D.C Motor Starters

Starters :-

- The starter is nothing but a variable resistance device, which is connected in a series.
- Starters are used to protect DC motor from damage that can be caused by very high current during start up

Necessity Of Starter

- In a DC motor the value of armature current

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

- When the motor is in off condition, the armature is stationary and the back emf (E_b) which is proportional to speed is zero.
- In motor armature resistance is very low.
- If the rated voltage is applied to the armature, it will draw heavy current many times that of full load current.

- And there is more possibility of damaging the brushes, commutator and windings.
- Consider a case of a 440 V, 5 H.P motor having a cold armature resistance of 0.25 ohm and a full-load current of 50 A. If the motor is started from the line directly, it will draw a starting current from the line directly, it will draw a starting current of 440/0.25 = 1760 A, which is 1760/50 = 35.2 times of full-load current.
- This excessive current will damage the commutator,brushes and winding.
- o avoid this happening, a resistance is introduce in series with the armature (for the duration period only, say 5 to 10 seconds), which limits the staring current to a safe value.
- The starting resistance is gradually cut out as the motor gain speed and developed the back e.m.f which then regulates its speed.

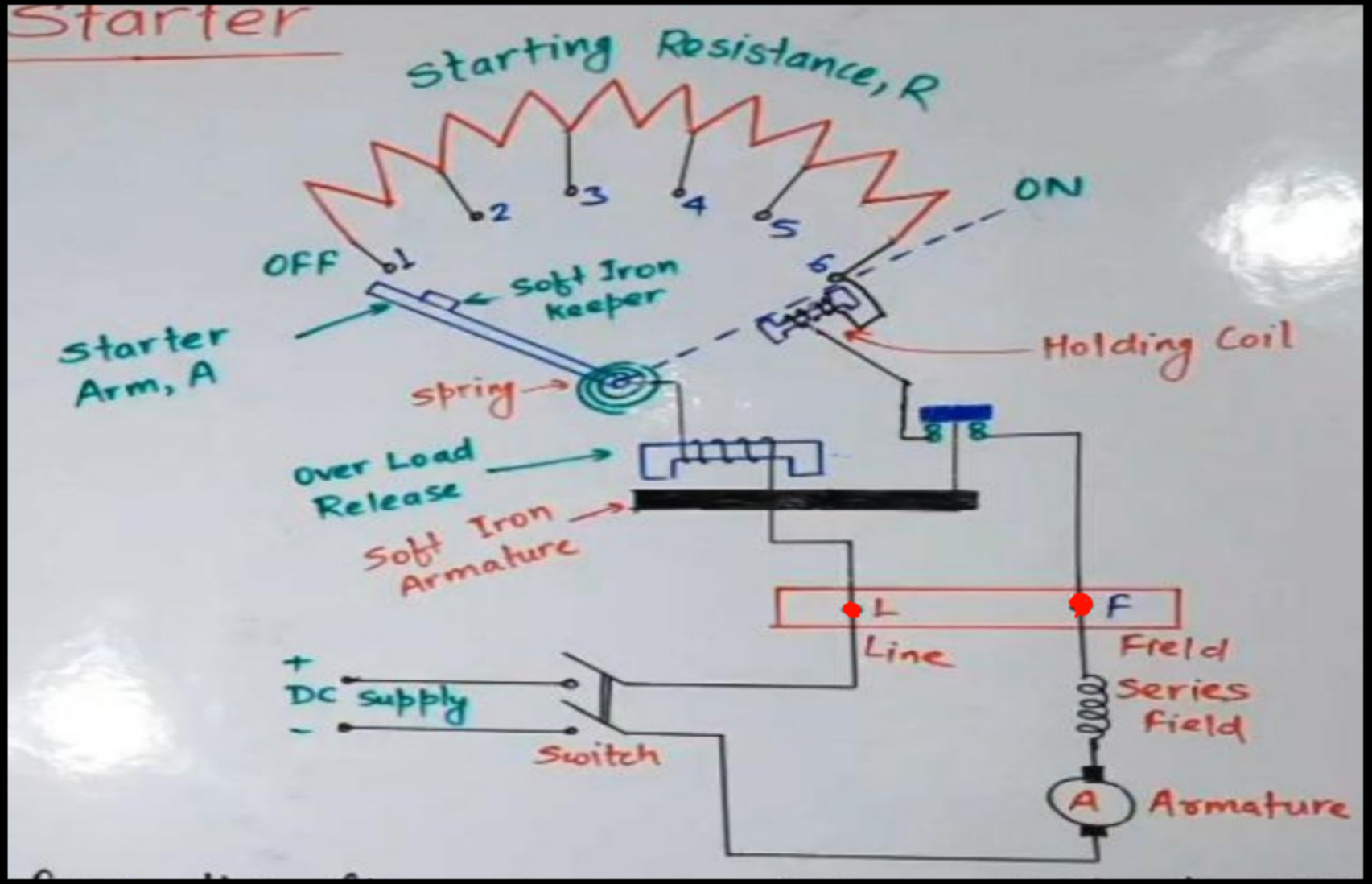
Note :- In a small size DC motor starter do not required because of following reasons
a) They have high armature resistance than large motors, hence their starting current is not so high.
b) Small in size, hence they speed up quickly.

Types Of Starters :-

There are following types of starters
1. Two Point Starter
2. Three Point Starter
3. Four Point Starter

1. Two Point Starter

- A two point starter is used for starting of DC series motor.
- It has only two point L (Line) and F (Field) so its name is two point starter.
- The basic function of 2 point starter is to protect DC series motor from high starting current.
- At the time of starting large armature current is drawn by motor which is limited by 2 point starter by connection resistance is series with the armature.
- It consists of a series atarting resistance, divided into many sections and connected to brass studs.
- The last stud of starting resistance is connected to terminal F to which one terminal of the armature is connected.
- The positive supply line is connected to the line terminal L through main switch.
- From the line terminal L, supply is connected to the starter arm through over-load release.
- A spiral spring S is placed over the lever to bring the starter arm to the OFF position in case of failure the supply.
- The soft iron keeper is attached to the starter arm which is pulled by the holding coil or no-volt release under normal running condition.


Starter
Starting Resistance, R
1
2
3
4
5
6
OFF
ON
Soft Iron Keeper
Starter Arm, A
Holding Coil
spring
Over Load Release
Soft Iron Armature
L
F
Line
Field
Series Field
+
DC supply
-
Switch
A
Armature

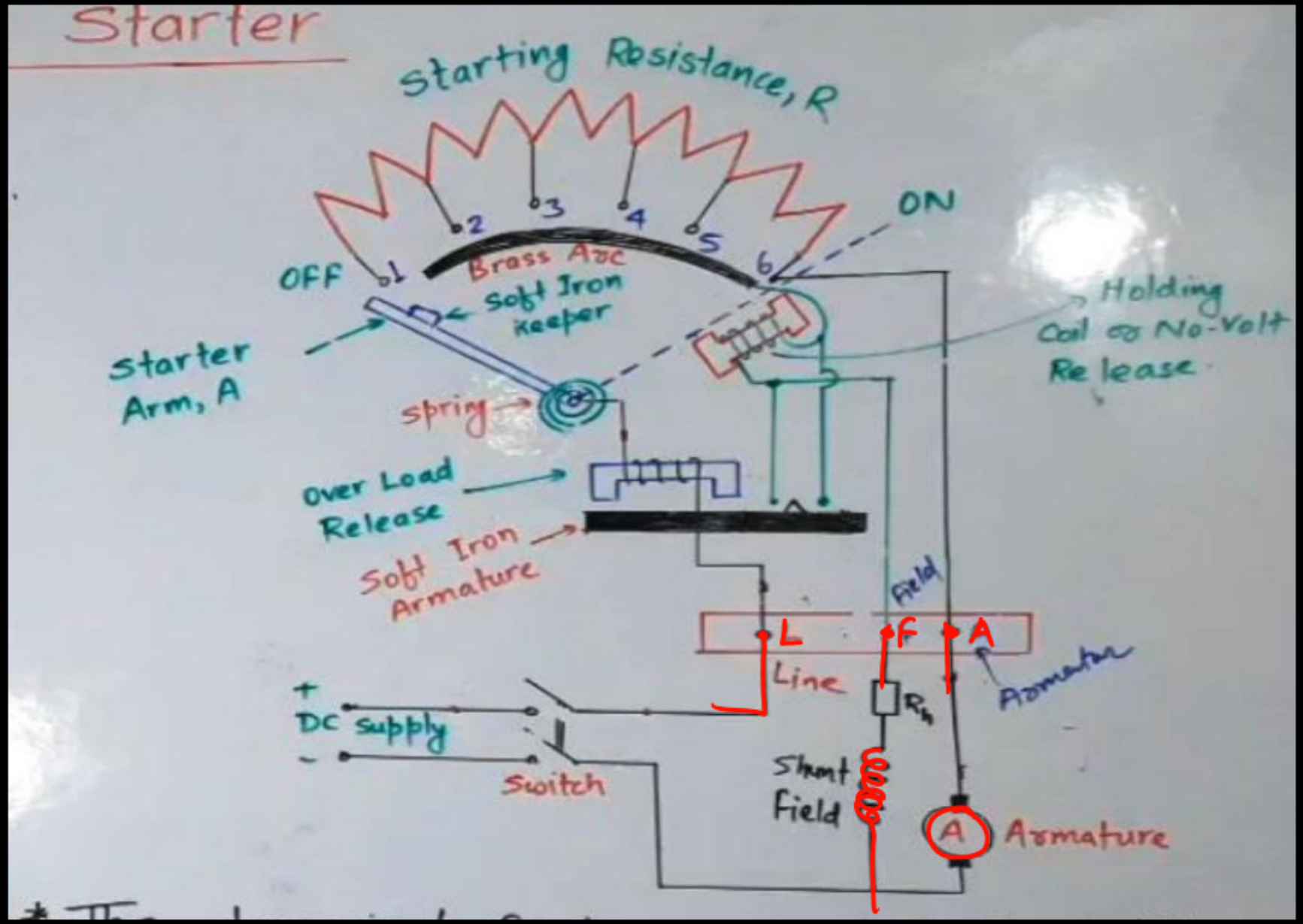
Working

- The dc supply is switched on and the started arm is moved to the right for starting the motor.
- As soon as the starter arm comes in contact with the stud no-1, the series motor gets connected through the total starting resistance to the supply main.
- When starter arm move in right hand side the resistance is decreases and value of current increases. The motor speed increases.
- When the starter arm reaches the "ON" position the starting resistance is completely cut-off and the motor starts running at normal supply.
- The arm is held in "ON" postion by the holding coil.
- When supply is fail while the motor is running then current in holding current becomes zero so that starter arm is released and current stop to flow in motor. Hence motor is turn-off.
- The spiral spring attrack the start arm in back in OFF position.
- In case of fault, accessive current flow through the overload release coil which magnetised strongly and attrack the soft iron armature up ward direction. Therefore contact between holding coil and field point is open. Hence no current flow through the motor and motor becomes safe in faulty condition.

DC 2 - POINT STARTER TE

Three Point Starter

- A three point starter is used for starting of DC shunt motor.
- It has three terminals L (Line) , F (Field) and A (Armature), so it is called three point starter.
- The basic function of 3 point starter is to protect DC shunt motor from high starting current.
- At the time of starting large armature current is drawn by motor, which is limited by 3 point starter by connection resistance is series with the armature.
- It consist of a series starting resistance, divided into many section and connected to brass studs.
- The last stud of starting resistance is connected to terminal A to which one terminal of the armature is connected.
- The terminal F is connected to holding coil and field winding.
- The positive supply line is connected to the line terminal L through main switch.
- A spiral spring S is placed over the lever to bring the starter arm to the OFF position is case of failure of supply.
- A soft iron keeper is attached to the starter arm which is pulled by the holding coil or no-volt release under normal running condition.

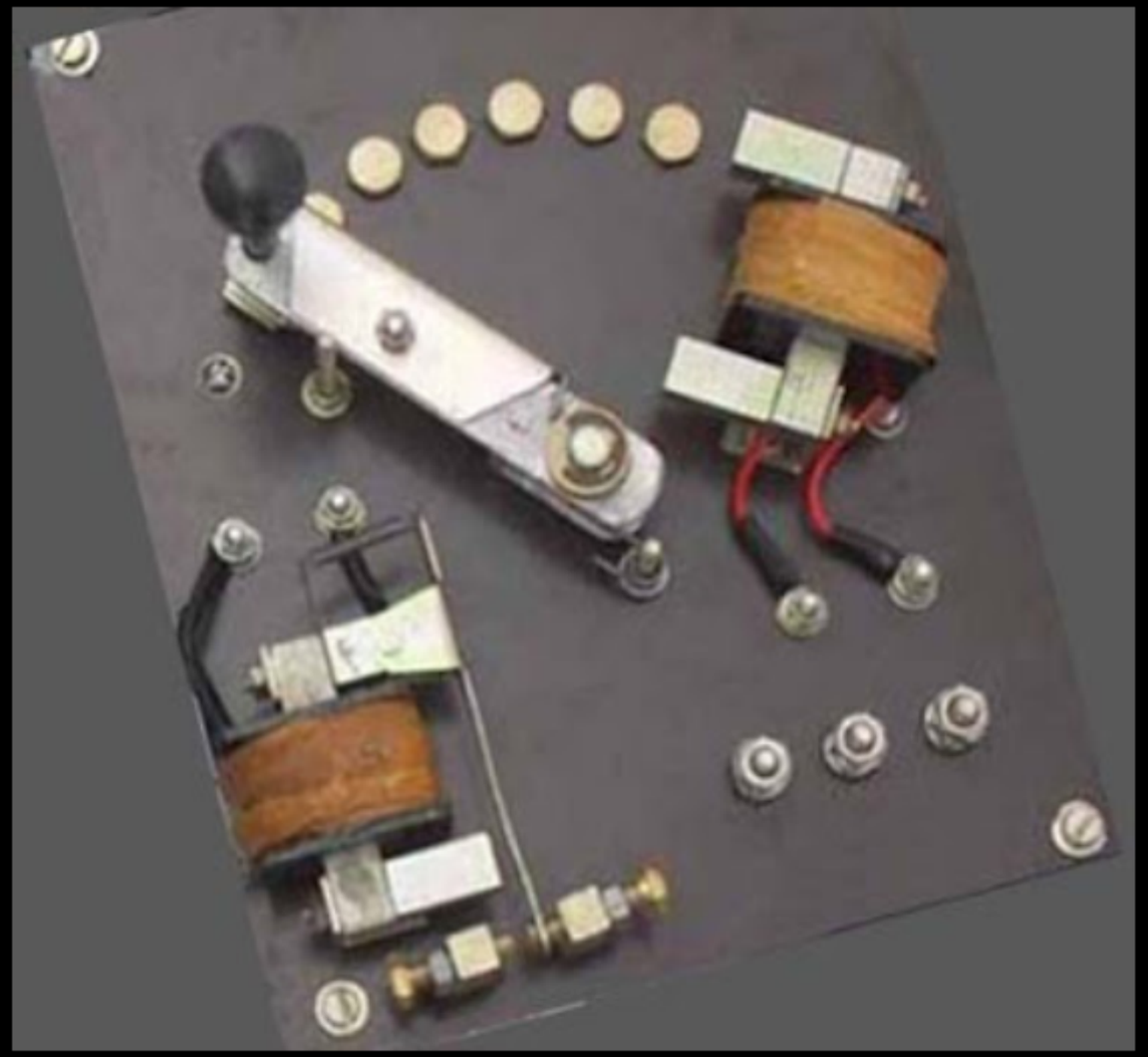

Starter
Starting Resistance, R
OFF
1
2
3
4
5
6
ON
Brass Arc
Soft Iron keeper
Starter Arm, A
spring
Holding Coil or No-Volt Release
Over Load Release
Soft Iron Armature
Field
L
F
A
Line
Armature
+
DC supply
-
Switch
Shunt Field
A
Armature

Operation :-

- When the motor is at rest, the starter arm is in the OFF position.
- For starting the motor the dc supply is switched on by closing the main switch keeping starter arm is OFF position.
- The starter arm (or handle) is than turned clock wise to first stud to last stud.
- As soon as the starter arm comes in contact with stud no-1, whole of the starting resistance R is inserted in series with armature of the motor.
- The field winding is directly connected across the supply through the brass arc and the holding coil is also energized.
- As the starter arm is turned further the starting resistance is cut out of the armature circuit in step and finally entire resistance R is cut out the armature circuit.
- When the starter arm reaches the ON position the resistance is completely cut off and motor starts running at normal speed.
- Now when supply fails, the holding coil is demagnetised and so release the starting arm A, which goes back to "OFF" position due to the force of spring.
- The over load release coil is provided to protect the motor from excessive current.
- When excessive current flow through the over load release hence it magnetises heavily which pull up the soft iron armature.

- The no-volt release coil, being short-circuited, demagnetise and release the starting arm.
- In this case starting arm goes back to "OFF" position with the action of spring attached to it and motor is automatically disconnected from the supply main.
- Thus the motor is dosconnected from the supply and is protected against over-loading.


MOTHER
3 POINT STARTER



Four Point Starter → DC Compound Motor.

- A three point starter is used for starting of DC compound motor.
- It has four terminals L (Line) , F (Field) and A (Armature) and N(No voltage coil) so it is called four point starter.
- The basic function of 3 point starter is to protect DC shunt motor from high starting current.
- At the time of starting large armature current is drawn by motor, which is limited by 3 point starter by connection resistance is series with the armature.
- It consist of a series starting resistance, divided into many section and connected to brass studs.
- The last stud of starting resistance is connected to terminal A to which one terminal of the armature is connected.
- The terminal F is connected to holding coil and field winding.
- The positive supply line is connected to the line terminal L through main switch.
- A spiral spring S is placed over the lever to bring the starter arm to the OFF position is case of failure of supply.
- A soft iron keeper is attached to the starter arm which is pulled by the holding coil or no-volt release under normal running condition.
- Four point starter is also used to control the speed of DC compound motor.

V.V.I

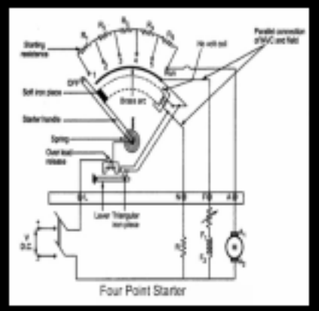
$N = \frac{V - E_b}{K\Phi}$

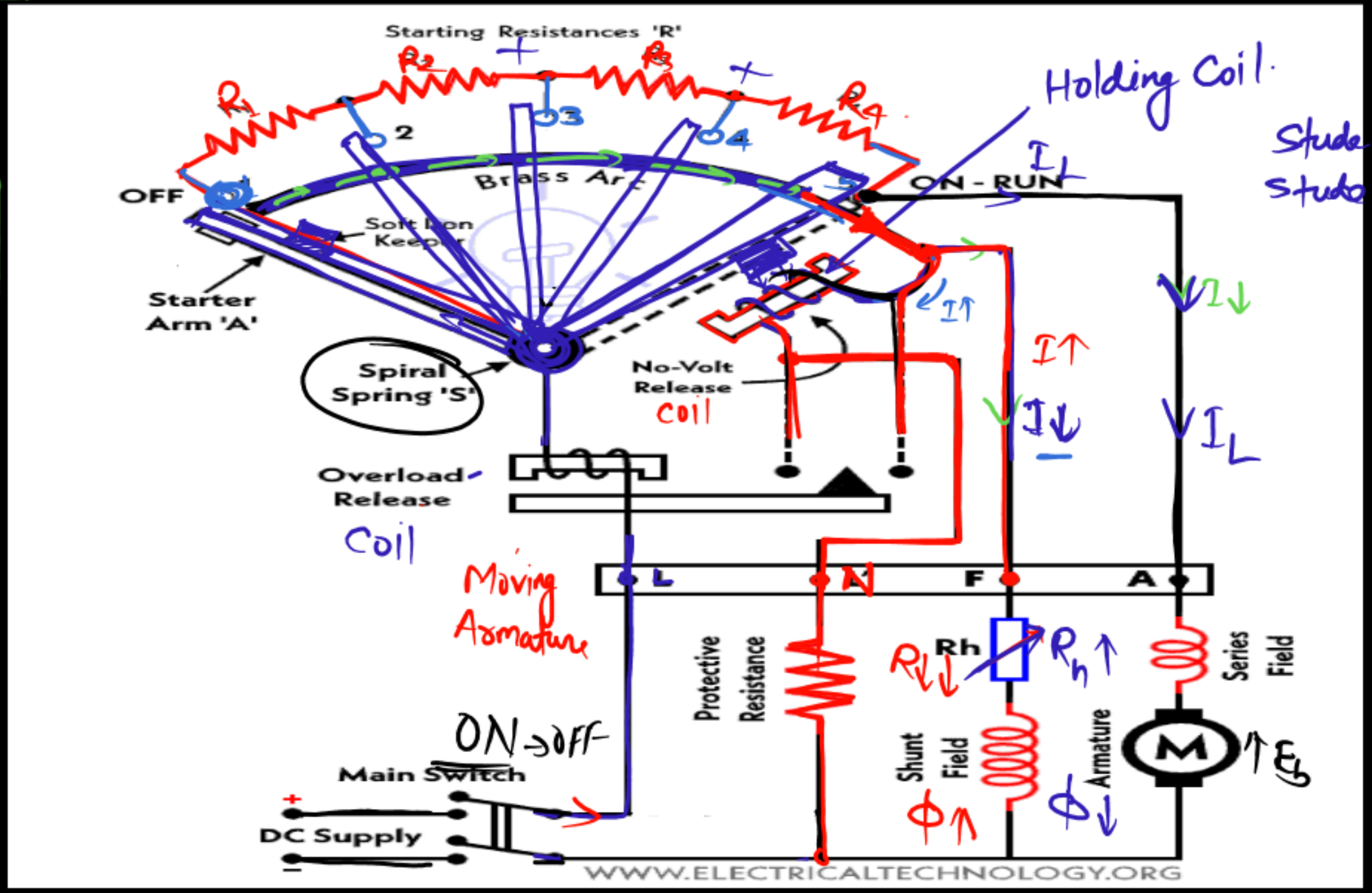
$\uparrow N \propto \frac{1}{\Phi \downarrow}$

$\Phi\uparrow \; N\downarrow$

$\Phi\downarrow \; N\uparrow$

Four Point Starter

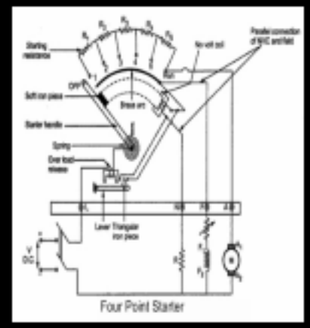


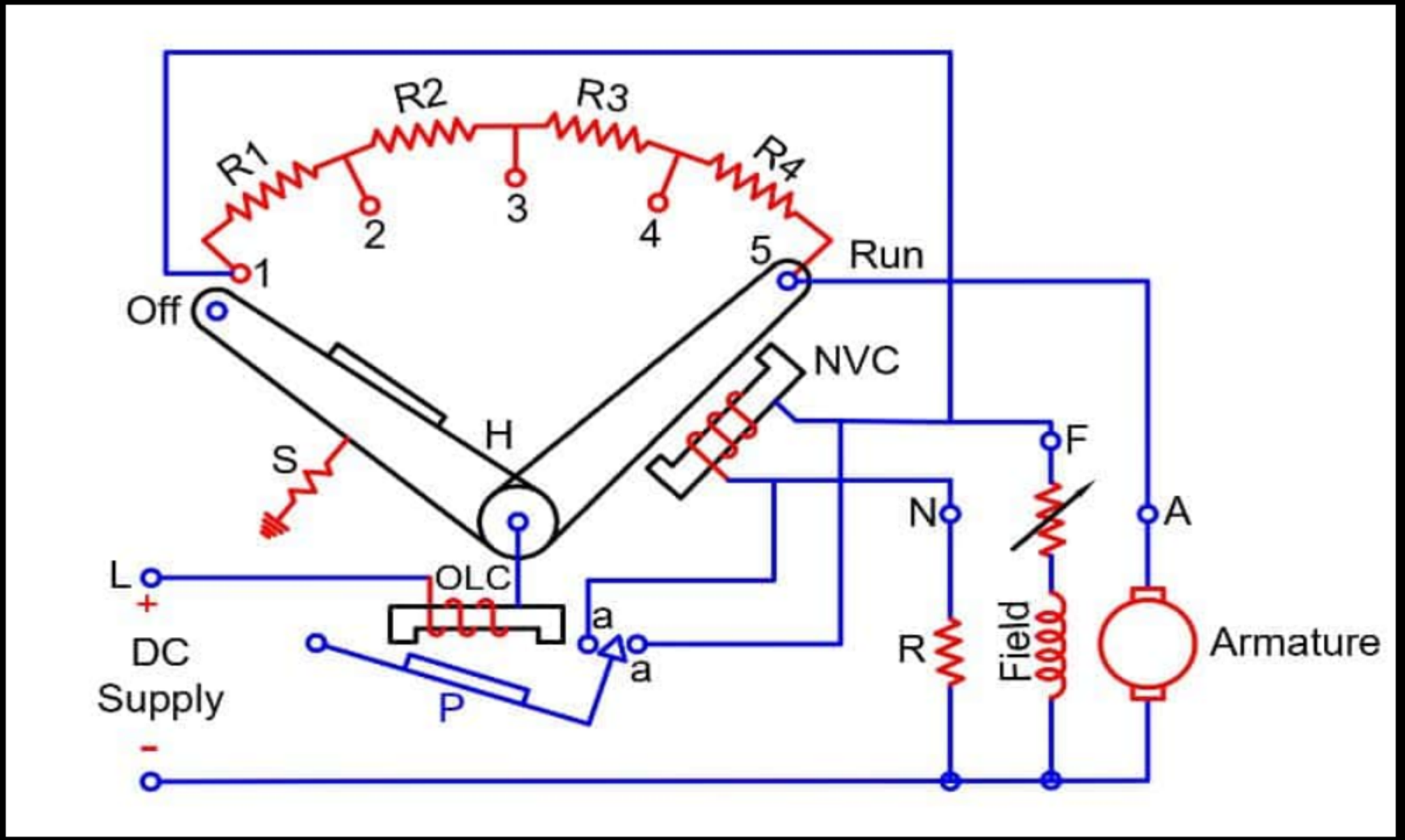


Stude No – 1 → R↑ I↓

Stude No → 2 → R↓ I↑

I↓ Φ↓




R1
R2
R3
R4
1
2
3
4
5
Off
Run
NVC
H
S
F
N
A
L
+
DC
Supply
-
OLC
a
a
P
R
Field
Armature

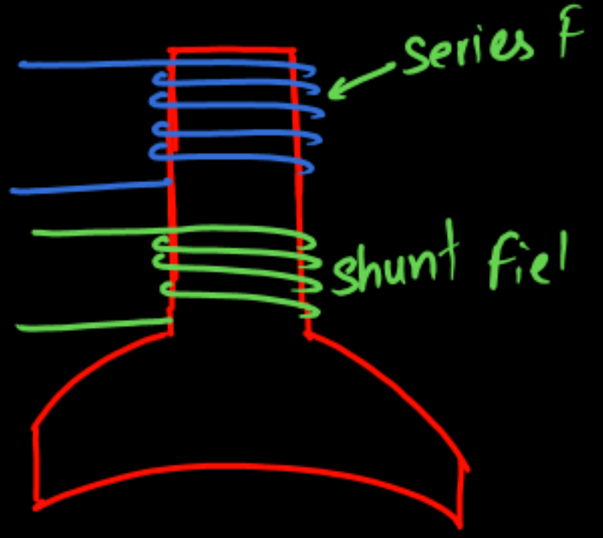
Operation :- → 3-Point Starter.

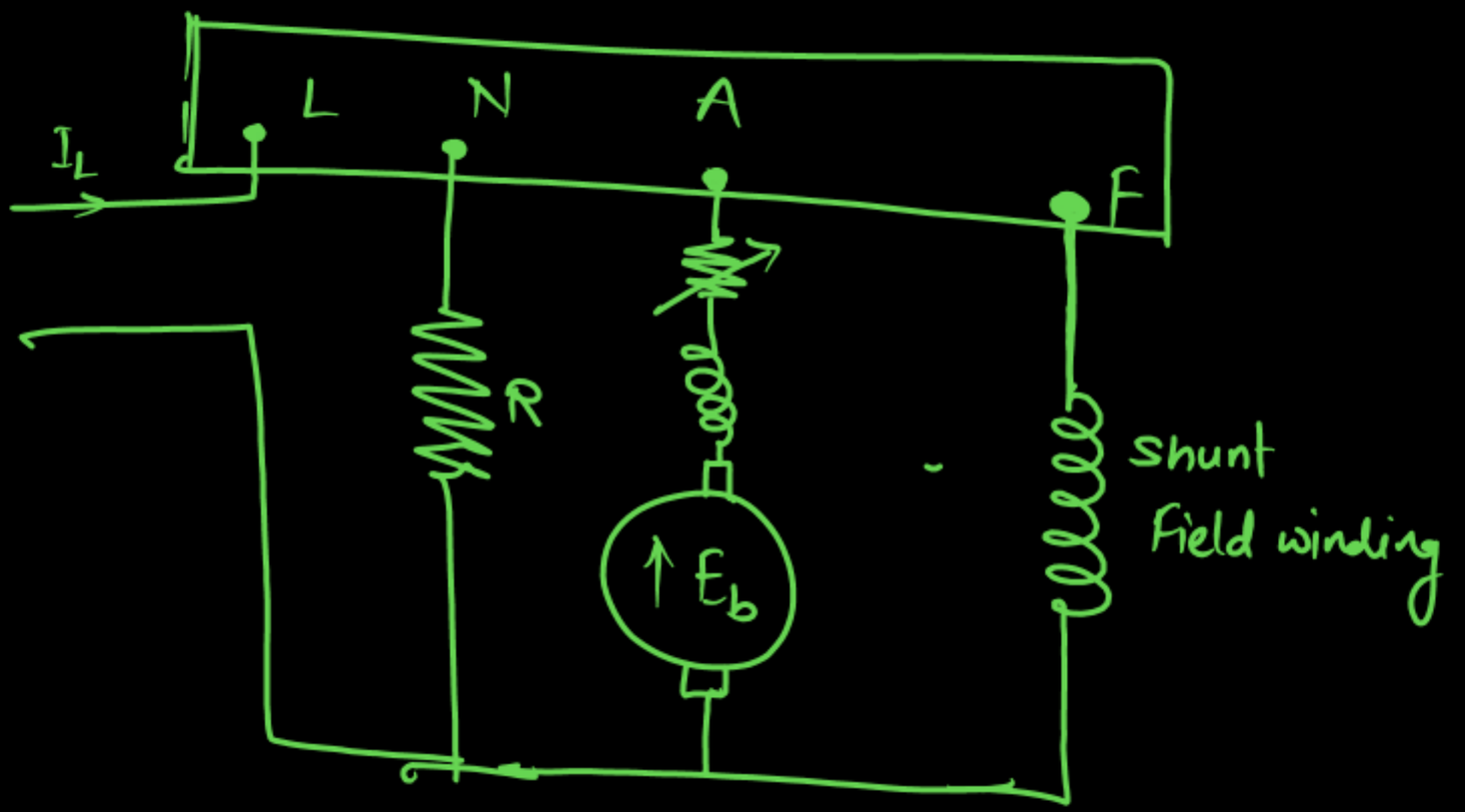
$V = E_b + I_a R_a$

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

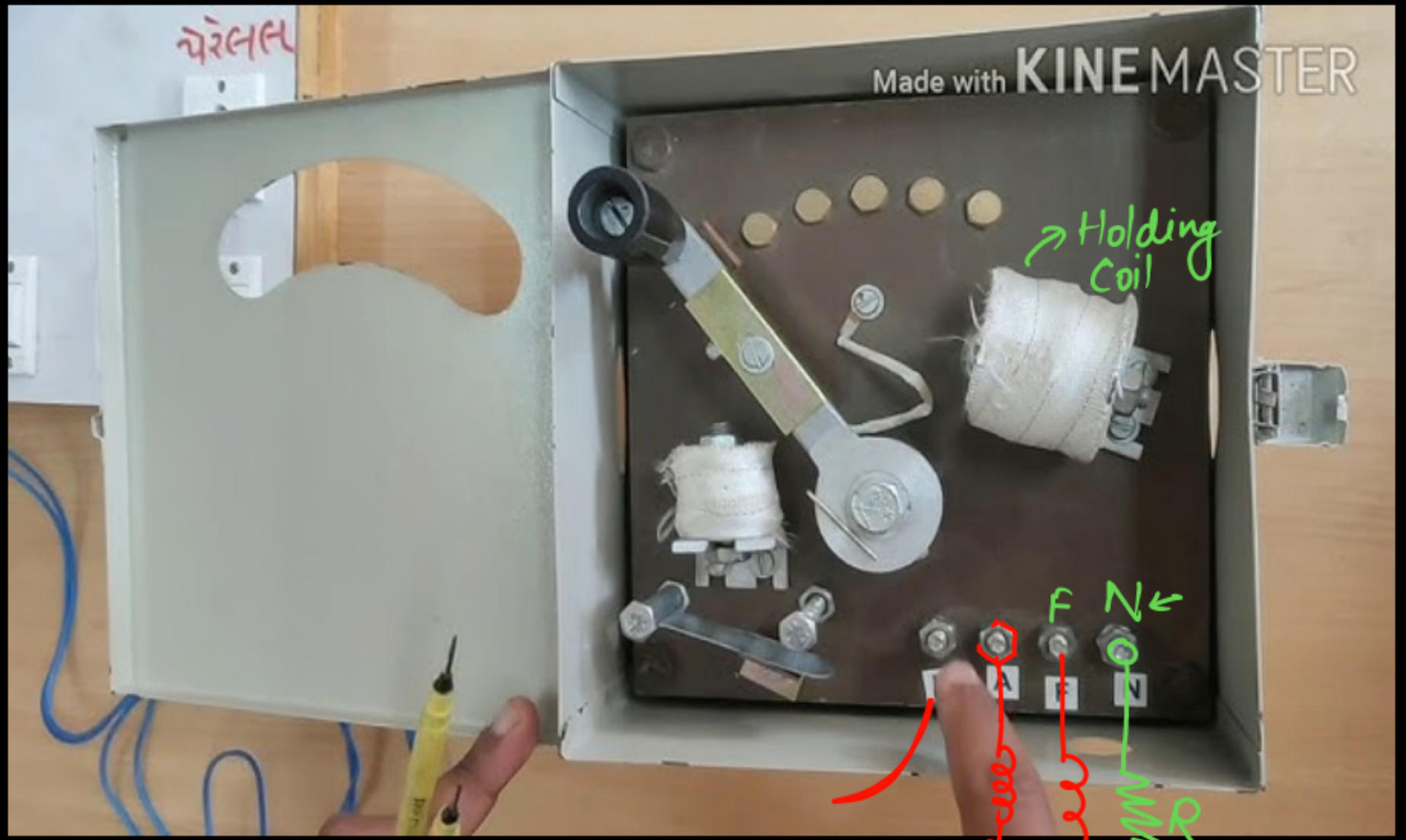
- When the motor is at rest, the starter arm is in the OFF position.
- For starting the motor the dc supply is switched on by closing the main switch keeping starter arm is OFF position.
- The starter arm (or handle) is than turned clock wise to first stud to last stud.
- As soon as the starter arm comes in contact with stud no-1, whole of the starting resistance R is inserted in series with armature of the motor.
- The field winding is directly connected across the supply through the brass arc and the holding coil is also energized.
- As the starter arm is turned further the starting resistance is cut out of the armature circuit in step and finally entire resistance R is cut out the armature circuit.
- When the starter arm reaches the ON position the resistance is completely cut off and motor starts running at normal speed.
- Now when supply fails, the holding coil is demagnetised and so release the starting arm A, which goes back to "OFF" position due to the force of spring.
- The over load release coil is provided to protect the motor from excessive current.
- When excessive current flow through the over load release hence it magnetises heavily which pull up the soft iron armature.

- The no-volt release coil, being short-circuited, demagnetise and release the starting arm.
- In this case starting arm goes back to "OFF" position with the action of spring attached to it and motor is automatically disconnected from the supply main.
- Thus the motor is dosconnected from the supply and is protected against over-loading.






OFF
ON


Made with KINEMASTER
Holding Coil
F
N
R

A starter is necessary to start a DC motor because :

(a) At start, the value of back emf is zero
(b) DC motors do not have starting torque
(c) Initially, there is a high starting torque
(d) It helps in restricting the initial high armature current that is present on account of starting back emf being zero

PGCIL Diploma Trainee 14.11.2018
MPMKVVCL (Bhopal) JE 2018
WBPSC SAE 2018
BWSSB Code 198, 30.05.2017
WBPSC SAE 2003

14. In DC motor, the condition for maximum power is-

(a) $V = \frac{E_b}{2}$

(b) $V = \sqrt{2}E_b$

(c) $E_b = \frac{V}{2}$

(d) $E_b = \sqrt{2}V$

RSMSSB JEN (Diploma) 26.12.2020
UPPCL JE 14.03.2016
SSC JE 2010

190. In three point starter, the overload release coil operates, if _____ current increases beyond set limit.

(a) Armature
(b) Field
(c) Line
(d) Neutral

Vizag Steel JET 25.10.2018, Shift-II
UPPCL JE 2015

202. **The 2 point starter is used for starting -------.**

(a) the DC Series motor
(b) the DC Shunt motor
(c) the DC long shunt compound motor
(d) the DC short shunt compound motor

Vizag Steel 25.10.2018 Shift-I

34. The starter in DC- motor:

(a) Reduce the armature reaction.

(b) Control the voltage regulation.

(c) Limit the armature current to its rated current.

(d) Enhance the efficiency of DC-motor.

HPPSC PWD AE 24.08.2021

Ans. (c) : Function of starter in DC

18. **How is the efficiency of a DC motor is not defined?**

(a) $\eta = \dfrac{\text{Input Power}}{\text{Input Power} - \text{losses}}$

(b) $\eta = \dfrac{\text{Output Power}}{\text{Input Power}}$

(c) $\eta = \dfrac{\text{Input Power} - \text{losses}}{\text{Input Power}}$

I_a 40 A

29. **The back emf of motor at the time of starting is**

(a) zero (b) maximum

(c) moderate (d) infinite

APTRANSCO Sub. Engineer 2012

20. What is the value of back emf in a dc shunt motor at the instant of starting?

(a) Zero
(b) Equal to the input voltage
(c) Half of the input voltage
(d) Double the input voltage

DMRC JE 2018, Shift-I

O/P Power = 1.6 KW

41. When the dc motor is at rest, the value of the back emf is:

(a) Equal to the supply voltage
(b) Less than the supply voltage
(c) Greater than the supply voltage
(d) Zero

FCI JE 2015

49. Starters are used with DC motors because

(a) These motors have high starting torque

(b) These motors are self-starting

(c) Back emf of these motors is zero

(d) The armature current has to be restricted as there is no back emf at starting

Karnataka PSC JE 2017

WBPSC SAE 2005

Ans. (d) : Starters are

58. DC motors are started by using starters because

(a) To increase the starting current
(b) To reduce the starting current
(c) To increase the speed
(d) none of the above

MPPGCL Plant Assit. 2019
RRB JE 19.09.2019, Shift-II
SSC JE 24.01.2018, Shift-I
Karnataka PSC JE 2016
Mizoram PSC Nov. 2015, Paper-II
KSEB Sub Engineer 2015
Kerala PSC Asst: Gr. II Electrical Inspectorate 2015
BWSSB (Code 127) 13.11.2010

$R = 4.17\ \Omega$

117. Windage losses are caused by:

(a) Air friction
(b) Bearing friction
(c) Non uniform air flow
(d) Window in a transformer

NPCIL Stipendiary Trainee 2016

290. A 3-point starter is considered suitable for dc .....motors.

(a) Series (b) Shunt
(c) Compound (d) Shunt as well as compound

SSC JE 04.03.2017, Shift-I
NMRC JE 2017
LMRC JE 2015
UPPCL JE 2015

is imposed by residual magnetism of generation.

230. The function of a starter in a D.C. motor is to

(a) Control its speed
(b) Increase its starting torque
(c) Limit the starting current to a safer value
(d) Reduce armature reaction effect

UPSSSC JE 31.07.2016

Ans : (c) The function of a starter in DC

215. Commutator of DC motor are made of

(a) Copper
(b) Cast Iron
(c) Steel
(d) Tungsten

RSMSSB JEN (Diploma) 26.12.2020