System of Train lighting

Introduction

① Train lighting by electricity was first introduced on Indian Railways in 1987.

② Supply of electricity in trains is required primarily for lighting - a necessity, for fans - an amenity and for air conditioning - now a luxury, but as it usually happen the luxury of today is the necessity of tomorrow.

③ Besides the electricity is also used in the kitchen cas for refrigrators and for cooking purposes.

System of Train lighting:

power requirement of a train can be met with in following different ways.

ⓐ By axle driven generators in conjuction with batteries or

ⓑ By a seperate generator driven either by ~~septon~~ steam turbine mounted on the locomotive or by diesel prime mover installed either on the under frame of the coach or in seperate power van.

Latter solution is adopted in case of heavy power requirement and is technically called end on ~~geneit~~ generation.

Three system are in general use with axle generation viz single battery system, double battery parallel block system and modified system.

⇒ Before we discuss above system in details, we will try to understand the special requirement of train lighting.

Special requirements of train lighting:

Requirements of d.c generation for train lighting differ from conventional generation on following accounts.

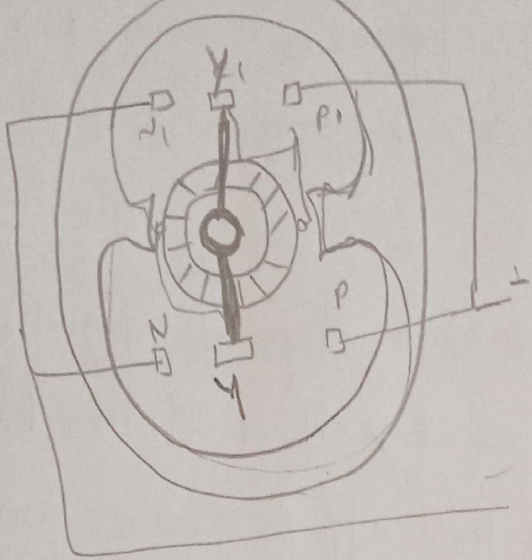
① D.C. dynamo is of totally enclosed and of robust construction so that road dust and jerks have no effect on its working.

② Since dynamo has to operate in parallel with batt[illegible] it is essential that its polarity should not change wi[illegible] the change in the direction of rotation of dynam[illegible]

③ It should give constant output at varying speed.

Method of obtaining Unidirectional polarity:

As shown in fig: dynamo has roker arm mounted on the shaft, friction tight.



- For the movement of armature clockwise, X terminal of the rocker arm will be positive and Y terminal will be negative.
- Rocker arm being friction tight, will move in the direction of armature rotation. This will make X brush to touch brush P_1 and Y' to touch brush N. This is gives outside-polarity of supply as shown.
- If direction of rotation is now made anti clockwise, X brush will have negative polarity and 'Y' brush positive polarity.
- Due to anticlockwise rotation of shaft, termina 'X' will now touch N and Y terminal with touch P. once again outside polarity remains unchanged.

Methods of obtaining constant output

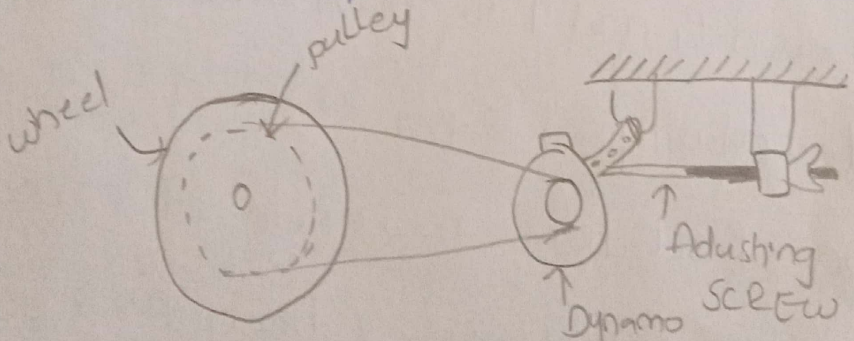
Various method to achieve constant output irrespective of speed changes are discussed below.

① As shown in fig. dynamo is hung from the carriage under frame and driven by means of belt from wheel axel pulley.

② Tensioning of the belt depends upon the component of weight of dynamo and position of the tension screw.

③ Any increase in the output makes armature heavy to rotate. This results in the belt to slip.

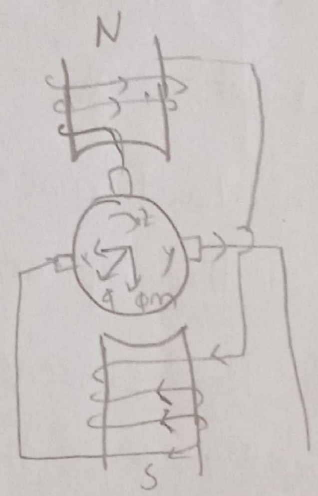
④ This can be explained thus. Increase in the drag on the armature results in the increase in belt tension which pulls the suspended dynamo towards pulley and belts get slack and slip.



(II) Any increase in load current can be arrested from, further rise if e.m.f generated is reduced with increase in load current. This principle is utilized in following two ways.

⇒ In three brush generator as shown fig. field is excited from one of the normal main brush x and and third brush z fixed at 90 degree electrical with the axis of normal brushes. As load increases, value of armature reaction flux ϕ_a will increase.

*) This brings about more and more of distortion in the main flux in such a way that resultant flux threading brushes ZX reduces.



⇒ This makes emf generated across them less thereby reducing the field excitation. This further reduces the emf generated across main brushes xy.

→ In another method, Variable resistance is inserted in the field circuit. Value of the resistance is made to increase with speed of armature there by reducing the excitation and keeping the output constant.

cutin Anoutout switch — ϕa ϕp

(iii) Rosenberg Dynamo as shown in fig. It has got two Pairs of brushes. Current flow through shunt field winding produces weak primary flux ϕp. Under the action of the flux, emf is induced across ~~the~~ brushes xy.

=> Being short circuited by fuse, heavy current flow through these brushes which produces main flux ϕm at 90 degree space displacement with respect to primary flux ϕp.

=> Rotation of armature in main flux ϕ_m, produces an emf across brushes AB. Which supplies current to load or battery through "cut in and cut out switch".

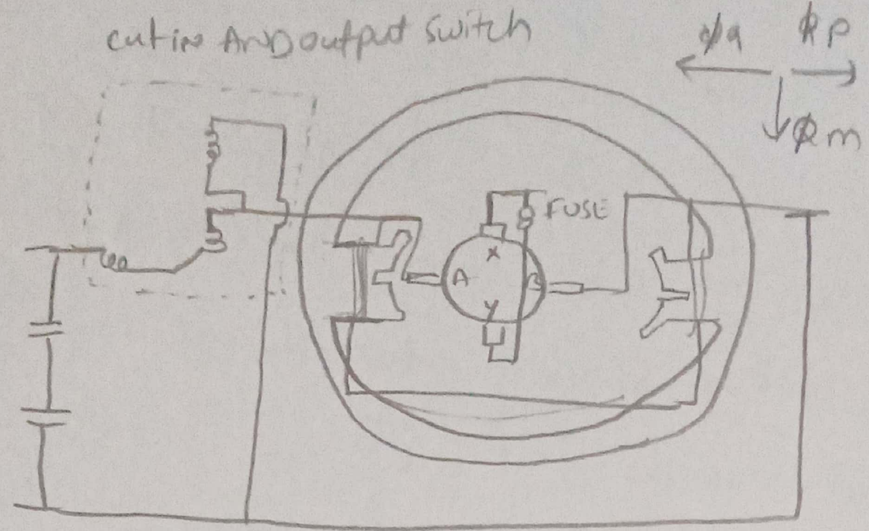
=> Flux produced by the load current ϕm is in opposite direction to that of primary flux thereby reducing it's value.

=> Any tendency for load current to increase as a result of increase in speed will increase the demagnetizing flux ϕa.

=> This reduces the net flux $(\phi p-\phi a)$ which is turn reduces emf generated emf generated across brushes AB.

=> In this way load current is self regulating in spite of changes in the speed of armature.

=> Reversal of direction of rotation will reverse the direction of emf generated by primary flux across xy.



⇒ Now both direction of rotation of the armature and direction of main field flux have changed. Therefore, there will be no change in the polarity of e.m.f generated across brushes AB.

⇒ Fuse in the brush circuit 'xy' is ~~produced~~ provided for the protection of armature. If due to any reason load circuit is disconnected while armature is being rotated, value of will be ϕ_q will be zero.

⇒ The magnitude of ϕ_p will be so much as to produce very ~~heavy~~ heavy e.m.f across brushes XY. Since these brushes are short circuited, it will produce dangerous currents in armature.

⇒ In that eventuality fuse will blow off and armature will be saved from damage. we thus see that Rosenberg dynamo satisfies both of the requirements of train lighting.

Single Battery system:

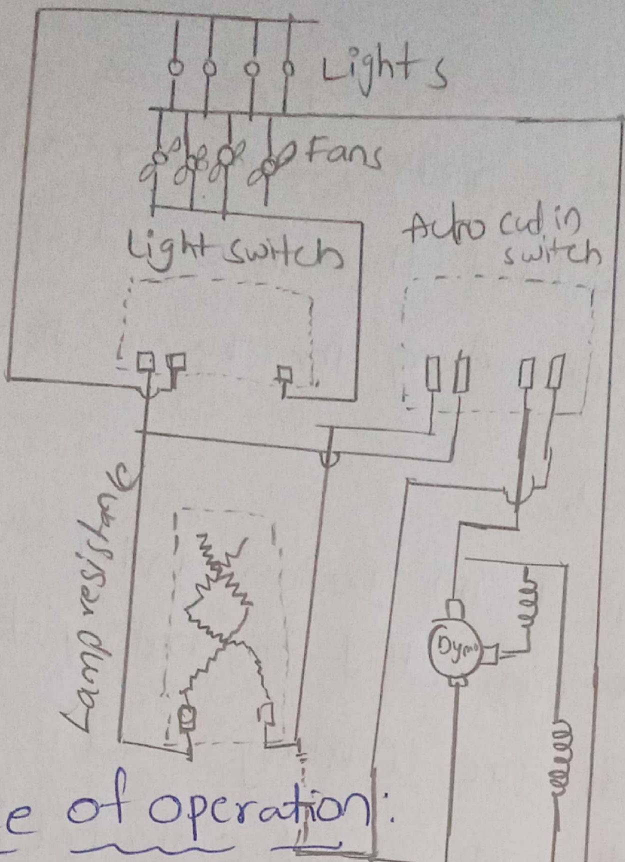
⇒ This system, shown in below fig I65 is the cheapest among all axle generation system. In this system only one set of battery is used. when the generator is driven above certain speed auto cut in switch will operate and dynamo will be supplying the light load as well as changing the batteries through Lamp resistance

⇒ when Speed falls below cut out value, auto cut in switch will disconnect ~~that~~ dynam and the Lamp resistance will be short circuited.

⇒ Now batteries will be suppling the load directly.

⇒ The main drawback of this system is that the insertion and cutting out of the resistance is invariably attended by ~~the~~ lamp flicker.

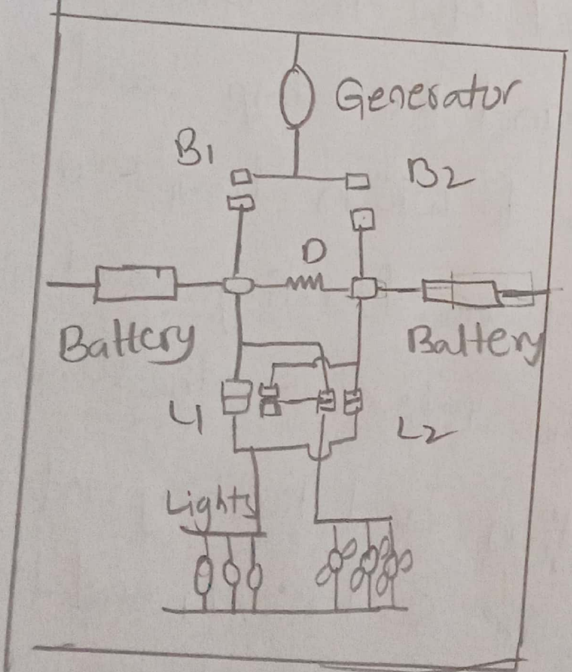
⇒ However, by the employement of automatic voltage regulator is conjuction with shunt dynamo, this defect has been overcome.

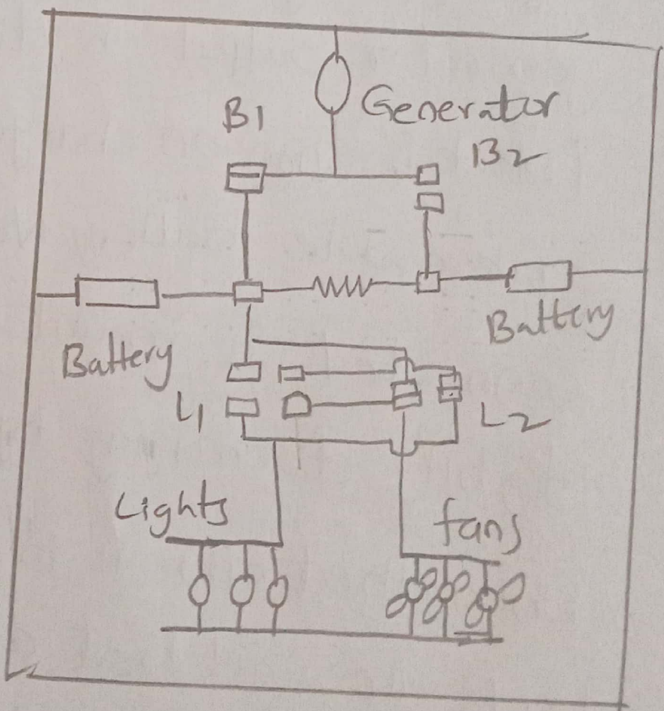


single battery system

Sequence of operation:

sequence of operation will be best understood by reference to schematic diagram as shown in below fig.





⇒ when the train is stationary or runs slowly generator contact B_1 and B_2 are open and both batteries supply the load through closed contacts L_1 and L_2, short circuiting the Lamp resistance 'D' as shown fig (a), and Lights on fig (b).

⇒ when the train is in motion and when the generator is connected to battery No. 1 through closed contacts 'B1' are lighting load is connected to battery No. 2 through closed contacts "L2".

⇒ By suitably proportional Lamp resistance 'D', the generator output is divided b/w the battery No. 1 (which is than on charge) and the Lamp Load, meanwhile battery No: 2 to which Lamps are connected, is maintained in floating condition or sligbtly discharging by the action of the Lamp resistance.

⇒ When the train is in motion and lighting and other loads are switched off, i.e switches L_1 and L_2 are open, the Lamp resistance D is short circuited when both generator contacts B_1 and B_2 are closed and both the batteries will then be charged in parallel.

Principal Equipment of Double Battery System.

principal components of the double battery System as observed from fig are.

(1) Coach wiring including inter vehicular coupler and Junction boxes.

(2) Dynamo.

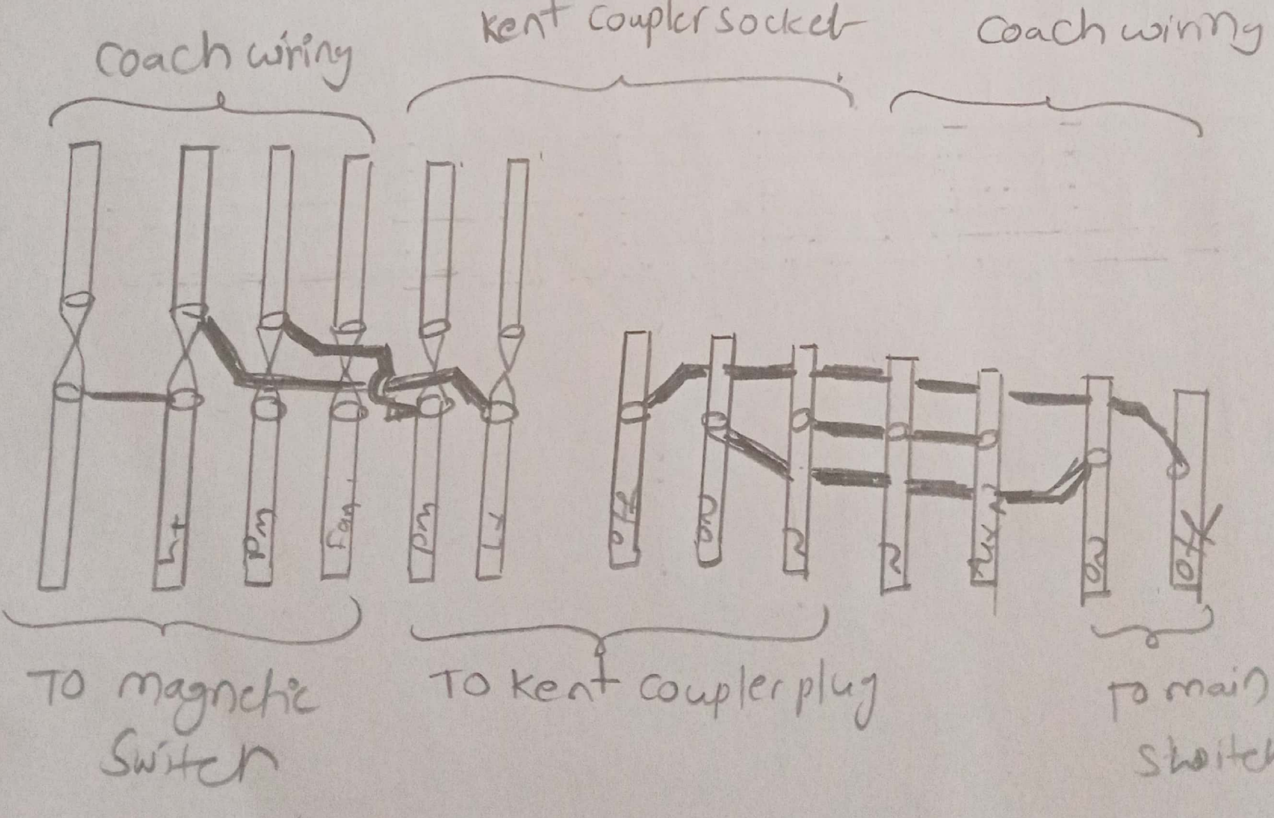
(3) Switch gear consisting of (a) Auto cut in and cut-out switch (b) Over voltage and overcharge relays (c) Battery Change over switch and (d) Load switch for the remote control of lights.

(4) Lamp resistance.

(5) set of accumulators.

Coach wiring:- As shown fig. Five roof wires of following details run throughout the length of the coach and are connected to adjacent coach by inter vechicular couplers.

Designation of the line	wire size	colour scheme for the core
Negative (–)	631.018	Blue
Light positive (+)	41/018	yellow
paralleing main (pm)	41/018	Red
o.n control (on)	44/.012	Black
off control (off)	44/.012	Green.



⇒ Intervehicular coupler acts as a jumper to the five roof wires, making then the main bus wires

⇒ This enables feed being taken from the adjoing coaches if the generating equipment on the coach itself is defective.

⇒ It also enables switching on or off the lights and fans on each coach simultaneously by remote control from Guard's brake van.

⇒ Junction boxes provide a convenient terminating arrangement for roof mains, under frame coupler and socket wires with facilites for every isolation.

⇒ standard practice on B.G is to use one 24 way Junction box. fig at one end of equipped coach and 1 way junction box at the other end and to employ two inter vehicular couplers.

Over voltage and over charge Relay:

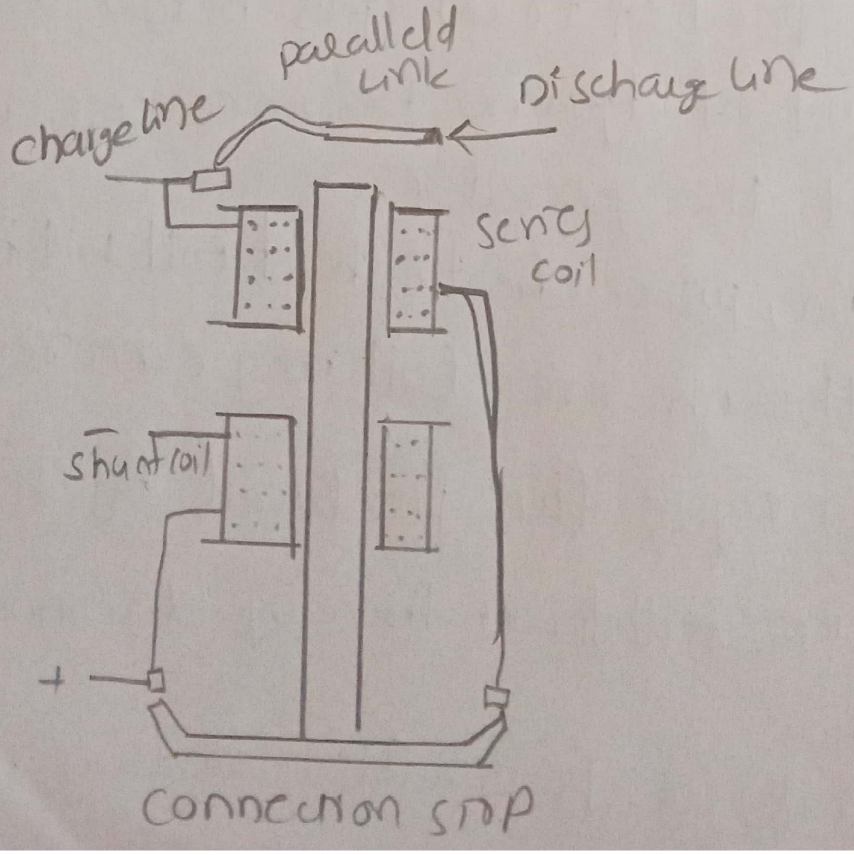
It has two seperate elements.

- When battery voltage has reached 29V at full charge, the overcharge element operates to reduce the o/p from the dynamo to approximately 30% of full value.
- The overcharge element automatically restores the dynamo output to its full value when battery voltage drop from overecharge value.
- Voltage of inherently regulated dynamo builds up rapidly to a high value on open circuit, if this is continued and dynamo field coils.
- The function of the over voltage element of the relay is to disconnect the dynamo field coils at certain predetermined dynamo voltage.
- Voltage element usually is set to operate at 40V. Once operated over voltage element requires manual resetting which is to be only after investi-gating the cause of over voltage

Auto cut in And Cut out switch: It performs following functions.

① Till train picks up speed above 20kmph and voltage generated is above 28 volts, dynamo should not be connected to supply load. During this period both banks of batteries should jointly supply Load and dynamo should not be fed back to run as motor.

② After train has attained speed above 20kmph dynamo should be connected to supply the load in parallel with one bank of battery, other bank should remain connected on charge. feed back to dynamo should, of course, not be allowed during this period also.



⇒ when speed of 20 kmph is reached and dynamo generated voltage of 28 V is attained, shunt coil of "auto cut in and cut out" switch is energized enough to pull up the plunger.

⇒ this makes connection strip to connect positive terminal of dynamo to positive roof wire through charge line and series coils of the switch.

⇒ Simultaneous with the plunger rising up, paralleling link is lifted. Since magnetic light switch is already in on position, out of the two banks of batteries, previously jointly supplying load, one is disconnected and is put on charge through charging resistance R.

⇒ As soon as speed of train goes below 20 kmph, generated e.m.f of dynamo becomes less and battery tries to feed the generator.

⇒ Not only holding power due to shunt coil will be reduced but current through series-coil may even reverse.

⇒ This will de-energize flux produced by shunt coil, plunger, therefore, fall down thereby disconnecting the dynamo.

⇒ Paralleling link, which will also fall down, brings both the banks of batteries in parallel to supply load jointly.

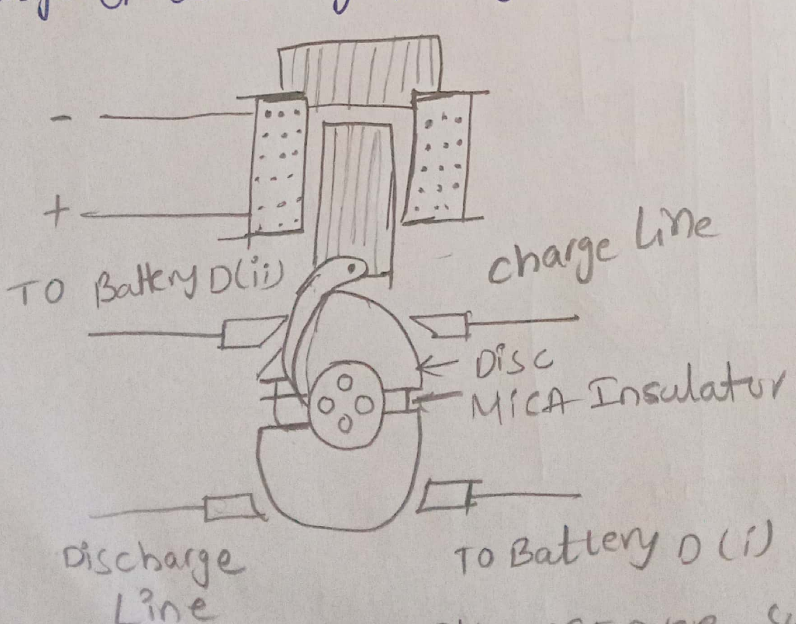
Battery change over switch:

⇒ It is seen that when train is at rest, both battery are supplying the load jointly. When train is running above 20kmph, only one of the bank of battery has to run in parallel with dynamo, other bank of battery is being charged.

⇒ In order that both of the batteries be doing same amount of duty, it becomes necessary to put them on charge and dischage alternately.

⇒ After every stoppage, when train picks up speed and dynamo generates enough voltage so as to energize the coil of charge over switch, books turns the discs through 90° as shown in fig below.

⇒ This makes the batteries altenatly to remain on charge or discharge, every time the train stops and restarts



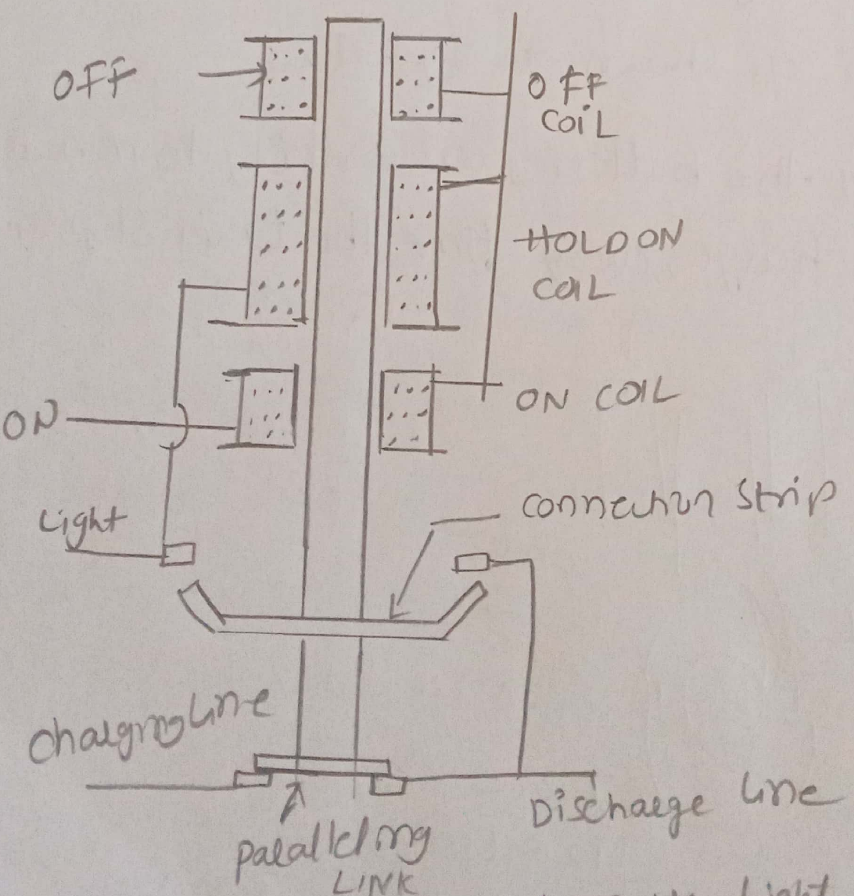
Battery CHANGEOVER SWITCH

Magnetic light switch:

⇒ when train guard put on, for a moment, the "guard control switch" which is situated in his cabin "on roof wire" is energized fig.

⇒ this energizes "on coils" of magnetic light switches of all self generating carriges. plunger of the magnetic light switch rises up. Paralleling link breaks the connect between charge and discharge line.

⇒ Connecting strip also rises up simultaneously, thereby connecting discharge line to negative roof wire through hold on the magnetic light switch.



MANGETIC Light switch

⇒ "On coil" of magnetic light switch gets deenergized as guard only presses the "Gaurd control on switch" momentarily. Hold on coil then keeps the plunger of the magnetic light switch up".

⇒ Prior to this operation dynamo was charging both batteries, one directly and through paralleling link of magnetic light switch.

⇒ After this operation when paralleling link is lifted up, one of the battery is put on charge through the resistance 'R' and other battery is running in parallel with dynamo to supply the load.

⇒ When guard presses his off switch, it energizes momentarily the 'roof off' wire, off coils of all the magnetic light switches are now energized.

⇒ Since there coils are wound in such a way so to produce magnetism in opposite direction to that of "on and hold on coils", this de-energizes magnetic light switch and plunger fall down under its own weight there by breaking the light circuit.