Basic Electronics textbook
for students and younger engineers

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TG Junior emphasis practical electronics technologies and is read by students and young engineers.

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Featured Article

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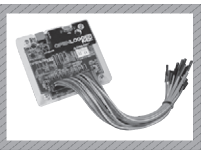


Featured Article

From battery-powered brushed motors to small, high-powered, water-cooled brushless motors

Use properly according to outputs, lifespans, and sizes!

DC motors used in automobiles, drones, and ships (water and air)

Tomoya MIYAMURA
Shinpei GOTOH

Introduction **Automobiles, aircraft (including helicopters), and waterships . . . . If you know the motor to be used with a radio-controlled model, you can obtain guidance for its proper use.**

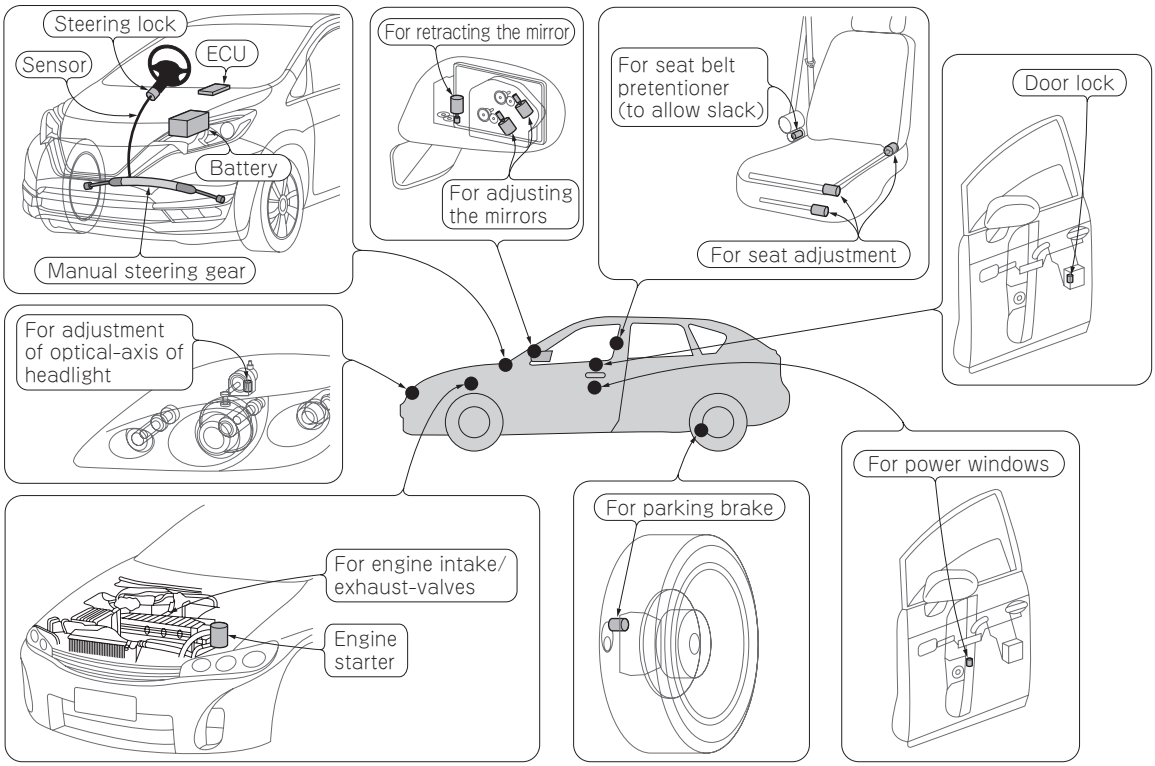


Fig. 1. Examples of motors used in modern automobiles.
A modern car has a total of at least some tens of motors, and luxury cars have more than 100 motors.

● Electrification is accelerating/ Modern cars have many motors.

The electrification of familiar ordinary vehicles—automobiles— is being accelerated by improved performance of batteries and electronic components, and by the evolution of control technologies.

Even in a nonelectric vehicle, as shown in Fig. 1., motors are used in various places. There are at least tens of motors in a typical car, and more than 100 motors in a luxury car. Most of them are located in places where they cannot be seen.

● Knowledge of motors will be indispensable for making things in the future.

Various types of motors can properly be used, depending on what and how they are to move, and where they are to be used, because how the motors operate are factors that determine their strengths and weaknesses.

The number of motors used around us will continue to increase in order to make our lives more comfortable, more convenient, and more enjoyable. Knowing the types of motors and their strengths and weaknesses will become increasingly important in manufacturing in the future.

● Do not take radio-controlled models lightly/ A motor is properly used based on its purpose.

This paper includes some tips for properly using a motor in the right place for the right purpose. In order to simplify the explanation, motors mounted on radio-controlled models of automobiles (land), ships (sea), and aircraft (sky), as shown in Photo. 1. are discussed and organized in terms of their types, structures, and strengths and weaknesses.

▶ Classification of radio-controlled model motors discussed in this paper

There are various types of motors for radio-controlled models, which can be classified as shown in Table 1 according to their applications and sizes.

Brushed DC motors are often used for radio-controlled

Column Electric-propulsion system that generates power for the Antarctic research ship *Shirase*

● Start the motor by electricity generated by the power-generation engine, and turn the propeller!

There are various types of ships that sail on water, and screws are mainly used to generate the force to move them. A screw is equivalent to a tire of an automobile. But unlike a car, a propeller is attached to the end of the shaft, and this rotates to stir water and to generate thrust.

How is the shaft rotated? The fact is that shafts are connected to engines and motors just like in automobiles. In a ship, the main power source is called the main engine. This is to distinguish the main engine from other engines that generate power for the ship's lighting and computers.

Many ships rotate the shaft and propeller by operating the engine. However, in order to produce high-output power with the engine alone, the engine must be high-powered, which increases the volume of fuel required.

▶ A huge ship also is driven by a motor!

In recent years, therefore, there has been an increase in the methods of rotating the propeller by operating the motor with electricity generated by a power-generation engine, rather than rotating the propeller directly by the engine. This method is called electric propulsion, and it is often used in marine-research vessels that require fine adjustment of output.

However, when you hear of a motor, you might get the impression that it doesn't have as much power as an engine to move a huge ship. This electric propulsion system is also used in the *Shirase* Antarctic observation ship, which can break through thick ice (Fig. A). Shirase's electric propulsion system can generate approximately 30,000 horsepower, and therefore it is capable of continuously breaking ice that is 1.5-m thick without stopping, even when sailing at a speed of 3 knots per hour (approximately 5.5 km per hour). Japanese Antarctic research ships have used the electric propulsion method since the second-generation *Fuji* (1965–1982). <Shinpei GOTOH>

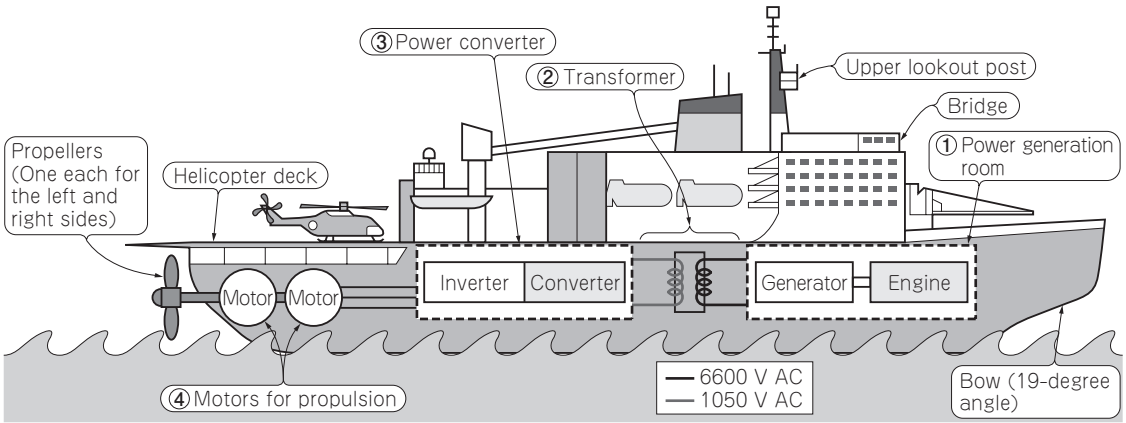
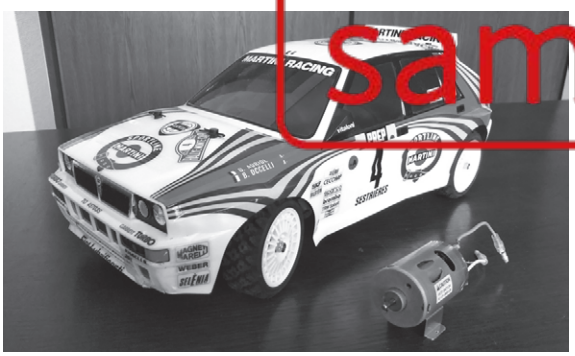


Fig. A. Electric-propulsion system to operate the Antarctic research ship *Shirase* AGB5003



(a) Vehicles that have tires and that operate on land

(b) Helicopters that fly by being driven by propellers

Photo 1. Radio-controlled models prepared for confirming the structure of their entire bodies by disassembling their respective motors.

models that are relatively small and that can operate even with low power output. Brushless DC motors are often used for radio-controlled models that are relatively large and require higher output power.

Depending on the application, brushless DC motors differ in cooling methods (air-cooled/water-cooled), structure (outer rotor/inner rotor), and control methods (with or without rotation sensors). <Tomoya MIYAMURA>