PADAMASHREE KRUTARTHA ACHARYA
INSTITUTE OF ENGINEERING & TECHNOLOGY,
BARGARH

ELECTRICAL LAB PRACTICE -II

COURSE AS PER *S.C.T.E & V T,* ORISSA

(SEMESTER – V)
BRANCH- ELECTRICAL ENGINEERING

Total Period:- 90

No. of Period:- 6 P/W

Examination:- 4 Hours
Total Marks:- 150
Practical:- 100 Marks
Sessional:- 50 Marks

List of Experiment:-

1. Study of **direct-on-line (D.O.L)** starter, connecting and running of a 3-Phase Squirrel cage Induction motor and measurement of starting current.
2. Study of **Y-Δ** starter, connecting and running of a 3-Phase Squirrel cage Induction motor and measurement of starting current.
3. Study of **auto-transformer** starter, connecting and running of a 3-Phase Squirrel cage Induction motor and measurement of starting current.
4. Study of **rotor-resistance** starter, connecting and running of a 3-Phase Slip-ring Induction motor and measurement of starting current.
5. Heat run of 3-Phase transformer.
6. O.C.and S.C. test of Alternator and determination of regulation by **Synchronous-impedance method.**
7. Determination of regulation of alternator by direct loading.
8. Parallel operation of two alternators.
9. Measurement of power of a 3-Phase circuit by 3-Phase wattmeter.
10. Conection of 3-Phase energy meter to a 3-Phase load and measurement of energy.
11. Study of voltage and current ratio of a 3-Phase silicon controlled rectifier.**(S.C.R.)**
12. Connecting and running of a 1-Φ motor such as (i) Capacitor-start motor
    (ii) Shaded pole motor
    (iii) Repulsion motor
13. Study of an **O.C.B.**(Oil-Circuit-Breaker)
14. Study of induction type **over current** relay/**reverse power** relay
15. Study of a **Buchholz's relay.**
16. Study of an **earth fault relay.**

P.K.A.I.E.T., BARGARH

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10. Study of an **O.C.B.**(Oil-Circuit-Breaker)
11. Study of induction type **over current** relay
12. Study of a **Buchholz's relay.**

DIRECT-ON-LINE STARTER (D.O.L)

AIM OF THE EXPERIMENT :- To study the direct-on-line starter ,connecting and running of 3-Φ squirrel cage Induction motor and measurement of the starting current .

APPARATUS/MACHINE REQUIRED:

Sl.No.	Name of items	Type	Range	Quantity
1	D.O.L Starter	A.C.	--------	1
2	3-Φ squirrel cage Induction motor	A.C.	--------	1
3	Ammeter	M.I.	--------	1
4	Connecting wire	S.W.G	--------	As per req.
5	Combination plier	Insulated	--------	1
6	Screw driver	--------	--------	1
7	Line tester	--------	--------	1

THEORY :-In this type of starter there is no arrangement for reducing the line voltage at the time of starting and therefore full line voltage is applied to the motor while on starting and running condition .So it is named as D.O.L. starter. It has provided with the following safety devices .

(i) Push buttons switches .

(ii) Plunger with strips .

(iii) NO-Volt release coil .

(iv) Over load release coil .

PUSH BUTTONS SWITCHES:-There are two push button switches to (1)start (normally open) and (2) stop (normally closed) the motor .

PLUNGER WITH STRIPS :-There is one plunger whose three strips contacts connects the motor to the line and fourth strip works as an hold-on -contact when start push button is released after pressing it .

NO-VOLT RELEASE COIL :-It safe guards the motor against sudden failure of supply or if the voltage drops unduly it releases the plunger and thus motor is disconnected from the supply .

OVER LOAD RELEASE COIL:-It protects the motor against over current beyond the setting of current .It is made of thick heating element inside of which there are bi-mettalic strips . When abnormal current follows through the motor ,the over load coil becomes hot and the bi-mettalic strips expands which opens the trip contact point .The tripping systems should operate at approximately 20 to 30 % over load .After tripping off the contact point ,the current through the no-volt-coil stops flowing and thus the plunger comes to off position .

OPERATION :- When the start push button is pressed ,the no-volt-coil becomes magnetized and the plunger makes contacts with the motor and supply terminals which causes to start the motor . This type of starter is used with the motor of range from 1/4 H.P.to 5 H.P.

PROCEDURE :-

(1)First read out the name plate and rating of the starter carefully .

(2)Remove the cover of the starter .

(3)Study about the moving and fixed contacts of the starter in which the moving contacts are working on the base of spring .

(4)Then study about the over load circuit carefully .In the starting the contacts of load circuit are closed and when the current is flowing above normal, then the contacts get open by the tripping load and the circuit is opened and due to this ,the motor is stopped .

(5)NO-Volt coil is operated on two phases in this starter .One phase is going directly and another one is going through auxiliary, O.L. contacts, ON (Normally open) and OFF(Normally closed) switches .

(6)Connect the motor as per ckt. Diagram .

(7)Push the "START" button to start the motor .

(8)Measure the starting current of the motor by ammeter .

(9)Push the "STOP" button to stop the motor .

PRECAUTION :-

(1) All the line contacts should made contact properly at a time .

(2) Setting of the O.L. current of the starter should be same as the given rating on the name plate of the motor .

(3) The contacts of the over load switch ,OFF switch should be in ON i.e. normally closed position at the starting or when the starter is in the normal position .

(4) All connection should be right and tight .

(5) Fuse wire in the main switch should be correct size (3/2 times the full load current of motor or 3 times the H.P. of the motor .

TABULATION :-

Sl.No.	Starting current in amp.	Running current in amp.
1		

CONCLUSION :- The D.O.L. starter was studied and we got a brief knowledge about it and the motor was connected and running successfully and the starting current was found to be ______ amp.

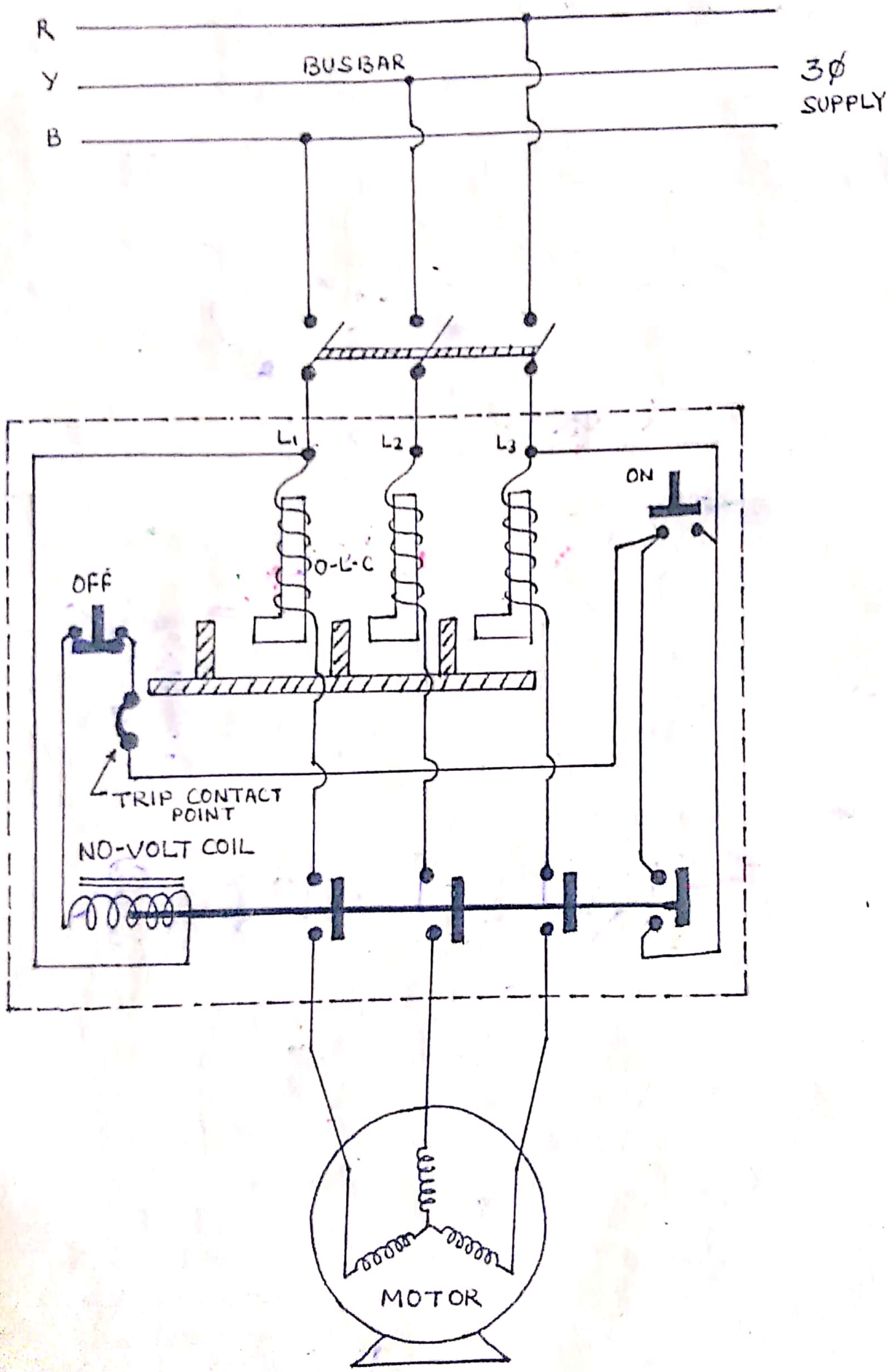
***

N.B.

(1) Direct-on-line (Air break) starter is used upto 1/4H.P. to 5 H.P.

(2) Direct-on-line (Oil immersed) starter is used upto 3 H.P. to 25 H.P.

(3) Direction of motion of motor can be changed by changing the any phase of supply ,starter or motor .



CONNECTION OF DIRECT-ON-LINE STARTER

STAR-DELTA STARTER (Y-Δ)

AIM OF THE EXPERIMENT :To study the star-delta starter (Y-Δ) starter, connecting and running of 3-Φ squirrel cage Induction motor and measurement of the starting and running current .

APPARATUS/MACHINE REQUIRED:

Sl.No.	Name of items	Type	Range	Quantity
1	Star-delta starter	A.C.	--------	1
2	3-Φ squirrel cage Induction motor	A.C.	--------	1
3	Ammeter	M.I.	--------	1
4	Connecting wire	S.W.G	--------	As per req.
5	Combination plier	Insulated	--------	1
6	Screw driver	--------	--------	1
7	Line tester	--------	--------	1

THEORY :- Star-delta starter can be used ,provided the starter winding of the motor is designed for delta connection during its normal operation .This starter starts the motor first in "STAR" condition and when the motor gains about 75% speed ,the connection is changed to "DELTA" by moving the handle quickly in run position. A four pole double throw-switch is generally used to change over the connection from star to delta .It is also provided with no-volt release and over load release which protect the motor against sudden failure of supply and over loading on the motor respectively and to stop motor a STOP-PUSH button is used .By connecting the motor in star connection during starting the applied voltage to each phase of the winding is reduced to $1/\sqrt{3}$ or 58% of the line voltage in delta connection .Thus the starting line current in star is only one third that in delta .

I_{st} per phase = $(1/\sqrt{3})\, I_{sc}$ ------ (i)

Where I_{st} → Starting current per phase if the motor is started in star

I_{sc} → Starting current per phase if the motor is started in delta

In star connection line current is equal to phase current so I_{st}/phase = I_{st}/line

But in delta connection line current is equal to $\sqrt{3}$ times of phase current.

Hence I_{sc} /phase =$(1/\sqrt{3}) I_{sc}$ line.

Putting the above values in equation (i)

we have I_{st} line =$(1/\sqrt{3})(1/\sqrt{3}) I_{sc}$ line=$(1/3) I_{sc}$ line

Hence we found that line current is 3 times more if the motor is started without starter.

The torque in "STAR" connection is also decreased and is only one third that in delta .Hence the Star-Delta starter can be used only with motors where the load torque at the moment of starting is not more than about 50% of the rated torque. This starter is used for motor having output from 5 H.P. to 15 H.P.

OPERATION:

When the handle operated in "STAR" position the ends A_2, B_2 and C_2 of the motor become short circuited and A_1, B_1 and C_1 get the supply .The motor becomes in star and gets $1/\sqrt{3}$ times or 58% of the full voltage by which the motor take 1/3rd current of that which the motor takes by starting directly in delta giving full voltage. After taking 75% speed the handle is moved to delta .In this position the ends C_1A_2, A_1B_2 and B_1C_2 are short-circuited and each joint gets supply which connects the supply in delta .Now the motor is on full speed and the back e.m.f. is full .The motor is taking full current thereby giving the full torque .

PROCEDURE:-

(2) First read out the name plate of the starter as well as rating of it .

(3) Remove the cover of the starter .

(4) Then study about the over load circuit and no-volt-coil .

(5) There are 9 terminals of the starter in which 3 of them are of line and remaining 6 terminals are for motors i.e. A_1B_2 ,B_1C_2 and C_1A_2 .

(6) Test phase sequence of the motor .

(7) Connect the motor as per ckt. diagram .

(8) Switch-on the main switch and make the handle in "STAR" position of the starter and measure the starting current and steady starting current in star connection .

(9) When motor attains 75% of the synchronous speed ,make the handle in "DELTA" position quickly. Note the running current and steady running current in delta connection .

PRECAUTION :-

(1) Setting of the O.L. current of the motor should be same as per given rating on the name plate of the motor .

(2) Starter should be well earthen .

(3) All contacts should be well cleaned .

(4) Check whether all strips are making contacts with fixed contacts at a time while making handle in star and delta position .

(5) The connection should be right and tight .

TABULATION :-

Sl.No.	In STAR(Starting)		In DELTA(Running)	
	Starting current in amp.	Steady Starting current in amp.	Running current in amp.	Steady Running current in amp.

CONCLUSION :- The Star-Delta starter was studied and we got a brief knowledge about it and the motor was connected and running successfully and the starting current and running current was found to be ______ amp &______ amp.

N.B.

(1) Mechanically operated Star-Delta starters are generally used with motor having an output from 5H.P. to 10 H.P.

(2) Automatic air break Star-Delta starters are employed with 20 H.P.

(3) Oil immersed Star-Delta starters are suitable for 50 H.P.

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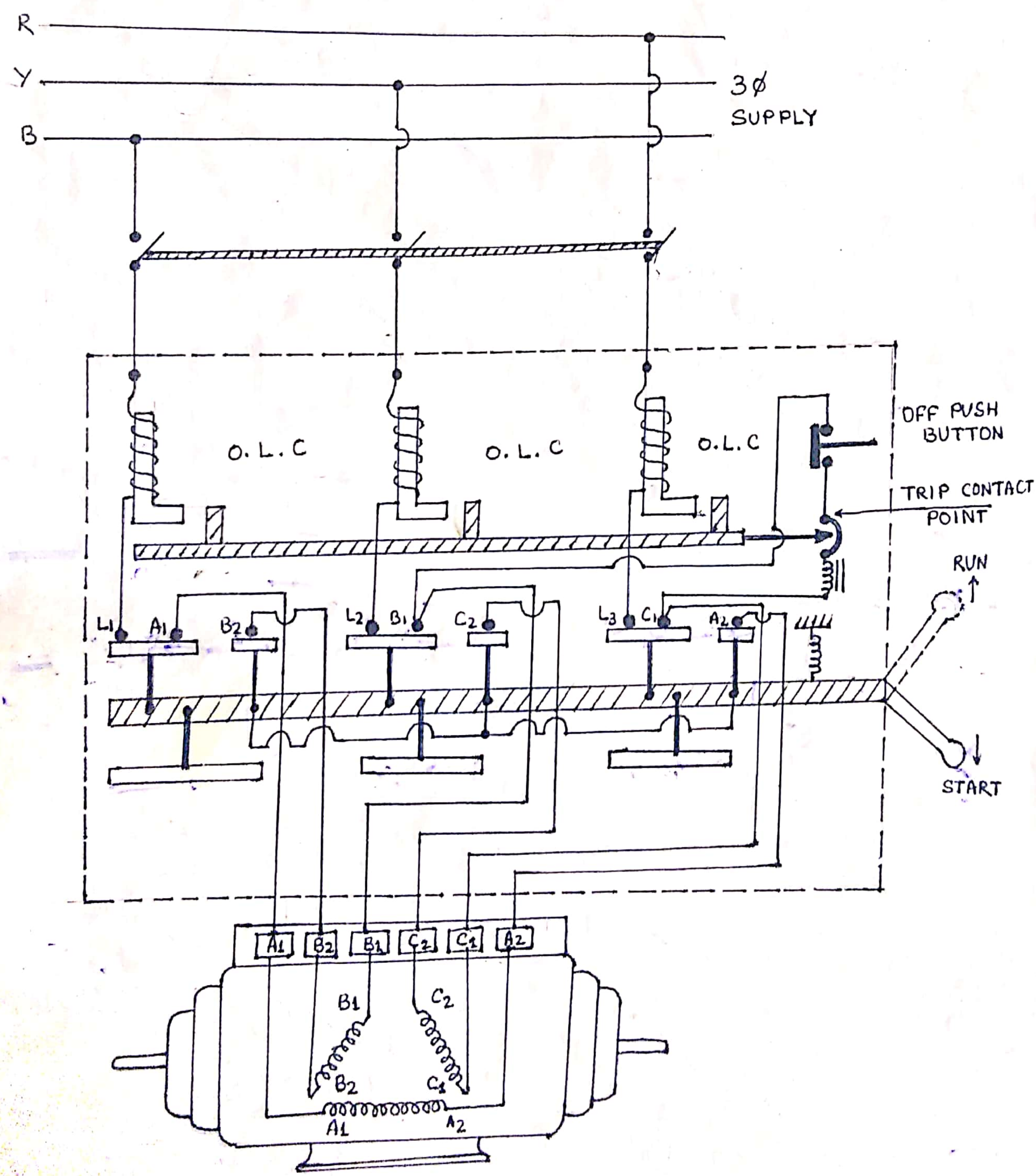

CONNECTION DIAGRAM OF STAR-DELTA STARTER

AUTO-TRANSFORMER STARTER

AIM OF THE EXPERIMENT : To study the auto-transformer starter, connecting and running of 3-Φ squirrel cage Induction motor and measurement of the starting and running current .

APPARATUS/MACHINE REQUIRED:

Sl.No.	Name of items	Type	Range	Quantity
1	Auto-transformer starter	A.C.	--------	1
2	3-Φ squirrel cage Induction motor	A.C.	--------	1
3	Ammeter	M.I.	--------	1
4	Connecting wire	S.W.G	--------	As per req.
5	Combination plier	Insulated	--------	1
6	Screw driver	--------	--------	1
7	Line tester	--------	--------	1

THEORY :- 3-Φ Auto-transformer with fixed tapping can be used to obtain reduced voltage for starting the 3-Φ squirrel cage Induction motor .Starting current of the motor is in the safe limit with 60% tapping on the Auto-transformer .Thus 60% of the rated voltage is applied at starting and the Auto-transformer is cut out of the motor circuit ,when the motor has picked up the speed .Hence during normal running condition the voltage across the starter terminal is of rated value .It also consists of safety devices like (i) No-volt-coil and (ii) over load release which safe guard the motor against sudden failure of supply and against over load respectively .It is also provided with a locking device ,so that the change over switch of the starter can not be taken directly to running position ,thus avoiding the risk of applying rated voltage at starting .It is used up to 25 H.P.

OPERATION:-

To start the motor the handle of the starter is turned down ward and the motor gets a reduced voltage from the auto-transformer tapping. When the motor attains about 75% of its synchronous speed the starter handle is moved upward and the motor gets full voltage & the Auto-transformer gets disconnected from the motor circuit .

PROCEDURE :-

(1) Open the upper cover of the starter .
(2) Remove the bottom cover .
(3) Compare the connection of the starter and the Auto-transformer .
(4) Note the working of over load coil and relay .
(5) Reassemble all the parts .
(6) Connect the circuit as per the ckt. diagram .
(7) Switch-on the 3-Φ power supply .
(8) Turned the handle of the starter down ward to start the motor .
(9) As the motor gains 75% speed , move the starter handle to upward position and hence motor gets full voltage and runs in its rated speed .
(10) Measure the starting and running current of the motor .
(11) To stop the motor press the reset switch .

PRECAUTION :-

(1) Do not try to change the tap of the auto-transformer .
(2) While opening take care of oil filled in the bottom cover .
(3) All connection should be right and tight .

TABULATION :-

Sl.No.	Starting current in amp.	Running current in amp.
1		

CONCLUSION :- The Auto-transformer starter was studied and we got a brief knowledge about it .The motor runs smoothly in its rated speed and the starting and running current was found to be ______ amp &_______amp.

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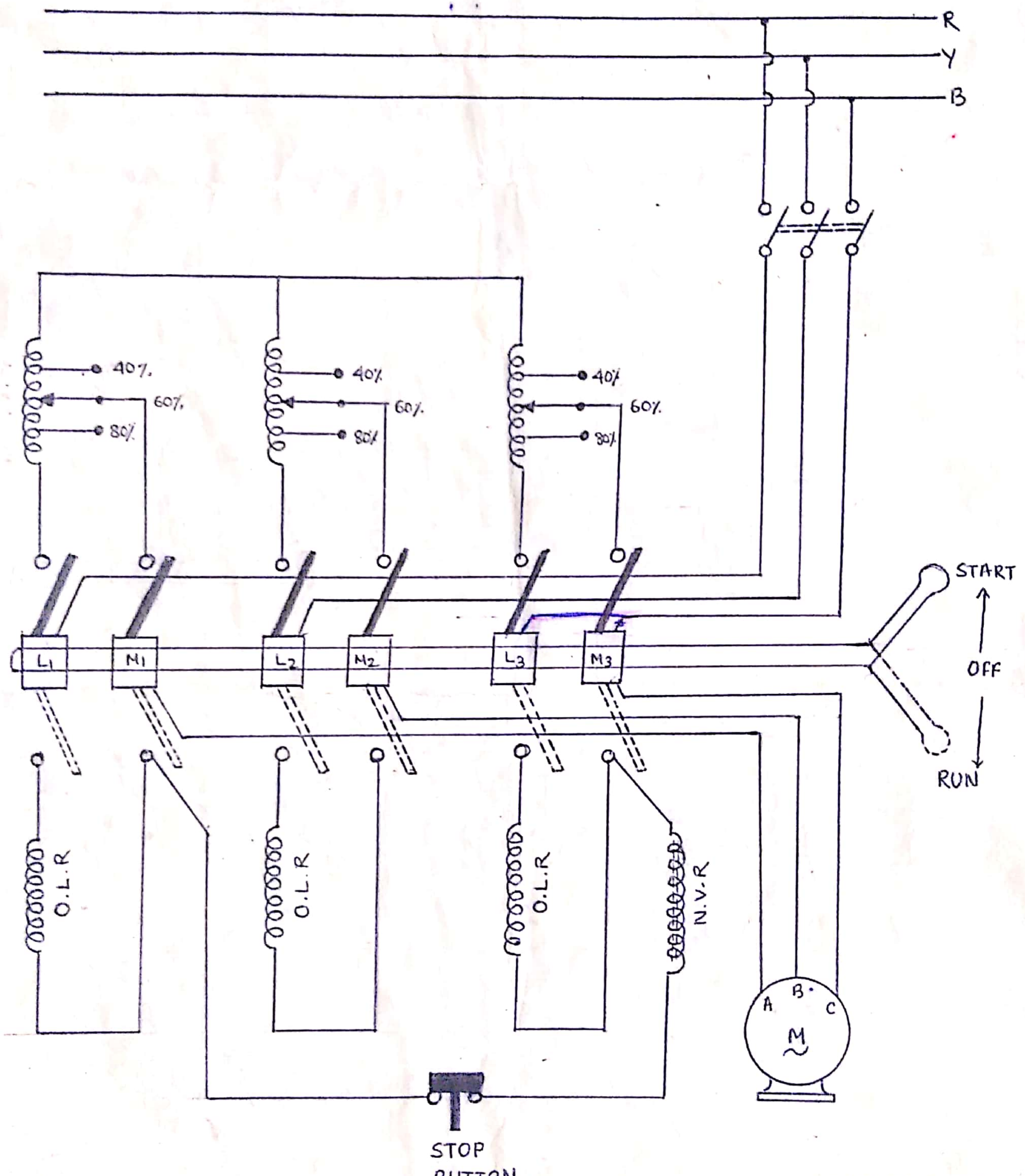
N.B.

(1) Hand operated Auto-transformer starter are suitable for motors from 20 to 150 H.P.

(2) Automatic Auto-transformer starter are used with large H.P. motors upto 425 H.P.

(3) Direction of motion of motor can be changed by changing the any phase of supply ,starter or motor .



O.L.R - OVER LOAD RELEASE COIL

N.V.R - NO VOLT RELEASE COIL

AUTO TRANSFORMER STARTOR.

ROTOR RESISTANCE STARTER

AIM OF THE EXPERIMENT : To study the rotor resistance starter, connecting and running of 3-Φ slipring Induction motor and measurement of the starting and running current .

APPARATUS/MACHINE REQUIRED:

Sl.No.	Name of items	Type	Range	Quantity
1	Rotor resistance starter	A.C.	--------	1
2	3-Φ slipring Induction motor	A.C.	--------	1
3	Ammeter	M.I.	--------	1
4	Connecting wire	S.W.G	--------	As per req.
5	Combination plier	Insulated	--------	1
6	Screw driver	--------	--------	1
7	Line tester	--------	--------	1

THEORY :-

This starter is used for slipring Induction motor, where high starting torque is essential. At the time of starting the rotor is connected in series with 3-Φ star connected starting resistance's which improves the power factor and reduces the rotor current and thereby decreases the starter starting current .Hence increased the starting torque .As the motor starts rotating and attains its normal speed ,this additional rotor resistance is gradually cut off from the circuit and finally the rotor winding (slipring)is short circuited (during normal running condition) .This starter is also provided with over load relay ,no-volt-coil ,start and stop push button switches and a plunger for better performance.

PROCEDURE :-

(1) Read out the name plate of rotor resistance starter .

(2) Study about the motor and the slipring terminals carefully .

(3) Mark the terminals----- 3 of them are for line .
3 of the resistance for rotor .
and 3 for starter .

(4) Study about the no-volt-coil ,over load relay and other important parts thoroughly .

(5) Connect the motor, rotor resistance starter, Main switch and meters as per ckt. diagram .

(6) Give the supply to the motor through starter .

(7) Start the motor by pressing "START PUSH" button and giving full resistance in the rotor circuit by regulating the handle .

(8) Keeping the "START PUSH" pressed , cut off the full resistance from the rotor circuit .Motor runs in its rated speed .

(9) Note the reading of ammeter at the time of starting and full on position .

(10) To stop the motor,push the "STOP" button switch .

PRECAUTION :-

(1)The 3-phase supply should not be given to the rotor resistance starter while testing the starter .

(2)Never give supply to resistance terminals of the starter .

(3) "START PUSH" button should be kept pressed while cutting the resistance .

(4) All connection should be right and tight .

TABULATION :-

Sl.No.	Starting current in amp.	Running current in amp.
1		

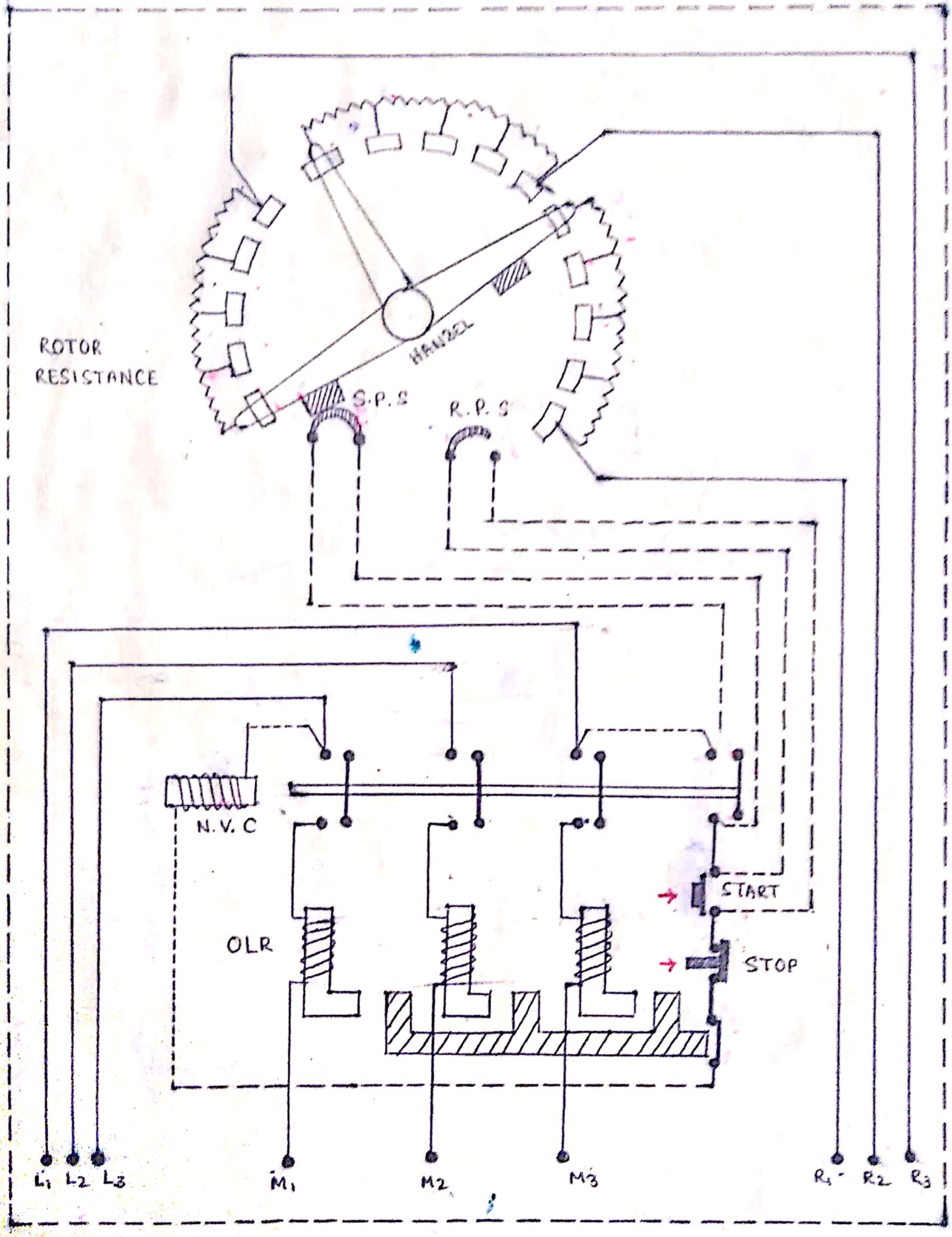
CONCLUSION :- The Rotor resistance starter was studied and we got a brief knowledge about it .The Slipring motor runs smoothly in its rated speed and the starting and running current was found to be ______ amp &________amp.

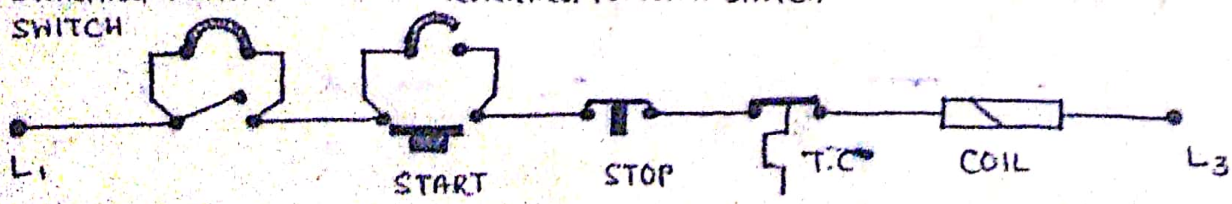
***

N.B.

(1) The resistance of Rotor resistance starter are immersed in oil in case of big H.P. motors for cooling them but in small motor ,it is not required to dip them in oil .

(2) Direction of rotation (DOR) of motor can be changed by changing the any phase of supply or motor .


ROTOR RESISTANCE
HANDEL
S.P.S
R.P.S
N.V.C
OLR
START
STOP
L1 L2 L3
M1
M2
M3
R1 R2 R3


STARTING POSITION SWITCH
RUNNING POSITION SWITCH
L1
START
STOP
T.C
COIL
L3

VOLTAGE REGULATION BY SYNCHRONOUS IMPEDANCE METHOD

AIM OF THE EXPERIMENT:

a) To perform O.C. & S.C. test of an alternator.

b) To measure the resistance of the stator winding of alternator.

c) To find out regulation of alternator at full load and at (i) unity p.f. (ii)0.85p.f lagging (iii) 0.85 p.f. leading, using synchronous impedance method.

APPARATUS REQUIRED:

S.No.	Name of items	Type	Range	Quantity
1	Ammeter	M.C	(0-1/2)A	1
2	Ammeter	M.I	(0-10/20)A	1
3	Voltmeter	M.I	(0-300/600)V	1
4	Rheostat	Variable	(0-500)Ohm	1
5	Tachometer	———	(0-5000)R.P.M.	1

THEORY :- To find out the regulation of alternator by synchronous impedance method, following characteristics and data has to be obtained experimentally,

(i) open circuit characteristic at synchronous speed.

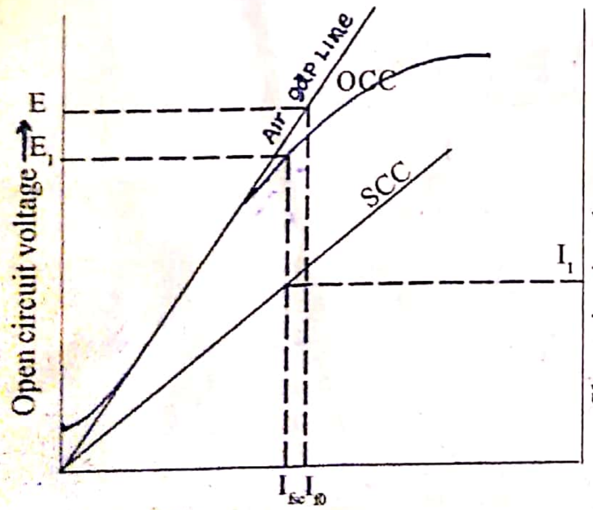
(ii) short circuit characteristic at synchronous speed.

(iii) ac resistance of the stator winding, per phase i.e. R_a

Fig.1 shows the open circuit and short circuit characteristics of a 3-phase alternator, plotted on the phase basis. To find out the synchronous impedance from these characteristics, open circuit voltage, $E_1$and short circuit current, I_1(preferably full load current), corresponding to a particular value of field current is obtained. Then, synchronous impedance per phase is given by,

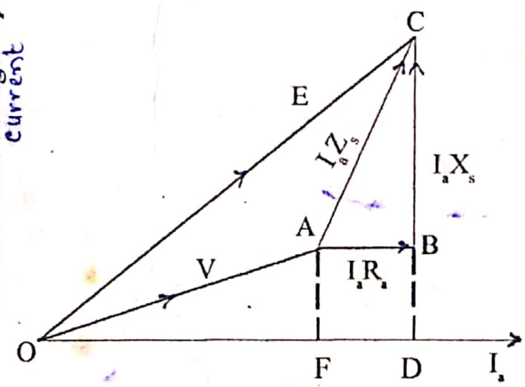
Synchronous impedance, $Z_s = E_1/I_1$

Then, Synchronous reactance, $X_s = \sqrt{Z_s^2 - R_a^2}$



Theoretical OCC & SCC of Alternator

Fig.1



Phasor diagram

Fig.2

Fig.2 shows the phasor diagram of the alternator, supplying full load current of I_a ampere, lagging the terminal voltage V by an angle Φ . The open circuit voltage E of the alternator is given by,

$E = V + I_a R_a + I_a X_s$ (phasor sum)

The diagram has been drawn with the current as the reference phasor and is self explanatory. The open circuit voltage as finally obtained from the phasor diagram, corresponding to this loading condition is E volts.

Then the regulation of the alternator under the above loading condition is given by,
Regulation = (E -V) /V × 100 %

An approximate expression for the open circuit voltage can be established referring to the phasor diagram.

Open circuit voltage, $E = \sqrt{OD^2 + DC^2}$

$= \sqrt{(OF + FD)^2 + (DB + BC)^2}$

Or, $E = \sqrt{(V \cos\Phi + I_a R_a)^2 + (V \sin\Phi + I_a X_s)^2}$ (for lagging p.f. load)

$E = \sqrt{(V \cos\Phi + I_a R_a)^2 + (V \sin\Phi + I_a X_s)^2}$ (for leading p.f. load)

CIRCUIT DIAGRAM

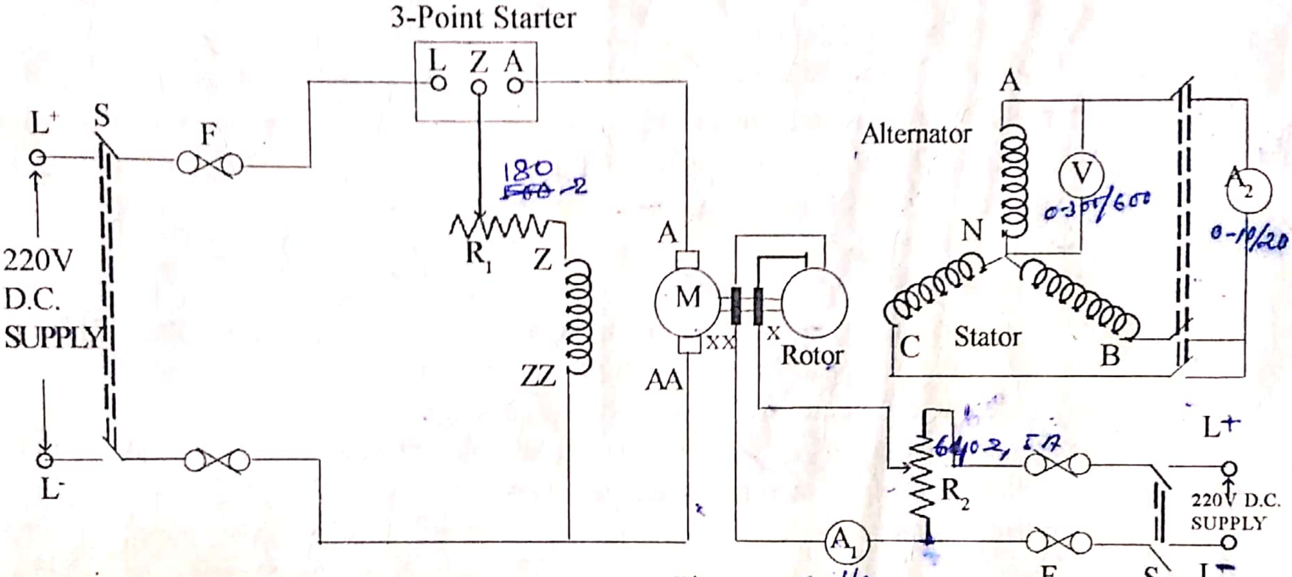


Fig.3

The above expression is for lagging power factor load. In case, alternator is operating at leading power factor, open circuit voltage, E can be found out in a similar way and is given by,

The value of regulation obtained by this method is higher than obtained from as actual load test, as such it is called the pessimistic method.

It is essential to include the following equipment/instruments of proper type and range, to serve the function indicated against each.

1. DC motor - used as a prime-mover for the alternator i.e. coupled with the alternator.
2. Rheostat, R_1 - used as a variable resistance and connected in the field circuit for dc motor to obtain and maintain the speed of the motor and hence the alternator at its rated value.
3. Rheostat, R_2 - connected in field circuit of alternator as a variable resistance to vary the field current of alternator.
4. Ammeter, A_1 - connected in the field circuit of alternator to measure the field current.
5. Voltmeter - connected across a stator phase to measure open circuit voltage.
6. Ammeter, A_2 - to measure the short circuit current of alternator.

Complete circuit diagram, drawn on the basis of above discussion has been shown in Fig.3.

PROCEDURE:

1 Connect the circuit as per circuit diagram.

2. Adjust the position of rheostat, R_1 for maximum possible current in the field circuit of dc motor, to ensure (i) low starting speed (ii) high starting torque.
3. Set the position of rheostat, R_2 for minimum current in the field circuit of alternator, to ensure low value of generated emf at starting.
4. Switch on the dc mains, feeding the dc motor and the field circuit of alternator.
5. Start the dc motor, using the starter properly. Various resistance steps of the starter should be cut out slowly, so that the motor does not drawn high current during starting.
6. Set the speed of the motor and hence the alternator at its rated value by varying rheostat, R_1 provided in the field circuit of the motor.
7. Note-down the open circuit voltage of the alternator and the field current.
8. Repeat step 7 for various values of field current (can be obtained by varying the rheostat, R_2 provided in the field circuit of alternator). Observations should be continued, till the open circuit voltage is 25 to 30 percent higher than its rated value.
9. Set the position of rheostat, R_2 again for minimum possible current in the field circuit of alternator.
10. Short-circuit the stator winding of the alternator, by closing the switch provided for this purpose in the circuit diagram.
11. Note-down the short circuit current and the field current.
12. Repeat step 11, for various values of field current, till the short circuit current becomes equal to the full load current of alternator.
13. Readjust the setting of rheostats R_1 and R_2 to their initial positions and then switch-off the dc supply to stop the dc motor.
14. Measure the dc resistance of the stator winding by usual voltmeter-ammeter method. To obtain ac resistance, skin effect must be taken into account. As such, ac resistance may be taken approximately 1.3 times the dc resistance measured.

OBSERVATIONS :

	Open Circuit Test		Short Circuit Test	
Sl.No.	**Field Current(I_f) in Amp.**	**Open circuit Voltage(E) in Volt.**	**Field Current(I_f) in Amp.**	**Short Circuit Current(I_{sc}) in Amp.**
1				
2				

CONCLUSION :- From the above experiment the regulation of alternator at full load and p.f. 0.8 lag & 0.8 lead respectively were found to be——% & ——%.

STUDY OF A BUCHHOLZ RELAY

AIM OF THE EXPERIMENT :- To study of a Buchholz Relay.

APPARATUS REQUIRED :-

Sl.No.	Name of items	Type	Specification	Quantity
1	Buchholz Relay	-----	----------	1
2	Combination plier	Insulated		1

THEORY :- Buchholz relay is a gas activated relay installed in oil immersed transformers for protection against all kinds of faults (internal) and makes use of the fact that fault decompose the oil, thus generating gases. It is usually installed in the pipe connecting the conservator to the main tank. It is the form of a domed shaped vessel. It has two elements. The upper element consists of a mercury type switch attached to a float. The lower element contains a mercury switch mounted on a higher type flap located in the direct path of the flow of oil from the transformer to the conservator. The upper element closes an alarm cut during incipient faults.

OPERATION :- When an incipient fault occurs within the transformer, the heat due to the fault causes the decomposition of some transformer oil in the main tank.. When a predetermined gas gets accumulated it exerts sufficient pressure on the fleat to cause it to filet & close the contacts of mercury switch attached to it. This completes the alarm ckt to sound alarm. If a serious fault occurs in the transformer an, enormous amount of gas is generated. Thus the oil in the main tank rushes towards the conservator via the Buchholz relay & in doing so fits the flap to close the contacts of mercury switch. This completes the trip ckt to open the circuit breaker controlling the transformer.

PROCEDURE :-

1. Read and note the name plate of Buchholz relay.
2. Opened the relay with the help of screw driver and plier.
3. Studied the all internal parts of the relay.
4. Closed its cover after studied all about Buchholz relay.

CONCLUSION :- Hence we studied the Buchholz relay & know its operation.

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SINGLE PHASE CAPACITOR MOTOR

AIM OF THE EXPERIMENT :- To connect, start & run a single phase capacitor motor and measure the starting & running current of it and to reverse its D.O.R.(Direction of rotation) .

APPARATUS REQUIRED :-

Sl. No.	Name of items	Type	Specification	Quantity
1	Capacitor motor	-----	--------------	1
2	Capacitor	-----	--------------	1
3	Ammeter	M.I.	--------------	1
4	Voltmeter	M.I.	--------------	1
5	Combination plier	Insul	--------------	1
6	Screw driver	-----	--------------	1
7	Connecting wire	S.W.G.		As per requirement

THEORY :- It is a split-phase motors. It consists of 'stator'(having two winding), 'squirrel-cage rotor'(not self starting) and a 'capacitor'(Permanently fix). The stator consists of one main winding (Running winding) & one auxiliary winding (starting winding). The main winding is connected directly to the supply mains and auxiliary winding is connected in series with the capacitor. The capacitor and the auxiliary winding remain in the circuit while the motor is even in full operation. The motor obtains its starting torque from a rotating magnetic field produced by the two stator windings physically displaced i.e. electrically 90°. The direction of rotation can be changed by changing the connection of any one of the winding. These motors are used where the low starting torque is required.

PROCEDURE :-

1. Connect the motor and all the meters as per ckt diagram.
2. Give supply to the motor.
3. The motor should run successfully.
4. Observe the Voltmeter & Ammeter reading at starting as well as when running smoothly .
5. Switch-off the supply.
6. To change the D.O.R. interchange the connection of any one of the winding.
7. Again switch-on the supply
8. Observe the direction of rotation. (It is in reverse direction)
9. Switch-off the supply to stop the motor.

PRECAUTION :-

1. Connections should be correct.
2. There should not be any bare conductor.
3. Capacitor should be of proper rating.

OBSERVATION TABLE

Sl. No.	Voltmeter reading in volt.(v)	Starting current in amp.(I_s)	Running current in amp.(I_r)	Remarks

CONCLUSION :- By running the single phase capacitor motor we came to know that ,it takes more current at starting & normal at running.

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EFFICIENCY OF SINGLE PHASE TRANSFORMERS BY DIRECT LOADING

AIM OF THE EXPERIMENT:- To determine the efficiency of a single phase transformer by direct loading.

APPARATUS REQUIRED :-

Sl. No.	Name of items	Type	Specification	Quantity
1	Transformer	-----	-----	1
2	Ammeter	M.I.	-----	1
3	Voltmeter	M.I.	-----	1
4	Variac	-----	-----	1
5	Load	-----	-----	1
6	Combination plier	Insulated	-----	1
7	Screw driver	-----	-----	1
8	Connecting wire	SWG	-----	As per requirement

THEORY:-

The efficiency of a transformer is defined as the ratio of output to input in a transformer. The output and input is measured in KVA, Watts or Kilowatts.

$\therefore$ Efficiency (η) = Output/Input

%(η) = (Output/Input)$\times$ 100

= Output/(Output + Losses)

Sometimes the output and input namely equal due to the high efficiency of the transformer and above formula does not give correct result. So the alternate formula can be used to calculate the correct efficiency of the transformer i.e. efficiency (η) = (Input - Losses)/ Input. Moreover of unity power factor the efficiency will be maximum for a given load and decrease when there is low power factor.

Power input to the transformer = W_1 (reading of w`att-meter)

Power output to the transformer = VI watt (Cosϕ being unity for lamp bank load).

Thus, efficiency at a particular load, η= (VI/ W_1) x 100%.

PROCEDURE:-

1) Connect the circuit diagram as per the circuit diagram.
2) Ensure that there is no load on the secondary winding of the transformer.
3) Switch on the A.C. supply and record the no load voltage(V_2) across the secondary winding.
4) Adjust approximately 10 percent of full load current in the secondary by switching on certain lamps in the lamp bank load. Record the readings of all the meters.
5) Repeat step 4 for various load currents, till the full load value.
6) Reduce the load on the transformer by switching off the bulbs in the lamp bank load.
7) Switch off the a.c. supply.

TABULATION:-

Sl.No.	Load position	W_1	V_2	I_2	V_2I_2	%η
1						
2						
3						

CALCULATION:-

Power input to the transformer = W_1 (reading of watt-meter)

Power output to the transformer = V_2I_2 watt (Cosϕ being unity for lamp bank load).

Thus, efficiency at a particular load, $\eta = (V_2I_2 / W_1) \times 100\%$.

Thus, %efficiency (%η) of the transformer = $(V_2I_2 / W_1) \times 100$.

PRECAUTIONS:-

1) Connection should be correct and tight.
2) Increase the load gradually.
3) Adjust the needle of the instruments before conducting practical.
4) Note down the readings attentively.

CONCLUSION:- Efficiency of the transformer is found out at full load and at half load.