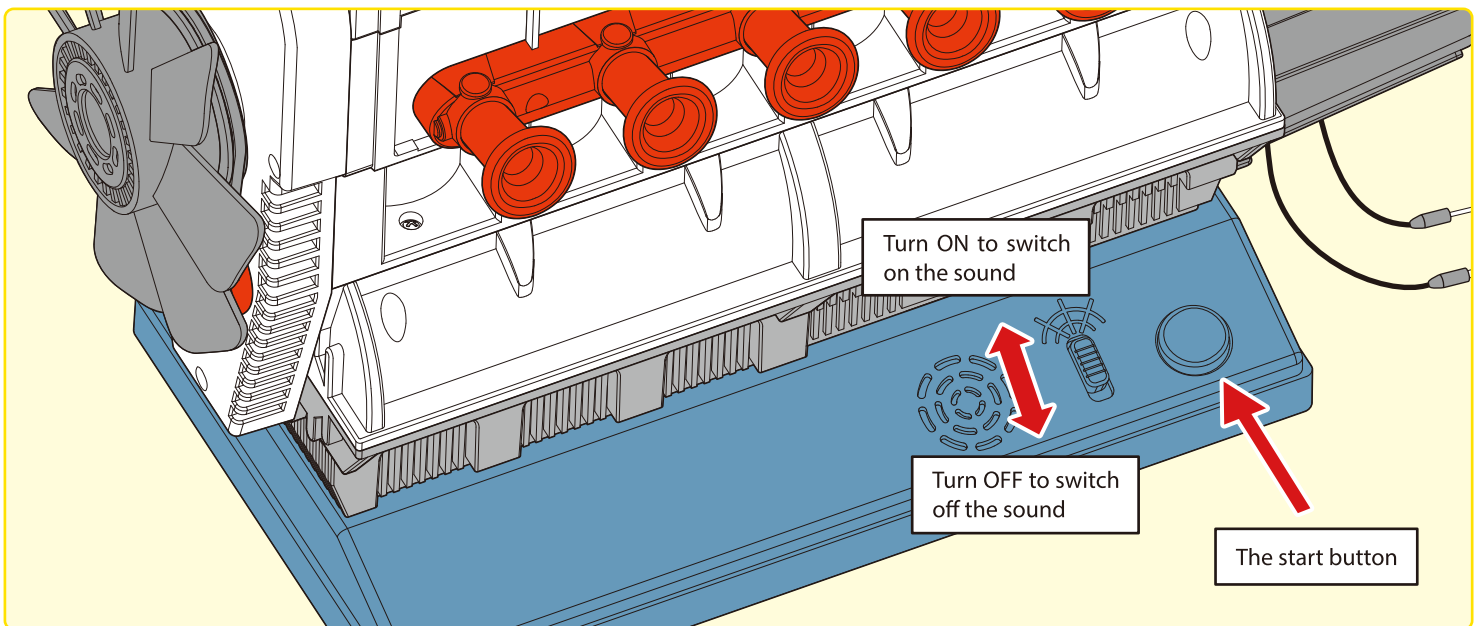
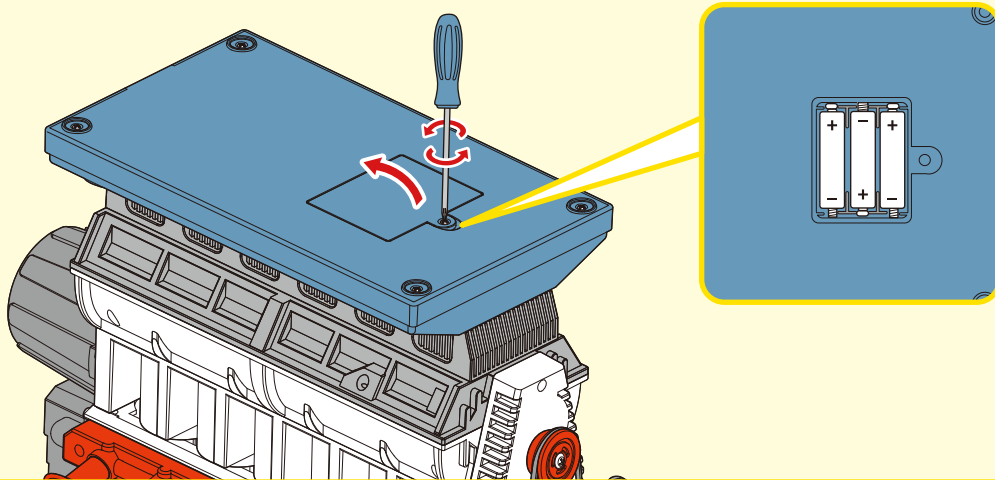
Tip:
You may need to
compress the wire to fit
in the grey plastic.

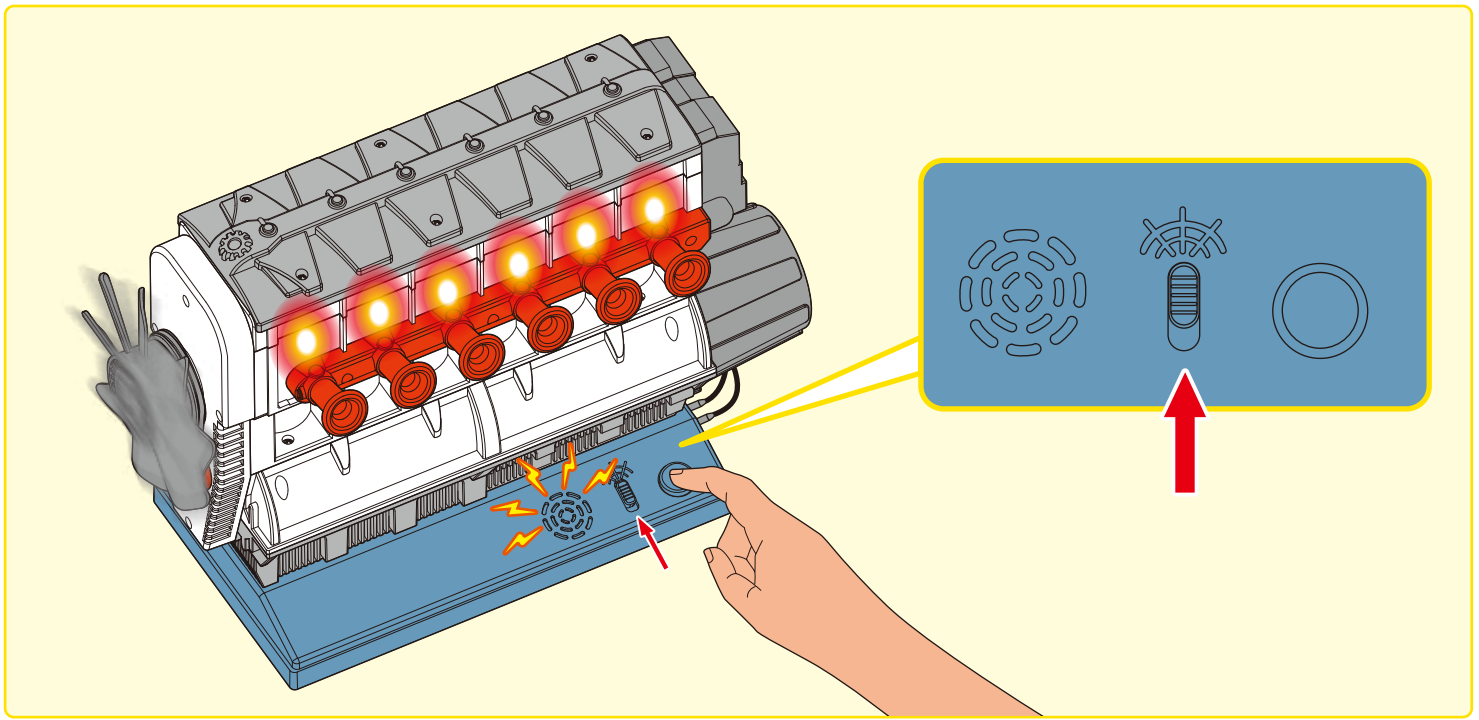
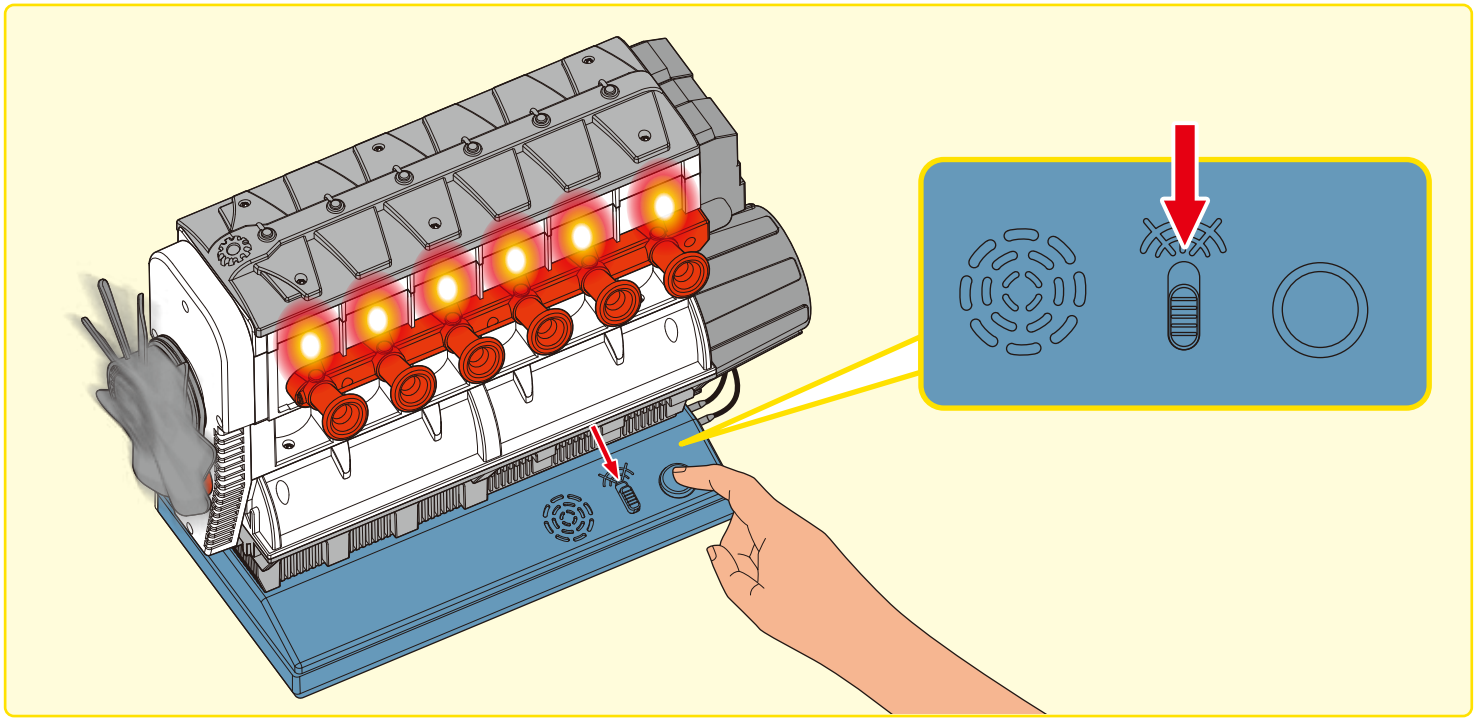




Starting the Inline 6 Engine

Turn the engine upside down. Remove the cover of the battery compartment by using a screwdriver and insert 3 AA batteries with the correct polarity as shown. Then cover it and tighten the screw.





How It Works

When you pressed the start button, the model works, stimulating the 4-stroke-cycle and the engine sound. In this model, the crankshaft is cranked by a motor. When a LED lights up, it represents the power cycle that the air-fuel mixture is combusted. The inlet and exhaust valves will automatically open and close at the proper time, in phase with the cycle that it is undergoing. The sound at the bottom of the speaker is simulating the sound when a real Inline 6 Engine operates. It will run for about 26 seconds and goes off.

Comparison

This model is a simulation of the real engine. In a real engine, the combustion of air-fuel mixture in the cylinders is the power source that cranks the crankshaft. In this model, the crankshaft is cranked by the motor to simulate the action. Also, a real engine is made of metal, so that it can withstand the combustion process. Since the combustion will generate lots of heat, a cooling system is required to avoid the engine from overheating. Water is used as a coolant to circulate around the engine to the "radiator" at the front part of the car. Because the combustion process will produce exhaust gas, this is why the engine in a car needs an exhaust pipe--- to exhale the exhaust gas.



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WARNING

