UNIT I
CLASSIFICATION OF DRIVES SYSTEM

By

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INTRODUCTION

- Nowadays, modern power electronics and drives are used in electrical as well as mechanical industry. The power converter or power modulator circuits are used with electrical motor drives, providing either DC or AC outputs, and working from either a DC (battery) supply or from the conventional AC supply.
- Here we will highlight the most important aspects which are common to all types of drive converters. Although there are many different types of converters, all except very low-power ones are based on some form of electronic switching.
- The need to adopt a switching strategy is emphasized in the Wrist example, where the consequences are explored in some depth. We will see that switching is essential in order to achieve high-efficiency power conversion, but that the resulting waveforms are inevitably less than ideal from the point of view of the motor.

DEFINATIONS OF ELECTRICAL DRIVES

- An electrical drive can be defined as an electromechanical device for converting electrical energy into mechanical energy to impart motion to different machines and mechanisms for various kinds of process control.
- An electrical drive is an industrial system which performs the conversion of electrical energy into mechanical energy or vice versa for running and controlling various processes.
- An electrical drive is defined as a form of machine equipment designed to convert electrical energy into mechanical energy and provide electrical control of the processes.
- The system employed for motion control is called an electrical drive.

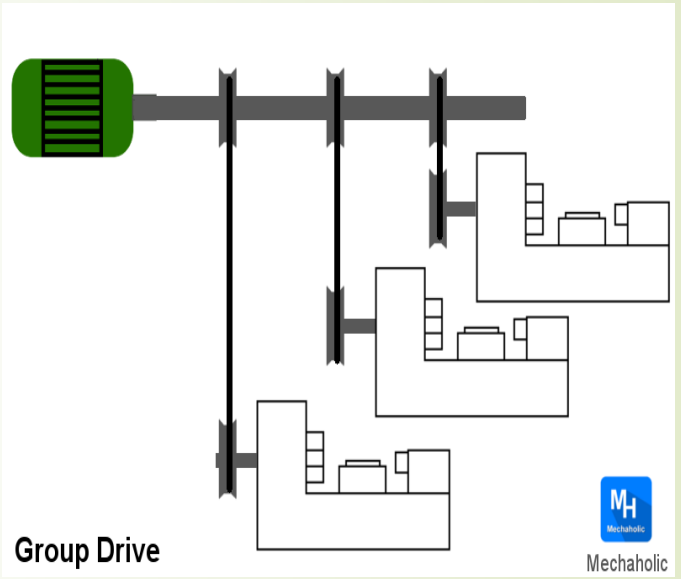
CLASSIFICATIONS

- Group Drives
- Individual Drives
- Multimotor Drives

Group Drive

- What is group drive?

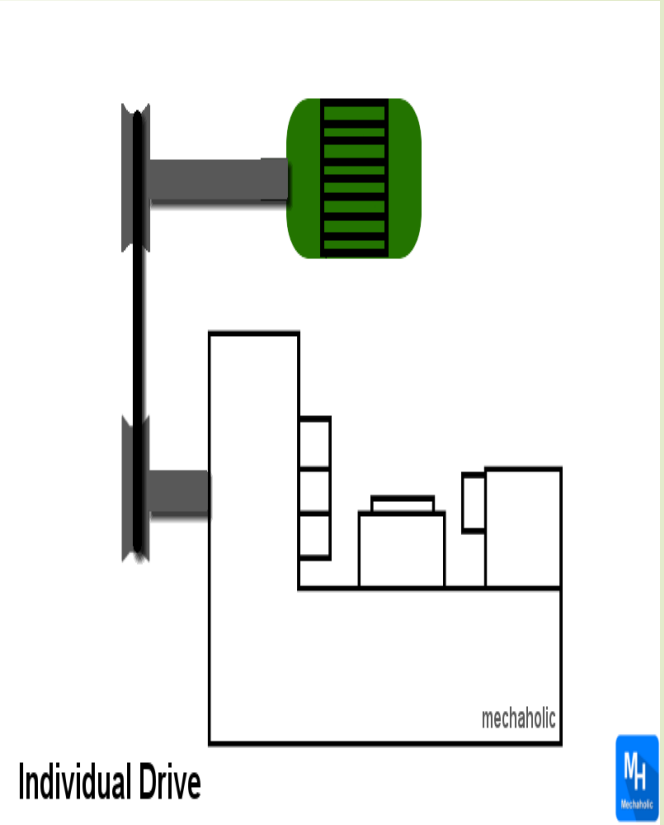
-It consists of single machine which actuates several machines or mechanism by means of one or more line shaft. Hence this is also called "line shaft drive". This line shafts are connected to multi stepped pulleys and belts that connect this pulley and shaft of the driven machine, serves to vary their speed.



Individual Drive

- What is individual drive?

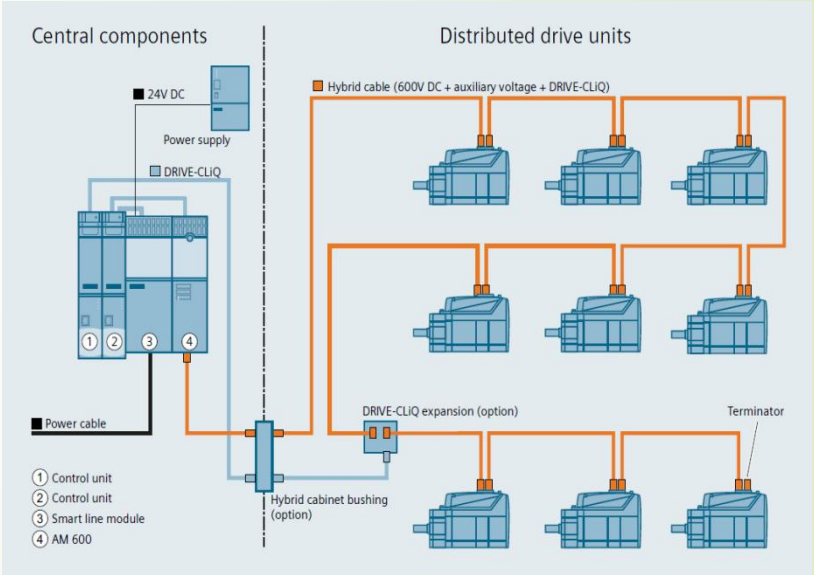
- In individual drive an electric motor used for transmitting motion to various parts or mechanism belonging to single equipment. For example, such drive are used to rotate the spindle, moves the feed and with the help of gears imparts motion to lubricating and cooling pumps in lathe. In application, individual drive consist of motor which is specifically designed to form an integral part of the machine.



Multimotor Drive

●What is multimotor drive?

- The multimotor drive consist of several individual motor which serve to one of many motions or mechanism in some production unit. For example, in travelling crane, there are three motors used. One for hoisting, other for long travel motion and third for cross travel motion. Such a drive is essential in complicated metal cutting machine, paper making machine, rolling mills, rotary printing machine, etc. The use of multimotor drive is expanding in modern industries due to their advantage outweighs increase in capital cost compared to the group drive.



Constant Torque and Constant Power

Constant torque:

Applications require a constant level of torque throughout a process regardless of different speeds. The vast majority of applications for an AFD are constant torque. Any application that involve conveyors mixers, elevators, feeders, hoists, bottling machines, screw compressors, and numerous others, are constant torque.

in the example above constant torque must be maintained on the conveyor. Notice that the torque curve drops when the speed is reduce below a minimum speed of about 5hz. To compensate for this drop, some AFDs can perform “motor tuning” which matches the AFD setting to a particular motor. This “tuning allows foe more precise calculations by the AFD giving motor torque throughout the CT curve. But particularly noticeable is the torque boost at those slow speeds from 1 to 10hz.

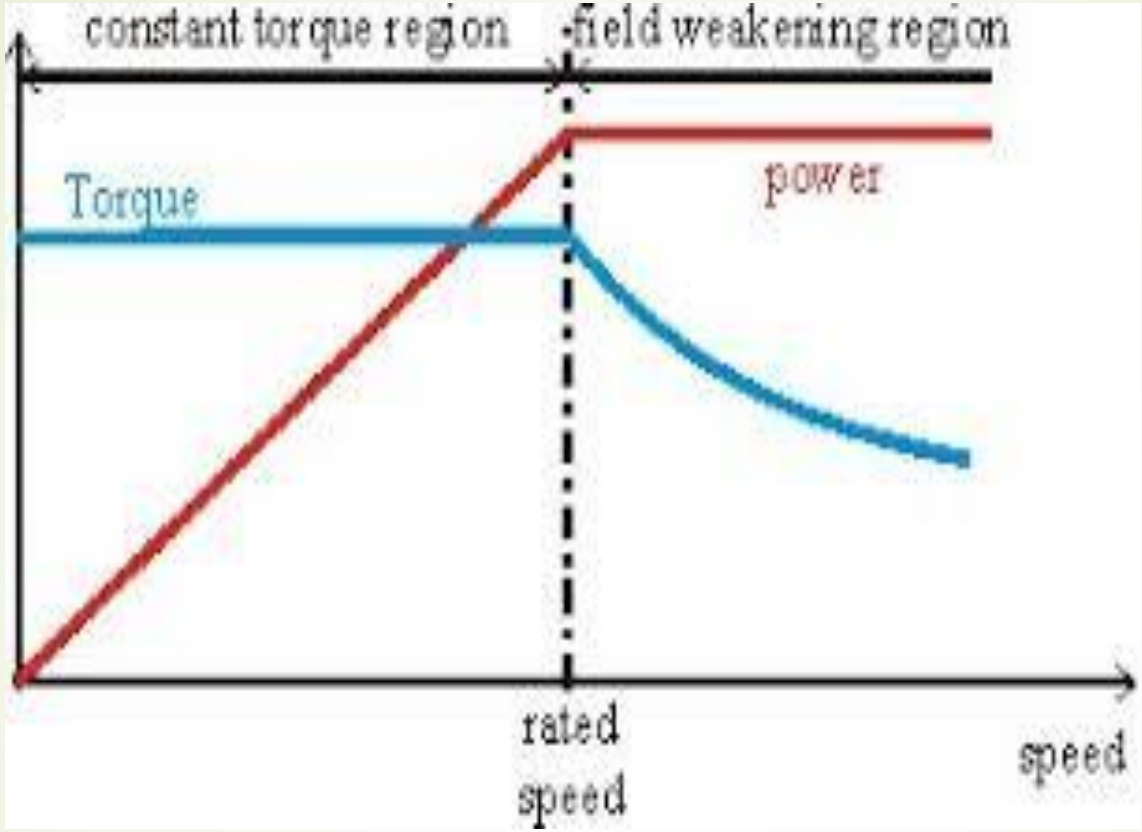


Fig. Constant Torque

Constant power:

Applications are always run at speeds above base speed 60hz and higher on a constant torque curve, the area above base speed is knowns as the constant power curve. The few applications that require these high speeds are typically saws, and grinders.

in the example above notice that the torque curve drops off above 60hz (1800rpm.) it is at this point that the voltage being sent to the motor can NOT be increased it has hit its maximum limit. As the drive continues to increase the speed, and with a the voltage staying the same, the current to the motor starts to drop off, which means that the torque drops as wall.

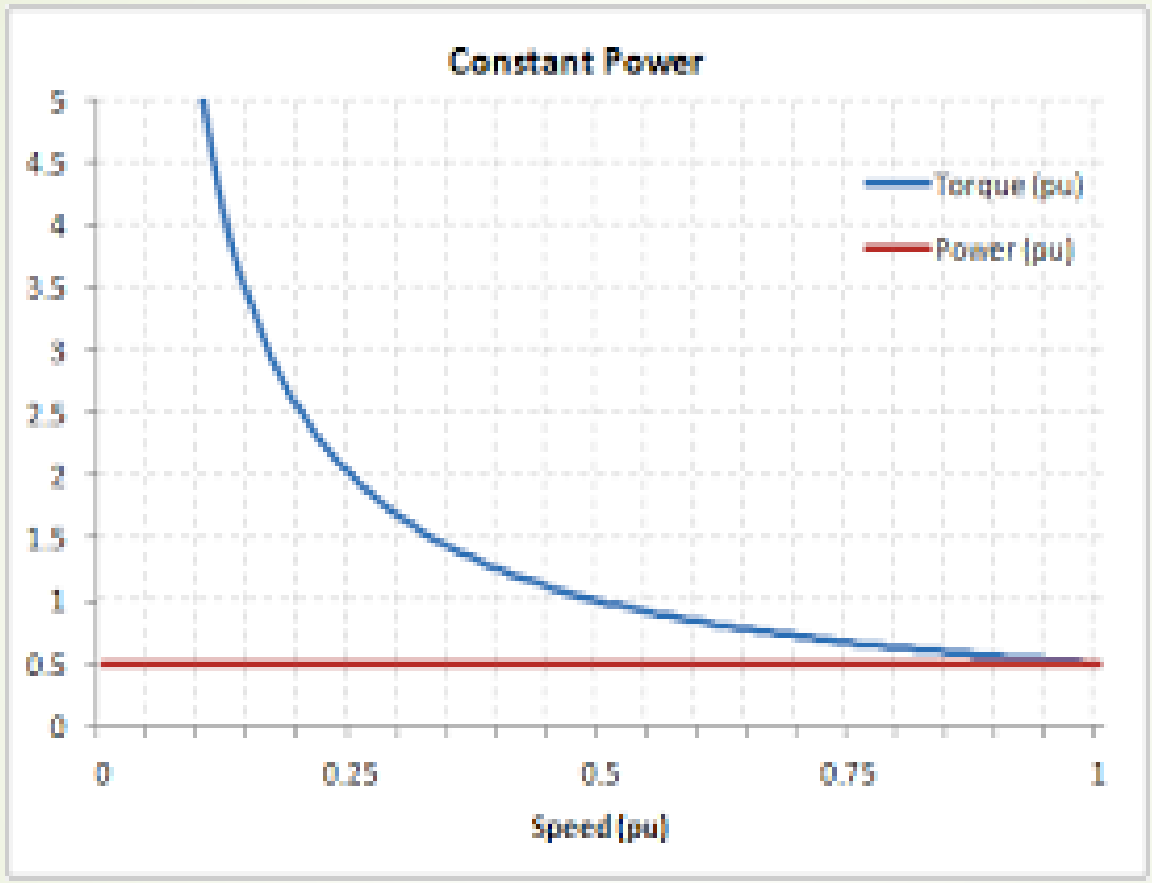


Fig. Constant Power

CHARACTERISTIC OF DC SHUNT MOTOR

Generally, three characteristic curves are considered important for dc motors which are :

(i) Torque vs. armature current

(ii) Speed vs. armature current and

(iii) Speed vs. torque.

These are explained below for each type of dc motor. These characteristics are determined by keeping the following two relations in mind.

$T_a \alpha\propto \phi.I_a$ and **$N \propto E_b/\phi$**

For a DC motor, magnitude of the back emf is given by the same emf equation of a dc generator i.e.

$E_b = P\phi NZ / 60A.$

For a machine, P, Z and A are constant,

therefore, $N \propto E_b/\phi$

1. Torque Vs. Armature Current (Ta-Ia)

In case of DC shunt motors, we can assume the field flux ϕ to be constant. Though at heavy loads, ϕ decreases in a small amount due to increased armature reaction. As we are neglecting the change in the flux ϕ, we can say that torque is proportional to armature current. Hence, the Ta-Ia characteristic for a dc shunt motor will be a straight line through the origin. Since heavy starting load needs heavy starting current, **shunt motor** **avy load**.

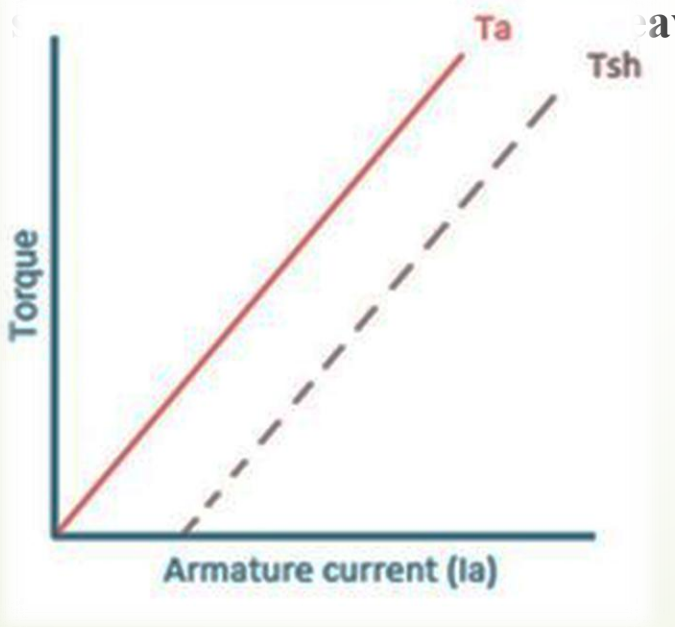


Fig. Torque Vs. Armature Current

2. Speed Vs. Armature Current (N-Ia)

As flux ϕ is assumed to be constant, we can say N ∝ Eb. But, as back emf is also almost constant, the speed should remain constant. But practically, ϕ as well as Eb decreases with increase in load. Back emf Eb decreases slightly more than ϕ, therefore, the speed decreases slightly. Generally, the speed decreases only by 5 to 15% of full load speed. Therefore, a shunt motor can be assumed as a constant speed motor. In speed vs. armature current characteristic in the following figure, the straight horizontal line represents the ideal characteristic and the actual characteristic is shown by the dotted line.

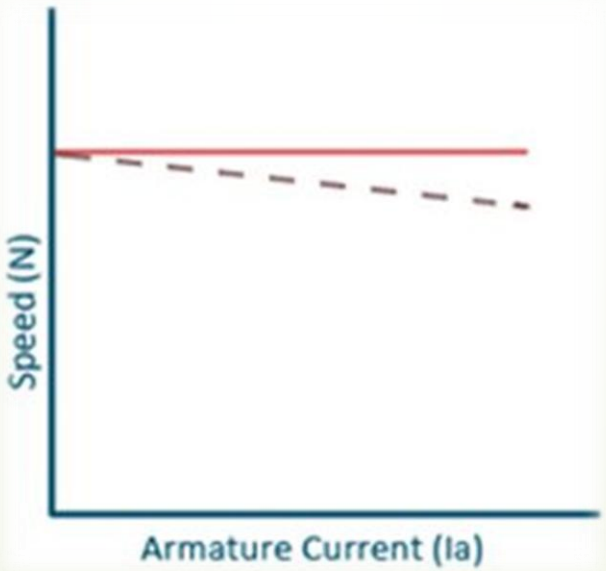


Fig. Speed vs. armature current

3. SPEED VS. TORQUE (N-TA)

when the shunt motor runs from no load to full load there is slight change in speed. Thus, it is essentially a constant speed motor. Since the armature torque is directly proportional to the armature current, the starting torque is not high.

From the curve it is understood that the speed reduces when the load torque increases.

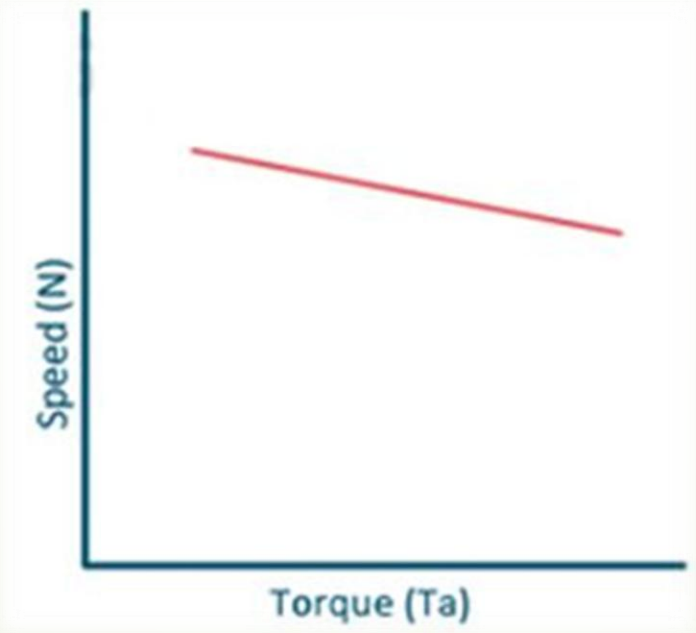


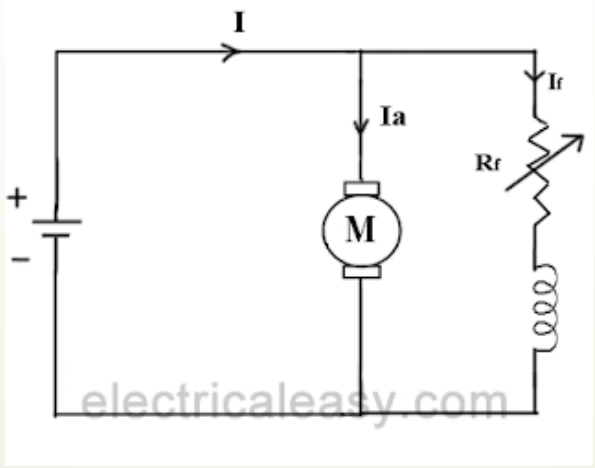
Fig. Speed Vs. Torque

METHODS OF SPEED CONTROL

- **Speed control of DC shunt motor**

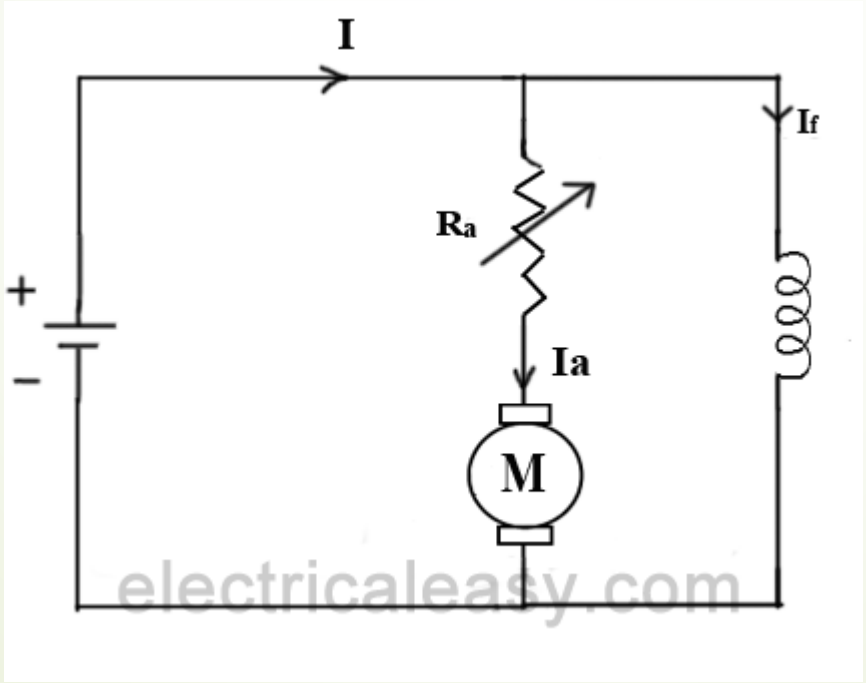
1.FLUX CONTROL:

By varying flux, the motor speed can be changed. In this method, a variable resistance (shunt field rheostat) is placed in series with shunt field winding. By using rheostat, shunt field current can reduce and flux is reduced. Therefore the speed of motor raise above the normal speed.



1. ARMATURE CONTROL:

By varying the voltage available across the armature & back emf and hence the speed of the motor can be changed. This is done by inserting a variable resistance Rc (Known as controller resistance)in series with the armature. Due to voltage drop in the controller resistance the back emf is decreased.

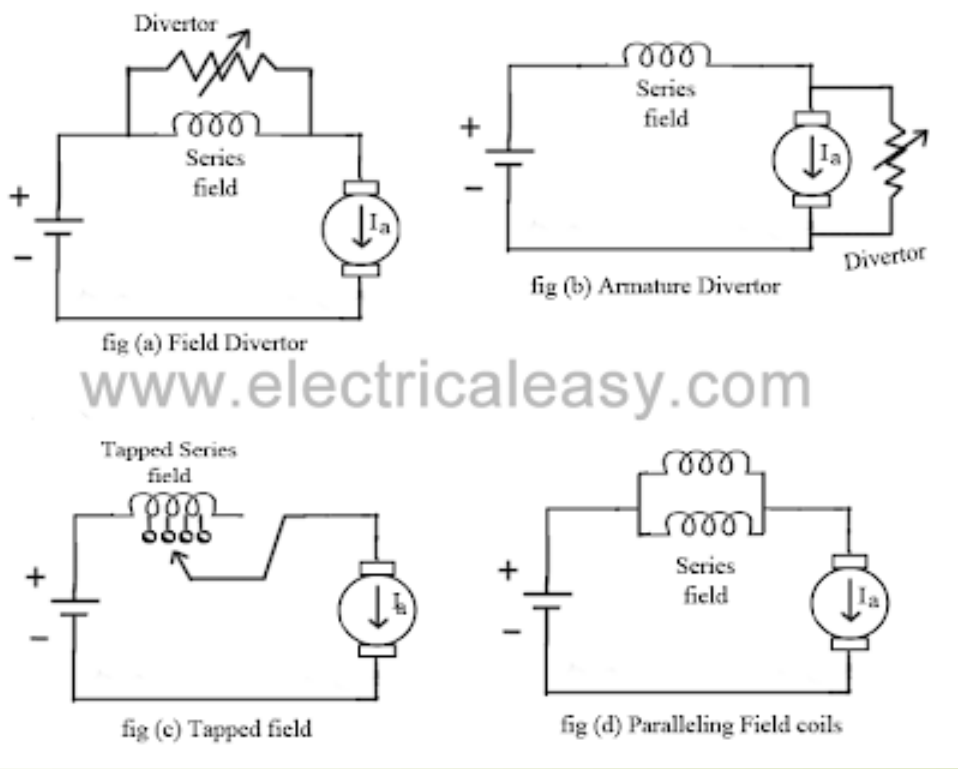


Speed Control of Dc Series Motor

1. FLUX CONTROL:

a. Field diverter
b. Armature diverter
c. Tapped field control
d. Paralleling field coil

2. ARMATURE CONTROL:



STARTING of 3 PHASE INDUCTION MOTOR

1. Direct Online Starting:

the motor is started by connecting it directly by 3 phase supply.

rotor input = 2πNsT

rotor cu loss = S x rotor input

3 I^2R2 = S KT

$$T \alpha \frac{I2^2}{S} \quad OR \quad T \alpha \frac{I1^2}{S}$$

$$\frac{Tst}{Tf} = \left(\frac{Ist}{If}\right)^2 . Sf$$

when motor is direct switched on normal voltage then starting current is short circuit current.

$$\boxed{\frac{Tst}{Tf} = \left(\frac{Ist}{If}\right)^2 . Sf}$$

2. Star Delta Starting:

The star winding of motor is designed for delta operation and is connecting in star during the starting period. When the machine is upto speed connections are changed delta.

Six loads of the star winding are connected to change over switch. At the instant of starting the charge is thrown to “start” position which contacts the stator winding in star.

The star delta starter is shown in below fig.

$$\text{Isc} = \frac{V}{Zsc}, \quad \text{Ist} = \sqrt{3}\, Isc$$

$$\frac{Tst}{Tf} = \left(\frac{Ist}{If}\right)^2 \text{Sf} = \left(\frac{Isc}{\sqrt{3}If}\right)^2 \text{Sf}$$

$$\boxed{\frac{Tst}{Tf} = \frac{1}{3}\left(\frac{Ist}{If}\right)^2 \text{Sf}}$$

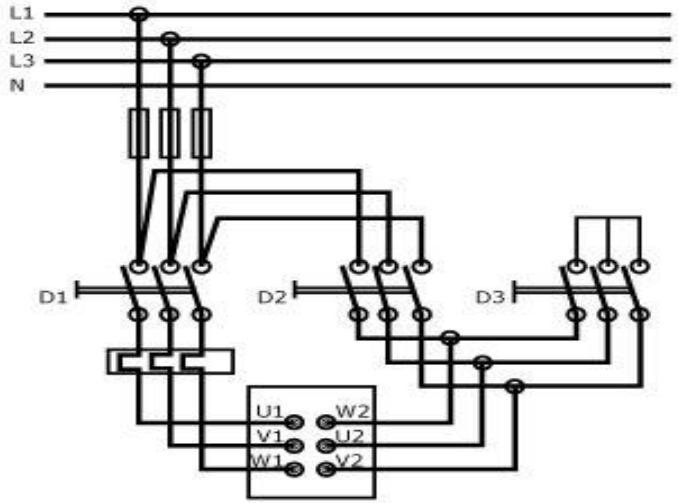


Fig. Star Delta Starting

3. Auto Transformer Starting:

Taps are provided on the autotransformers so that the motor can be started at reduced voltage. Taps are for 50, 60 and 80% of line voltage. The 50 % tap being provided only the case of sizes above 50 h.p.

The tapping on the autotransformer is so set that when it is in the circuit 65% to 80% of line voltage applied to the motor.

Voltage across motor phase on direct switching is $\frac{V}{\sqrt{3}}$ and starting current is Ist = Isc.

$$\frac{Tst}{Tf} = \left(\frac{Ist}{If}\right)^2 \text{Sf} = \left(\frac{KIsc}{If}\right)^2 \text{Sf}$$

$$\boxed{\frac{Tst}{Tf} = K^2 \left(\frac{Ist}{If}\right)^2 \text{Sf}}$$

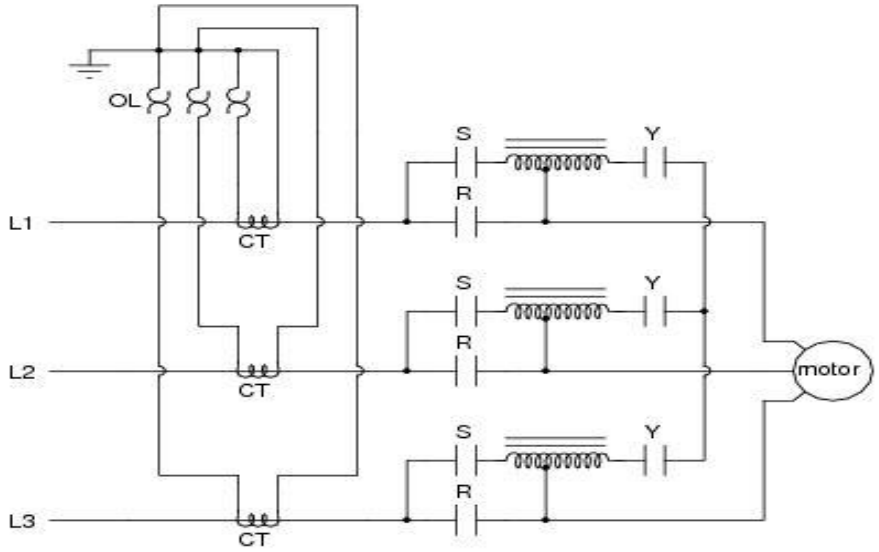


Fig. Autotransformer

THANK YOU