Three Point Starter: Diagram and Working Principle

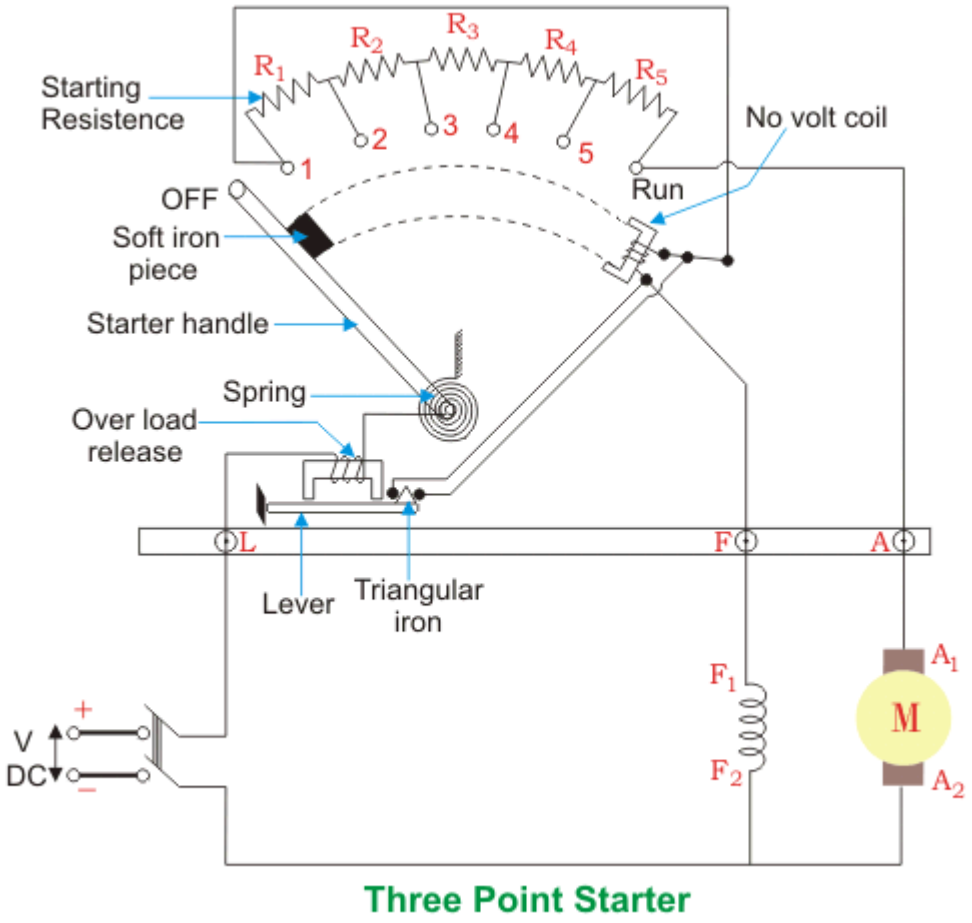
DC motors require the starter due to the presence of back emf (E_b). The back emf at the starting of the motor is zero, but it develops gradually as the motor gathers speed.

The general motor emf equation is: $V = E_b + I_a R_a$

Where V=Supply Voltage; E_b=Back EMF; I_a=Armature Current; and R_a=Armature Resistance. Since at starting $E_b = 0$, then $E = I_a.R_a$. Hence we can rearrange for the armature current I_a:

$$I_a = \frac{V}{R_a}$$

We can see from the above equation that the **current will be dangerously high at starting** (as the armature resistance R_a is small). The **3 point starter** is used to limit the starting current.



Three Point Starter

Construction of 3 Point Starter

Construction wise a starter is a variable resistance divided in sections as shown in the figure. The contact points of these sections are called studs and are shown separately as **OFF, 1, 2, 3, 4, 5, RUN**. Other than that there are three main points, referred to as

1. 'L' Line terminal (Connected to positive of supply)
2. 'A' Armature terminal (Connected to the armature winding)
3. 'F' Field terminal (Connected to the field winding)

The point ‘L’ is connected to an electromagnet called **overload release (OLR)** as shown in the figure. The other end of OLR is connected to the lower end of conducting lever of starter handle. This handle is free to move to the other side RUN.

Stud ‘1’ is connected to electromagnet called No Volt Coil (NVC) which is further connected to terminal ‘F.’ The starting resistance at starting is entirely in series with the armature. The OLR and NVC act as the two protecting devices of the starter.

Working of Three Point Starter

To start with the handle is in the OFF position when the supply to the DC motor is switched on. Then handle is slowly moved against the spring force to make contact with stud No. 1. At this point, field winding of the shunt or the compound motor gets supply through the parallel path provided to starting the resistance, through No Voltage Coil. While entire starting resistance comes in series with the armature. The high starting armature current thus gets limited as the current equation at this stage becomes:

$$I_a = \frac{E}{(R_a + R_{st})}$$

As the handle is moved further, it goes on making contact with studs 2, 3, 4, etc., thus gradually cutting off the series resistance from the armature circuit as the motor gathers speed. Finally, when the starter handle is in ‘RUN’ position, the entire starting resistance is eliminated, and the motor runs with normal speed.

This is because back emf is developed consequently with speed to counter the supply voltage and reduce the armature current.

Working of No Voltage Coil of 3 Point Starter

When the field curret is present this coil will hild the starter handle to Run positionhence also called **hold on coil**.

Now when there is any kind of supply failure, the current flow through NVC is zero and handle comes back to OFF position.

Drawbacks of a Three Point Starter

The **3 point starter** suffers from a serious drawback for motors with a large variation of speed by adjustment of the field rheostat. To increase the speed of the motor field resistance can be increased. Therefore current through the shunt field is reduced.

Field current becomes very low which results in holding electromagnet too weak to overcome the force exerted by the spring. The holding magnet may release the arm of the starter during the normal operation of the motor and thus disconnect the motor from the line. This is not desirable. A 4 point starter is thus used instead, which does not have this drawback.