EXPERIMENT NO 07

AIM: (a) BRAKING OF DC MOTOR BY MECHNICAL METHOD

(b): BRAKING OF DC MOTOR BY ELECTRICAL

APPRATUS:

S. No.	Name	Type	Range	Quantity
1.	Digital Ammeter	MC	0-25 A	1
2.	Digital Voltmeter	MC	0-300 V	1
3.	Rheostat	Single tube	290 Ω, 1.2 A	1
4.	Techmeter	Digital	0-2000 rpm	1

THEORY

The Braking on a dc motor is performed to obtain its various performance characteristics including efficiency. The motor can be loaded by a belt and pulley arrangement.

If W_1 and W_2 be the tension in kg indicated by the two spring balances provided on the two sides of the belt, then the load torque on the motor is given by,

Load torque, $T = (W_1 - W_2) \times r$ kg-m

Then, the mechanical power output of the motor,

$$P_m = \frac{2 \pi N T}{60 \times 0.102} \text{ watts}$$

Power input to the motor, P_i = V X I watts

Hence, efficiency of the motor, $\eta = P_m / P_1$ X 100 percent

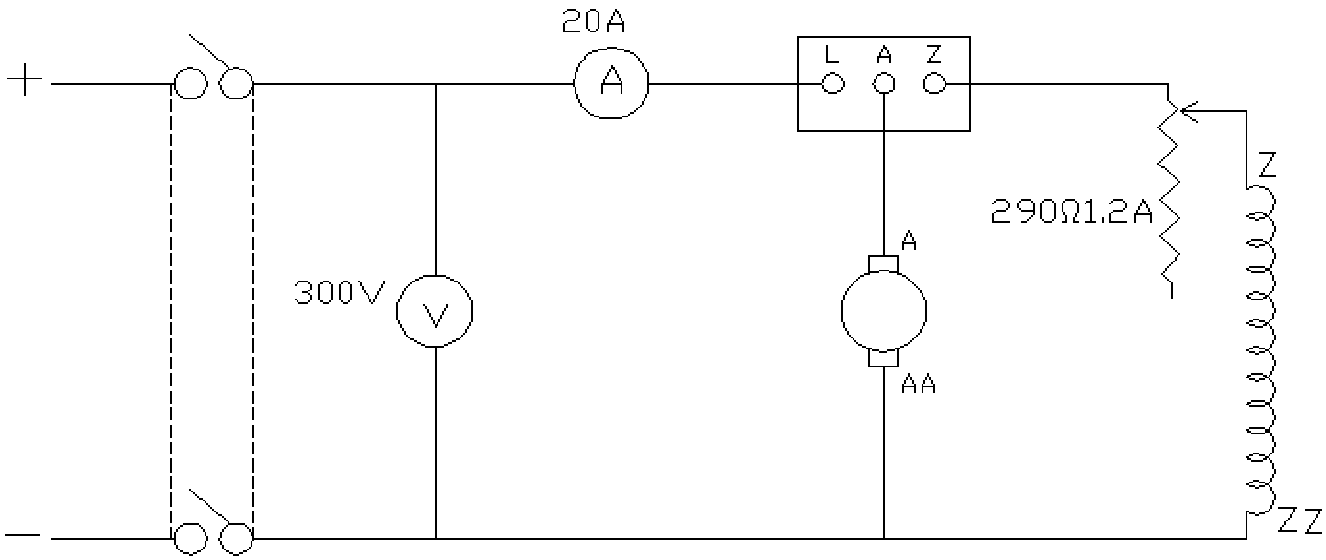
Where, r – radius of the pulley in meter.
N – Speed of the motor in rpm.
V – Voltage applied to the motor.
I – Input current drawn by the motor.

The speed of the dc motor is given by the following expression,

$$\text{Speed of rotation, } N = k \frac{V - I_a R_a}{\Phi}$$

Where, the applied voltage V is constant, more over the flux φ is nearly constant for shunt motor. Thus the speed of the dc shunt motor will decrease as the load on the motor increases, because of the increase in the armature voltage drop, $I_a R_a$. The drop is speed from no load to full load operation is hardly 4 to 5 percent of the rated speed

CIRCUIT DIAGRAM



1. Starter – to limit the starting current to safe value and to protect the motor against (i) sudden failure of supply (ii) over load.
2. Ammeter – to record the voltage applied to the motor.
3. Voltmeter – to record the voltage applied to the motor.
4. Rheostat – to adjust the speed of the motor to rated value.
5. Mechanical load – in the form of belt and pulley arrangement to vary the load on the motor in steps.
6. Mechanical load – in the form of belt and pulley arrangement to vary the load on the motor in steps.

PROCEDURE

1. Connect the circuit as per fig.
2. Ensure that there is no load on the motor.
3. Adjust the field rheostat, so that the field current is maximum at the instant of starting the motor.

4. Switch-on the dc mains. Now Press the green push button provided on the panel and starts the motor using the starter properly.
5. Adjust the speed of the motor to rated value by varying the resistance in the field circuit.
6. Record the reading of all the meters at no load.
7. Load the motor by tightening the belt on the pulley and record the readings of all the meters, speed and the reading of both the spring balance.
8. Repeat step 7 by increasing the load on the motor in steps, till the rated current of the motor.
9. Remove the load gradually and then stop the motor by pressing the red Push button provided on the panel .The motor will immediately stop .This is a electrical braking.
10. Measure the diameter of the pulley.

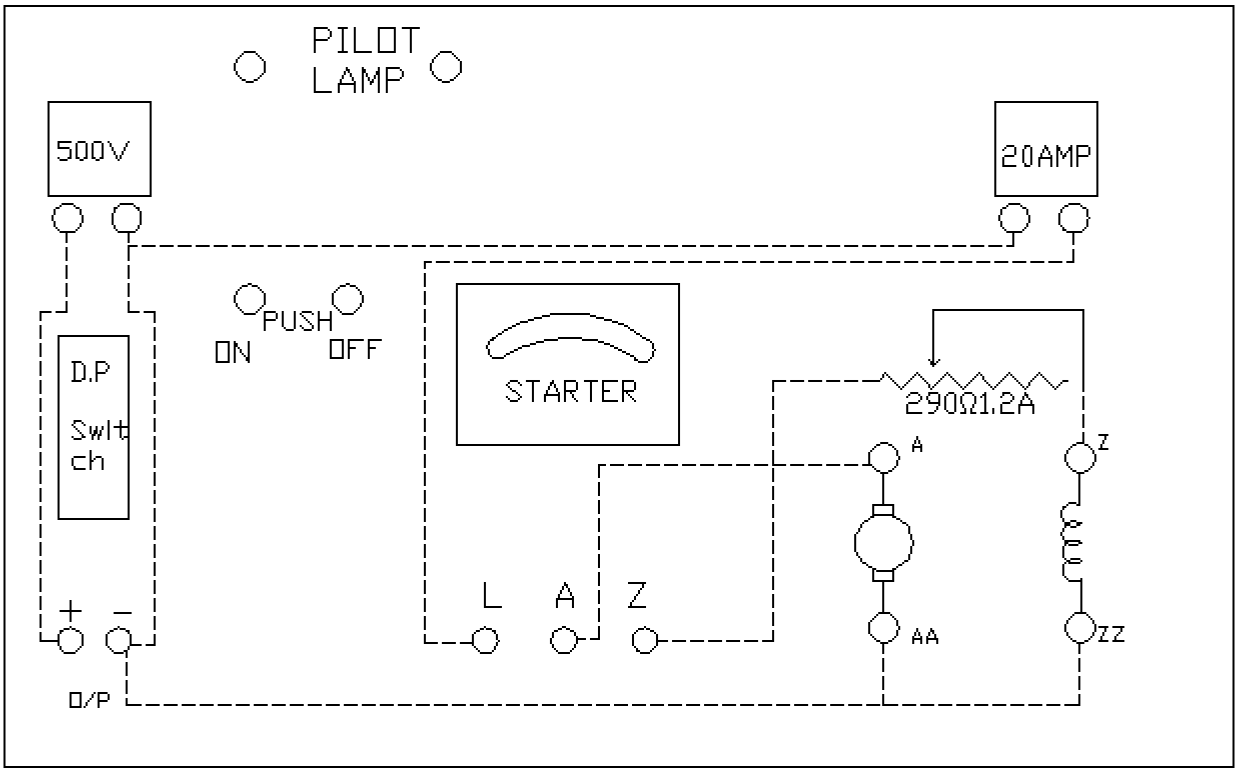
OBSERVATION

S. No.	V	I	N	W_1	W_2	W

CALCULATION :

S. No.	Torque	Mech power output	Input Power	Efficiency

PANEL FOR BRAKING OF D.C MOTOR BY ELECTRICAL $ MECHANICAL METHOD.



EXPERIMENT NO 08

AIM: To see the effect of a rotor resistance starter in a slip ring motor.

(1) Effect on the starting current

(2) Effect on the speed

INSTRUMENTS

S. No.	Name	Type	Range	Quantity
1.	Digital Ammeter	MI	0-10 A	1
2.	Digital Voltmeter	MI	0-500 V	1
3.	Techometer	Digital	0-2000 rpm	1

THEORY

This concept can be used only for slip ring induction motor, in which, the terminals of the rotor winding are brought out externally. In rotor resistance starter, the terminals of the roter winding are connected to a 3-phase variable resistor through slip ring as shown in fig. Resistance are fully in the circuit at starting, so that the starting current is reduced. More over the appreciably decreased, because of additional resistance in the rotor circuit at starting. The external reistance in the rotor circuit is gradually cut, out as the motor speeds up and finally the rotor winding is short circuited during normal running condition.

SLIP : The speed of the rotor, N_r droops slightly as the load on the motor is increased. The synchronous speed, N_s of the rotating magnetic field is calculated field is calculated, based on the number of poles, P and the supply frequency, *f* i.e.

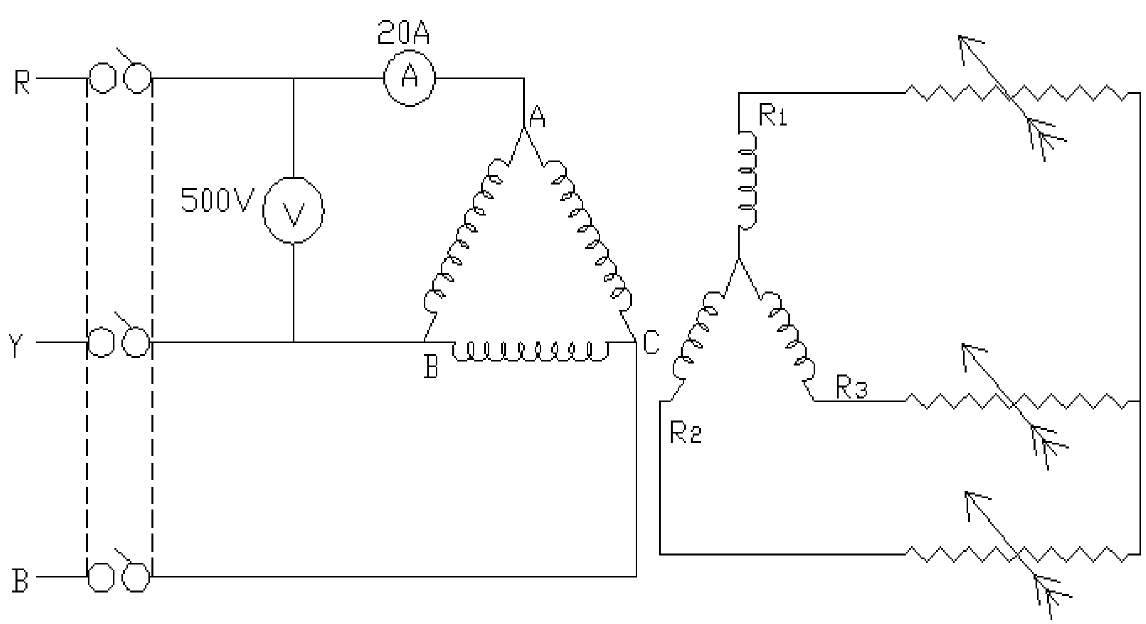
Synchronous speed $N_S = 120f / P$

$$\text{Then, slip, } S = \frac{N_S - N_r}{N_s} \times 100 \text{ percent}$$

Normally, the range of slip at full load is from 2 to 5 per cent.

CIRCUIT DIAGRAM

Fig. shows the circuit diagram of load test on 3 phase squirrel cage induction motor. Instruments connected in the circuit serve the function indicated against each.



3 phase variac – to limit the starting current of the motor
Ammeter – to measure the current drawn by the stator
Voltmeter to measure the voltage across the stator
Wattmeters – to measure input power and power factor.

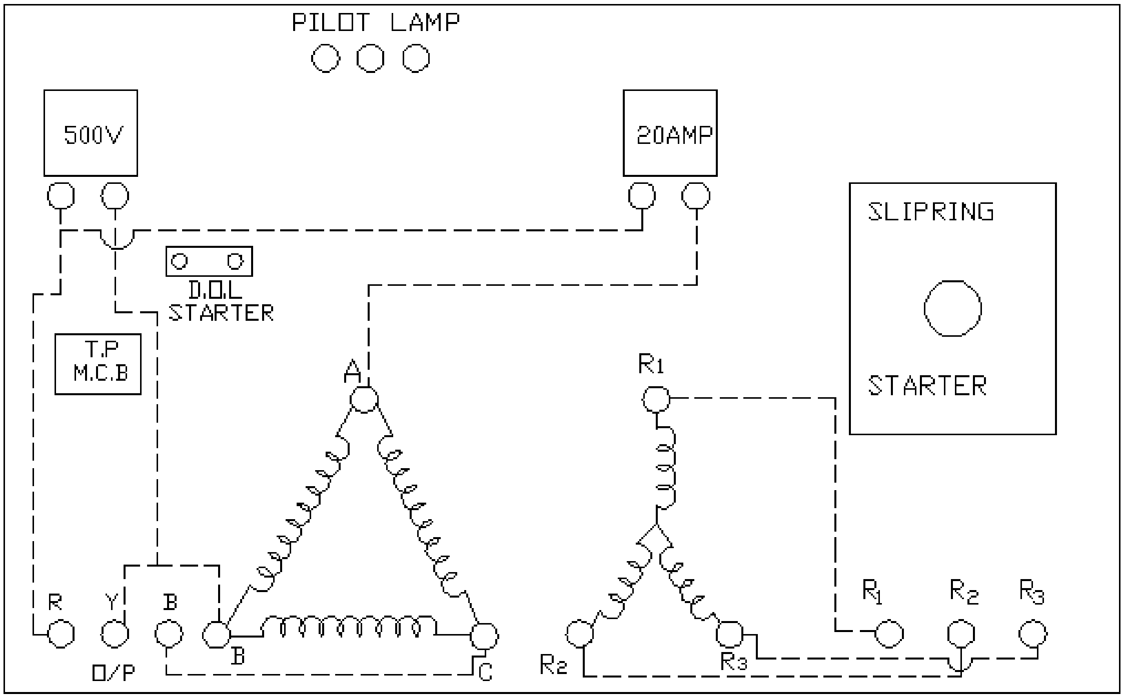
PROCEDURE

1. Connect the circuit as per fig.
2. Ensure that the motor is unloaded and external resistance in the rotor is maximum.
3. Switch-on 3 phase ac mains and start the motor with the help of D O L Starter.
4. Observe the direction of rotation of the motor. In case, it is reverse, change the phase sequence of the applied voltage.
5. Now cut off the resistance step by step.
6. Take-down the readings of all the meters and the speed under no load running, you will observe that the current and speed will change.
7. Switch-off the supply to stop the motor.
8. Note-down the efficiency diameter of the brake drum.

OBSERVATIONS :

S. No.	Line Voltage	Input current	speed

PANEL FOR ROTOR RESISTANCE CONTROL OF 3Ø SLIPRING MOTOR.



ELECTRIC DRIVE LAB

LIST OF EXPERIMENTS

1. To control the speed of three phase induction motor by variable voltage, variable frequency drives.
2. Speed control of induction motor using Ac regulator.
3. To study mosfet based chopper dc motor controller.
4. Speed control of DC Motor using single phase dual converter.
5. To study speed control of DC motor using single phase half controlled bridge controller.
6. To study speed control of DC motor using three phase fully controlled bridge.
7. Regenerative braking of DC motor.
8. Effect of a rotor resistance starter in a slip ring motor.

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

ELECTRICAL DRIVE LAB

EXPERIMENT NO 04

AIM: Speed control of DC Motor using single phase dual converter.

APPRATUS:

1. Single phase dual converter kit.
2. DC Motor.
3. Connecting wires.
4. Digital Multimeter

THEORY

The phase controlled rectifiers using SCRs are used to obtain controlled D.C. output voltage from the fixed A.C. mains voltage .The output voltage is varied by controlled the firing angle of the SCRs. The phase controlled rectifiers are simple and less expensive. The efficiency of these rectifiers o general is above 95%. The SCRs in phase controlled circuits are turned on but a gate trigger signal generated in synchronizes with the A.C mains voltage. They are turned off dire to natural or line commutation since these rectifiers convert from AC to /dc, these controlled rectifiers are also called AC –DC converters and are used extensively in industrial applications especially in variable speed of EDC Motor drives. The phase controlled converters can be classified into single phase and three phase **converter.**

A semi converter operates only in one quadrant a fully controlled converter can operate in two quadrants, i.e. first and fourth. The fully controlled converter can give a five D.C output voltage with the same direction of output current. This operation is suitable for a D.C. motor which is required to be run in both clockwise and anticlockwise direction and unidirectional torque.

A dual converter can be operated in all four quadrants. This converter consists of two fully controlled converters connected in anti parallel. The basic diagram is shown below

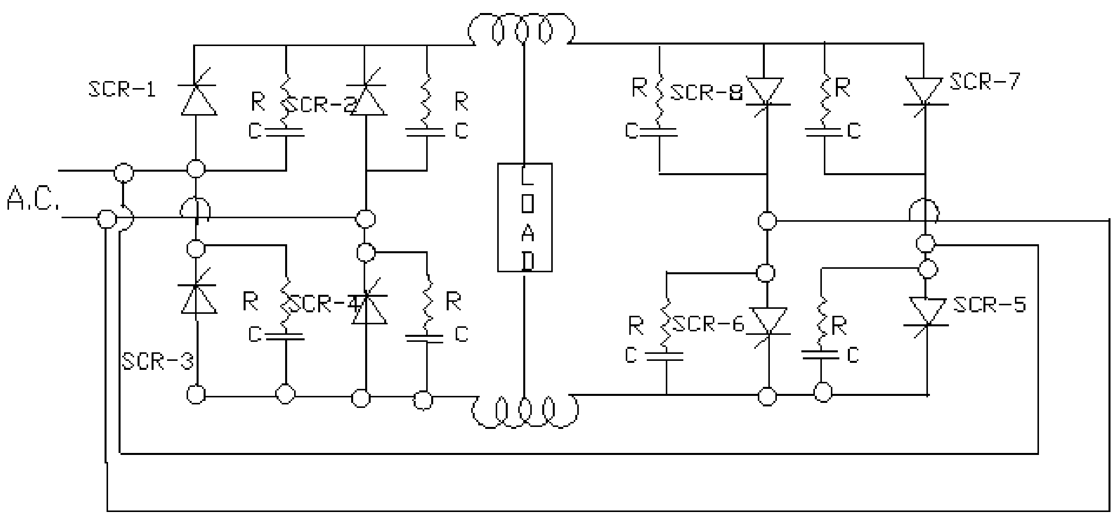


FIG-1 SINGLE PHASE DUAL CONVERTER

It is very suitable for high power variable speed drives/ the polarities of both cottage bad current can be reversed giving four quadrant operation. One converter operates as rectifier and the other operates as inverter. The instant output voltages of the two converters are out of phase.

Therefore, a circulating current will flow thought the converter, this circulating current will not flow through the load.

The single phase dual converter can be operated in two modes

1. Non-Circulating mode.
2. Circulating current mode.

PROCEDURE:

1. Connect power cord to main supply (230Volt, ±10%, 50HZ) A.C.
2. Also, connect the load (Bulb or Motor) to the marked V_{out} terminal.
3. Switch ON the power Switch.
4. Vary the control pot minimum to maximum step by step and slowly.
5. For each step note down output voltage, firing angle (ά) and calculated output voltage .using the above given formula and tabulate the results.

OBSERVATION TABLE:

S.No	Firing Angle(ά)	Output Voltage (Observed)		Output Voltage (Calculated)		Output Voltage V_{out}
		Vo1	Vo2	Vo1	Vo2	
1.						
2.						

PRECAUTIONS:

1. Connections should be tight.
2. Take the reading carefully.
3. Connect the circuit when MCB is switched off.

EXPERIMENT NO 02

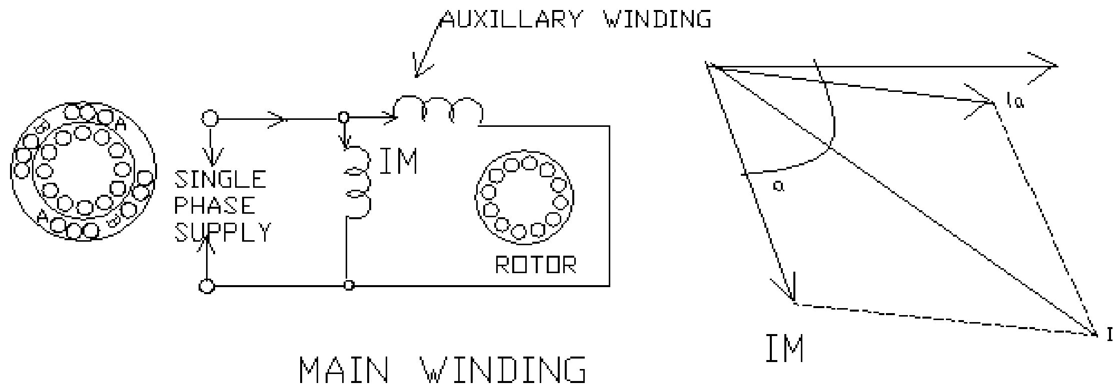
AIM: To study speed control of single phase induction motor using single phase ac voltage controller.

EXPERIMENTAL SETUP

1. Ac voltage controller kit.
2. Single phase induction motor, capacitor run with mechanical loading arrangement.

THEORY

When Single phase supply is applied across one single-phase winding on the stator of a single phase induction motor, the nature of field produced is alternating and such the motor will not develop any starting torque. It has been observed that once the motor is given an initial rotation it continues to rotate.
In a single phase induction motor, to provide starting torque an additional winding is provided which is called auxiliary winding. The main and auxiliary winding is connected in parallel across single phase supple. The impedances of two winding are made different so the current flowing through these winding will have a time phase difference as shown in FIG-A.



A single phase motor having a main winding and auxiliary winding fed from a single phase supply can be considered as equivalent to a two phase motor having a single phase supply. Since two winding are not identical, two current component Im and Ia will have a time phase displacement Now if by any means the time-phase displacement between two currents Im and Ia flowing through the two windings can be made 90^O a single phase induction motor will be have exactly as two phase motor. The time phase displacement between Im and Ia can be increased by using capacitor in auxiliary winding as shown in FIG-B. The capacitor will also improve overall power factor of the motor. From the phasor diagram of FIG-A and FIG –B it will be observed that the power factor of the motor improved when capacitor introduced in the auxillary winding of circuit. If capacitor is to e used only for achieving high starting torque, then auxiliary winding can be switched off when motor picks up speed.

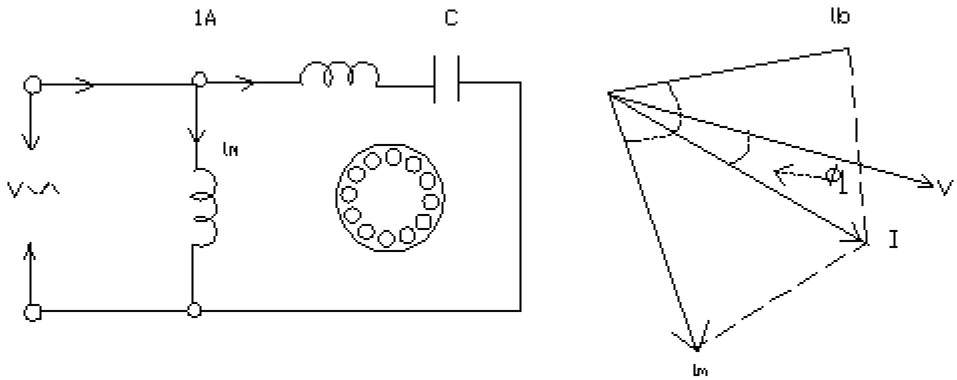
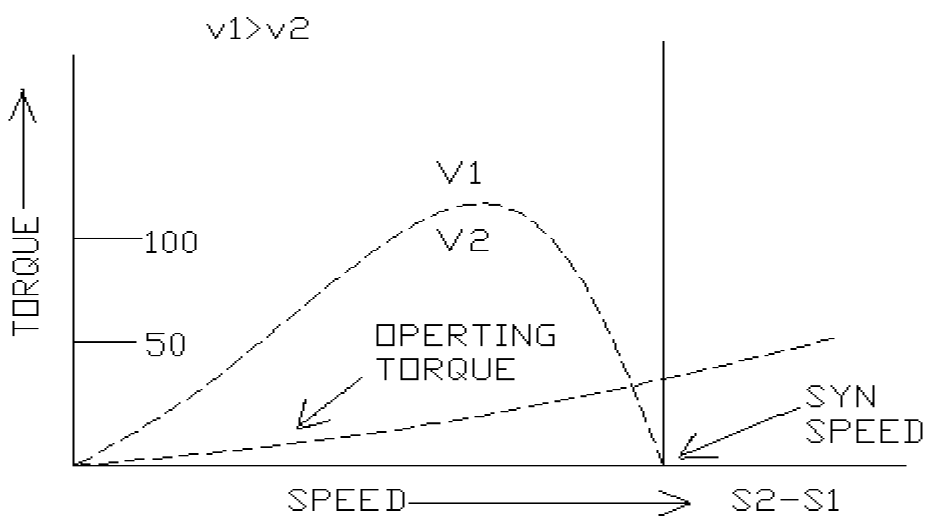


FIG-B Time –phase difference of nearly 90deg between the main and auxiliary winding current is achieved by using a capacitor in auxiliary winding circuit.

<u>SINGLE PHASE INDUCTION MOTOR</u>

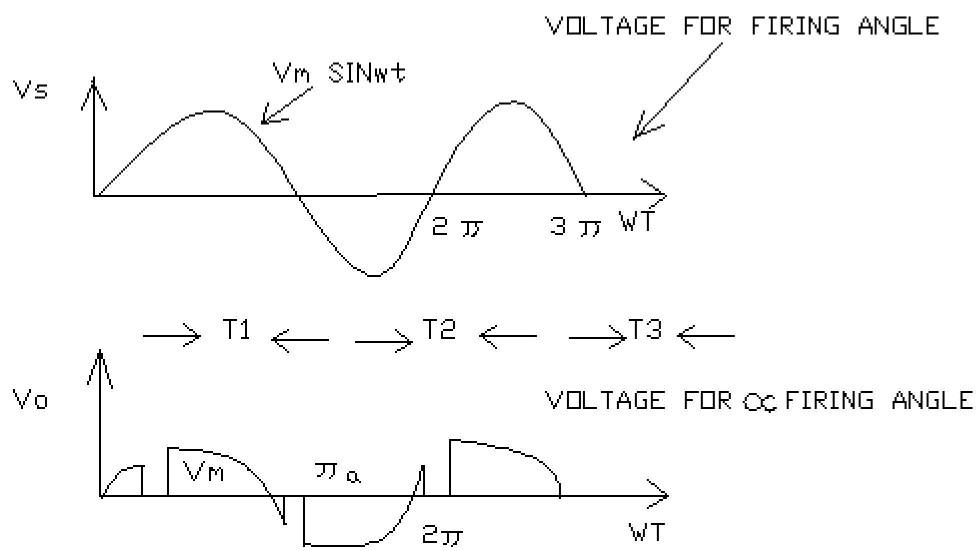
Speed –torque characteristics of capacitor run motor at different voltage are shown in FIG-C



S1=speed corresponding to voltage V1
S1=speed corresponding to voltage V1

When motor is supplied through ac voltage controller as shown in FIG-D by changing the firing angle of the SCR the voltage. Applied to the motor can be changed and hence the speed of single phase induction motor can be changed.

AC voltage controller is used to obtain desired voltage. Output voltage can be varied by adjusting voltage setting potentiometer



INPUT AND OUTPUT VOLTAGE WAVEFORMS OF AC VOLTAGE CONTROLLER.

FIG-D

PROCEDURE:

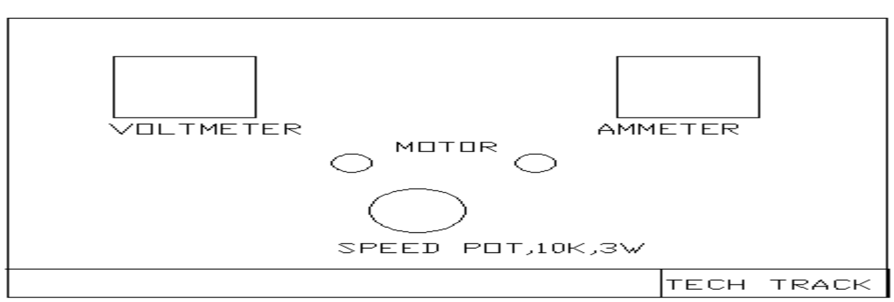
1. Connect the circuit as per the diagram.
2. Switch on the supply.
3. Vary the speed setter which will vary the applied voltage.
4. Note down the reading of current and speed at different voltage.
5. Apply load by applying the mechanical load and note down the reading of current and speed at different voltage and load.
6. Switch off the MCB.

OBSERVATION TABLE:

S.NO	VOLTAGE	CURRENT	SPEED

PRECAUTIONS:

1. MCB should be off while circuit is connecting.
2. Take reading carefully.
3. Connections should be tight.



EXPERIEMENT NO 01

AIM: - TO CONTROL THE SPEED OF THREE PHASE INDUCTION MOTOR BY VARIABLE VOLTAGE, VARIABLE FREQUENCY DRIVE.

EQUIPMENT REQUIRED: -

1. AC motor 1HP 220Volt Three phase type
2. Control panel comprising of voltmeters, Ammeters, Variable frequency drive.
3. NOTE-IN THIS DRIVE, INPUT-220V 1PH, OUTPUT 3PH-220V.

THEORY: -

The Commander SK is an open loop Vector AC Variable speed inverter drive used to control the speed of an AC induction motor. The drive uses an open loop vector control strategy to maintain almost constant flux in the motor by dynamically adjusting the motor voltage according to the load on the motor.
The AC supply is rectified through a bridge and then smoothed across high voltage capacitors to produce a constant voltage DC bus. The DC bus is then switched through an IGBT bridge to produce AC at a variable voltage frequency. This AC output is synthesized by a pattern of on-off switched applied to the gates of the IGBTs.This method of switched the IGBTs is known as Pulse width modulation (PWM).

SLIP: The speed of the rotor, N_r drops slightly as the load on the motor is increased. The synchronous speed, N_s of the rotating magnetic field is calculated field is calculated, based on the number of poles, P and the supply frequency, f i.e.

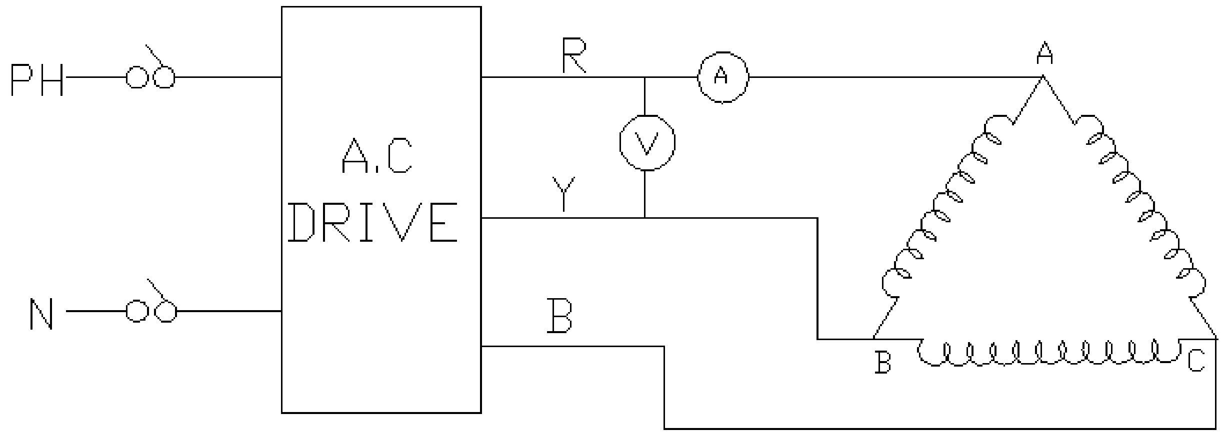
$$\text{Synchronous speed, } N_s = \frac{120\, f}{P} \text{ r.p.m.}$$

$$\text{Then, slip, } S = \frac{N_S - N_r}{N_s} \times 100 \text{ percent}$$

Normally, the range of slip at full load is from 2 to 5 per cent.

Speed of the induction motor directly proportional to the frequency .In this drive we will find V/F constant.

CIRCUIT DIAGRAM



PROCEDURE

1. Switch on the MCB.
2. Connection is internally connected.
3. Press the green button provided on the drive.
4. Now press the upward button provided on the drive, we will observe the motor will start and the frequency and voltage will change in the same ratio .that means V/F constant.
5. Repeat the above step in number of values of frequency keeping V/F voltage and record RPM of the motor.
6. Stop the motor by pressing red push button provided on ac drive.
7. Plot graph between Hz and RPM

PRECAUTION

1. Connections should be tight.
2. Take the reading carefully.

RESULT

The experiment is performed successfully.

EXPERIMENT NO 03

AIM: To study mosfet based chopper dc motor controller.

APPRATUS:

1. Chopper power circuit based on MOSFET.
2. Electronic control circuitry.
3. DC voltmeter 0-300V DC
4. DC Ammeter 0-5A DC.
5. 1:10 Attenuator for C.R.O(RESISTOR DIVIDER NETWORK)
6. Resistive load(1 lamps of 230v, 100W each.).
7. DC MOTOR 250W (SPARATELY EXCITED)

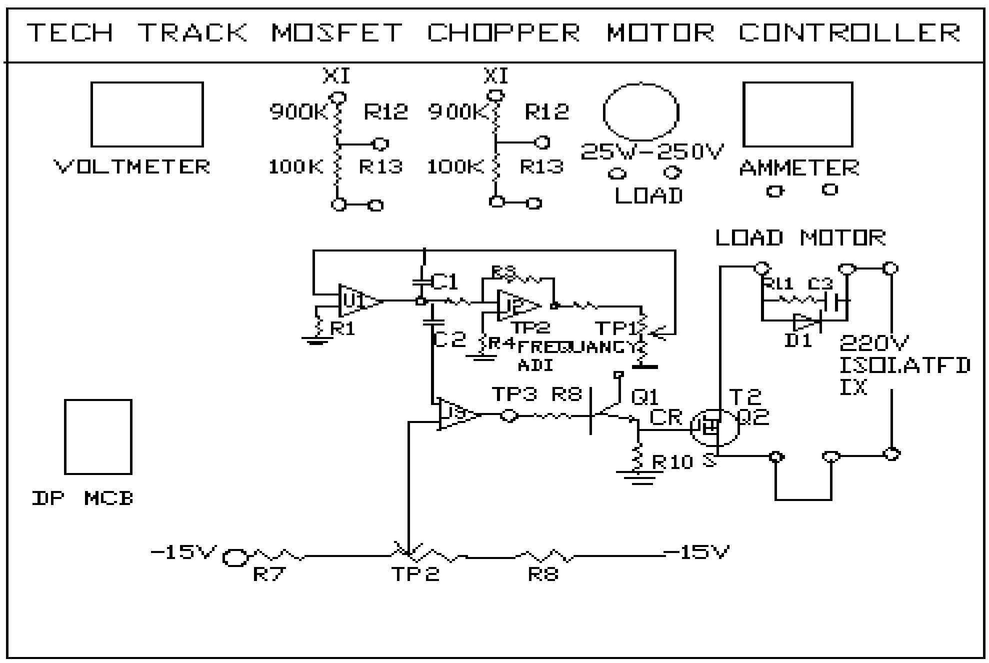
THEORY:

There is several ways o control speed of dc motor speed control one of them. In this method on and off time of supply to motor is controlled .If higher speed is desired ON portion is increased. At full speed on portion is 100% and at zero speed off portion is 100%.
Mosfet based chopper dc motor controller.

1. Power section – mosfet based.
2. Control section – electronic circuitry.

A Here a triangular pulse generator is made by using operational amplifier IC UI and U2 IN Association with components R16,C1, R5, VR1,R6,R2.IC UI is used as an integrator whose output is fed to COMPARATOR U2. Comparator output is again fed back to integrator via resistor R16. In this way U1 and U2 together make as oscillator.U1 output is fed to another comparator u3.The reference voltage is +15vdc to -15vdc via a potentiometer VR2.

POTENTIOMETER VRI CONTROLS THE FREQUENCY. POTENTIOMETER VR2 CONTROLS CUTY RATIO OR SPEED OF DC MOTOR.



PROCEDURE:

1. Keep mcb off.
2. Keep Frequency control potentiometer at minimum.
3. Keep speed control armature at terminal
4. Connect the motor armature at terminal
5. Switch on the MCB.
6. Increase the speed control potentiometer slowly. Motor speed increase accordingly.
7. Observe the Voltage across the motor.

PRECAUTION

1. Earth all equipment properly.
2. Switch off the MCB then make or remove the connection.
3. Input voltage not to exceed 250v
4. Use attenuator for CRO observation.

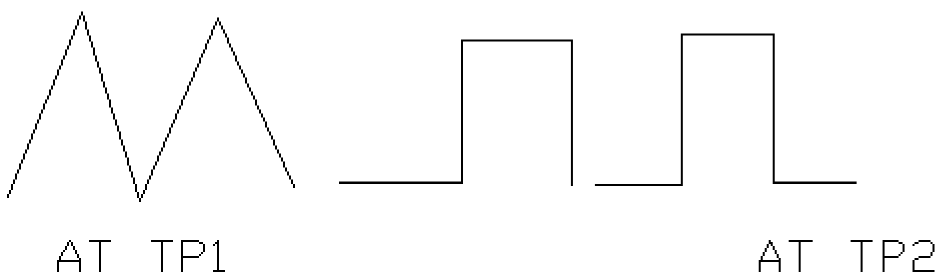


Fig-'2'

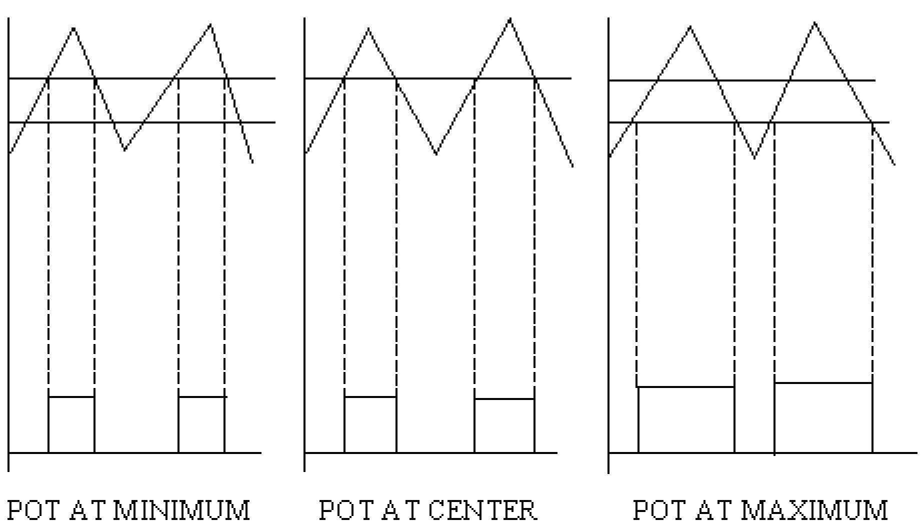


Fig - '3'

EXPERIMENT NO 05

AIM: To study speed control of dc motor using single phase half controlled bridge controller.

APPRATUS:

1. Single phase half controlled bridge rectifier.
2. Electronic control circuitry.
3. DC voltmeter 0-300V DC
4. DC Ammeter 0-5A DC
5. Resistive load (1 lamps of 230v, 100W each.).
6. DC MOTOR 250W (SPARATELY EXCITED)

THEORY:

Single phase half controlled bridge converter consist of

1. Power section- single phase bridge converter consisting of 2 SCR and 2DIODES.
2. Control section –electronic circuitory

The circuit diagram of power section of half controlled bridge is shown in FIG-A.

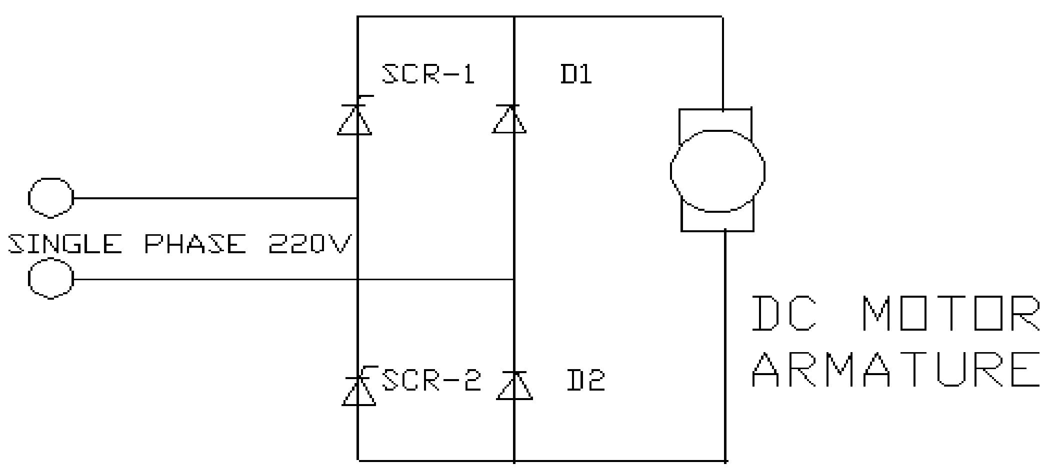
In the first half positive cycle the current will flow from second Cycle the current will flow through neutral, DIODE D1, LOAD, SCR-2 to phase. The required gate pulse will be provided by electronic circuitary.

PROCEDURE:

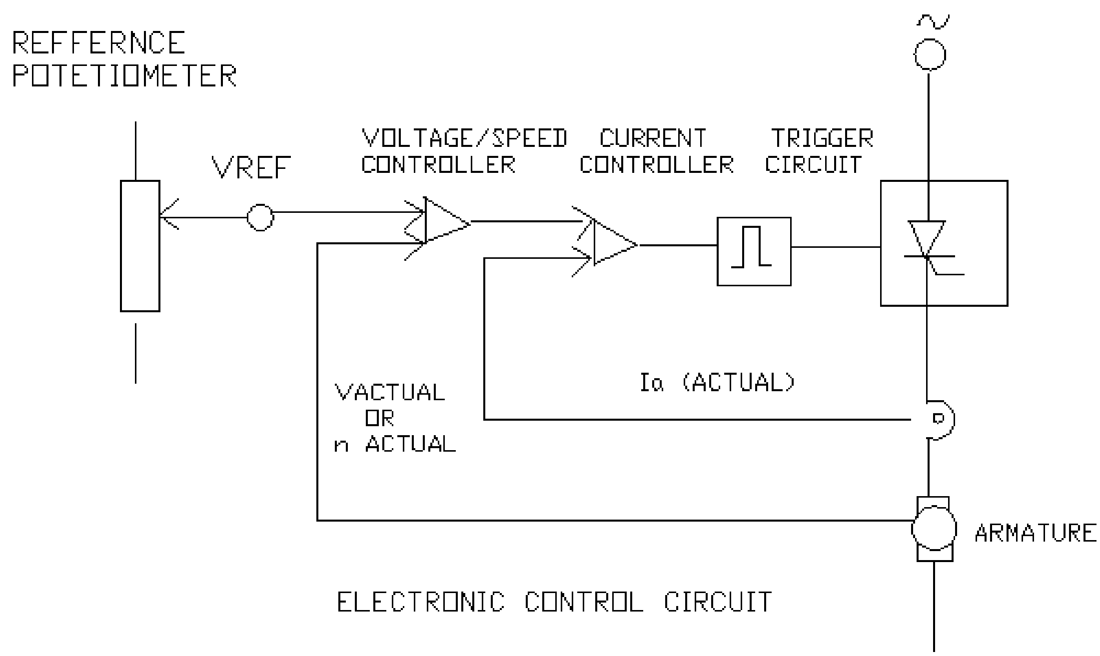
1 Keep MCB off.
2. Keep VOLTAGE control potentiometer at minimum.
3. Connect the resistive load at terminal +ve and –ve terminals
4. Switch on the MCB.
5. Increase the voltage control potentiometer slowly.
6. Observe the wave shape between + ve and _ve terminals.

PRECAUTION

1. Earth all equipment properly.
2. Switch off the MCB then make or remove the connection.
3. Input voltage not to exceed 250v
4. Use attenuator for CRO observation.

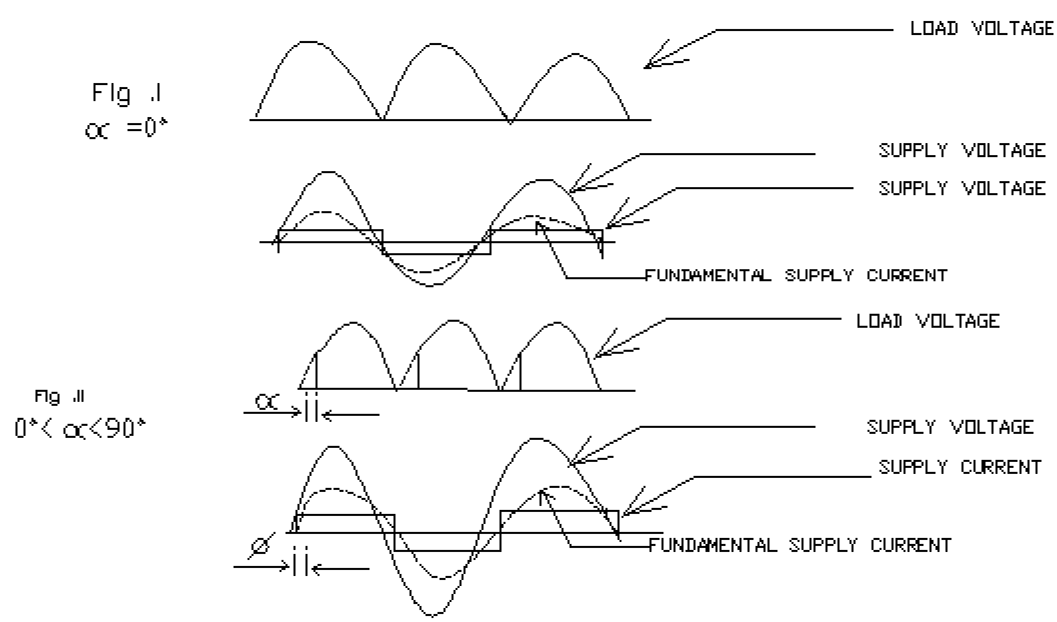


SINGLE PHASE HALF CONTROLLED BRIDGE RECTIFIER POWER CIRCUIT


REFFERNCE
POTETIOMETER
VREF
VOLTAGE/SPEED
CONTROLLER
CURRENT
CONTROLLER
TRIGGER
CIRCUIT
Ia (ACTUAL)
VACTUAL
OR
n ACTUAL
ARMATURE
ELECTRONIC CONTROL CIRCUIT

FIGA

FIG . 3


LOAD VOLTAGE
Fig .I
α =0°
SUPPLY VOLTAGE
SUPPLY VOLTAGE
FUNDAMENTAL SUPPLY CURRENT
LOAD VOLTAGE
Fig .II
0°< α<90°
α
SUPPLY VOLTAGE
SUPPLY CURRENT
Ø
FUNDAMENTAL SUPPLY CURRENT

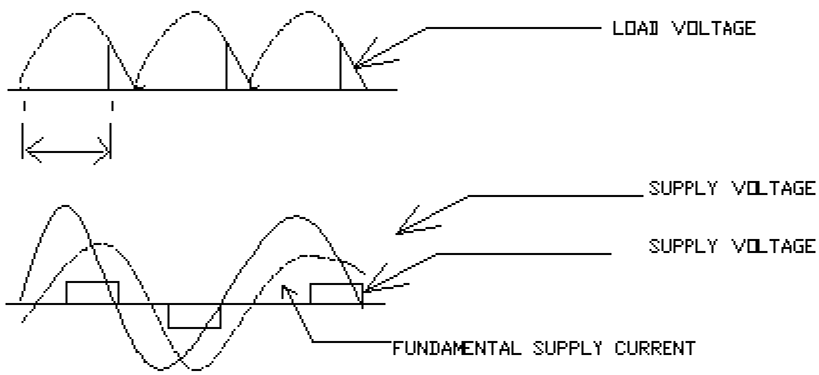
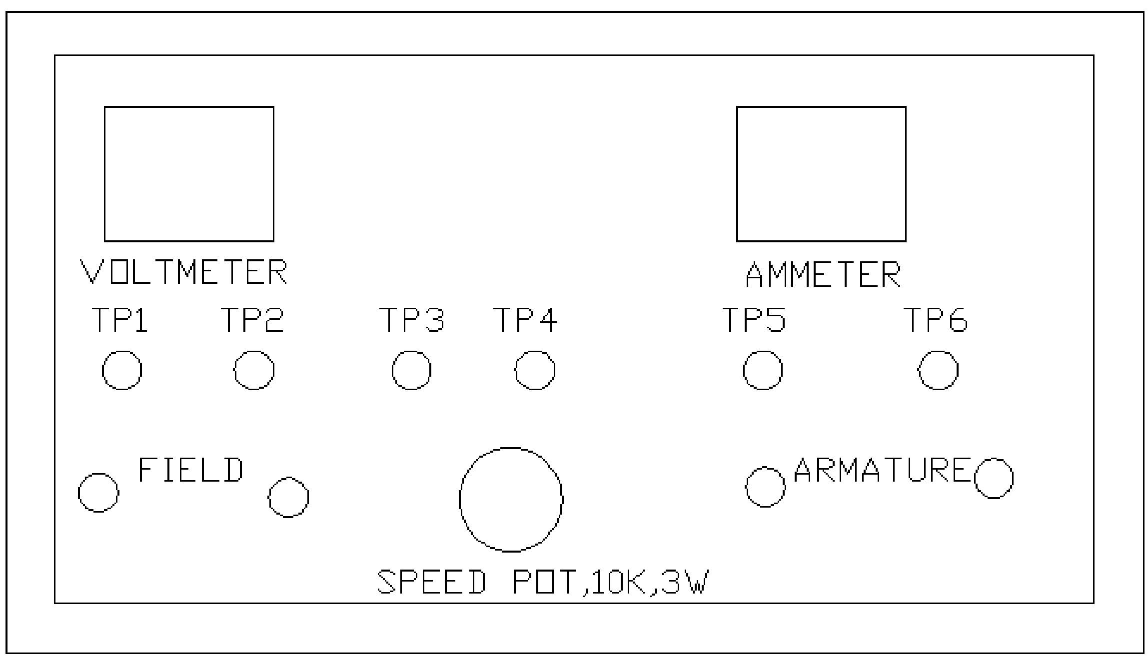


FIg .III
90°< α<180°



EXPERIMENT NO 06

AIM: To study three phase fully controlled bridge.

APPRATUS:

1. Three phase fully controlled bridge rectifier.
2. Electronic control circuitry.
3. DC voltmeter 0-300V DC.
4. Dc Ammeter 0-5A DC.
5. 1:10 Attenuator for C.R.O (RESISTOR DIVIDER NETWORK)
6. Resistive load (2 lamps of 230v, 100w each)
7. DC MOTOR 1HP (SEPARATELY EXCITED)

THEORY:

Three phase fully controlled bridge converter consist of

1. Power section – Three phase fully controlled bridge converter consisting of 6 SCR.
2. Control section – electronic circuitry.

When connected to a supply, firing gate pulses will be delivered to the SCR CORRECT SEQUENCE TO TWO SCR, ONE IN UPPER ARM AND ONE IN LOWER ARM SO THAT PROPER CURRENT PATHE CAN BE EST ABLISHED. The operation of this circuit can be explained with the help of vector diagram as shown in FIG –B .At the instant shown, voltages of phase R and phase B are equally positive with respect to natural, that is voltage B-R is zero. After this instant phase Voltage R assumes the highest value. If SCR TI is triggered at this instant, it can provide there us a return path for the current.

Since phase Y is the maximum negative, or vector R-Y is the largest, the return path should be to phase Y. That means SCR T- 5 must be triggered simultaneously with SCR T-1 .Similarly when phase Y has the highest value, SCR T-2 and T-6 and when phase B has the highest value, SCR T-3 and T-4 must be triggered simultaneously.

For six pulse operation, each SCR has to be fired twice in its conduction cycle, that is firing interval should be 60deg. As shown maximum conduction angle of 60 deg.

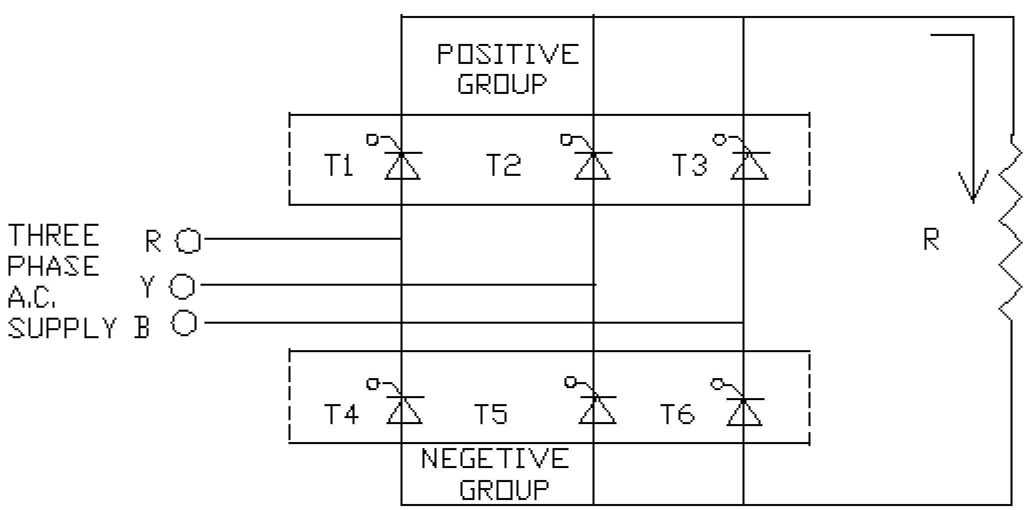


FIG – A 3PHASE FULLY CONTROLLED BRIDGE RECTIFIER WITH RESISTIVE LOAD

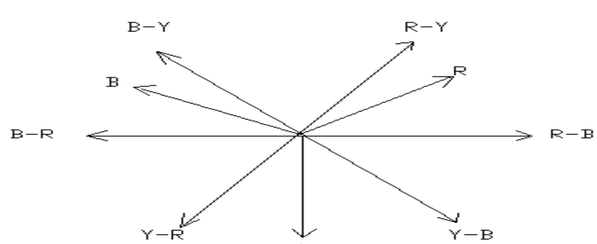


FIG – B VECTOR DIAGRAM

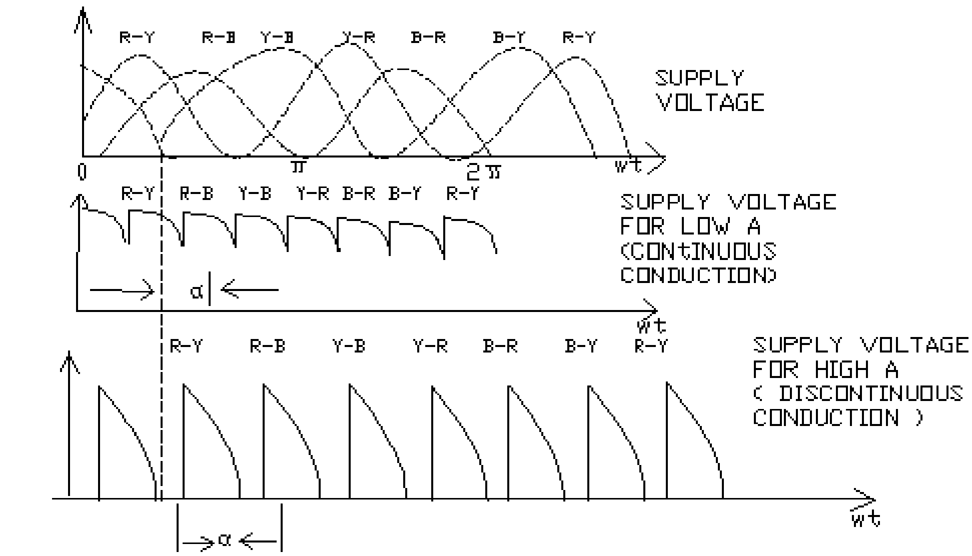


FIG – C VOLTAGE WAVEFORMS FOR VARIOUSE FIRING ANGLES

1. Continuous conduction mode ($0 \leq \alpha \leq \pi/3$)

The firing angle of each phase is varied through a range of 60 deg to 180 ^{0}. The minimum firing angle is 60^0 and is taken as =at 60^0. When the phase R-Y is allowed to conduct at between 0 to π/3, it continuous to conduct by 60^0 when the phase R-B is fired. The conduction is shift to SCR T-5 to SCR T-6 .SCR T-% is commuted off by the reverse voltage phase y. The phase R-B conducts after another 60deg after which it is replaced by phase – Y-B when phase Y voltage assumes greater value than b or R.H. Hence load current is continuous for between 0 to π/36.

2. Discontinuous conduction mode ($\pi/3 \leq \propto \leq 2\pi/3$)

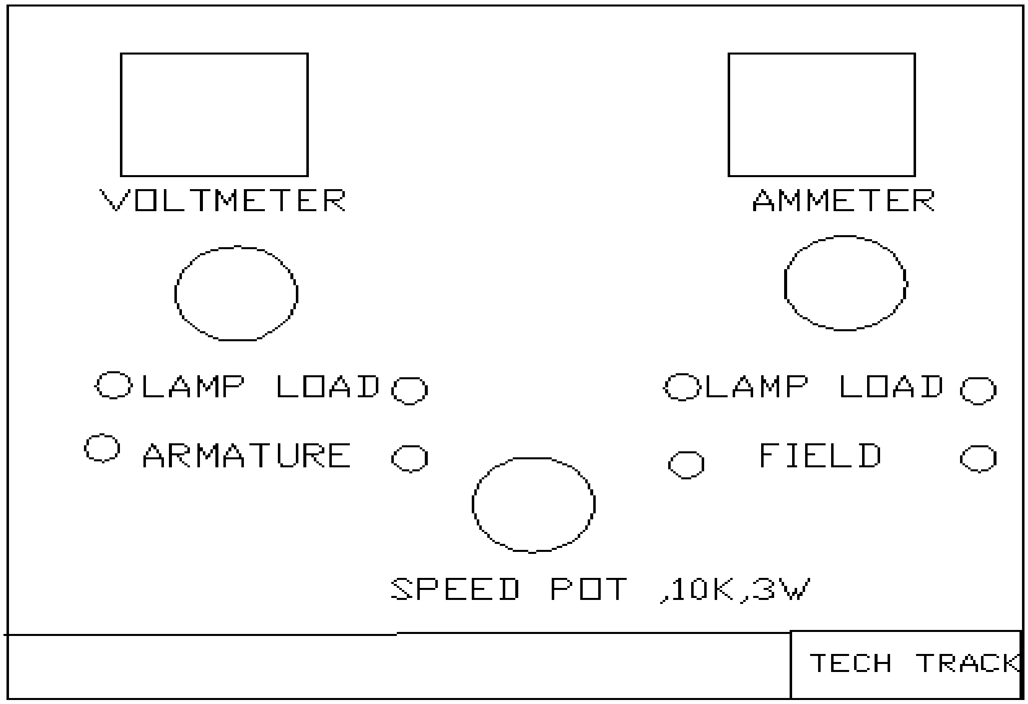
When $\pi/3 \leq \propto \leq 2/3$, the phase R-Y conducts up to an angle after which both the SCR T-I and T-5 are commuted off because phase Y becomes positive with respect to phase B and after 60 ^{0}, when T-6 and T-1 are fired phase R-B conducts also up to an angle, hence load current remains zero from angle to the next firing pulse and becomes discontinues.

EXPERIMENTAL PROCEDURE

1. Keep MCB off.
2. Keep voltage control potentiometer at minimum.
3. Connect the resistive load at terminal +Ve and –Ve terminals.
4. Switch on the MCB.
5. Increase the voltage control potentiometer slowly.
6. Observe the wave shape between +Ve and –Ve terminals.

PRECAUTION

1. Earth all equipment properly.
2. Switch off the MCB then make or remove the connection.
3. Input voltage not to exceed 415v
4. Use attenuator for CRO observation


VOLTMETER
AMMETER
LAMP LOAD
LAMP LOAD
ARMATURE
FIELD
SPEED POT ,10K,3W
TECH TRACK