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Speed Control Method OF DC series motor

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Abstract: **In this paper will be studying about the various speed control methods of a DC series motor. The aim of this this paper is to describe the principle of DC motor speed control using armature control methods and field control methods and stopping the DC series motor immediately in case of emergency. The speed variation of series motor by armature control method requires that voltage applied to the armature terminals shall be changed, without alternating the field current. In field control method the field is weaken and strengthen according to the requirement. The main idea behind this paper is to understand how the speed of the Dc series motor can be controlled by armature and field control method.**

KEYWORDS

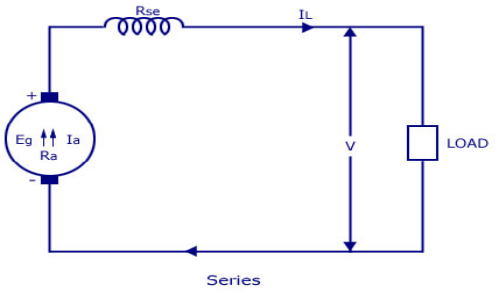
Speed control, armature, RPM Field control, DC motor, Series, Parallel, Voltage, and Current

I. INTRODUCTION

DC SERIES MOTOR

A DC motor, whose field winding is excited by the current produced by itself, is called self-excited. In DC series motor the field windings are connected to the armature in series so that whole current flows through the field windings as well as load. Since series field winding carries a full load current, series field is designed with less turns of thick wire or strips. The resistance of series field is kept very low.

$\mathbf{I_a=I_{se}=I_L}$



- The speed of dc series motor is given by:

$$RPM = \frac{E_g \times a \times k}{\Phi \times z \times P}$$

where -
E_g : motor counter emf
a : number of parallel circuits
Φ : flux (per pole)
z : number of armature conductors
P : number of magnetic poles
k : constant related to units

Speed Control of DC Series Motor with Field and Armature Rheostat Control

Speed control means change of a speed to a value required for performing the specific work process. The greatest advantage of DC motors may be speed control. Since speed is directly proportional to armature voltage and inversely proportional to the magnetic flux produced by the poles, adjusting the armature voltage or the field current will change the rotor speed.

A. Field Control Methods

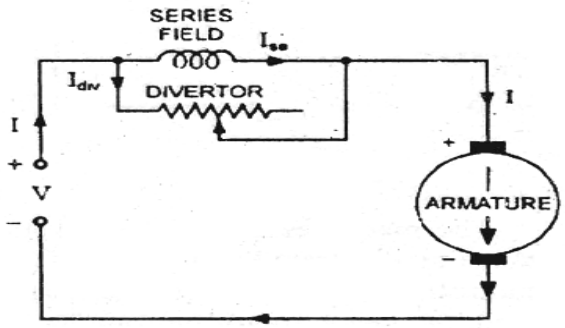
The speed of the DC series motor can be controlled by varying the field resistance of the

motor. Weakening the field causes increase in the speed of the motor, and strengthening the field reduces the speed. The method of control is generally used when the motor has to run above its rated speed. To understand the operation of field control the DC motor should be running at a constant speed. If the field current is reduced by reducing the voltage across the field coil, the flux density will be reduced. This will reduce the back emf (E_b) instantaneously and will cause armature current I_a to increase resulting in the motor speed increasing. Consequently the back emf will increase and a new equilibrium will be established at a higher speed. Speed adjustment of DC shunt motor can be obtained any one of the following method

- Field Diverter Method
- Tapped Field Control
- Paralleling Field coils Method

The speed of the DC series motor can be controlled by varying the flux in any one of the following manners.

I. **Field Diverter Method:** the flux can be reduced by shunting a portion of motor current around the series field, the introduced diverter in parallel with series field reduce the excitation mmf and weakens the field.

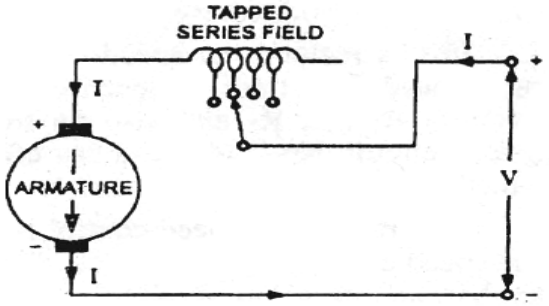


The introduction of the diverter helps us to get the speed above normal as the flux is reduced by this method. Lesser the diverter, lesser will be the field current, less flux, and therefore, the speed will be more

less diverter ⟹ Less Field current ⟹ flux reduced ⟹ More Speed

This Method of speed control is used in electric devices in which the speed should be raised sharply as soon as the load falls

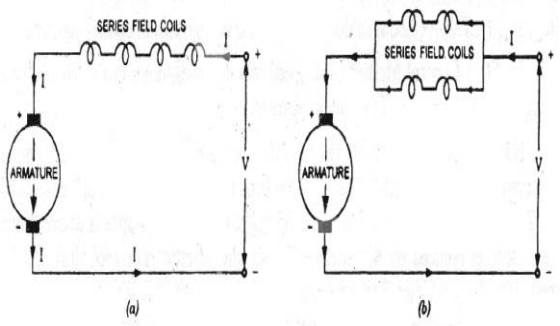
II. TAPPED FIELD CONTROL: in this method the speed is controlled by varying the number of series field turns



This is a method of increasing the speed by reducing the flux and it can be accomplished by reducing the number of series field winding turns through which the current flows. The series field turns can be reduced by short-circuiting them as per the requirement. When all the field winding turns is in the circuit the motor runs at very low speed as soon as the number of turns is reduced the speed of the motor starts rising.

Decreasing the no.of series field turns ⟹ Speed increases

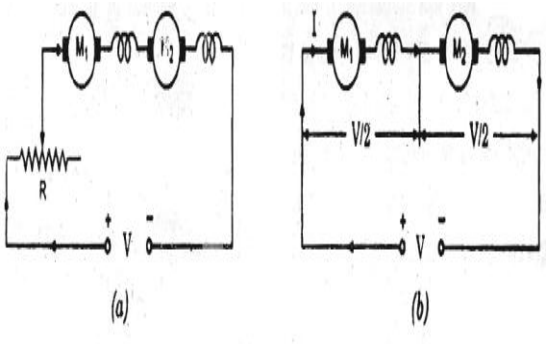
III. Paralleling Field coils method: In this method the re-grouping of the field coils is done to control the speed of the DC series motor, this method is used in fan motors, several speed can be obtained by re-grouping of the field coils



B. SERIES-PARALLEL CONTROL

This system is widely used in electric traction, where two or more mechanically coupled series motors are employed. Speed control can be obtained by combining series resistance with series and parallel combinations. For low speeds, motors are joined in series, and for higher speeds motors are joined in parallel. When in series, the motors have the same current passing through them, although voltage across each motor is divided. When in parallel, voltage across each motor is same although current gets divided.

The motor is started up in series with each other:-



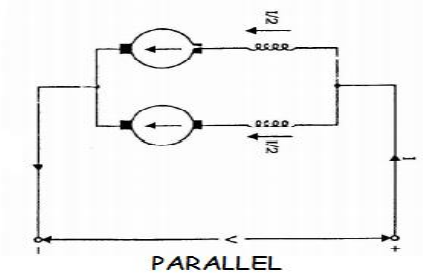
Additional resistance (**R**) is gradually cut-out by the controller when the motor attain speed then finally the control resistance is removed, then each motor has 1/2voltage of the line across it, this is the first running position. Here for any given value of armature current, each motor will run at half of its normal speed.

- Voltage across each motor = V/2
- Current through each motor = I

Since there is no external resistance in the circuit, there is no waste of energy and so motors operate at efficiency nearly equal to that obtainable with full line voltage across the terminals of each motor.

When it is desired to increase the speed of the combination, @motors are connected in parallel and in series with a variable R. This resistance is gradually cut out as the motor attains speed and finally when this resistance is totally removed from the circuit as in fig. shown below, the second running position is obtained. In this position each motor is connected across the full line voltage.

- Voltage across each motor = V
- Current across each motor = I/2

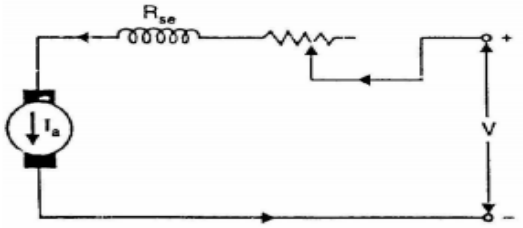


C. ARMATURE CONTROL METHODS

Speed can be controlled by armature control may be had by any one the following 2 methods:-

- Armature resistance control
- Armature terminal voltage control

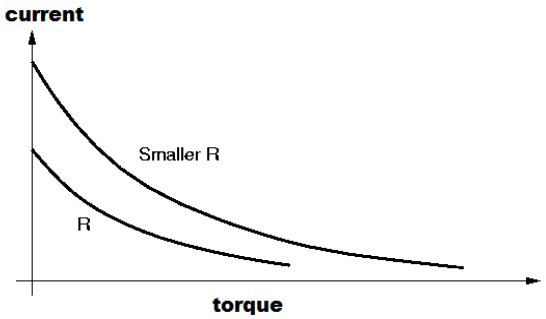
I. **Armature resistance control**:-In this method, a variable resistance is directly connected in series with the supply to the complete motor as shown in Fig.



This reduces the voltage available across the armature and hence the speed falls. By changing the value of variable resistance, any speed below the normal speed can be obtained. This is the most common method employed to control the speed of DC series motors. Although this method has poor speed regulation, this has no significance for series motors because they are used in varying speed applications. The loss of power in the series resistance for many applications of series motors is not too serious since in these applications, the control is utilized for a large portion of the time for reducing the speed underlight-load conditions and is only used intermittently when the motor is carryingfull-load.

The speed at full-load may be reduced to desired value depending on amount of Resistance **(R)**.

- The graph between torque and current with variable resistance **(R)**



II. ARMATURE TERMINAL VOLTAGE CONTROL:-

The speed control of Dc series motor can be accomplished by supplying the power to the motor from a separate variable voltage supply. This method gives a large speed range with any desired no. of speed points. It is essentially a constant-torque system, because the output delivered by the motor decreases with a decrease in applied voltage and a corresponding decrease in speed.

B. BRAKING

Sometimes it is desirable to stop a DC motor quickly. A running motor may be brought to rest quickly by either mechanical braking or electrical braking.

The motor and its load may be brought to rest by using either of the 2 methods:

- Mechanical (friction) braking
- Electric braking

In **Mechanical braking**, the motor is stopped due to the friction between the moving parts of the motor and the brake shoe i.e. kinetic energy of the motor is dissipated as heat. Mechanical braking has several disadvantages including non-smooth stop andgreater stopping time.

In **Electric braking**, the kinetic energy of the moving parts (i.e., motor) is converted into electrical energy which is dissipated in a resistance as heat oralternatively, it is returned to the supply source (Regenerative braking). For DC series as well as shunt motors, the following three methods of electric brakingare used:

- Rheostatic or Dynamic braking
- Plugging
- Regenerative braking

Conclusion:- We can run a DC series motor at desired speed by using various methods mentioned above and DC series motor can be stopped by electric braking in emergency.

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