Classes, Speed Control and Starting of DC motors

Classes, Speed Control and Starting of DC motors (on photo: Sugarcane Mill Rolling DC Motor; 440/220VDC; 500kW; with Shunt-wound construction)

DC Motor Classes

D.C. motors are divided into three classes, as follows:

1. The series-wound motor

In this type (***Figure 1***) the field is in series with the armature. This type of **DC motor** is only used for direct coupling and other work where the load (*or part of the load*) is permanently coupled to the motor. This will be seen from the speed-torque characteristic, which shows that on no load or light load the speed will be very high and therefore dangerous.

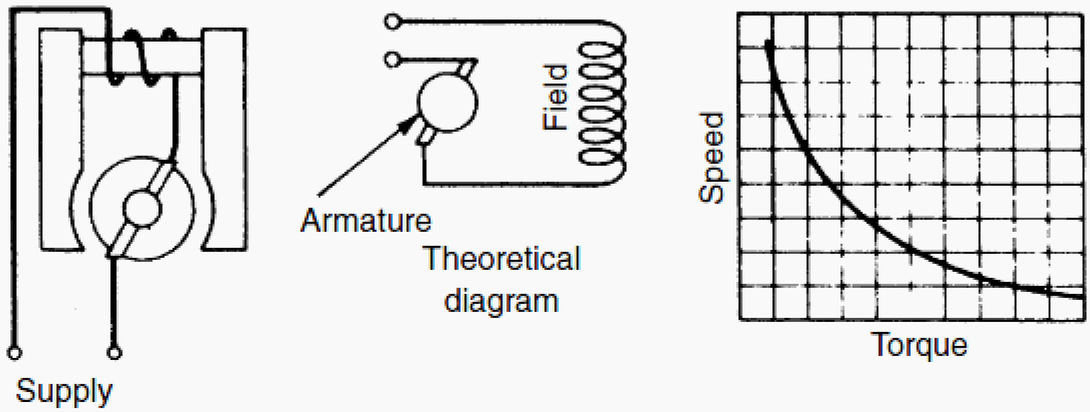

Figure 1 - Series-wound motor

2. The shunt-wound motor

In this case the field is in parallel with the armature, as shown in ***Figure 2***, and the **shunt motor** is the standard type of d.c. motor for ordinary purposes.
Its speed is nearly constant, falling off as the load increases due to resistance drop and armature reaction.

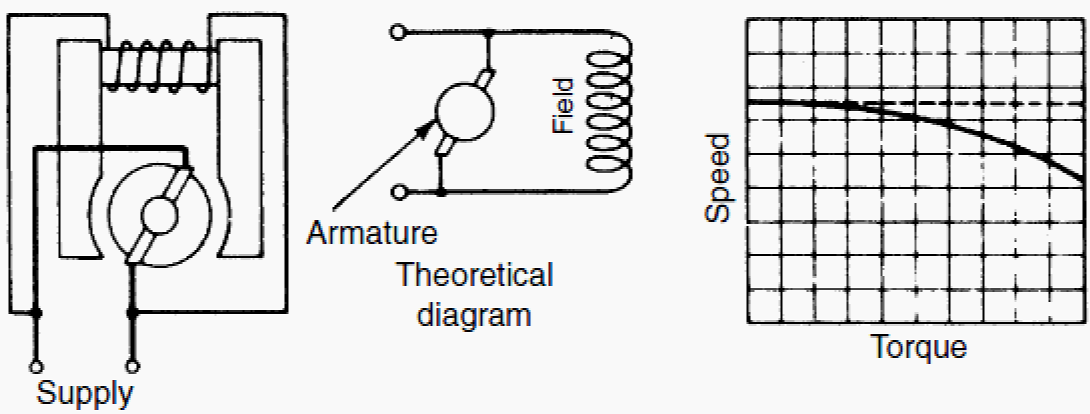

Figure 2 - Shunt-wound motor

3. The compound-wound motor

This is a combination of the above two types. There is a field winding in series with the armature and a field winding in parallel with it (***Figure 3***). The relative proportions of the shunt and series winding can be varied in order to make the characteristics nearer those of the series motor or those of the shunt-wound motor.
The typical ***speed-torque curve*** is shown in the diagram.
Compound-wound motors are used for ***cranes*** and other ***heavy duty applications*** where an overload may have to be carried and a ***heavy starting torque*** is required.

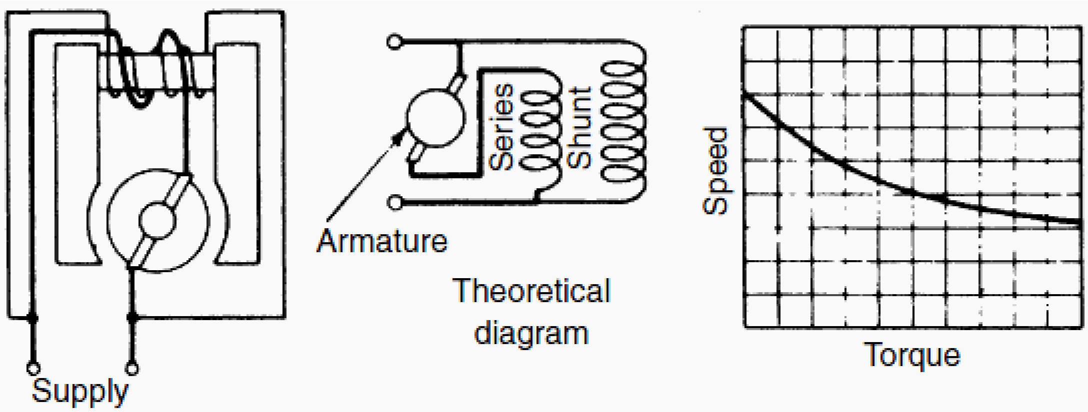

Figure 3 - Compound-wound motor

Speed control

Speed control is obtained as follows:

For series motors

By series resistance in parallel with the field winding of the motor. The resistance is then known as a ***diverter resistance***.
Another method used in traction consists of starting up two motors in series and then connecting them in parallel when a certain speed has been reached. Series resistances are used to limit the current in this case.

For shunt and compound-wound motors

Speed regulation on shunt and compound-wound motors is obtained by resistance in series with the shunt-field winding only. This is shown diagrammatically for a shunt motor in ***Figure 4***.

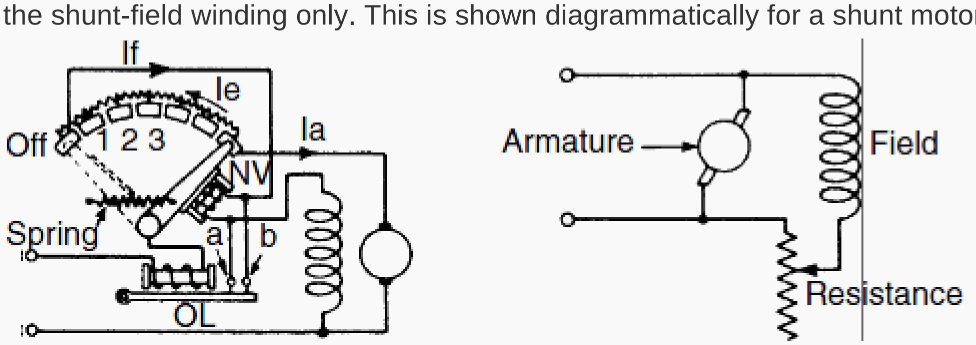

Figure 4 - Left: Diagram of faceplate starter for shunt motor; Ritght: Speed control of shunt motor by field rheostat

Starting

The principle of **starting a shunt motor** will be seen from ***Figure 4*** which shows the faceplate-type starter, the starting resistance being in between the segments marked ***1, 2, 3***, etc. The starting handle is held in position by the no-volt coil, marked ***NV***, which automatically allows the starter to return to the off position if the supply fails.
Overload protection is obtained by means of the overload coil, marked ***OL***, which on overload short-circuits the no-volt coil by means of the contacts marked ***a*** and ***b***.
When starting a shunt-wound motor it is most important to see that the shunt rheostat (*for speed control*) is in the slow-speed position. This is because the starting torque is proportional to the field current and this field current must be at its maximum value for starting purposes.
Many starters have the ***speed regulator interlocked*** with the starting handle so that the motor cannot be started with a weak field.

These methods of starting are not used much today but are left in because many installations still exist. Modern methods of control employ static devices described below.

Ward-Leonard control

One of the most important methods of speed control is that involving the Ward-Leonard principle which comprises a d.c. motor fed from its own motor generator set.

The diagram of connections is shown in ***Figure 5***.
The usual components are an a.c. induction or synchronous motor, driving a d.c. generator, and a constant voltage exciter; a shunt-wound d.c. driving motor and a field rheostat. The speed of the driving motor is controlled by varying the voltage applied to the armature, by means of the rheostat in the shunt winding circuit of the generator.

The d.c. supply to the field windings of the generator and driving motor is obtained by means of an exciter driven from the generator shaft.

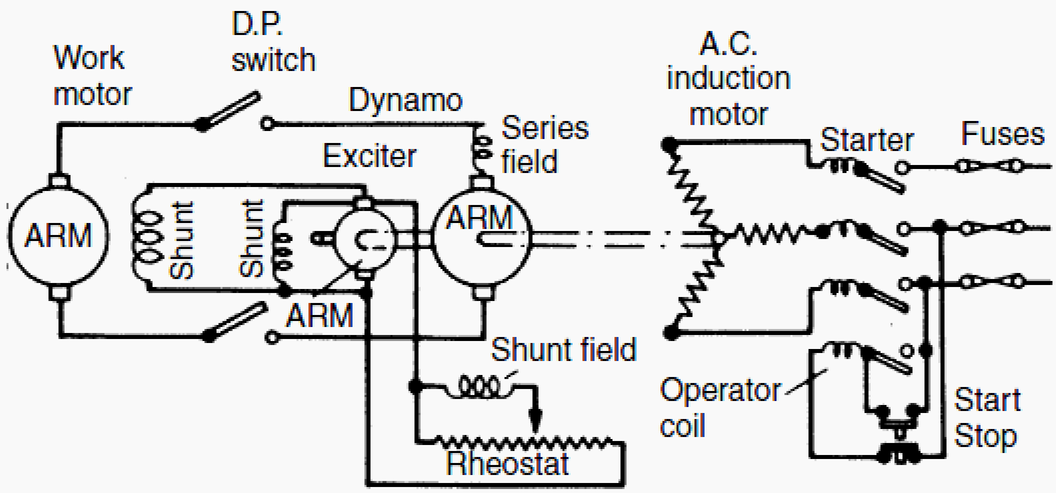

Figure 5 - Ward-Leonard control

With the equipment it is possible to obtain 10 to 1 speed range by regulation of the generator shunt field and these sets have been used for outputs of 360W and upwards. On the smaller sizes speed ranges up to 15 to 1 have been obtained, but for general purposes the safe limit can be taken as 10 to 1.

Speed control obtained in this way is extremely stable and the speed regulation between no load and full load at any particular setting is from 7 to 10%, depending on the size and design of the equipment.

This type of drive has been used for a variety of industrial applications and has been particularly successful in the case of electric planers and certain types of lifts, with outputs varying from 15 kW to 112 kW, also in the case of grinders in outputs of 360 W, 3/4kW and 11/2kW with speed ranges from 6 : 1 to 10 : 1.

Thyristor regulators

The development of thyristors with ***high current carrying capacity*** and ***reliability*** has enabled thyristor regulators to be designed to provide a ***d.c. variable drive system*** that can match and even better the many a.c. variable-speed drive systems on the market.
This has meant a redesign of the d.c. motor to cater for the characteristics of the thyristor regulator.
Machines have laminated poles and smaller machines may also have laminated yokes. This is to improve commutation by allowing the magnetic circuit to respond more quickly to flux changes

caused by the thyristor regulators. Square frame designs of d.c. machines have also been developed with much improved power/weight ratios together with other advantages.

Resource: *Newnes Electrical Pocket Book – E.A. Reeves, Martin J. Heathcote (**Get this book from Amazon**)*

Source:

http://electrical-engineering-portal.com/classes-speed-control-starting-dc-motors