STARTING METHODS

Functions of starters:

The functions are

* limit the starting current
* starting and stopping the motor quickly, safely dependably and repeatedly if required.
* Automatic control of the motor.
* Protection from the over load.

Necessity of starter:

* Since the armature in DC Motor is stationary before starting, the back EMF that is proportional to speed which is zero.
* As the armature Resistance is very small, if the rated Voltage is applied to the armature, it will drawmany times the full load current and thereby there is possibility of damaging the armature due to heavy starting current.

$$\therefore \quad I_a = \frac{V - E_b}{R_a} \rightarrow (1) \qquad [\because V = E_b + I_a R_a]$$

At the instant of starting (i.e from standstill condition), when speed of the Motor is zero, the back EMF is also zero.

$\therefore$ At the instant of starting

$$I_a = \frac{V-0}{R_a} \Rightarrow \frac{V}{R_a}.$$

* Assume the value of supply Voltage = 200V, R_a is 0.5Ω. so The $I_a = \frac{200-0}{0.5} = 400\,A.$

* Hence at starting, Ia is very very large and it's many times more than the full load current of the Motor. This current will burn out the armature and also causes very heavy voltage drop across the lines, which may effect the operation of other machines

* ∴ The heavy starting current should be limited to a safe value by inserting a resistance in series with the armature at the time of starting for a period of 5 to 10sec.

* As the Motor gains in speed, back EMF is build up, and then the starting resistance could be gradually cut off.

Effects of heavy starting current:

* It may damage the rotating parts of the motor and the load.

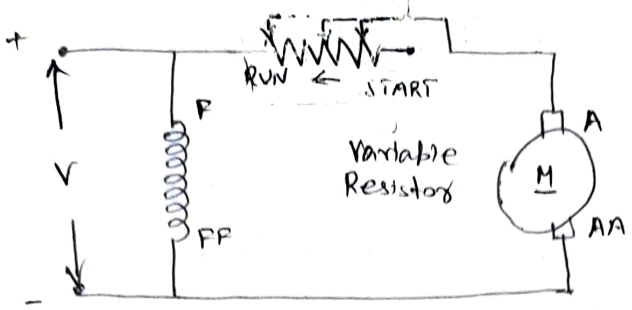
* Damage to the armature winding

* Failure of insulation due to over heating

* It produces high sparking in the commutator surface.

* large Amount of Dips in supply voltage.

Principle of starting:-



* The Resistance(R) is fully included in the armature circuit by keeping the moving arm in position 'start' at the time of starting, and then it's moved towards position 'Run' to exclude the Resistance(R) when the motor has picked up it's speed.
* The starters may have to protect the motor from overload and will switch 'off' the motor, when supply Fails.
* Two protective devices, over Load Release(OLR) and No volt Release(NVR) are connected suitably to protect the Motor during over load and during failure of supply.

Types of Dc Motor starters:-

There are 3 types of Dc Motor starters, are,

(i) Two Point starter → used for Dc series Motor

(ii) Three Point starter, (iii) Four Point starter → used for Dc shunt and compound Motors

(18) => **Three point starter:**

The three point starter is used in DC shunt and compound motors for starting. When the handle is moved to ON position the soft iron, which is attached to the handle, is attracted by the electromagnet.

* when the handle is in ON position, the Motor achieves it's full speed, which develops back EMF. This back EMF then regulates the armature current.

→ The starting resistance is connected in series with the armature of a DC Motor.

→ A handle, which can be moved over the starting resistance against the spring.

→ A No Voltage Release (NVR) coil is connected in series with the field winding.

→ An over Load Release (OLR) coil is connected in series with the armature.

→ A Movable arm is placed near the OLR coil.

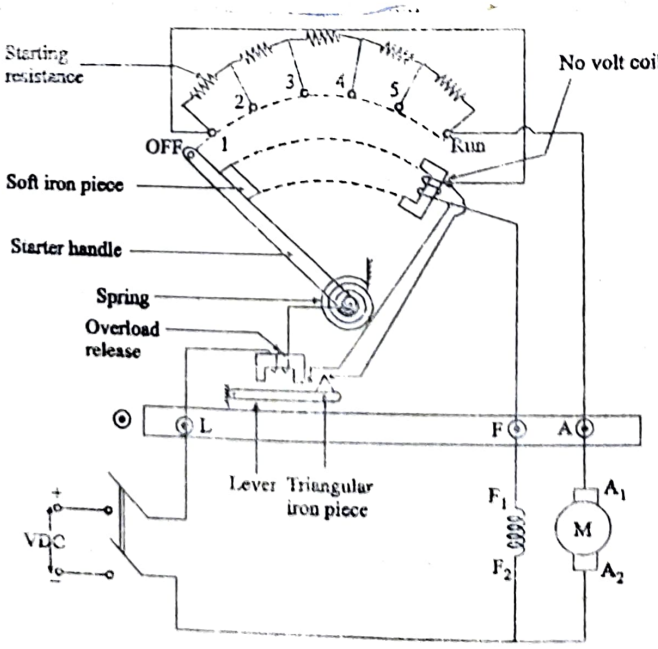


Fig: Three point starter

(i) To start the Motor, the DC supply is given and the Main switch is closed.

(ii) The handle is now slowly moved clockwise to the stud 1.

(iii) when the handle touches the stud 1, the Full resistance is connected in series with the armature. But the shunt field winding is directly connected across the supply voltage.

(iv) As the handle is gradually moved over to the final stud, the starting resistance is cut out of the armature circuit in steps. The handle move against the spring force.

(v) When the handle reaches the final stud. the soft iron piece is attracted by the electromagnet. (No volt Release coil)

Protective Device used in starters:

(i) No-Volt Release Coil (NVR)

The NVR is an electromagnet. The coil is connected in series with field winding. when the handle is in ON Position, the No Volt coil is magnetised and attracts the soft iron and keeps the handle in ON position against the spring tension. In case of failure or disconnection of the supply or a break in the field circuit, the NVR coil is de-energised thereby releasing the arm, which is Pulled back by the spring to the OFF Position.

(ii) OLR (Over Load Release)

The over current release consists of an electro-magnet connected in the supply line.

If the Motor becomes over-loaded beyond a certain pre-determined value, line current (or) armature current increases and hence the attracting power of the electromagnet increases, then the movable arm is lifted and short circuits the electromagnet (NVR). Hence the arm is released and returns to OFF Position

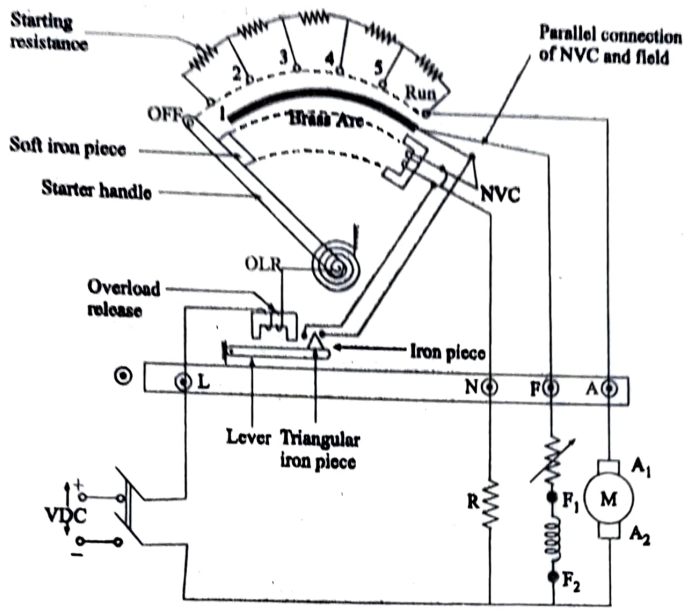
Demerits:

The motor speed can be increased by weaking the flux [$\because N \propto \frac{1}{\phi}$]; while employing this method, to decrease the flux, the field current is to be decreased to achieve speeds above the rated speed. To achieve higher speeds, the field current is to be reduced to a very low value. This low value of current also passes through NVR, which is unable to create enough electromagnetic pull to overcome the spring tension. Hence the arm is pulled back to OFF position. This is an undesirable feature of 3 point starter which makes it unsuitable for variable speed motors.

=> Four point starter:-

In three point starter, the coil of the No-volt Release is connected in series with field circuit. But here, the No-volt Release coil does not carry the field current. It is

connected directly across the line through a protective resistance (R_P). The No-Volt Release coil is independent of the shunt field current. ∴ proper speed control can be excited without affecting the operation of No-Volt Release coil.



Operation:

(i) To start the motor the DC supply is given and the main switch is closed.

(ii) The handle is now slowly moved clockwise to the stud1.

(iii) When the handle touches stud1, then the line current divides into three parts.

(a) one part passes through the starting resistance and motor armature.

(b) The 2nd part passes through the shunt field winding and is field rheostat.

(c) The 3rd part passes through the no-volt release coil and current protecting resistance(R_P) with this arrangement, any change of current in the shunt field circuit does not affect the current passing through the hold on coil.

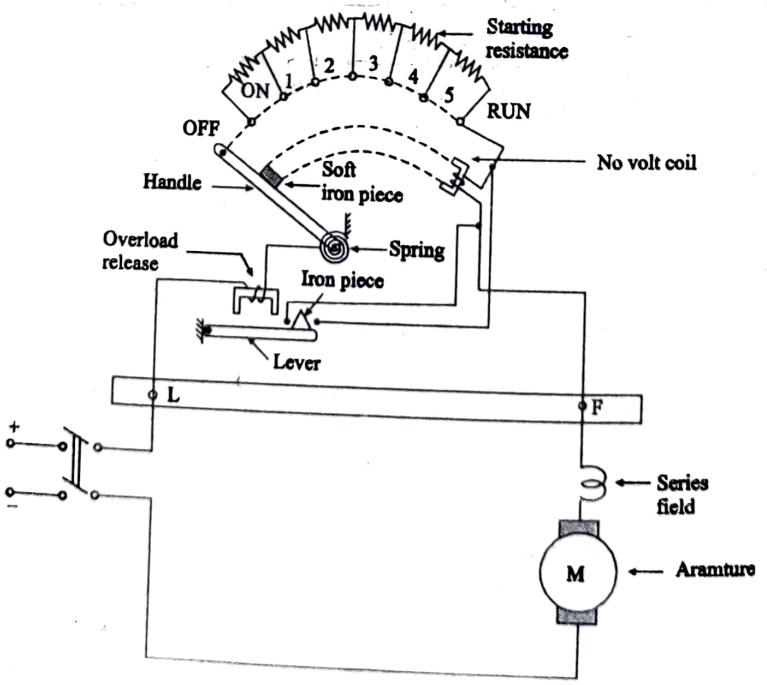
(iv).: The electromagnet pull produced by the hold on coil will always be the same and sufficient to hold the handle in 'ON' position.

Thus the misoperation as in three-point starter never takes place in four point starter.

Disadvantages:

The only limitation in this starter is, it will not protect the motor from high speed protection. During running condition, if field gets opened, the field current reduces. Then by the speed equation, $N \propto \frac{1}{\phi}$. the motor speed increases to a dangerously high value.

⇒ **Two point starter:**



The starting resistance is connected in series with the armature of a series motor. The No-Volt release coil is connected in series with the armature. After closing the supply, the handle is moved from OFF position. Then full starting resistance is included. ∴ the starting current is reduced. Then the starting resistance is gradually cut down and the motor gathers speed, which will then develope back emf. Now the NVC gathers sufficient magnetism to hold the starter handle in RUN position. Hence this NVC is also called as hold on coil.

The main problem in case of DC series motor is it's over speeding action when the load is less. This problem can be presented by using two point starter. All the other coil's operation are same as used in the three point and four point starter.

⇒ Starters for Three Phase Induction Motor:

Necessity of starter:

When a 3ϕ supply is connected to a stator of a 3ϕ Induction motor, a rotating magnetic field is produced and the rotor starts rotating.

* Thus, a 3ϕ Induction motor is self starting.
* At the time of starting the motor slip is unity and the starting torque is very large.