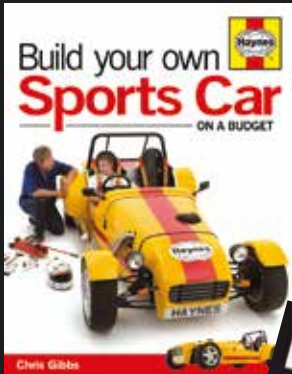
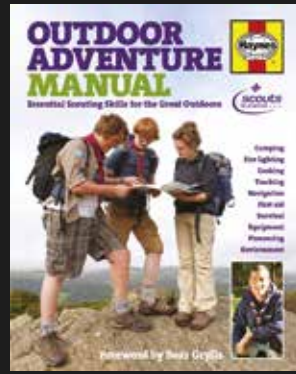
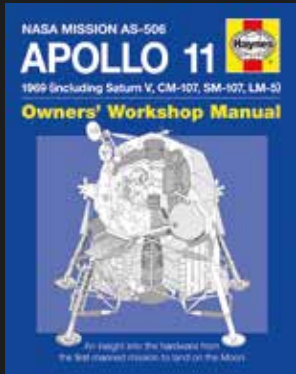


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BUILD YOUR OWN
JET ENGINE
HAYNES ASSEMBLY MANUAL



**A working model
of a jet engine**

**WITH
JET ENGINE
SOUNDS**

**JE01 Haynes Build Your Own
Jet Engine**

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INTRODUCTION

The turbofan is a type of gas turbine engine that has widespread use for powering aircraft, particularly those for civilian (passenger) use. The design was brought about by the need for an engine that would operate efficiently at the airspeeds between those of propeller aircraft (low speed) and those of pure turbojets (high speed). Working turbofan engines were first developed in the 1940s, by both German and English engineers, as part of the wider development of turbine (jet) engines. The word "turbofan" describes a gas turbine engine to which a fan (essentially a propeller operating within a circular duct or tube) has been added. The thrust provided by the engine is thus a combination of the flow of air generated by the fan and the flow of air from the central turbine portion (the core).

Early turbofans were generally low-bypass designs, which means that the majority of the thrust provided by the engine is generated by the gas turbine core. Conversely, a high bypass engine is one in which the majority of thrust is generated by the fan, and is typical of the engines used on modern commercial airliners. The bypass ratio expresses the proportion of air flowing around the outside of the core to the mass flowing through the core, and is usually between 5:1 and 10:1 in the engines used on passenger aircraft.

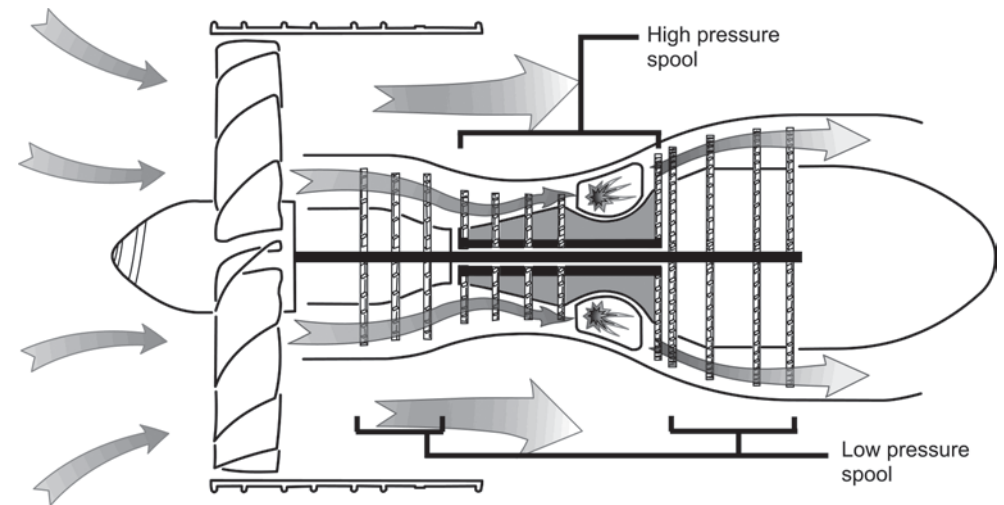
Because the addition of the fan has a relatively small effect on the fuel consumption of the central core of the engine, for a much greater increase in thrust, high bypass turbofan engines are very fuel efficient. This, and their low noise compared with low bypass designs, makes them the ideal choice for use on passenger planes.

The central (core) turbine section of the engine consists of one or more sets of compressor blades at the front, and turbine blades at the rear, linked by a shaft – this is collectively known as a "spool". Turbines may have one, two or even three spools, each of which rotates independently of the other(s). The basic principle is that fuel burning in the combustion chamber accelerates air towards the rear, driving the turbine, and in turn (by the connecting shaft), the compressor blades. The compressor blades accelerate and compress the air entering the combustion chamber, improving the efficiency of the combustion process. Having multiple spools allows the low and high pressure sections of the engine to operate at different speeds, which helps to optimize the operation of the engine. In a typical two-spool engine, the high pressure spool will rotate between 3 and 4 times faster than the low pressure spool. Stationary guide vanes between each set of compressor and turbine blades are used to improve the flow of air through the engine and increase efficiency.

INTRODUCTION

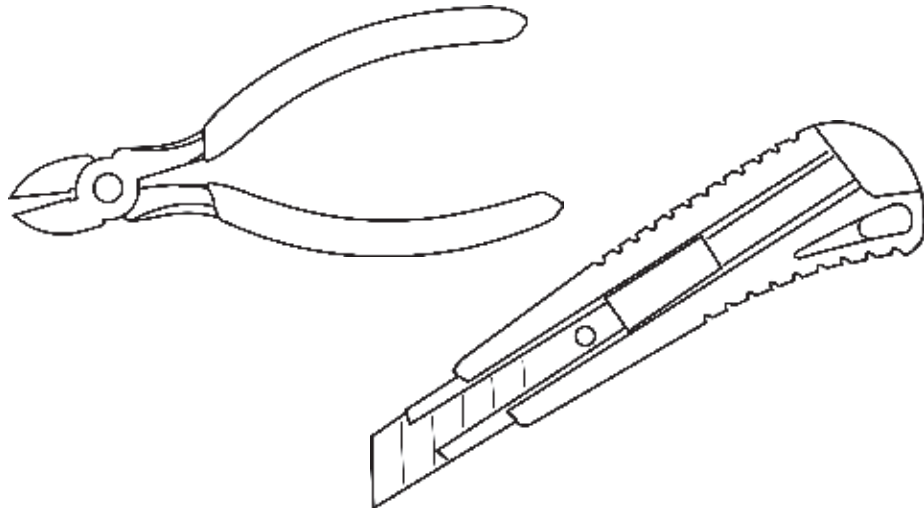
Turbofan engines are started by spinning the high pressure spool, either mechanically by a geared shaft or by blowing air from an auxiliary power unit, until it is rotating fast enough to draw sufficient air through the engine, and for fuel to then be ignited in the combustion chamber. This is typically between 10-30% of the rated maximum speed of the high pressure spool – any slower and the engine could overheat and be damaged.

The model is not intended to replicate any particular engine, but is intended to show the general principles of a two-spool turbofan. To make the different parts of the engine clearer, the low and high pressure spools are coloured light and dark blue, respectively. The high pressure spool rotates approximately twice as fast as the low pressure section, to simulate the effect seen in a real engine. Other features to note are the combustion chamber, which uses red LED lights to simulate the combustion process, and the white swirl pattern painted on the front of the fan. On real engines, the swirl pattern serves as a visual indication to ground crew that the engine is running when the aircraft is taxiing on the ground.



NOTES AND ADVICE

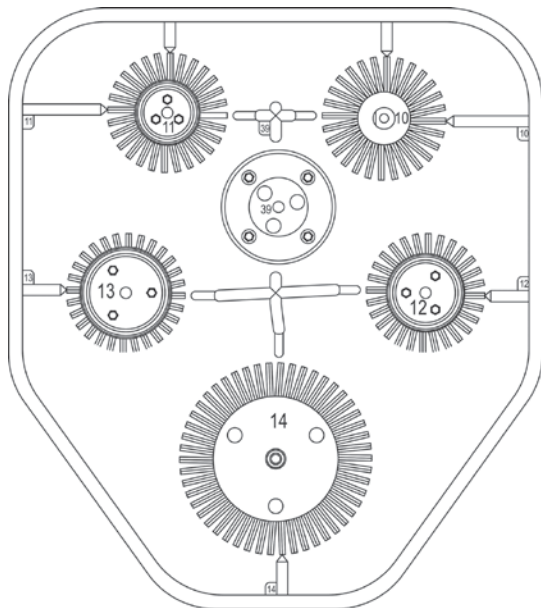
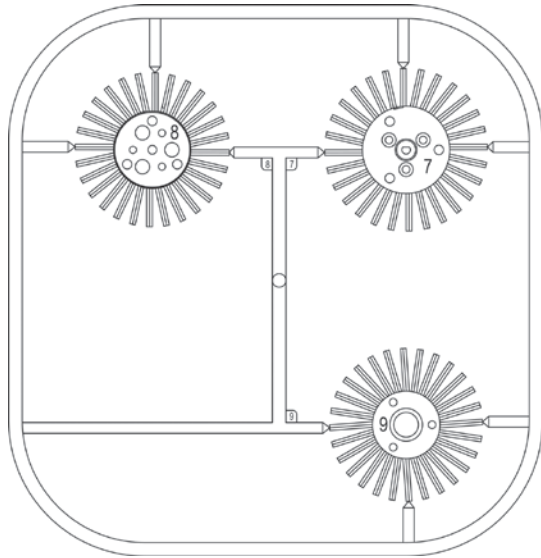
- Identify the various parts by looking at the list of components and the corresponding illustrations.
- When assembling the compressor/turbines, we recommend that you first remove the parts needed for each step from the plastic frames (sprues), and lay them out on the table in the correct order. This will help to ensure that the parts are assembled in the correct order.
- Take care not to over-tighten the screws as this may permanently damage the plastic.
- Use a sharp craft knife or some snips (see images below) to remove parts from the carrier frames. To ensure smooth running, always trim any excess plastic from the parts.
- The turbine blade assemblies are very fragile, so please take extra care when handling.
- 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.
- Different types of batteries, or new and used batteries are not to be mixed.
- 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 short-circuited.



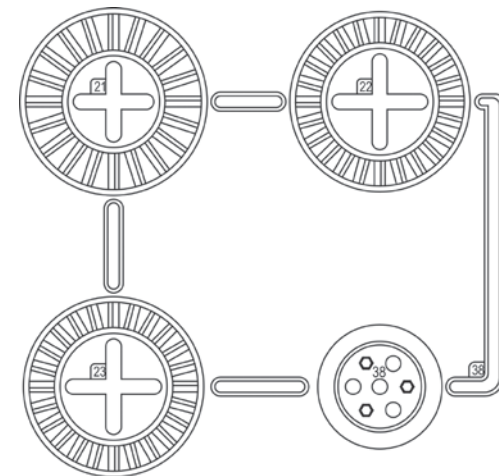
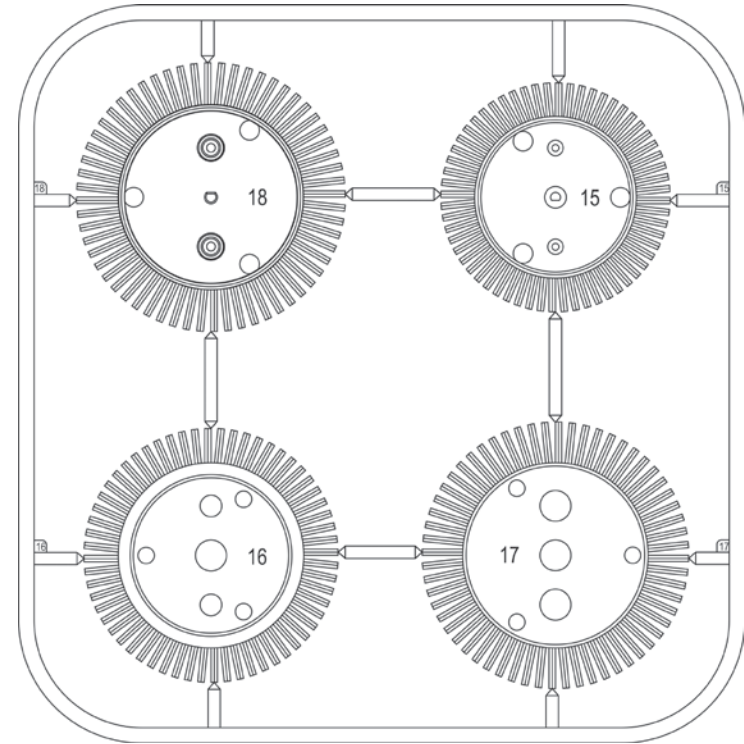
PARTS LIST

Qty.	Part	Part No.	Qty.	Part	Part No.
1	Housing right	1	1	High pressure compressor guide vane #1	21
1	Housing left	2	1	High pressure compressor guide vane #2	22
1	Fan housing front	3	1	High pressure compressor guide vane #3	23
1	Fan housing rear	4	1	High pressure compressor tube	38
1	Housing rear	40	1	High Pressure turbine tube	39
1	Fan blade front	5	1	Low pressure compressor guide vane #1	19
1	Fan blade rear	6	1	Low pressure compressor guide vane #2	20
1	Fan spinner	37	1	Low pressure turbine guide vane #1	24
1	Low pressure compressor vane #1	7	1	Low pressure turbine guide vane #2	25
1	Low pressure compressor vane #2	8	1	Low pressure turbine guide vane #3	26
1	Low pressure compressor vane #3	9	1	Pulley cover plate	32
1	High pressure compressor vane #1	10	1	Tail cone	53
1	High pressure compressor vane #2	11	1	Small geared pulley	30
1	High pressure compressor vane #3	12	1	Large geared pulley	31
1	High pressure compressor vane #4	13	1	Shaft bushing A	35
1	High pressure compressor turbine vane	14	1	Shaft bushing B	36
1	Low pressure turbine vane #1	15	1	Tail cone insert	56
1	Low pressure turbine vane #2	16	1	Engine support	55
1	Low pressure turbine vane #3	17	20	Screws	
1	Low pressure turbine vane #4	18	1	Screwdriver	
3	High Pressure compressor drive gear	51	1	Drive belt	
1	Metal shaft (181mm)				
1	Metal shaft (25mm)				
1	Combustion chamber assembly				
1	Base assembly				

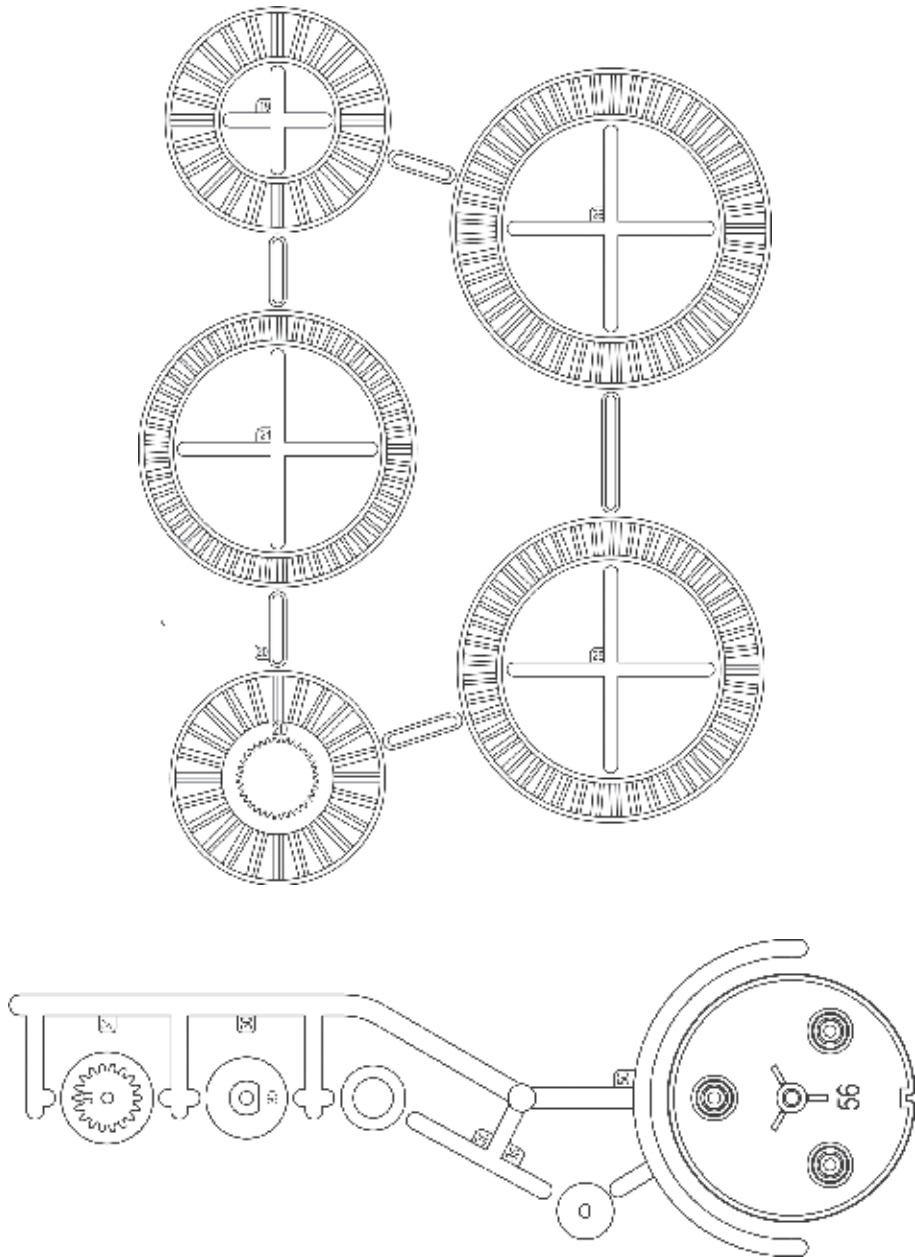
PARTS LIST



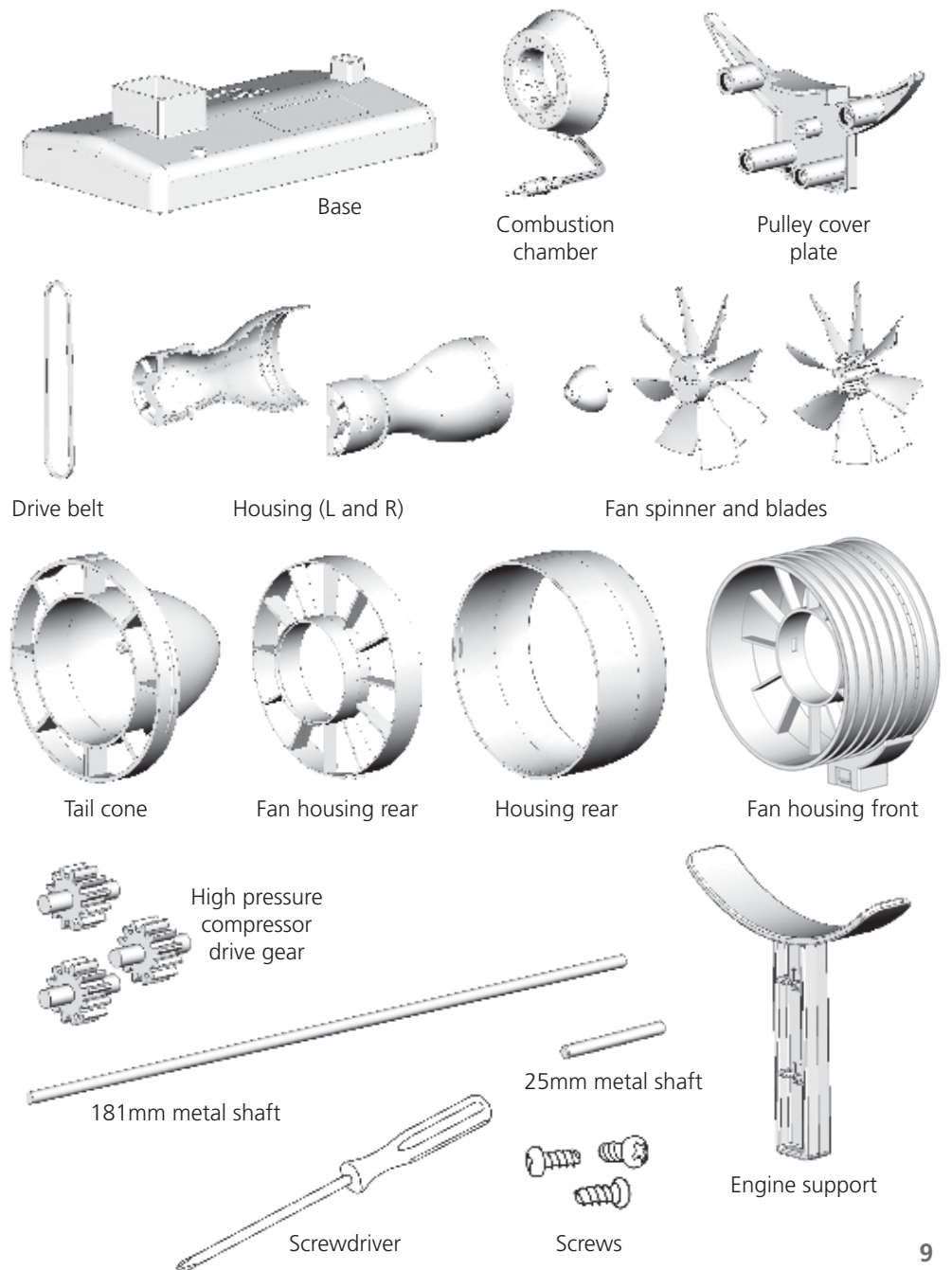
PARTS LIST



PARTS LIST

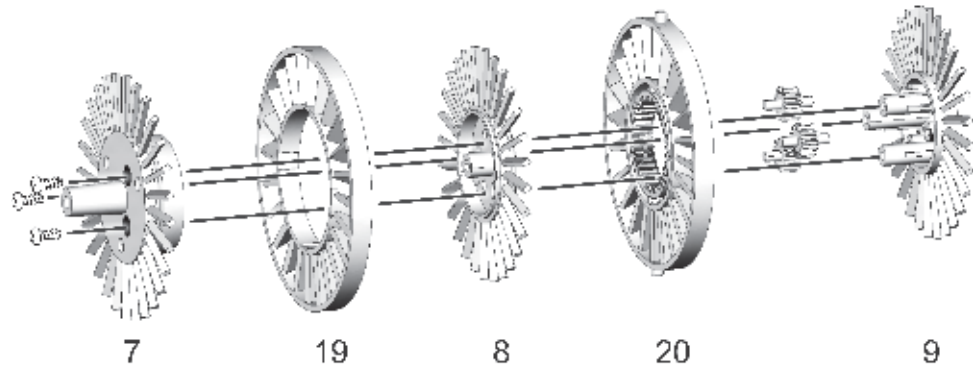


PARTS LIST

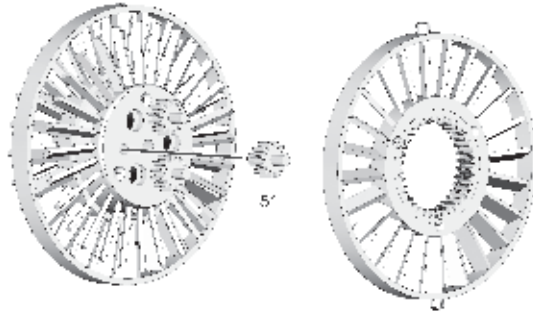


ASSEMBLING THE ENGINE

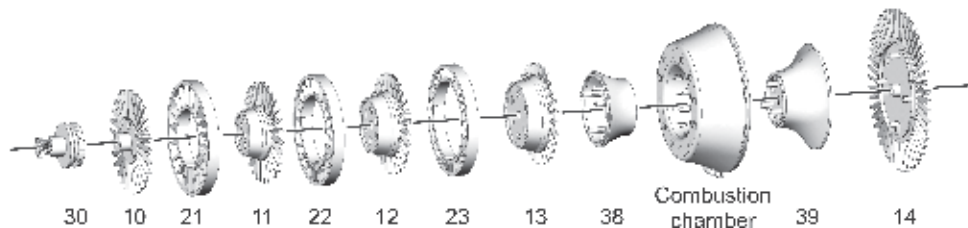
Step 1 - Low pressure compressor



Assemble the low pressure compressor stage using the parts shown. The guide vane (19) is a loose fit over the rear of part (7) – this is intentional. Secure with three screws. We recommend that you fit the drive gears (51) to the rear of part (8) first, then fit part (20) over these (refer to inset picture).



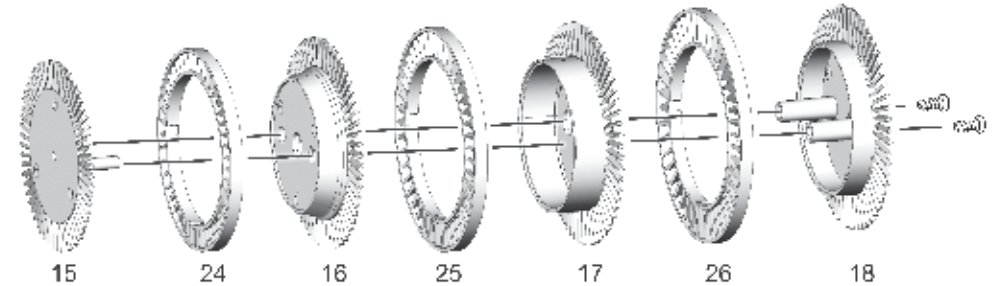
Step 2 - High pressure compressor and turbine



Assemble the high pressure compressor and turbine. Note how parts (38) and (39) are fitted through the middle of the combustion chamber. As in Step 1, the guide vanes (21, 22, 23) are a loose fit. Press firmly to ensure all parts are assembled correctly, but take great care to prevent damage to the fan blades.

ASSEMBLING THE ENGINE

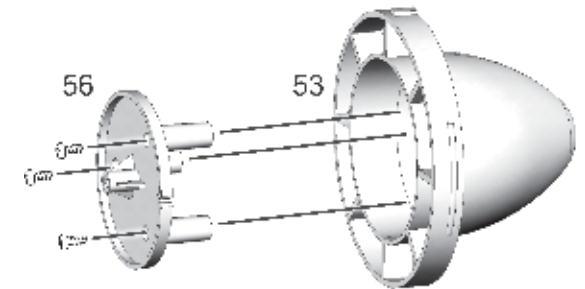
Step 3 - Low pressure turbine



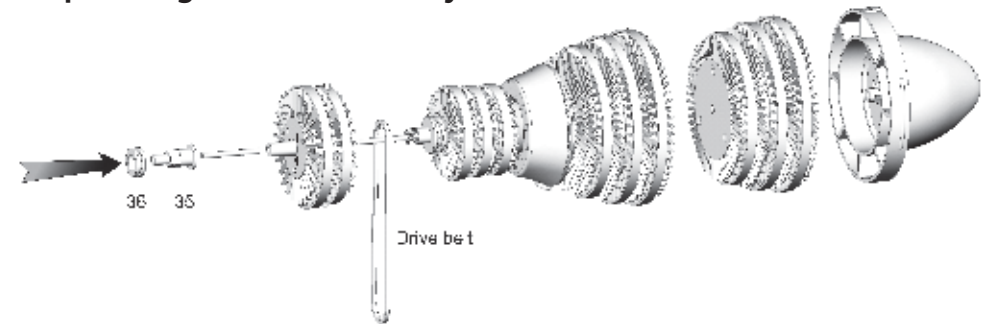
Assemble the low pressure turbine. Secure with two screws.

Step 4 - Tail cone

Fit the inner part of the tail cone (56) to the tail cone (53) and secure with three screws.



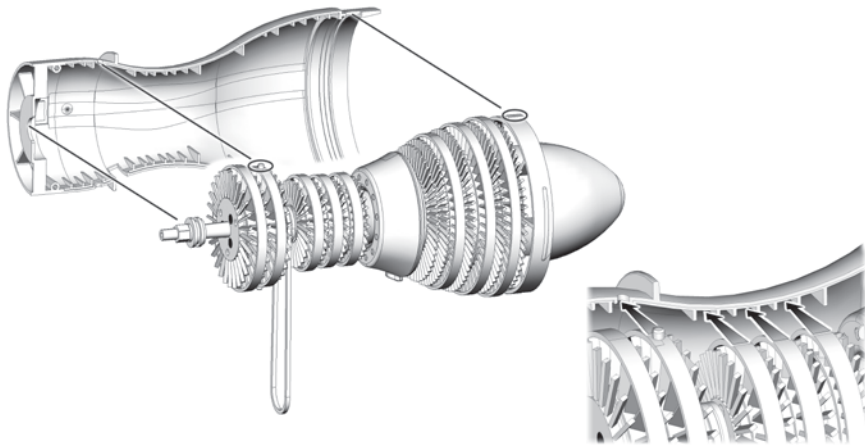
Step 5 - Engine core assembly



Slide the long metal shaft through the assemblies from Steps 1-4. The drive belt should be fitted to the small geared pulley (30) at this time. Finally, fit the shaft bushing A (35) and the shaft bushing B (36) to the end of the shaft.

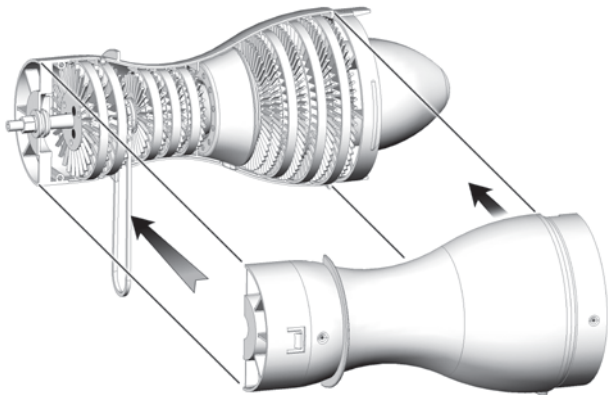
ASSEMBLING THE ENGINE

Step 6 - Engine housing (right)



Fit the turbine assembly to the right housing (1). There are lugs in the guide vane ring (20) and the tail cone (53) – make sure these locate correctly in the corresponding slots in the housing. Also make sure that the guide vanes fit within the slots moulded into the housing – refer to the inset picture. Note that the wire from the combustion chamber exits through the slot in the bottom of the housing.

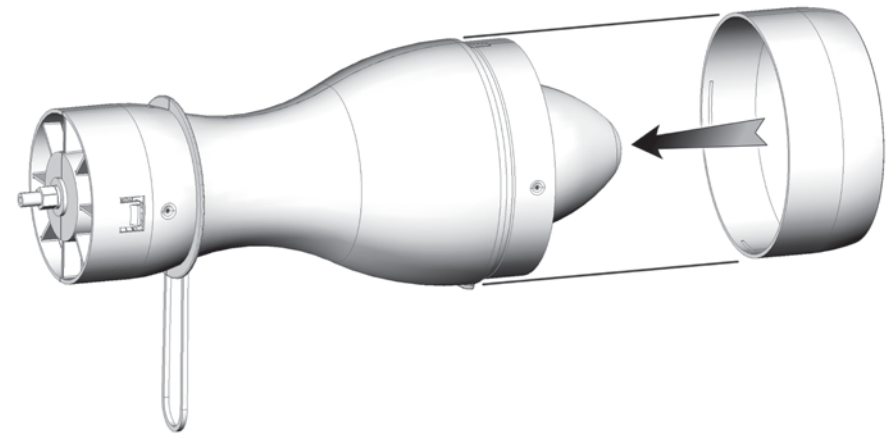
Step 7 - Engine housing (left)



Fit the left housing (2). Hold the two halves of the engine housing together. Pull the drive belt to check that all of the compressor and turbine blades rotate smoothly.

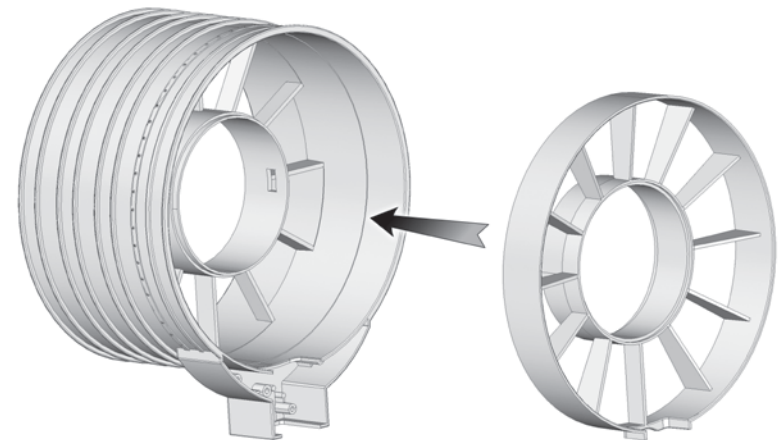
ASSEMBLING THE ENGINE

Step 7 - continued



Fit the rear part of the engine body as shown. This is a tight fit, so press firmly to ensure it is in place.

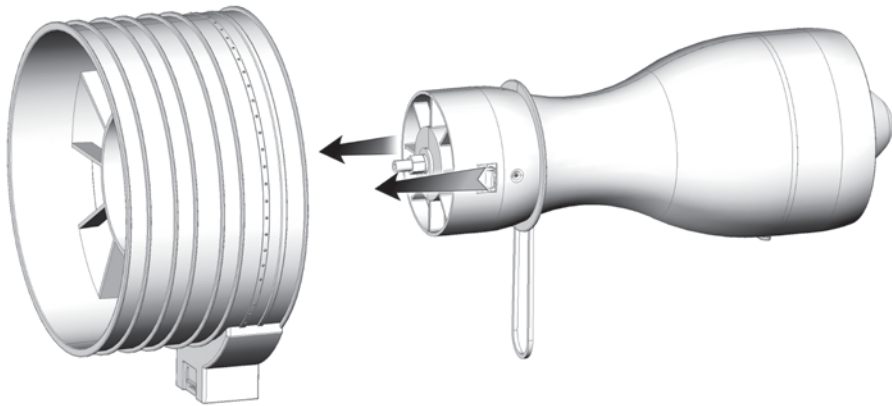
Step 8 - Fan housing



Fit the rear part of the fan housing. This is a friction fit in the main fan housing.

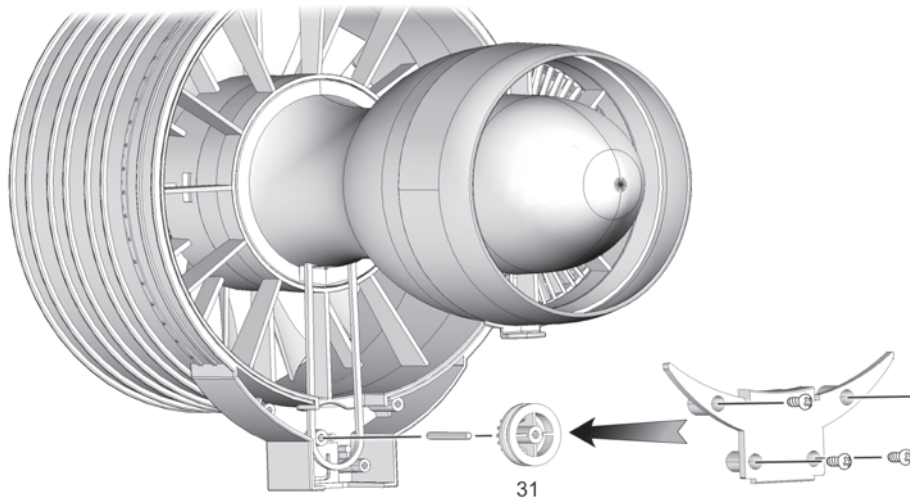
ASSEMBLING THE ENGINE

Step 9 - Fan housing/engine core assembly



Slide the assembled engine core in to the fan housing, making sure the clips on either side engage correctly with the corresponding slots in the housing.

Step 10 - Drive pulley

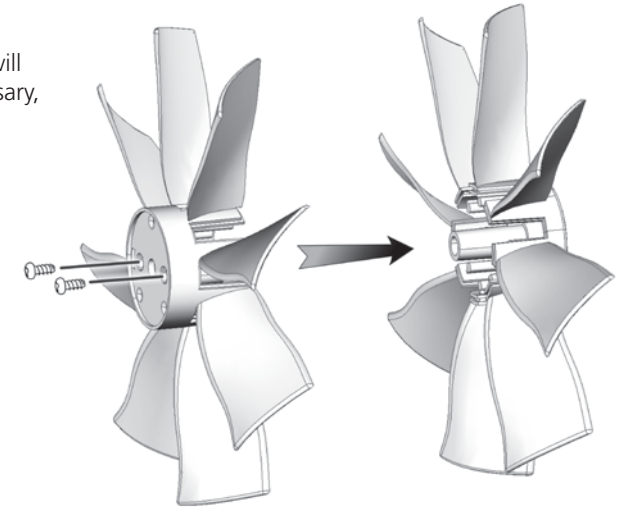


Slide the large geared pulley (31) over the short metal shaft (25 mm), and fit to the base of the fan housing. Attach the pulley cover plate (32) and secure with four screws.

ASSEMBLING THE ENGINE

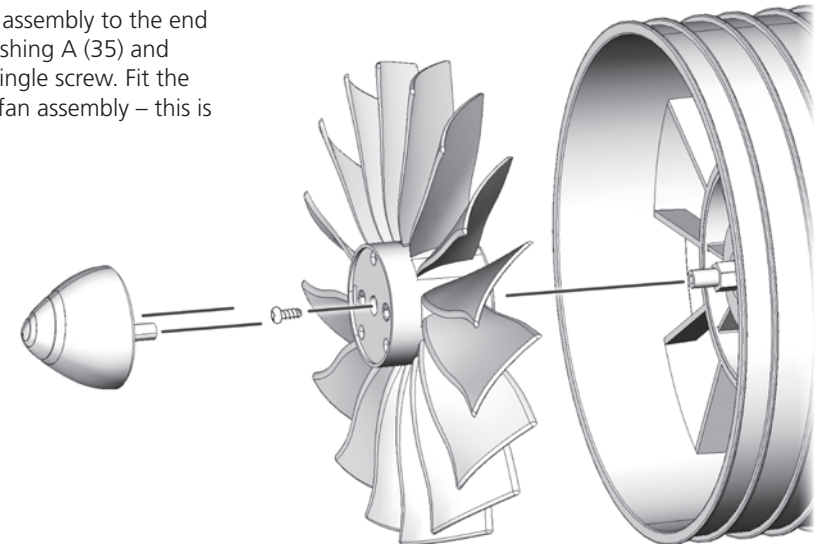
Step 11 - Fan blade assembly

Fit the two halves of the fan blade together, noting that these parts will only fit together one way. If necessary, reposition the parts and try again. Secure with two screws.



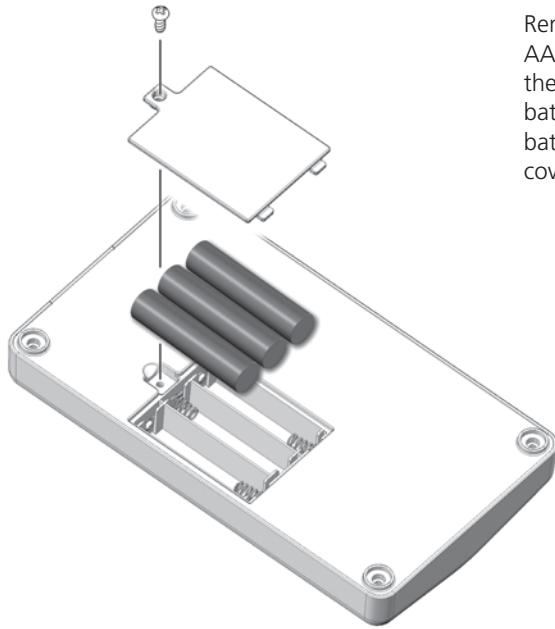
Step 12 - Fitting fan assembly

Attach the fan assembly to the end of the shaft bushing A (35) and secure with a single screw. Fit the spinner to the fan assembly – this is a press fit.



ASSEMBLING THE ENGINE

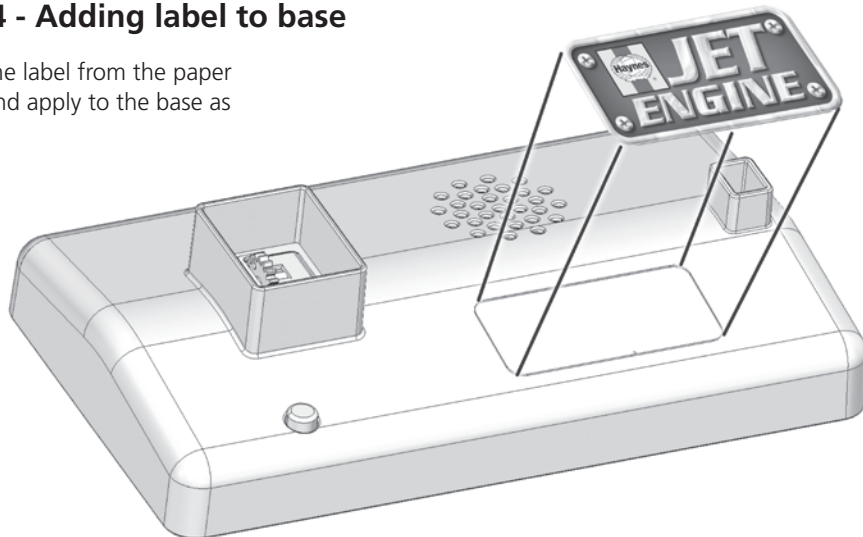
Step 13 - Battery installation



Remove the battery cover and fit 3 x AA batteries, as shown, making sure the polarity (+ and - markings) on the batteries match the markings in the battery compartment. Replace the cover.

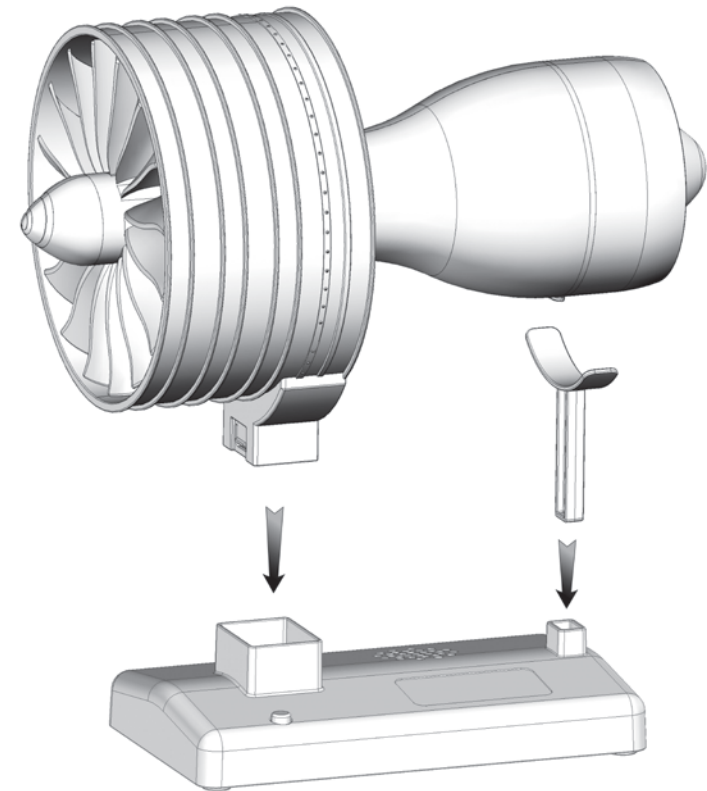
Step 14 - Adding label to base

Remove the label from the paper backing and apply to the base as shown.



ASSEMBLING THE ENGINE

Step 15 - Fitting engine to base



Insert the clear plastic support to the base. There are clips on one side of the support - these should face the front of the engine. Fit the engine assembly to the base/support. There is a lip on the underside of the rear of the engine which fits over the rear support. Attach this first, then carefully insert the front section into the base. Push down firmly so the drive system engages correctly - you should hear it click into place.

