DC motor

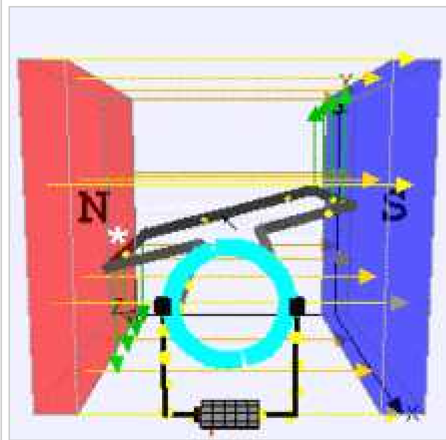
A **DC motor** is an electric motor that runs on direct current (DC) electricity. DC motors were used to run machinery, often eliminating the need for a local steam engine or internal combustion engine. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. Modern DC motors are nearly always operated in conjunction with power electronic devices.

Two important performance parameters of DC motors are the motor constants, K_v and K_m.

Brush

The brushed DC electric motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary magnets (permanent or electromagnets), and rotating electrical magnets.

Like all electric motors or generators, torque is produced by the principle of Lorentz force, which states that any current-carrying conductor placed within an external magnetic field experiences a torque or force known as Lorentz force. Advantages of a brushed DC motor include low initial cost, high reliability, and simple control of motor speed. Disadvantages are high maintenance and low life-span for high intensity uses. Maintenance involves regularly replacing the brushes and springs which carry the electric current, as well as cleaning or replacing the commutator. These components are necessary for transferring electrical power from outside the motor to the spinning wire windings of the rotor inside the motor.



This is a brushed DC electric motor generating torque directly from DC power supplied to the motor by using internal commutation, stationary permanent magnets. Torque is produced by the principle of Lorentz force, which states that any current-carrying conductor placed within an external magnetic field experiences a force known as Lorentz force. The commutator consists of a split ring 80 degree shows the effects of having a split ring.

Brushless

Brushless DC motors use a rotating permanent magnet or soft magnetic core in the rotor, and stationary electrical magnets on the motor housing. A motor controller converts DC to AC. This design is simpler than that of brushed motors because it eliminates the complication of transferring power from outside the motor to the spinning rotor. Advantages of brushless motors include long life span, little or no maintenance, and high efficiency. Disadvantages include high initial cost, and more complicated motor speed controllers. Some such brushless motors are sometimes referred to as "synchronous motors" although they have no external power supply to be synchronized with, as would be the case with normal AC synchronous motors.

Uncommutated

Other types of DC motors require no commutation.

- Homopolar motor – A homopolar motor has a magnetic field along the axis of rotation and an electric current that at some point is not parallel to the magnetic field. The name homopolar refers to the absence of polarity change.

Homopolar motors necessarily have a single-turn coil, which limits them to very low voltages. This has restricted the practical application of this type of motor.

- Ball bearing motor – A ball bearing motor is an unusual electric motor that consists of two ball bearing-type bearings, with the inner races mounted on a common conductive shaft, and the outer races connected to a high current, low voltage power supply. An alternative construction fits the outer races inside a metal tube, while the inner races are mounted on a shaft with a non-conductive section (e.g. two sleeves on an insulating rod). This method has the advantage that the tube will act as a flywheel. The direction of rotation is determined by the initial spin which is usually required to get it going.

Connection types

There are three types of connections used for DC electric motors: series, shunt and compound. These types of connections configure how the motor's field and armature windings are connected. The type of connection is significant because it determines the characteristics of the motor and is selected for speed/torque requirements of the load.[1]

Series connection

A series DC motor connects the armature and field windings in series with a common D.C. power source. This motor has poor speed regulation since its speed varies approximately inversely to load. However, a series DC motor has very high starting torque and is commonly used for starting high inertia loads, such as trains, elevators or hoists.[2] With no mechanical load on the series motor, the current is low, the magnetic field produced by the field winding is weak, and so the armature must turn faster to produce sufficient counter-EMF to balance the supply voltage (and internal voltage drops). For some types of motor, the speed may be higher than can be safely sustained by the motor. In a no-load condition, the motor may increase its speed until the motor mechanically destroys itself. This is called a runaway condition. The speed/torque characteristic is also useful in applications such as dragline excavators, where the digging tool moves rapidly when unloaded but slowly when carrying a heavy load.

Series motors called "universal motors" can be used on alternating current. Since the armature voltage and the field direction reverse at (substantially) the same time, torque continues to be produced in the same direction. Since the speed is not related to the line frequency, universal motors can develop higher-than-synchronous speeds, making them lighter than induction motors of the same rated mechanical output. This is a valuable characteristic for hand-held power tools. Universal motors for commercial power frequency are usually small, not more than about 1 kW output. However, much larger universal motors were used, fed by special low-frequency traction power networks to avoid problems with commutation under heavy and varying loads.

Shunt connection

A shunt DC motor connects the armature and field windings in parallel or shunt with a common D.C. power source. This type of motor has good speed regulation even as the load varies, but does not have as high of starting torque as a series DC motor.[3] It is typically used for industrial, adjustable speed applications, such as machine tools, winding/unwinding machines and tensioners.

Compound connection

A compound DC motor connects the armature and fields windings in a shunt and a series combination to give it characteristics of both a shunt and a series DC motor.[4] This motor is used when both a high starting torque and good speed regulation is needed. The motor can be connected in two arrangements: cumulatively or differentially. Cumulative compound motors connect the series field to aid the shunt field, which provides higher starting torque but less speed regulation. Differential compound DC motors have good speed regulation and are typically operated at constant speed. They are commonly used in elevators, air compressors, conveyors and punch presses.