

POWER SYSTEM-I Laboratory

(EE-303-G)

LABORATORY MANUAL

V - SEMESTER



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1	To study about the 220 KV Sub-Station	
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3	To study the performance of a over Current relay.	
4	To study the Ferranti Effect of transmission line.	
5	To measure the dielectric strength of transformer oil	
6	To study performance of a transmission line under no load condition & under load at different power factors	
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10	To find ABCD Parameter of a Model of Transmission Line	
11	To Study the gas actuated Buchholz relay for oil filled transformer.	

EXPERIMENT NO.-1

AIM: - To study about the 66 KV Sub-Station

THEORY: - A substation is precisely defined as an assembly of apparatus installed to control transmission and distribution of electric power. A substation is an intermediate link between the generating station and consumer. It may be defined as the assembly of apparatus, which transfers the characteristics of electrical energy from one, form to another for example one voltage to another. This sub-station receives power from incoming lines from generating plant. The electrical energy is generated at low voltage link 6.6 kV or 11 kV, through higher voltage to 33 kV are also possible due to economic consideration low voltage is converted to high voltage like 220 kV 400 kv for transmission purpose. This can be done with the help of transformer. The consumer apparatus are made up of low voltage, so this voltage is again to be stepped down to the required voltage at substation. There may be two or three voltage levels in sub-stations depending upon incoming and outgoing line voltage level.

CLASSIFICATION OF SUBSTATION: - The classification of sub-station is based on several aspects

➤ CLASSIFICATION BASED ON VOLTAGE LEVEL

A sub-station is named in accordance with its higher voltage level i.e. a 66 kV sub-station has higher voltage level of 66 kv standard rated voltages in power frequency phase to phase A.C. voltage. There is generally two or more voltage level in sub-station .the sub-station is designated after higher voltage level i.e. a 66kv buses besides say 33 kv , 11 kv , buses. The bus bars are either in two or three horizontal planes so as to permit proper Connection and clearances. Three level sub-stations are more compact and complex.

➤ CLASSIFICATION BASED ON APPLICATION

A substation can be classified on the basis of functional requirement related with applications. Some of types include:-

- 1) Substation in generating stations, receiving Stations, Distribution system.
- 2) Factory substation.
- 3) A.C. / D.C. conversion substations.
- 4) Sub-Station for load centre.

➤ CLASSIFICATION BASED ON PHYSICAL LOCATION

A substation can be classified on the basis of orientation of its equipments and physical location as under:-

A. Outdoor substation.

B. Indoor substation.

FUNCTION OF A SUB-STATION: -

A substation may be required to perform one or more of the following function.

- To switch on or off power lines the operation is known as switching operation.
- To raise the lower voltage, the operation is known as voltage transformation operation.
- To convert A.C. in to D.C. or vice versa, the operation is known as power converting operation.
- To convert frequency from higher to lower or vice-versa, the operation is known as frequency operating operation.
- To improve power factor by installing synchronous condensers at the end of the line. Operation is known as power factor correction operation.

EQUIPMENTS USED IN SUBSTATION:-

1. Circuit breaker 66/132 kV: a) Bulk oil (b) Minimum oil c) SF 6
2. Isolators
3. Transformer a) Power b) Distribution
4. Earth Switches
5. Potential Transformers: a) Current b) Potential
6. Circuit breaker 11 kV a) Bulk b) Minimum oil c) SF-6 d) Vacuum
7. Power line carrier communication equipment
8. Wireless set
9. Telephone
10. Batteries
11. Battery Charger
12. A C Distribution Board
13. D C Distribution Board
14. Neutral Resistance
15. Neutral Resistance
16. Capacitor Bank
17. Earthing Transformer
18. Fire Extinguisher
19. Lighting Arrestor

LAYOUT DIAGRAM OF 220 KV SUB-STATION:-

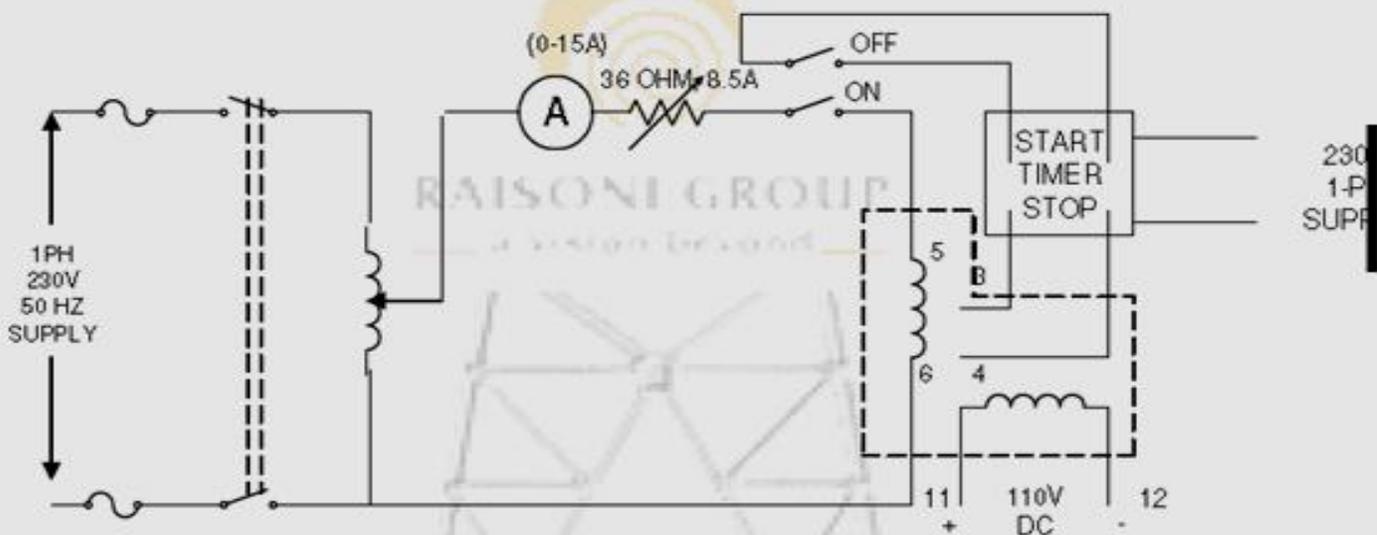
EXPERIMENT NO.-2

AIM: -
TO PLOT THE CHARACTERISTICS OF SINGLE POLE OVER CURRENT USING STATIC I.D.M.T. RELAYS

APPARATUS: -

- 1) Timer
- 2) IDMT relay (Model APR-11 P)
- 3) Auxiliary D.C. supplies = 110V
- 4) 1 phase Dimmer stat = 230V, 10A
- 6) Ammeter AC (0-15A)
- 7) Rheostat (38 ohm, 8.5 Amp)
- 8) Experiment Kit
- 9) Connecting wires

CIRCUIT DIAGRAM



THEORY: -

1. Define PSM, TSM.
2. Equation of time –current characteristics.
3. Principle & Operation of static IDMT Relay with block diagram

PROCEDURE: -

- 1) Make the connection as shown in fig.
- 2) Set current and time setting of relays as per requirement
- 3) Set phase trip to 50% and set phase time at X1 with phase TMS at maximum position.
- 4) Switch on variac and check power ON indication provided on relay front panel.
- 5) Very dimmer state with fault current of 1A, relay will trip after certain time delay.
- 6) Switch OFF dimmer state without disrobing its position and change the position of DPT switch. Also reset time.
- 7) Switch ON dimmer state change the position of switch and measure the relay time from timer.
- 8) Reap eat same procedure for varying a different fault current.
- 9) Repeat this procedure consider different set phase time (TMS)

OPERATION: -

With supply on load are continuously monitored Electronic comparator checks this value with set value (N) of phase & earth fault trip, which can be adjusted on front plate. Pick up response is (1.1 N) IDMT timing is applicable to over current above 2N as per chosen curve. Time setting multiplier for actual tripping time delay. TMS is adjusted by 11-position switch & with variable preset pot. These pots adjusted time for intermediate values indicated on TMS switch. Tripping cause is indicated by LED lamp (OC/EF). When over current trips the circuit relay ' NO ' contact changes to ' NC ' when relay trips indicating LED to ' NC ' when relay trip indicating LED to ' NC ' when relay trips indicating LED to ' NC ' when relay trip indicating LED flag will remain ON till manually reset.

OBSERVATION

1 CHARACTERISTICS TABLE: - current setting =....., Phase TMS

Sr. No.	Fault current (A)	PSM	Timer time for TSM =	Timer time for TSM=	Timer time for TSM=
1					
2					
.					
.					
10					

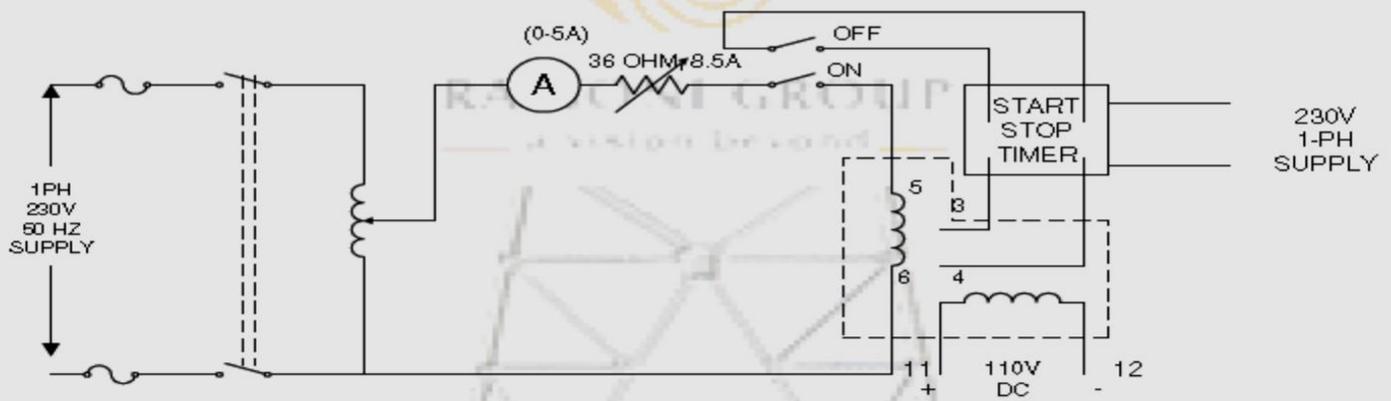
Experiment-3

AIM: - TO STUDY THE OPERATION OF DEFINITE TIME OVERCURRENT RELAY.

APPARATUS: -

- 1) Timer
- 2) Static definite O/C relay (Model ACTU 32 P)
- 3) Auxiliary D.C. supply = 110V
- 4) 1 phase variac = 230V, 4A
- 5) Ammeter AC (0-5A) and (0-1/2 A)
- 6) Rheostat (100 ohm, 5Amp)
- 7) Experiment Kit
- 8) Connecting wires

CIRCUIT DIAGRAM:

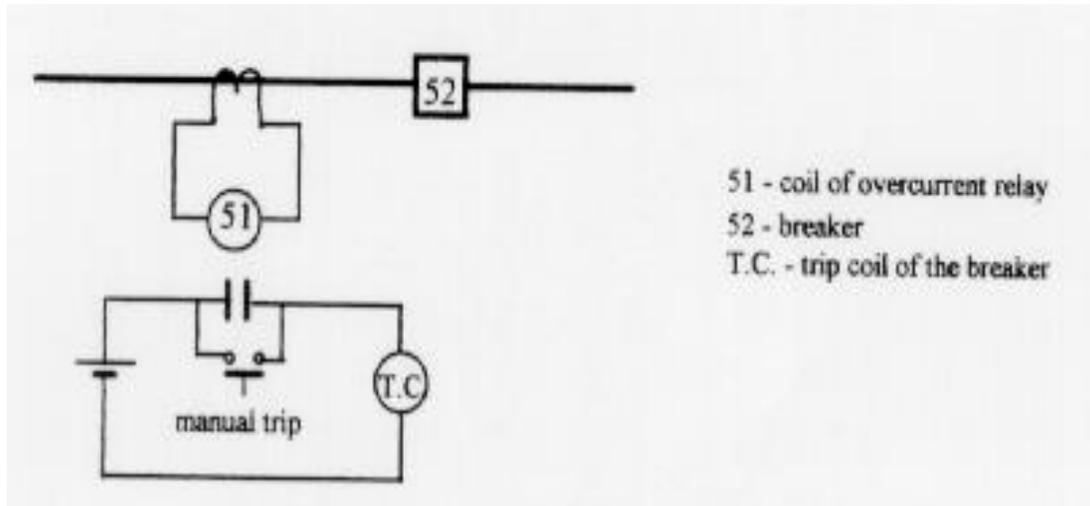


THEORY:

1. Principle and operation of static definite time over current relay, time – current charact. equation.
2. Block diagram of static over current relay.

Over current relays are used for protection of lines, transformer, generators, and motors.

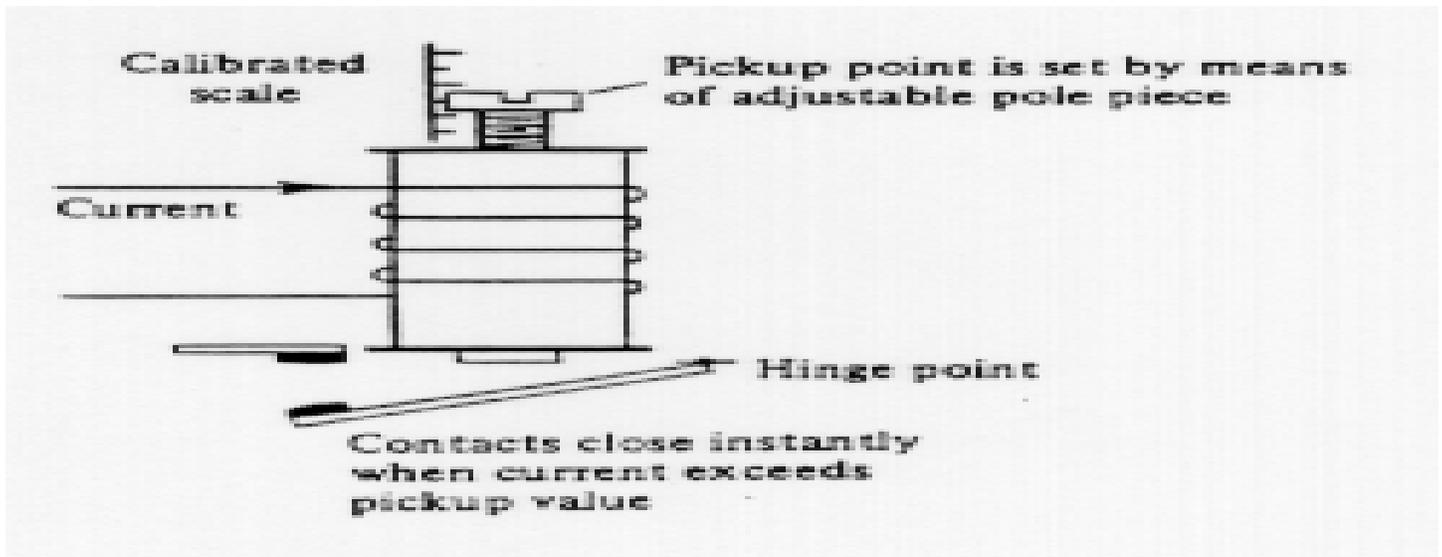
Principle of over current Protection



There are two types of over current relays

- instantaneous - NEMA # 50
- time overcurrent - NEMA # 51

Instantaneous Relays operate without intentional time delay. They are used for faults close to the source when the fault current is very high. The operating time is approximately 10 ms. The construction of the instantaneous relays is usually moving armature, plunger, or induction disk.

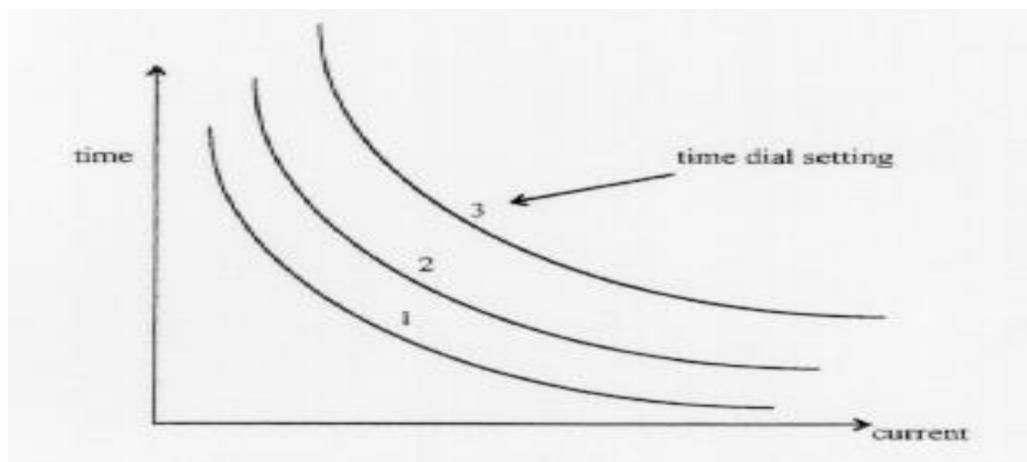


An important characteristic of an instantaneous relay is a drop-out ratio.

$$\text{dropout ratio} = \frac{\text{drop out current}}{\text{pickup current}}$$

Dropout ratio is usually less than 1.

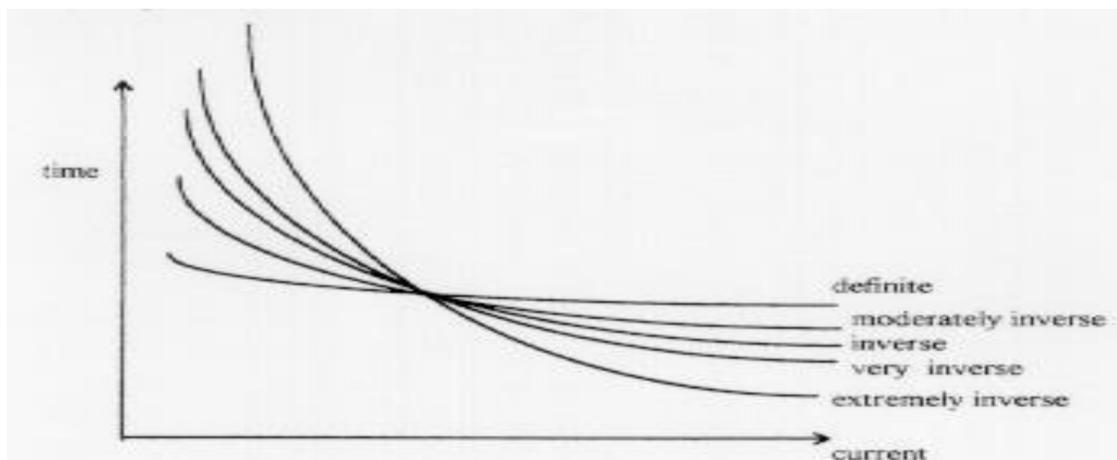
Time Over current Relays operate with a time delay. The time delay is adjustable. For a given setting, the actual time delay depends on the current through the relay coil. In general, higher current will cause a faster operation of the relay. The minimum current at which the relay operates (pick-up current) is also adjustable.



Typical Characteristics of an Over current Relay

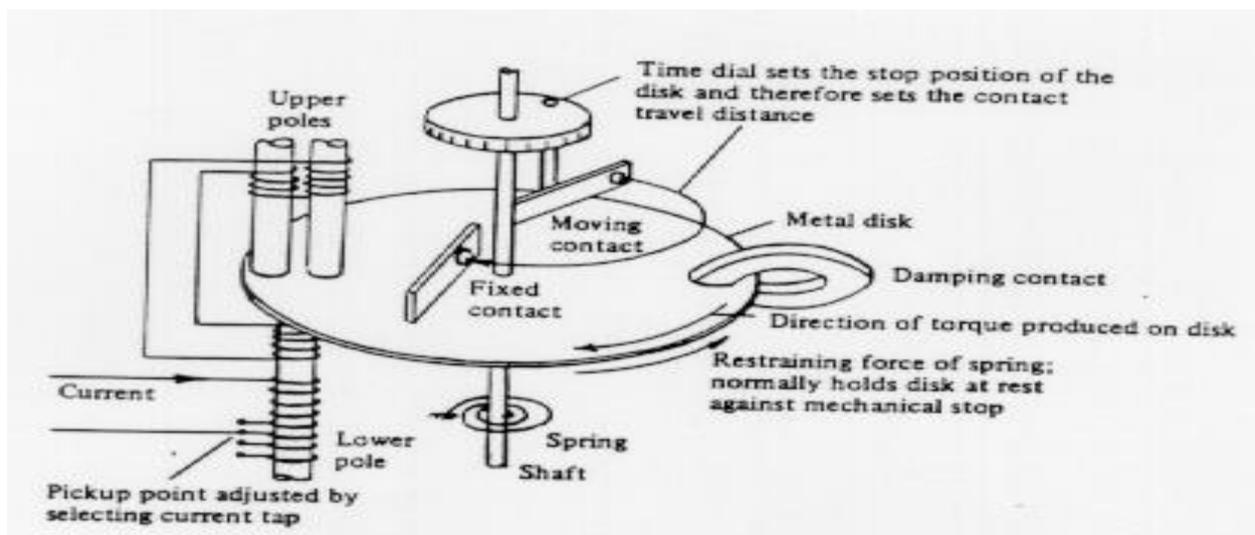
Time over current relays come in five different versions that are defined by the steepness of the time-over current characteristic:

- definite time
- moderately inverse
- inverse
- very inverse
- extremely inverse



The most commonly used over current relay incorporates both, the instantaneous unit and the time over current unit. The instantaneous response is provided by a moving armature

unit. Its purpose is to operate on very large currents. The inverse time response is provided by an induction disk unit and is set to operate for lower fault currents.



The induction disk unit operates on the same principle as induction motor. The metal disk is mounted on a shaft that can freely rotate. The current coils are fixed. They create magnetic field that induces eddy currents in the metal disk. The magnetic field of the eddy currents interacts with the magnetic field of the stationary coils and produce torque on the disk. The disk and its shaft rotate and bring the moving contact towards the fixed contact into a closed position. The motion of the shaft is opposed by a spring that returns the disk and the moving contact into the

10

open position when the current drops below a preset value. The time to close the contact depends on the contact travel distance which is set by a time dial. The pick-up current is adjustable by selecting current taps on the current coil. The relays are normally available with three ranges of current taps: 0.5 to 2.0 A, 1.5 to 6.0 A, and 4 to 16 A. The time dial has usually positions marked from 0 to 10, where for 0 setting the contact is permanently closed.

RESULT & CONCLUSION: -

The operation of definite time O/C relay is studied in this experiment. The reading is obtained for various time settings as well as current setting. It was found that for various time delay observed for peak up values of current is same.

Viva Question

- 1 Application of DTOC relay.
- 2 Draw back of DTOC relay
- 3 Importance of DC supply
- 4 Detail of other O/C relays
- 5 Use of timer



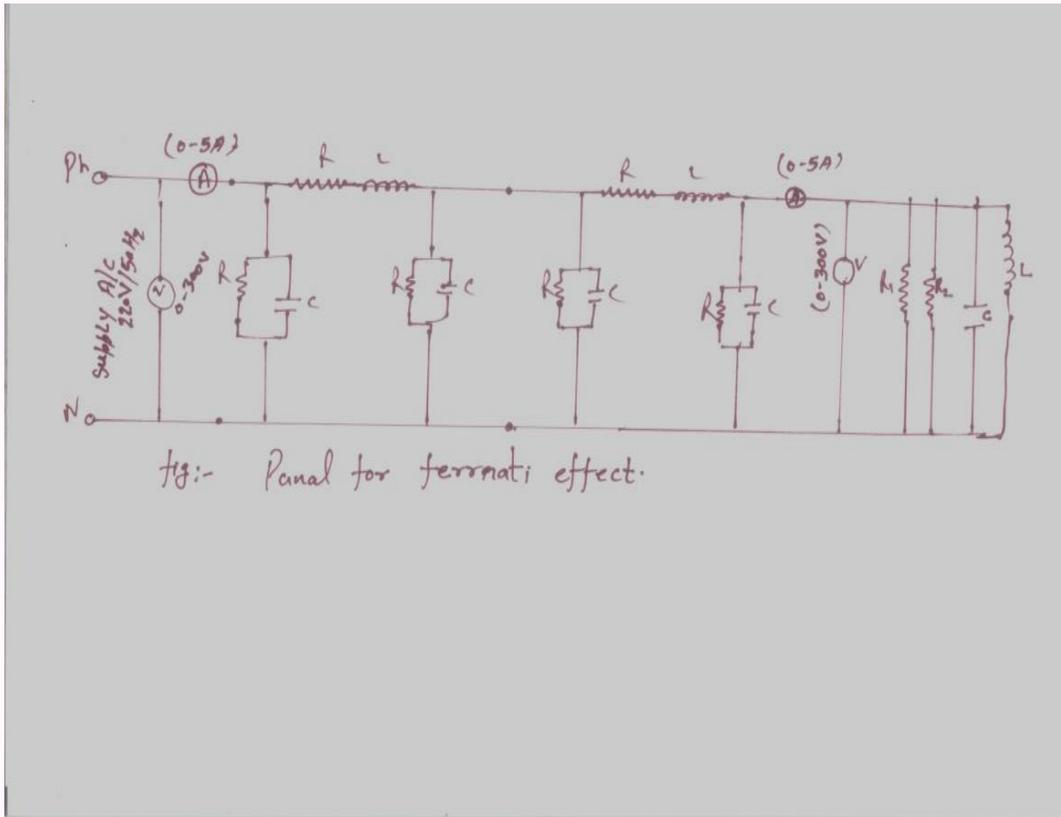
EXPERIMENT NO - 4

Aim:- To study the Ferranti Effect of transmission line.

EQUIPMENTS REQUIRED

1. Panel for Ferranti Effect of Transmission Line.
2. Ammeter
3. Voltmeter
4. Single Phase Variable R L C Load

5. CIRCUIT DIAGRAM



Theory and Procedure:

Ferranti Effect

A long transmission line/cables draws a substantial quantity of charging current. If such a line/cable is open circuited or very lightly loaded at the receiving end, the voltage at receiving end may become greater than voltage at sending end due to capacitive reactance. This is known as Ferranti Effect. Both capacitance and inductance is responsible to produce this effect. The capacitance (which is responsible for charging current) is negligible in short line but **significant** in medium line and **appreciable** in long line. Hence, this phenomenon occurs in medium and long lines. The figure shown below is representing a transmission line by an equivalent pi (π)-model. The voltage rise is proportional to the square of the line length.

The Line capacitance is assumed to be concentrated at the receiving end. In the phasor diagram shown above

$$OM = \text{receiving end voltage } V_r$$

OC = Charging current drawn by capacitance = I_c

MN = Resistive drop

NP = Inductive reactance drop

Therefore; OP = Sending end voltage at no load and is less than receiving end voltage (V_r) Since, resistance is small compared to reactance; resistance can be neglected in calculating Ferranti effect. From π -model, $V_s = V_r - \text{Impedance drop}$ Under open circuit condition $I_r = 0$ and hence, $V_s = V_r - I_c R - j\omega L * I_c$ i.e. receiving end voltage is greater than sending end voltage and this effect is called Ferranti Effect. It is valid for open circuit condition of long line. When load current is increased of R-L loads the resultant current is not remains leading, because of the inductive drop. Hence, receiving end voltage (V_r) is lesser than sending end voltage (V_s) under full load conditions.

PROCEDURE

1. Connect the Circuit as per circuit diagram.
2. Now the switch on the power Supply.
3. Note down the reading of sending end and receiving end Voltage and current.
4. Note down the reading when only resistance is on and after note the reading when resistance and capacitance is on and after that note the reading when all resistance, capacitance and inductance is on and so on take at least 2-3 readings of all .
5. Disconnect the all resistance, capacitance and inductance load
- 6 Switch off the power supply

Observations

S. No.	Sending end voltage V_i (volts)	Sending end current I_i (amp)	Receiving end voltage V_o (volts)	Variable R L C Load
1				NO Load
2				R1
3				R1+R2
4				R1+R2 +C1+C2
5				R1+R2 +C1+C2 +L

Effect of Transmission Line Length on:

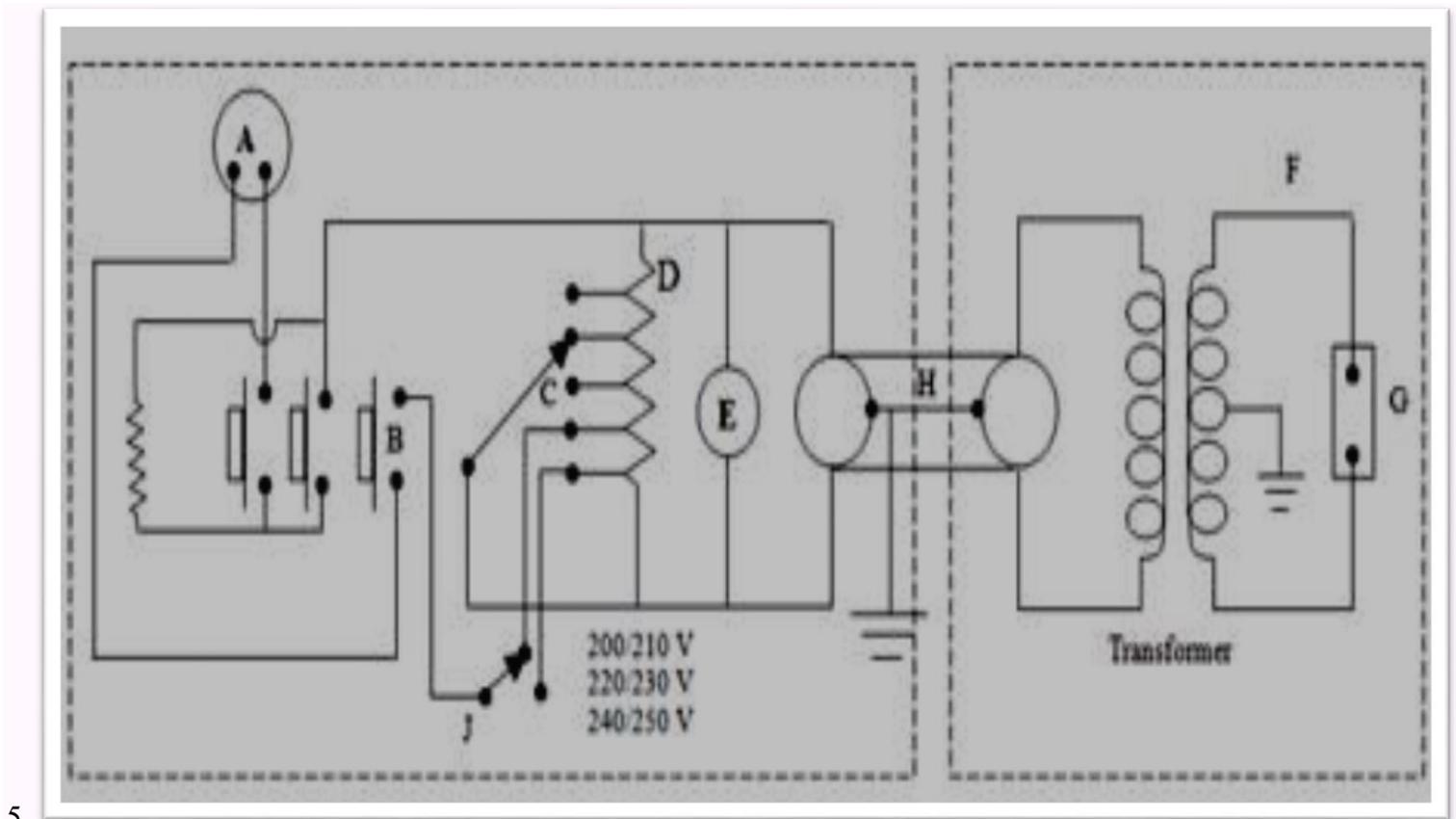
Experiment-5

OBJECTIVE

To measure the dielectric strength of transformer oil.

EQUIPMENTS REQUIRED

1. Portable oil testing set-220/250 V
2. HV transformer-50 kV/250 V
3. Gap setting gauges -0.15711 width
4. **CONNECTION DIAGRAM**



5.

6. Fig 4.1: Portable oil testing set (50 kV)

Theory

The two unit portable testing set is designed for the periodical testing of samples of insulating oils drawn from plant on site and for checking the dielectric strength of new samples of oil. The equipment is designed to operate from 200/250V, 50Hz, Single phase AC supply. Test gap voltage upto 50kV, it consists of two units, one is containing the testing transformer and other is control and metering equipments. These equipments are kept in a metal box to provide full protection to the apparatus during transport and storage. The gap is adjusted between electrodes in accordance with British Standard Specification (BSS) no. 148.

PROCEDURAL STEPS:

1. Place the High Voltage transformer unit about 7 away from the control unit.
2. The control unit is connected to supply voltage taking care that the earth connections are effective.
3. The multiple point control switch is set at its lowest tapping.
4. The push button on control unit is pressed firmly for at least 5 seconds. Note that no Breakdown to occurs, in which case button should be released at once without delay.

Break down is indicated by a continuous discharge across the gap, bubbling of oil in the cell and meter indicating a sudden voltage drop.

Observation Table

S.No.	Break Down Voltage
1.	.
2.	.
3.	.
n.	.

EXPERIMENT NO - 6

Aim:- To study performance of a transmission line under no load condition & under load at different power factors.

EQUIPMENTS REQUIRED

1. Transmission line model
2. Power Supply
3. Digital Voltmeter-2,
4. Digital Ammeter-2,
5. Resistive Load-1
6. Wattmeter-1
7. Connected Wire (As per requirement)

Diagram:-

Theory: -

Under No Load Condition:- when a long transmission line is operating under no load or light load condition. The receiving end voltage is greater than the sending end voltage drop across the line inductance (due to the charging current.)

Under Load Condition:- (resistive load) at different power factors:- in A.C Supply we know that

$$P = VI \cos \Phi$$

$$\cos \Phi = \frac{P}{VI} = \frac{\text{KW}}{\text{KVA}} = \frac{R}{Z}$$

Observation Table:-

Under No Load Condition:-

S. No	Vs	Is	Vr	Ir
1				
2				
3				

Under Load at Condition:- (Resistive load):-

S. No	Resistive load	Vs	Is	Vr	Ir	Power	
1							
2							
3							
4							
5							
6							

PROCEDURE

1. Connect the Circuit as per circuit diagram.
2. Now the switch on the power Supply.
3. Note down the reading of sending end and receiving end Voltage and current.

4. Note down the reading when only resistance is on and after note the reading when resistance and so on take at least 2-3 readings of all .
5. Disconnect the all resistance load
- 6 Switch off the power supply

Experiment-7

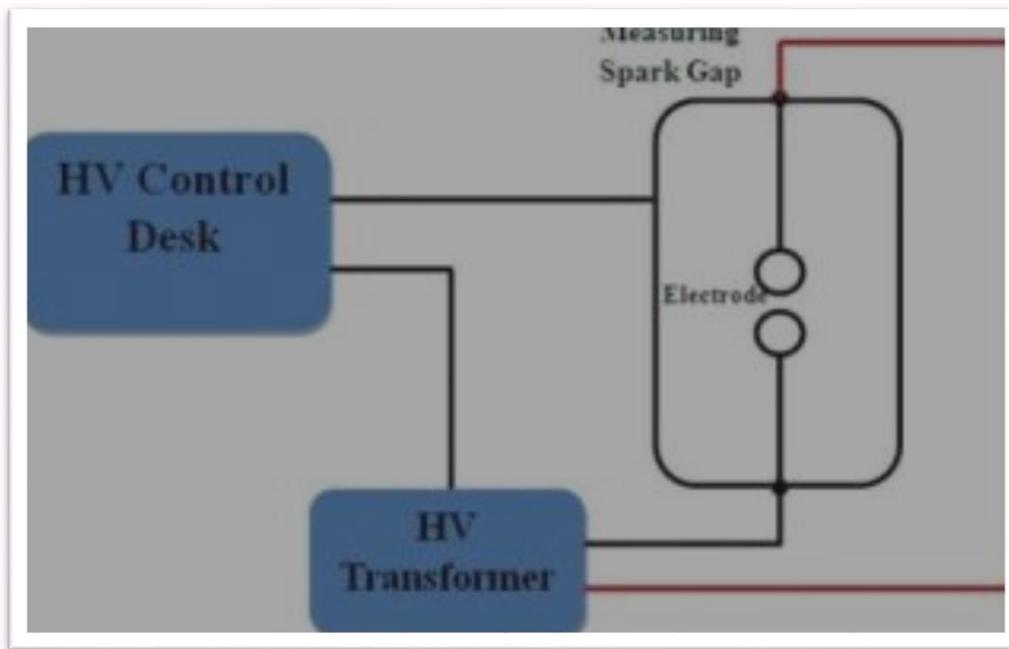
1. **Aim:** - To study flash point test of transformer oil.

EQUIPMENTS REQUIRED

1. High Voltage Transformer



BLOCK DIAGRAM



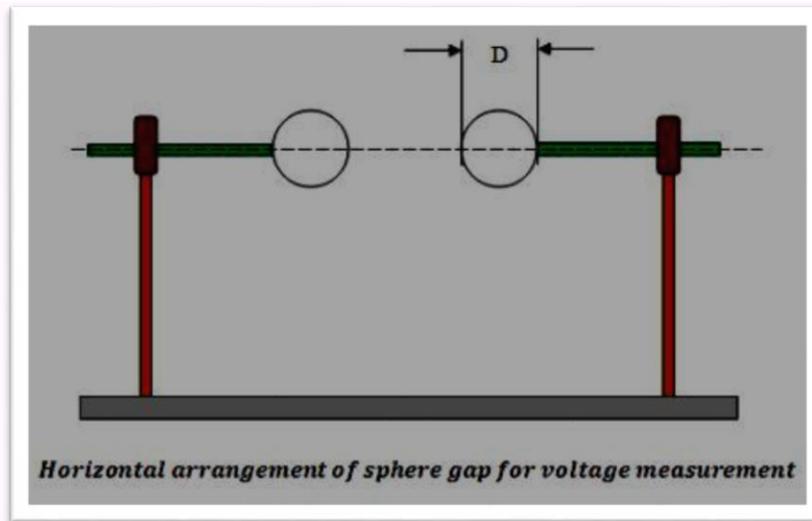
Theory and Procedure

High alternating voltages are required in laboratories for experiments and AC tests as well as for most of the circuits for the generation of high direct and impulse voltages. Test transformers generally used for this purpose have considerably lower power rating and frequently much larger transformation ratios than power transformers. The high voltage winding is so designed that it can withstand the routine breakdowns which generally occur on the specimen. The primary current is usually supplied by regulating transformers fed from main supply.

Measurement of high alternating voltage

Measurement of high alternating voltage is performed with sphere gaps and it measures peak value of voltage. Breakdown of a spark gap occurs within a few microseconds once applied voltage exceeds the “static breakdown discharge voltage”. Over such a short period the peak value of a power frequency voltage can be considered to be constant. Breakdown in gases will therefore always occur on the peak of low frequency AC voltages.

There are basically two basic arrangements of sphere gaps for measuring purposes i.e. first is horizontal arrangement and second is vertical arrangement. The horizontal arrangement is usually preferred for sphere diameters $D < 50$ cm used for lower voltage range; with the larger sphere the vertical arrangement is chosen; it is most suitable for measuring voltages with reference to earth potential only.



Procedural Steps:

1. Place the High Voltage transformer unit about 7' away from the control unit.
2. The control unit is connected to supply voltage taking care that the earth connections are effective.
3. The multiple point control switch is set at its lowest tapping.
4. The push button on control unit is pressed firmly for at least 5 seconds. Note that no Breakdown to occurs, in which case button should be released at once without delay. Break down is indicated by a continuous discharge across the gap and meter indicating a sudden voltage drop.

S.No.	Distance (mm)	BDV for Sphere	BDV for Flat	BDV for Pointed
1.
2.
3.
n.

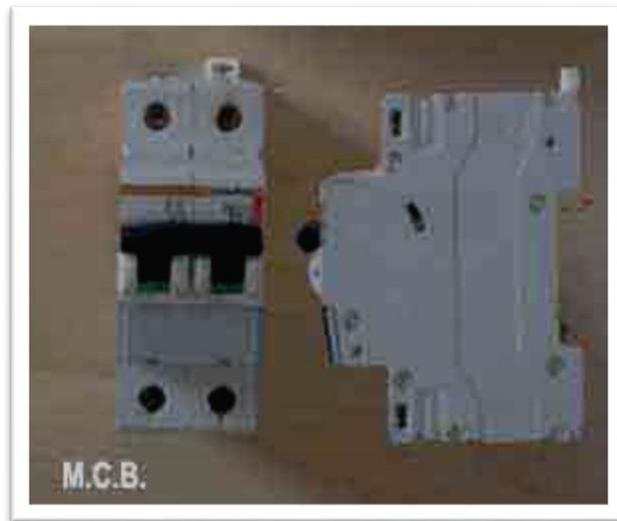
Experiment - 8

Miniature Circuit Breaker or **MCB** in low voltage electrical network instead of fuse.

The **MCB** has some advantages compared to fuse.

1. It automatically switches off the electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition. The fuse does not sense but **Miniature Circuit Breaker** does it in more reliable way. MCB is much more sensitive to over current than fuse.
2. Another advantage is, as the switch operating knob comes at its off position during tripping, the faulty zone of the electrical circuit can easily be identified. But in case of fuse, fuse wire should be checked by opening fuse grip or cutout from fuse base, for confirming the blow of fuse wire.
3. Quick restoration of supply cannot be possible in case of fuse as because fuses have to be rewirable or replaced for restoring the supply. But in the case of MCB, quick restoration is possible by just switching on operation.
4. Handling MCB is more electrically safe than fuse.

Because of to many advantages of MCB over fuse units, in modern low voltage electrical network, Miniature Circuit Breaker is mostly used instead of backdated fuse unit. Only one disadvantage of MCB over fuse is that this system is more cost lire than fuse unit system.



Miniature Circuit Breaker Working Principle

There are two arrangement of **operation of miniature circuit breaker**. One due to thermal effect of over current and other due to electromagnetic effect of over current. The thermal **operation of miniature circuit breaker** is achieved with a bimetallic strip whenever continuous over current flows through MCB, the bimetallic strip is heated and deflects by bending. This deflection of bimetallic strip releases mechanical latch. As this mechanical latch is attached with operating mechanism, it causes to open the miniature circuit breaker contacts. But during short circuit condition, sudden rising of **electric current**, causes electromechanical displacement of plunger associated with tripping coil or solenoid of MCB. The plunger strikes the trip lever causing immediate release of latch mechanism consequently open the circuit breaker contacts. This was a simple explanation of **miniature circuit breaker working principle**.

Miniature Circuit Breaker Construction

Miniature circuit breaker construction is very simple, robust and maintenance free. Generally an MCB is not repaired or maintained, it just replaced by new one when required. A miniature circuit breaker has normally three main constructional parts. These are:

Frame of Miniature Circuit Breaker

The Frame of Miniature Circuit Breaker is a molded case. This is a rigid, strong, insulated housing in which the other components are mounted.

Operating Mechanism of Miniature Circuit Breaker

The Operating Mechanism of Miniature Circuit Breaker provides the means of manual opening and closing operation of miniature circuit breaker. It has three-positions "ON," "OFF," and "TRIPPED". The external switching latch can be in the "TRIPPED" position, if the MCB is tripped due to over-current. When manually switch off the MCB, the switching latch will be in "OFF" position. In close condition of MCB, the switch is

positioned at "ON". By observing the positions of the switching latch one can determine the condition of MCB whether it is closed, tripped or manually switched off.

Trip Unit of Miniature Circuit Breaker

The Trip Unit is the main part, responsible for proper **working of miniature circuit breaker**. Two main types of trip mechanism are provided in MCB. A bimetal provides protection against over load current and an electromagnet provides protection against short-circuit current

Medium Voltage HRC FUSES



1. FEATURES

- High rupturing capacity
- Short-circuit current limiting
- Low rated minimum breaking current (I_{min})
- Low switching over voltages (U_m)
- Can be used with switch disconnected (it is fitted with a medium-size striker pin)
- Dimensions acc. to DIN and IEC Standards

2. APPLICATIONS

The HRC (high rupturing capacity) fuse-links are used to protect transformers, capacitor banks, cable and overhead lines against short-circuits. They protect switchgears from thermal and electromagnetic effects of heavy short-circuit currents by limiting the peak current values (cut-off characteristic) and interrupting the currents in several milliseconds. The type BMWW fuse-links interrupt overload currents greater than I_{min} (for the I_{min} values refer to Table 1). In situations where overloads lower than I_{min} are to be interrupted by the protective system, a switch-disconnector fitted with an over current protecting device is to be used together with the type BMWW fuse-links. BMWW fuse-links can be used with type BWMP, BWMPPE, BWMPNS, BWMPNW and BPS-01 fuse-bases as well as type OR5 or NALF switch-disconnectors.

3. ENVIRONMENTAL OPERATING CONDITIONS

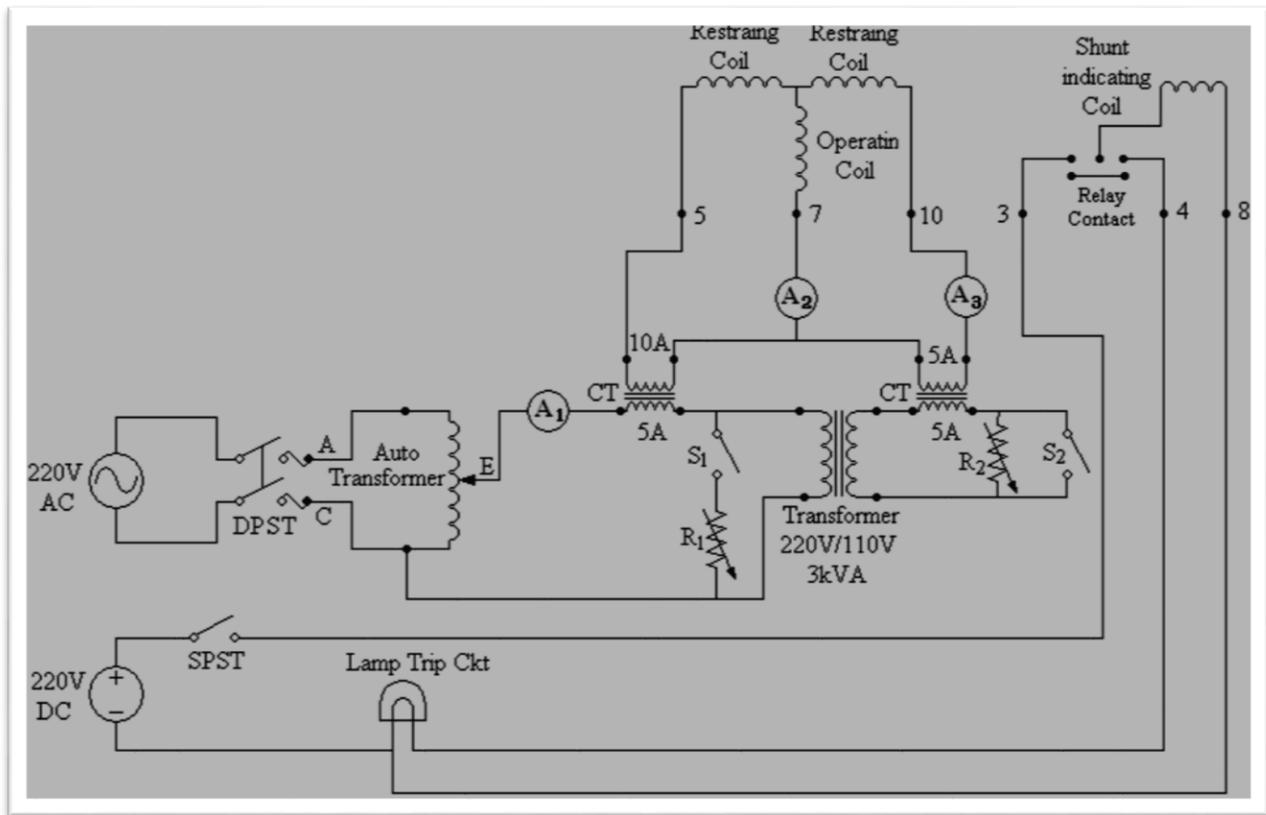
BMWW fuse-links can be operated under the following environmental conditions:

- on indoor and outdoor equipment,
- at ambient temperatures of -30°C to $+40^{\circ}\text{C}$,
- at relative humidity of ambient air of 100% at a temperature of $+20^{\circ}\text{C}$.

Experiment - 9

Aim:-To determine the Operating characteristic of Transformer Percentage biased Differential Relay.

EQUIPMENTS REQUIRED: - Percentage biased Differential Relay. Kit, Connected Wire Diagram



Circuit Diagram for Transformer Percentage Differential Relay.

Theory: DIFFERENTIAL PROTECTION

Differential protection is a very reliable method of protecting generators, transformers, buses, and transmission lines from the effects of internal faults.

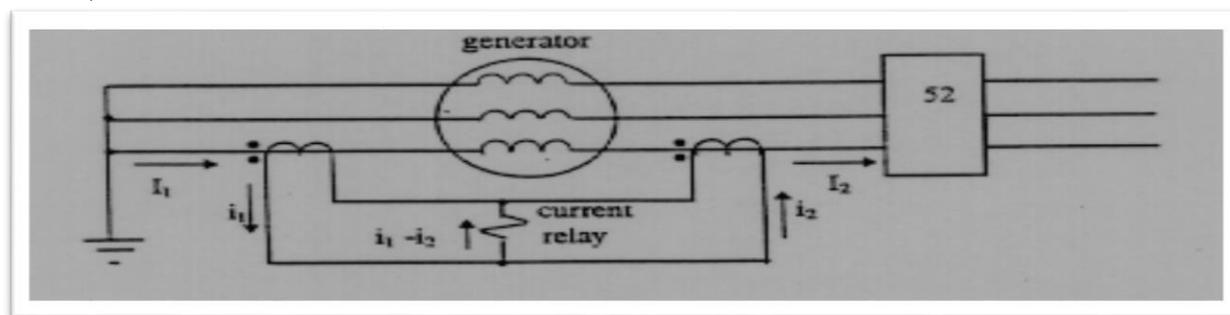


Figure: Differential Protection of a Generator

In a differential protection scheme in the above figure, currents on both sides of the equipment are compared. The figure shows the connection only for one phase, but a similar connection is usually used in each phase of the protected equipment. Under normal conditions, or for a fault outside of the protected zone, current I_1 is equal to current I_2 . Therefore the currents in the current transformers secondaries are also equal, i.e. $i_1 = i_2$ and no current flows through the current relay. If a fault develops inside of the protected zone, currents I_1 and I_2 are no longer equal, therefore i_1 and i_2 are not equal and there is a current flowing through the current relay.

Differential Protection of a Station Bus

The principle of the differential protection of a station bus is the same as for generators. The sum of all currents entering and leaving the bus must be equal to zero under normal conditions or if the fault is outside of the protected zone. If there is a fault on the bus, there will be a net flow of current to the bus and the differential relay will operate.

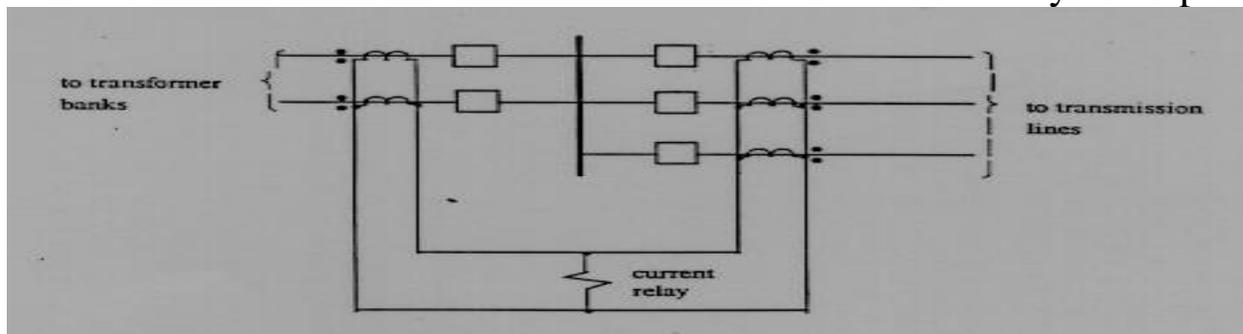
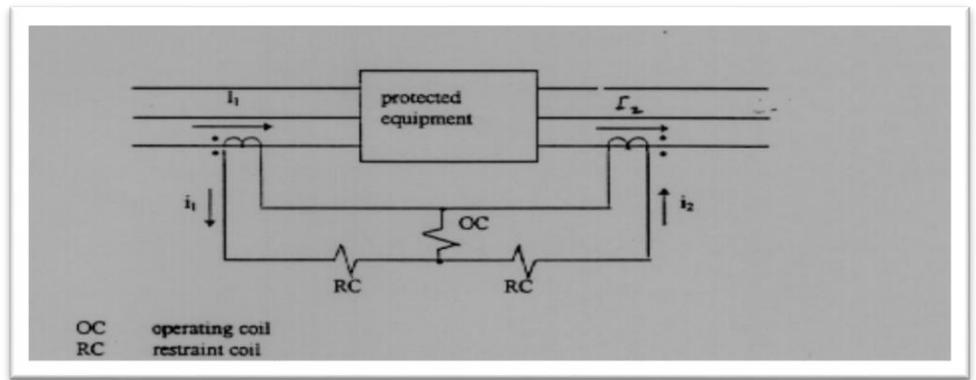


Figure: Single Line Diagram of Bus Differential Protection Percentage Differential Relays

The disadvantage of the current differential protection is that current transformers must be identical, otherwise there will be current flowing through the current relays for faults outside of the protected zone or even under normal conditions. Sensitivity to the differential current due to the current transformer errors is reduced by



percentage differential relays.

Figure: Percentage Differential Relay

In percentage differential relays, the current from each current transformer flows through a restraint coil. The purpose of the restraint coil is to prevent undesired relay operation due to current transformer errors. The operating coil current $|i_1 - i_2|$ required for tripping is a percentage of the average current through the restraint coils. It is given by

$$|i_1 - i_2| \geq k \left| \frac{i_1 + i_2}{2} \right| = k |i_{\text{average}}|$$

where k is the proportion of the operating coil current to the restraint coil current. For example if $k = 0.1$, the operating coil current must be more than 10% of the average restraint coil current in order for the relay to operate.

$$I_2 \eta_o > I_3 \eta_r. \text{ Where,}$$

η_o = no of turns of Operating coil.

η_r = no of turns of Restraining coil

Procedure:

1. Chose a particular biasing (say 20%)
2. Close S_2 . See that there is no relay operation (no current through A_2). If there is connect through A

Experiment - 10

OBJECTIVE

Aim: - To find ABCD Parameter of a Model of Transmission Line

Apparatus:- Transmission Line model is consisting of four sections of transmission Kit.

Voltmeter-1, Ammeter-1, Power Supply-220V, Connected Wire (As per Requirement)
 Theory:- ABCD Parameter are widely used in analysis of power transmission engineering where they will be turned as “Generalized circuit parameter” ABCD parameters are also called as Transmission parameter. It is conventional to designate the input port as sending end and the output port as receiving end while representing ABCD parameter

$$V_s = AV_r + B I_r$$

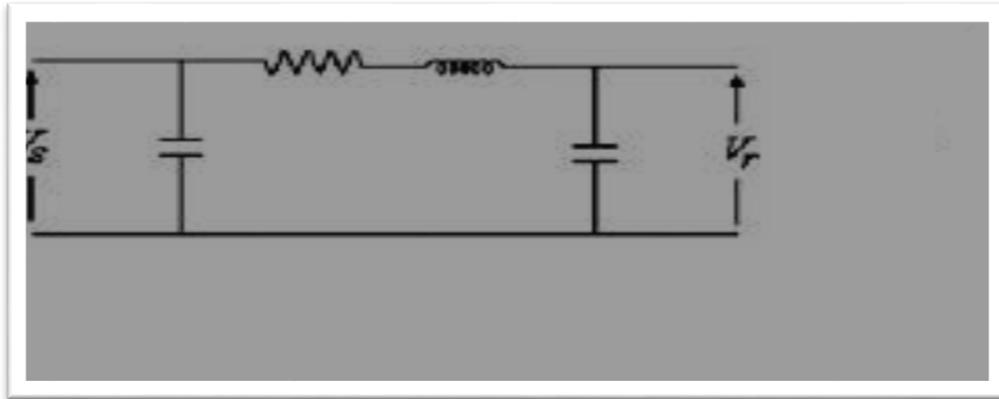
$$I_s = CV_r + D I_r$$

$$[V_s/I_s] = [A \ B/C \ D] [V_r / I_r]$$

Assuming the receiving end open Circuit i.e.

- A = V_s / V_r Where $I_r = 0$
- B = V_s / I_r Where $V_r = 0$
- C = I_s / V_r Where $I_r = 0$
- D = I_s / I_r Where $V_r = 0$

Diagram Circuit:-

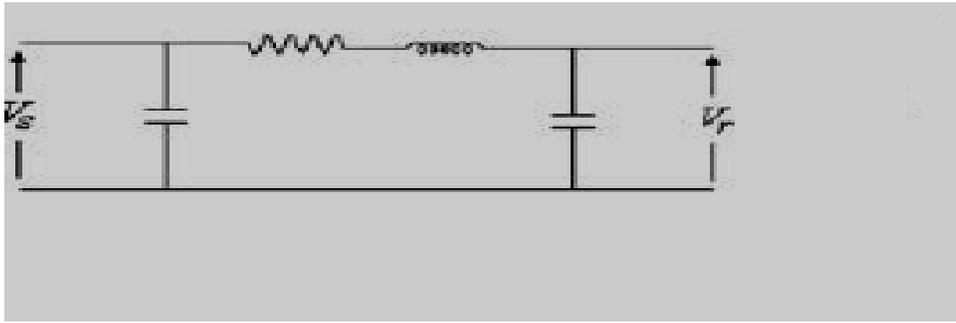


In transmission line if impedance at the sending end with Z_{12} at receiving end be Z_{11} and simulations the impedance looking back from receiving end with Z_{11} at input part is Z_{12} then Z_{11} and Z_{12} termed as the image impedance of the network

$$Z_{11} = \frac{\sqrt{AB}}{CD} \text{ and } Z_{12} = \frac{\sqrt{BD}}{AC}$$

$$\alpha = \tanh^{-1} = \frac{\sqrt{BD}}{AC}$$

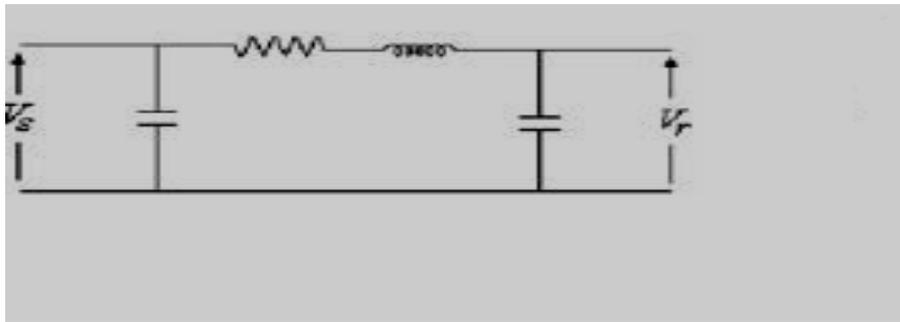
Open Circuit:-



Calculation & Observation:-

S. No	V_s	I_s	V_r	$A = V_1 / V_2$	$C = I_1 / I_2$

Short Circuit:-



S. No	V_s	I_s	I_r	$B = V_s / I_r$	$D = I_s / I_r$

Procedure:-

1. To find out A and C parameters connect voltage supply of 220V to sending end and open circuit receiving end.

2. Observe the voltage of V_s, I_s and V_r with the help of voltmeter and ammeters in the experimental kit.
3. To find out B and D receiving end is short circuited and supply of 220V is given to sending end.
4. Observe the voltage of V_s, I_s and I_r

Result: - The Calculated A, B, C, D Parameters are

A=

B=

C=

D=

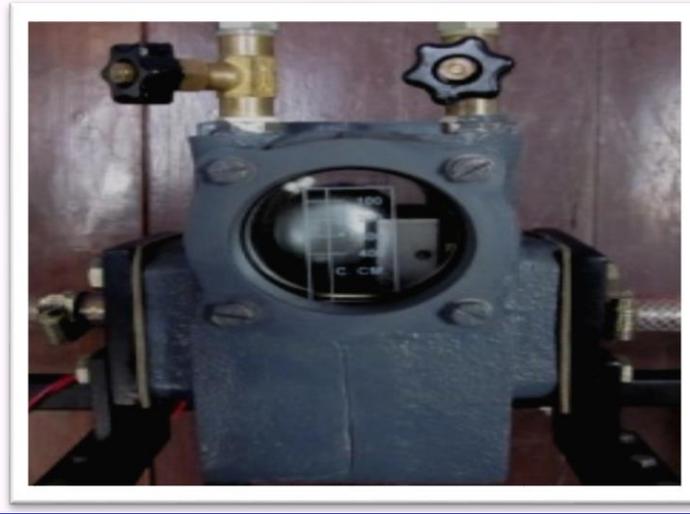
Experiment - 11

OBJECTIVE

To Study the gas actuated Buchholz relay for oil filled transformer.

EQUIPMENTS REQUIRED

1. Buchholz Relay Setup
2. 100 W Lamp



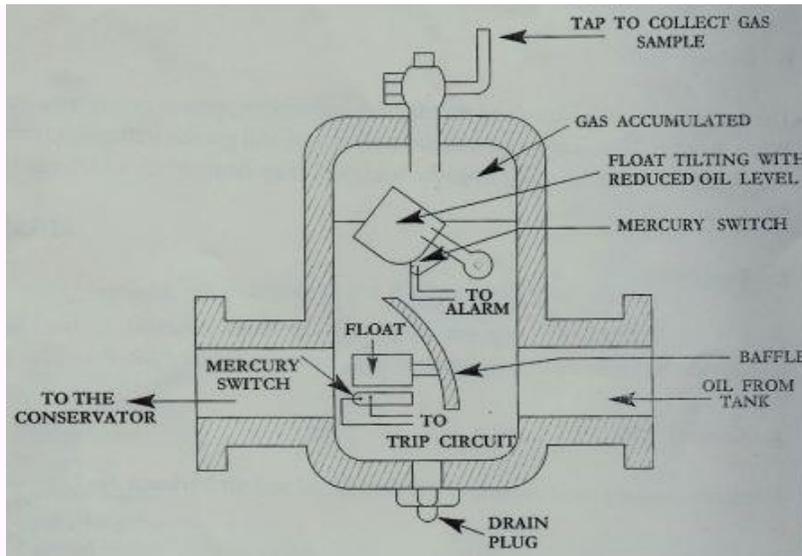
THEORY

The Buchholz relay is one of the important protective devices for oil immersed power transformer, which will operate based on the oil or gas pressure. It detects two types of faults i.e. minor and major fault. Minor faults comprise of faults in core laminations, over heating in windings, bad connections, low oil levels etc. In minor faults the alarm circuit will be actuated to switch on the buzzer. In case of major faults like internal short circuit between phase and earth, phase to phase fault, insulation break down etc., the trip circuit will be closed due to enormous amount of gas bubbles. Buchholz relay is a gas actuated relay used for protecting oil immersed transformer against all types of internal faults and makes use of the fact that fault produces over current and overheating that decomposes oil, thus generating gases.

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WORKING PRINCIPLE

The Buchholz relay comprises hinged float and mercury switch assembly for both the alarm and trip circuits. The entire assembly is in an oil proof case which has two glass windows. When the oil level is reduced from the desired level, the float switch moves down that will touch the contact. In case of major faults, the gases generated in transformer tank due to decomposing of oil rush towards conservator tank through Buchholz relay. These gases pressurize the oil and reduce the oil level in buchholz relay and the float switch go down to close the trip circuit as shown in the below figure. While reducing the oil level, the alarm will get activated. If the pressure is higher in the transformer tank the trip circuit will be activated to close the mercury switch and trip the power to transformer.



1. Keep all the front panel switches in OFF condition.
2. If any pressure is present in the relay, release it first by using Valve V₅ and also use the hand valve which is present on the reservoir to release the pressure from the remaining part.
3. The main power supply chord is connected at the back side of buchholz relay setup.
4. Close all Valves except V₂.

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5. Fill the oil in the buchholz relay by using foot pump by little opening of the Valve V₅ (only if air lock is present in the relay).
6. Switch ON the power supply.
7. Switch ON the buzzer toggle switch.
8. Open the Valve V₁ slightly and decrease the oil level manually below the particular level by carefully seeing the oil level in the buchholz relay. Now the alarm contact will be closed and the buzzer will operate in control panel.
9. After getting the alarm indication, close the Valve V₁.
10. First release the Valve V₁ and V₃ and collect the oil in to the resevoir then follow the steps 2-8 once again.
11. After completion of experiment open all the Valves including hand Valve except V₄ and V₅ to release the air pressure inside all the tanks.

