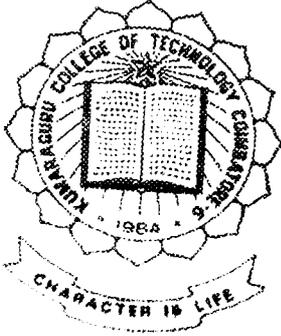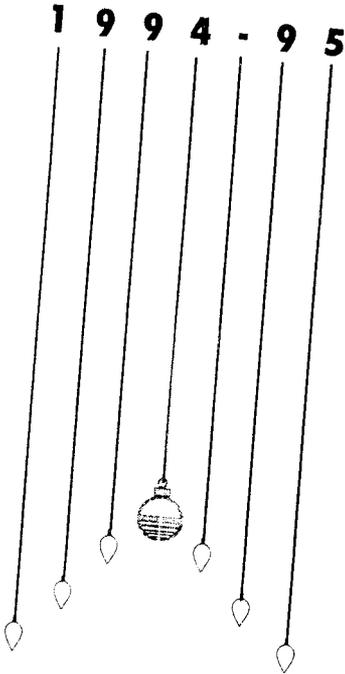# POINT-ON-WAVE-SELECTOR

PROJECT WORK

Submitted by

S. MURUGAN
R. VIDHYAPRAKASH
N. VENKATA VIJAYA BHASKAR

Under the Guidance of
Prof. CHRISTIAN PAUL

P-206

In partial fulfilment of the requirements
for the Award of the Degree of
BACHELOR OF ENGINEERING
In Electrical and Electronics Engineering
of the Bharathiar University, Coimbatore

1994-95

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
KUMARAGURU COLLEGE OF TECHNOLOGY
Coimbatore - 641 006

Department of Electrical and Electronics Engineering
Kumaraguru College of Technology
Coimbatore - 641 006

Certificate

Name _____

University Register No. _____

This is to certify that the Project work

"POINT ON WAVE SELECTOR"

is a bonafide work carried out by

Mr. **S. MURUGAN, R. VIDHYA PRAKASH, N.V.V. BHASKA**

In partial fulfilment of the requirements for the award of the degree of Bachelor of Engineering in Electrical and Electronics Engineering Branch of the Bharathiar University, Coimbatore during the academic year 1994-1995

Station : Coimbatore - 6

Date : 07 - 07 - 95
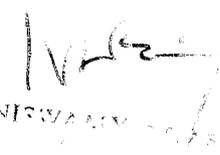
Dr. K. A. PALANISWAMY

Professor and
Department of Electrical and Electronics
Kumaraguru College of Engineering
Coimbatore 641 006.

Head of Department

Guide

Submitted for the University Examination held on ___ **04.95.**

Internal Examiner

External Examiner.

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SYNOPSIS

With increase in capacity of power systems, the duty of circuit breakers becomes very critical. The flawless operation of circuit breakers is a must for making the supply more reliable. Hence testing of circuit breakers have gained great importance and newer standards are being specified. The latest standard for testing involves finding the maximum arcing conditions during closing and opening under worst possible conditions. To ensure this condition a point-on-wave-selector is needed. This device has been developed in this project using six stages. This proves to be a sure way of precisely getting the required points on the voltage wave for testing the circuit breaker. The test results entirely rest on the precision of this device.

Contents

CONTENTS

Introduction

CHAPTER 1

INTRODUCTION

In the historical development of circuit breaker from its premitive knife switch to the most modern circuit breaker the short-circuit testing of circuit breakers has played a very definit and decisive role. A through experimental investigation of problems involved in circuit breaker operation would not have been possible without testing.

Service conditions impose many varied duties on a circuit breaker, as some special types of load can prove difficult to interrupt and the voltage produced by the breaker during interruption may be greater than what the system insulation may permit. In particular the breaking of line charging current or low value reactive current or the energizing of long lines can cause problems of this type. It

is important from this point of view that the proving tests made are comprehensive to cover all foreseable circumstances.

In order to verify the performance of the switchgear, maximum arcing conditions are to be obtained. This can be well achieved by choosing a suitable point on the wave of the voltage applied. The switchgear under test are connected with a low power factor circuit and with the help of point-on-wave-selector device, maximum asymmetry is created in the circuit. So the equipment under test clears satisfactorily under this severe arcing condition, the equipment can be declared as safe for utilization.

When an A.C. supply is switched ON to a load its immediate response to the sudden inrush of energy varies with the point on wave at which the voltage is switched ON.

To study the various switching responces it would be essential to include a device in the switching circuit. This is used to select the desired point on wave and to initiate the switching at the point. Such a device is known as a point-on-wave-selector.

Nowadays all the switchgears are passing through their own laboratory tests. As per ISI stipulation all the manufactures should have their own testing facility. Hence this device is essential in the testing laboratories.

The project outlined below deals with the design, construction and calibration of one such device point on wave selector.

CHAPTER II

CIRCUIT BREAKER - TYPES AND TESTING

A circuit breaker is a device in a switchgear used for switching and current - interrupting.

The circuit breaker serves two basic purposes,

1. Switching ON and OFF during normal operating conditions for the purpose of operation and maintenance.

2. Switching during abnormal conditions such as short circuit and interrupting the fault currents and reclosing after the fault is isolated.

Circuit breakers must be designed to interrupt the short-circuit current and also to close the circuitbreaker on to a short circuit without the contacts 'freezing' or becoming mechanically distorted.

Basically a circuit breaker comprises of a set of fixed and movable contacts. The contacts can be separated by means of an operating mechanism. The seperation of current carrying contacts produces an arc. There are different methods of quenching the arc. Accordingly the circuit breakers are classified into different types based on their capacity and medium used to quench the arc.

2.1 Types

The protection of any electrical installation is achieved by the following switchgears.

a) H.R.C. fuses

b) Air circuit breakers

c) Oil circuit breakers

d) Moulded case circuit breakers

e) Switch fuses and fuse switches

f) Miniature circuit breakers

In early days the HRC fuses were capable of clearing 50 KA short circuit fault level equivalent to 36 MVA. As the energy demands were increasing day by day, larger capacity transformers were installed, the fault levels correspondingly increased.

Today's vouge is using of High rupturing capacity (HRC) fuses of 80 KA and above.

In early installation oil circuit breakers were used as incomers and subsequently due to the poor breaking capacity of the oil circuit breakers, air circuit breakers were employed for the total circuit protection as incomers.

Due to the larger volumes occupied by the air circuit breakers, moulded case circuit breakers were designed with very compact size and performance comparable to air circuit breakers on breaking.

Moulded case circuit breakers (MCCBS) are being employed in all outgoing feeders and for incomers air circuit breakers are still being used. Moulded case circuit breakers have a disadvantage that they donot have the short time with standing current as compared to air circuit breakers. Air circuit breakers are designed with a short time withstand of 50 KA for one second with a scale of 105KA.

Switchfuses and moulded case circuit breakers are used for outgoing feeders.

2.2 PROBLEMS OF SWITCHING.

Whenever a highly inductive circuit [ex: locked rotor condition] is interrupted, maximum arcing is developed across the contacts of the switchgear. The arc energy will damage the equipment connected through the switchgear if it is not tested for the required condition. The switchgear is

a safety device and should offer adequate protection to the operating personnal and the connected equipment.

2.3. TESTING STANDARDS.

While testing the switchgear apparatus mentioned above the switchgears are tested at Government testing laboratories CPRI (CENTRAL POWER RESEARCH INSTITUTE) at Bangalore and Bhopal.

The switchgears are tested as per required Indian Standard specifications. The specifications are given below.

	INDIAN STANDARD NUMBER
(a) H R C fuses	IS 9224
(b) Aircircuit breakers	IS 2516
(c) Oilcircuit breakers	IS 2516
(d) Moulded case circuit breakers	IS 2516
(e) Switch fuses and fuse switches	IS 4064
(f) Miniature circuit brreakers	IS 8828

A new standard IS 13947 is to be introduced to include all the switchgears specified above.

The standards specify that the switchgear equipment to be tested at a varying powerfactor ranging from 0.15 to 0.25 at various angles of the applied voltage.

The purpose of varying the angles in the rising voltages is to study the behaviour of the switchgear equipment under arcing conditions. At the instant of zero closing of the voltages, maximum asymmetry will occur at the equipment. While breaking the severity of the arc will also be more. The asymmetry waveform is shown in fig 2.2.

Asymmetry is created in only one phase and then tested. For example if one phase has an asymmetry of about 99%, then the other two phases will have a relatively low asymmetry of about 40 % and 60 % respectively. So, we are

...lecting the point on the maximum asymmetry waveform which can be any one of the phases.

The equipment will be made to break at the rising voltages. The angular point of the rising voltage is chosen through a device called point - on - wave - selector.

The point - on - wave - selector switches ON the make switch. This make switch contains a moving contact and a fixed contact. The moving contact is held by a magnetic clutch. The contacts are kept in a HT insulated cylinder filled with transformer oil. This is shown in fig 2.1. The distance between the contacts can be adjusted and hence the time of closing the contacts can be controlled.

However the testing procedures warrant that the performance of circuit breakers are to be tested for

occurance of fault at different point on the voltage wave so as to ensure the successful operation of the circuit breaker. The device described in this project helps to choose a desired point on the wave.
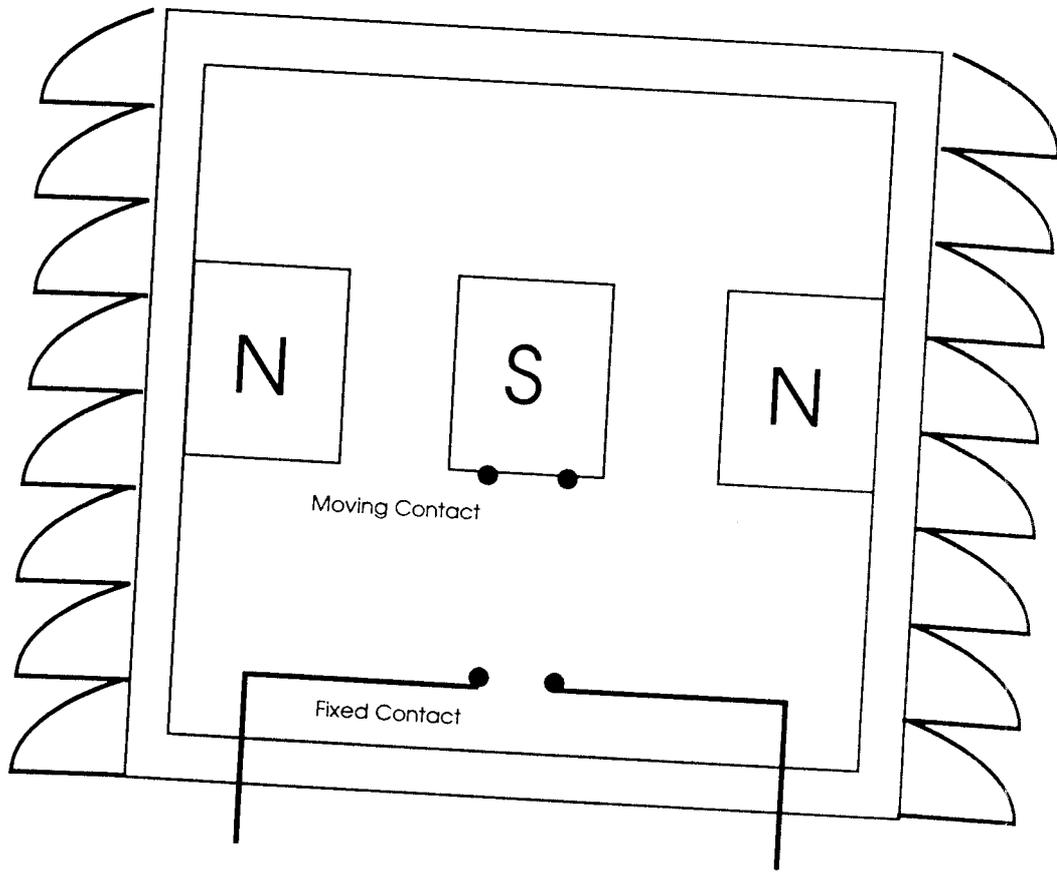
N   S   N

Moving Contact

Fixed Contact

FIG 2.1   MAKE SWITCH

CHAPTER III

PRINCIPLE OF WORKING OF THE DEVICE

Given a voltage waveform, the point on the waveform at
which the circuit breaker is simulated to make or break for
testing purposes. This device is used to select a desired
point on the wave precisely. The principle of operation is
clearly explained in the following paragraphs.

Considering the voltage waveform shown in fig 3.1, to
fix any point on this wave, say point x, one can start by
continuously measuring the line voltage and when the
magnitude of the voltage equals to that at point x, an
output pulse may be made to trigger the contactor. The
disadvantage of this system is that a particular magnitude
appears four times on a complete cycle (as seen in fig 3.2,
+x,+y and -x,-y). To differetiate between these four points,

additional circuits may have to be incorporated.

Another disadvantage of this system is that the position of the point a is function of the line voltage.Thus with variation in line voltage,the position shifts as in fig 3.3.

The second method of fixing the point x is by timing the duration t , from the instant the waveform crosses the zero towards its positive excursion fig 3.4.This is done by starting a timer at the 0 degree point and setting it in such a way that it produces an output at the end of delta t seconds. This output inturn can be made to start the switching circuit.

It is important to note that any change in the amplitude of the wave does not affect the position of the point (provided the timing remains unaltered). This is a major advantage over the other system because it is often impossible to maintain a constant line voltage over a resonable period of time.

The project carried out adopts the latter method of fixing the selected point on the wave.

3.1 BASIC BLOCKS OF POINT - ON - WAVE - SELECTOR SYSTEM :

The project out lined above consists of the following blocks,

     (1)   Squarer

     (2)   Marker

     (3)   NAND gate

     (4)   Monostable multivibrator

     (5)   RC Network

     (6)   Level detector

     (7)   Trigger amplifier

     (8)   Thyristor

     (9)   Contactor

The block diagram is shown in fig. 3.5

The method of selecting a particular point can be done with the help of a thyristor circuit as it produces a good switching response. For this a suitable firing circuit with the details outlined as in the block diagram as in fig3.5 can be made.

Hence we have to time the duration from the instant the waveform crosses the zero towards its positive excursion. For this we are squaring the waveform and then using a marker stage and monostable multivibrator before the timer circuit.

We are also using a NAND gate for resetting purpose. The different block diagrams are outlined as below.

SUPPLY :

The supply is suitably tapped as a sample from the same power source which supplies the circuit breaker. This is stepped down to the desired value of 15V using a stepdown transformer which is then converted into D.C using a bridge rectifier before it is filtered and used as the supply for the components. A sample of the line waveform is also derived from an auxillary winding which is used for converting into a squarewave of constant magnitude.

The sampled voltage waveform are as shown in fig3.6a

SQUARER :

The input signal which is a sample of the line waveform is converted into square waves of constant amplitude. The high points of the sample waveform corresponds to the negative half cycle and the lowpoints correspond to positive half cycle. The waveform got at this stage is as shown in fig3.6b.

As shown, the square waveform has a amplitude of 15V and corresponds to the sample waveform. This square waveform is given as an input to the marker stage.

MARKER :

This stage detects the trailing edge of square waves and at that instant produce a short rectangular pulse of 15V amplitude. This period is about 60 milliseconds. This is therefore a sharp pulse compared to the general period of

the square wave. Since the marker appear only on the trailing edges of the square wave trailing edges appear at approximately the zero degree point on the wave, this stage is known as zero degree marker. This is shown in fig3.6c.

As shown, the marker pulse waveform appears at the zero degree point on sample wave. This pulse is input to one part of NAND gate.

NAND GATE :

The NAND gate input is controlled by the reset switch. One input of the NAND gate is from the reset switch (fig3.6d) and the other is from the output of the marker [marker pulse - fig3.6c]. The output of the NAND gate is zero when both the inputs are high at 15V. But if any of the two inputs are at zero potential the output of the gate has a 15V potential (high).

The push button places one part of input to the ground level whereas the other part accepts positive pulse from marker (under normal condition). Under this condition the NAND gate output is at a high level of 15V.

The output of the NAND gate is connected to the trigger circuit of the monostable multivibrator. The monostable can be triggered only on a negative going pulse and the steady positive voltage on its input has no effect on the mono.

When the push button is pressed the NAND gate produces an output only at the instant of a marker pulse. Since it is only at this instant both inputs are at 15V potential. When the NAND gate goes from 15V to 0V the negative going pulse is fed to the mono stable. The output of the NAND gate is shown in fig3.6e.

MONOSTABLE MULTIVIBRATOR :

The monostable multivibrator is triggered by the negative edge of the NAND gate. Otherwise the monostable is in its stable state. The unstable period of the mono is about 150 milliseconds. The monostable starts the timer which remains stopped as long as the mono is in its stable state as shown in fig3.6f and resets it only after 150 milliseconds.

TIMER :

An R.C. network and a level detector forms the timer circuit. The multivibrator opens a short across the timing capacitor and this inturn starts charging through the timing resistor. The level detector produces an output pulse when the potential across the capacitor crosses the preset level. By adjusting the preset level to various values an output pulse at various instants may be obtained. The output at the

R.C. network is shown in fig3.6g and that at the level detector is shown in fig3.6h.

TRIGGER AMPLIFIER :

This stage amplifies the output of the timer output. This helps in increasing the speed of switching. The fast trigger pulse got is fed to the gate of the thyristor.

THYRISTOR AND CONTACTOR :

The trigger pulse fires the thyristor and the relay closes.The relay coil helps in closing the contactor at that instant. The thyristor firing point and the contactor closing point is shown in fig 3.6j.
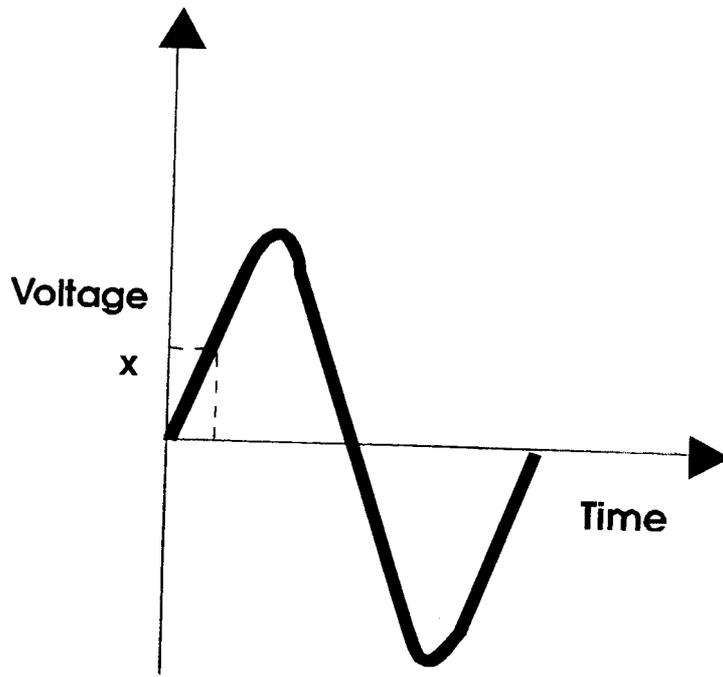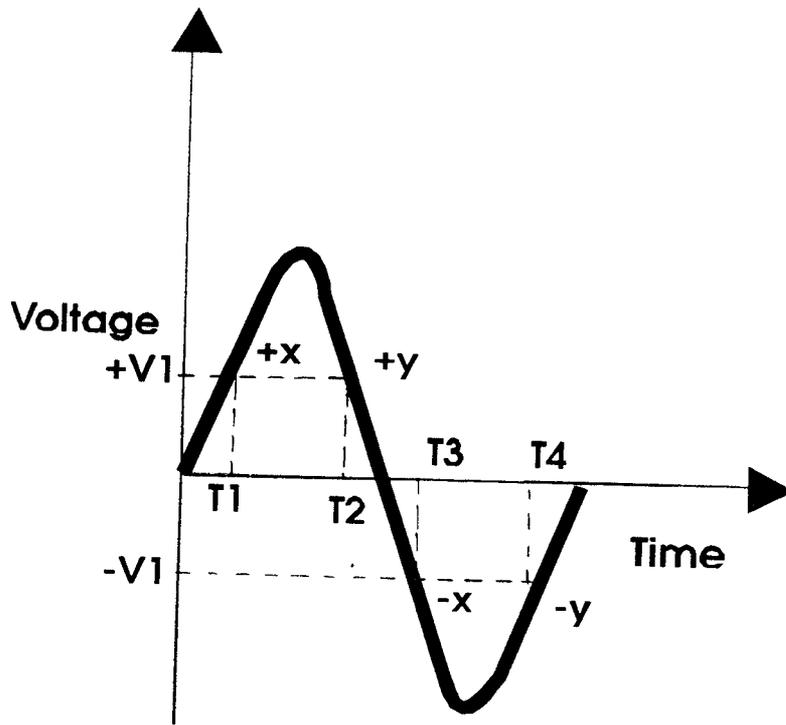
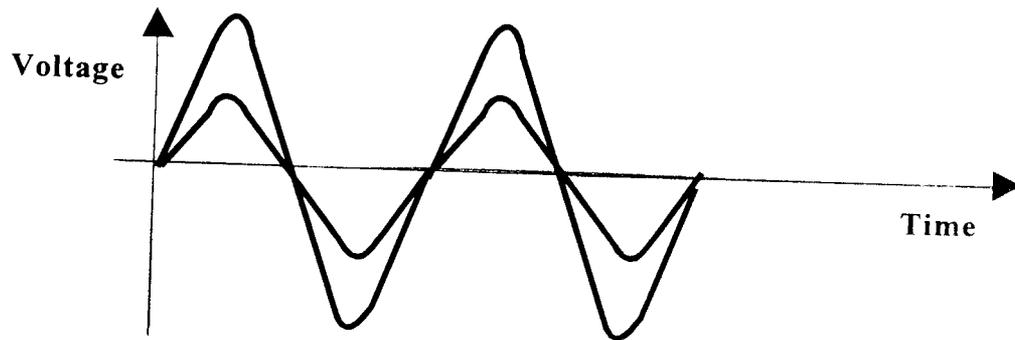**Fig 3.1**   **Voltage Wave form**

Fig 3.2   **Voltage Wave form**

Fig 3.3   **Voltage Wave form**

Fig 3.4   **Voltage Wave form**

```
                    ┌─────────────────────────┐
                    │        SQUARER          │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │      MARKER PULSE        │
                    └─────────────────────────┘
                                 │
                                 ▼
    ┌──────────┐    ┌─────────────────────────┐
    │          │    │       NAND GATE          │
    │   ─┤├─   │    └─────────────────────────┘
    └──────────┘                 │
                                 ▼
                    ┌─────────────────────────┐
                    │       MONOSTABLE         │
                    │     MULTI VIBRATOR       │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │       R.C NETWORK        │
                    └─────────────────────────┘
                                 │
        ┌────────────────────────┤
        ▼                        ▼
  ┌──────────┐    ┌─────────────────────────┐
  │   FEED   │    │     LEVEL DETECTOR       │
  │   BACK   │    └─────────────────────────┘
  └──────────┘                 │
        └───────────────────────┤
                                ▼
                    ┌─────────────────────────┐
                    │    TRIGGER AMPLIFIER     │
                    └─────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │        THYRISTOR         │
                    └─────────────────────────┘
                                 │
                                 ▼
  ● │ ● │ ●  │      ┌─────────────────────────┐
 ──────────────────│        CONTACTOR         │
  ● │ ● │ ●  │      └─────────────────────────┘
```

FIG 3.5   BLOCK DIAGRAM

Voltage

A

Time

B

C

D

E

F

G

H

I

J

THYRISTOR
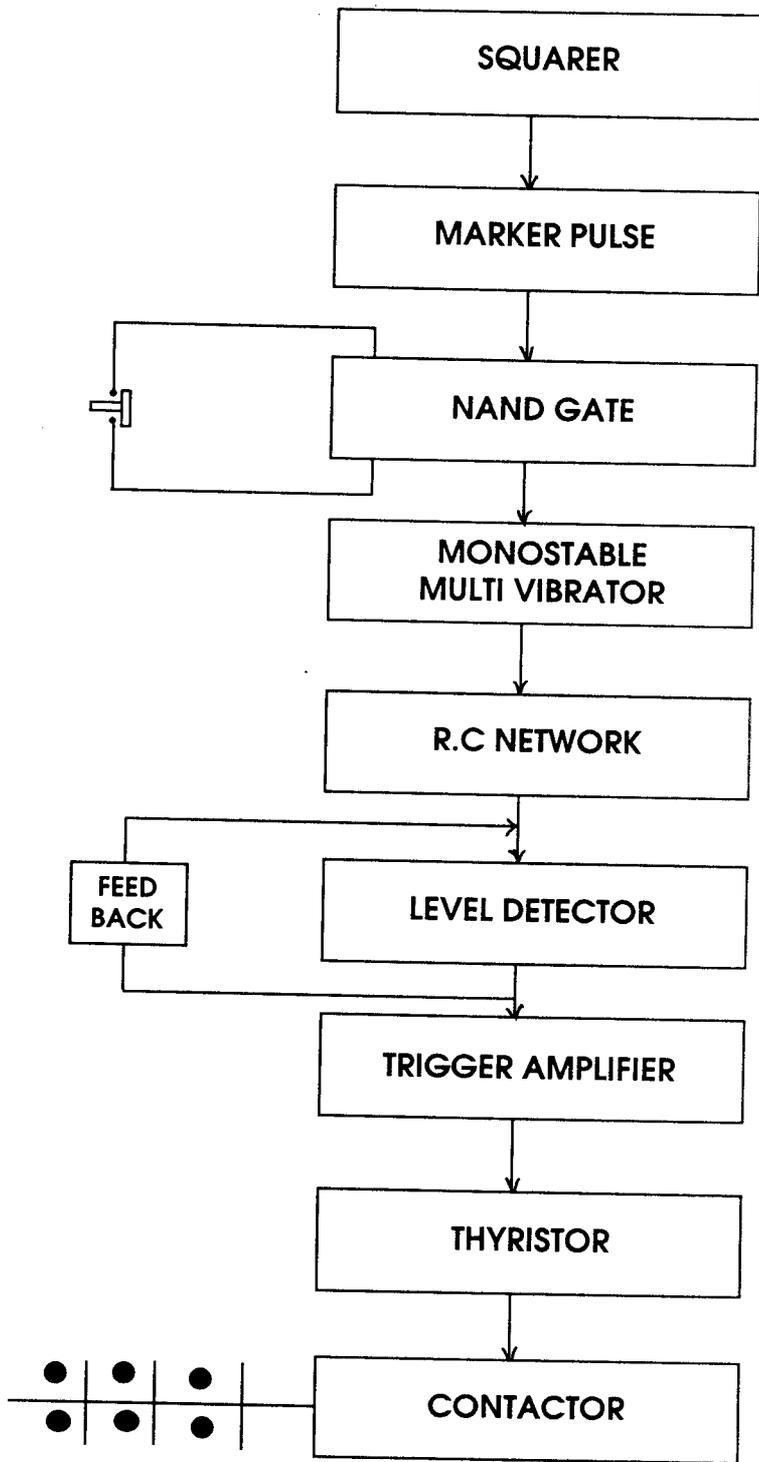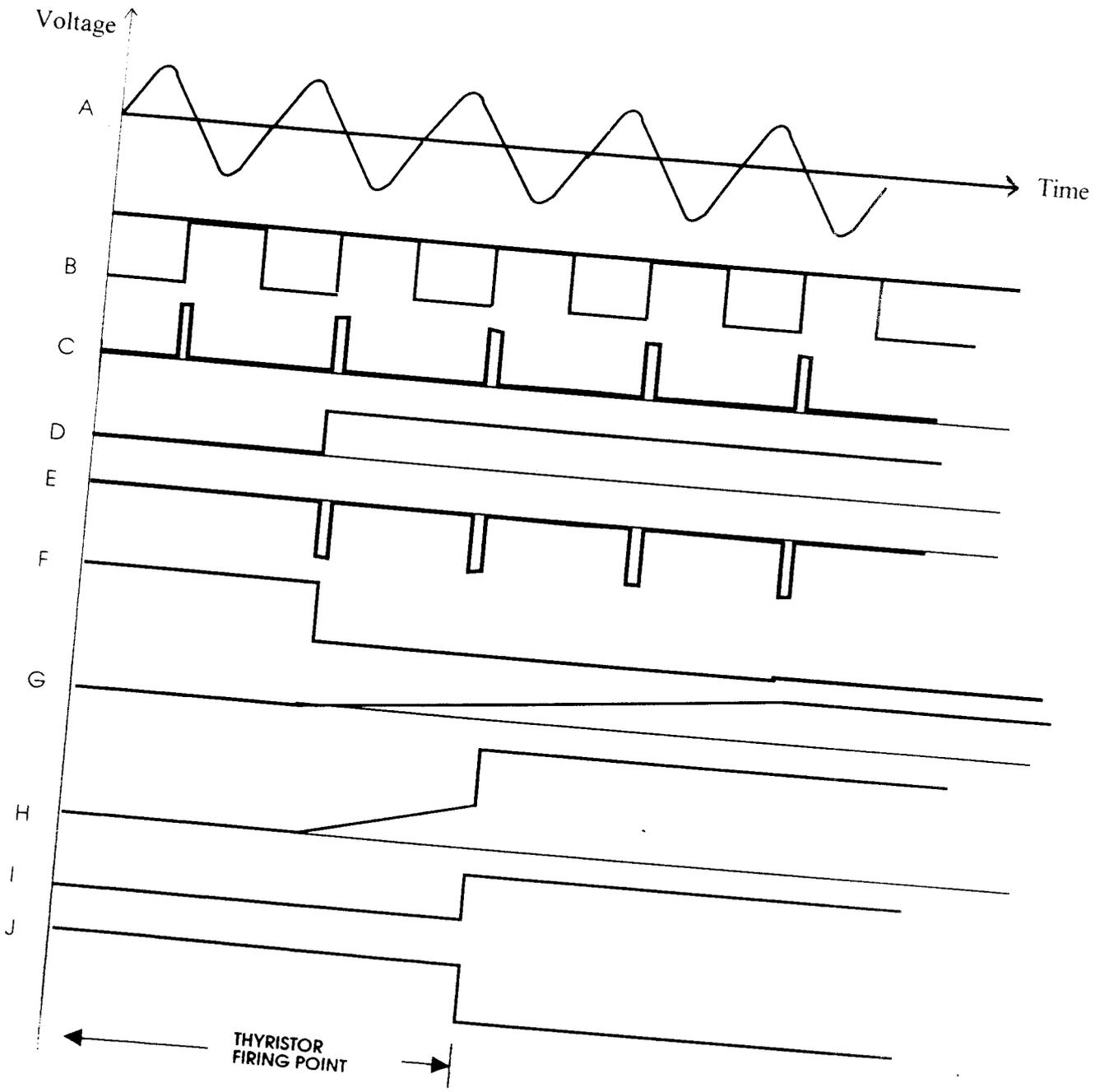FIRING POINT
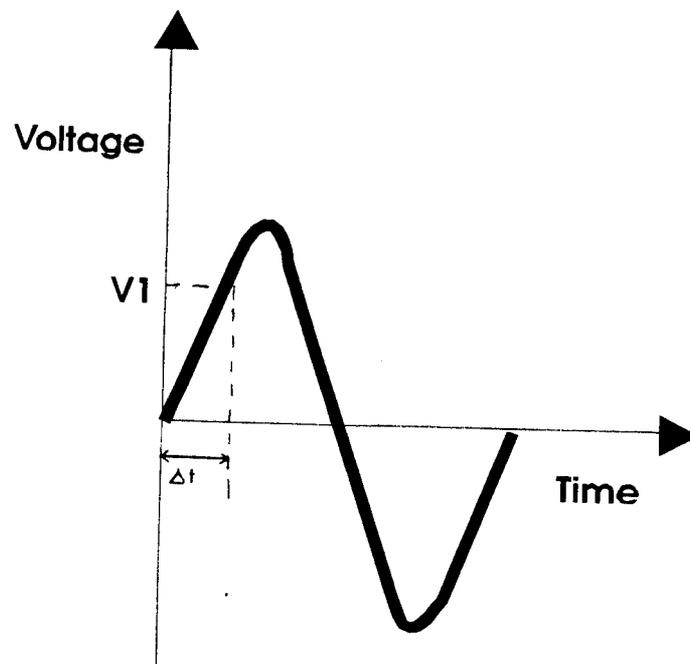
SIGNAL FLOW DIAGRAM

FIG 3.6

CHAPTER IV

CONSTRUCTION AND TESTING

4.1 CIRCUIT DETAILS

In this chapter the circuit details of different stages in the development of the device have been discussed.

SQUARER

A sample of the line waveform derived from winding 1 of the transformer T is fed through R4 to the base of TRI as seen in fig4.1. The positive portion of the waveform derives base current through the diode D3. TRI conducts to saturation on positive half cycle and switches 'OFF' during the negative half cycle. The purpose of diode D3 is to limit the reverse base emitter voltage to a low value in order to prevent junction breakdown R4 limits the current drive of the transformer. The output of TR1 can be monitered at

point E. This is also the input to the marker pulse stage. This waveform is shown in fig4.3b.

MARKER :

Referring to fig4.1 the circuit of the marker stage is expressed below. The transistor TR2 is under saturated condition due to continuous base current through R6. Thus the potential at point P would be at ground potential. Consider the moment when the point E is at 15V. Then the coupling capacitor C3 has a positive charge of approximately 15V with R6 end 0 and E, negative at the instant E goes to zero. (The trailing edge of square wave) C3 starts charging in this reverse direction through R6 (ie) the junction of R6 C3 starts going from -15v to +15v. This drives TR2 'OFF' for the period during which R6 C3 junction crosses the cut-in voltage of TR2. This period is about 60ms. This is therefore a sharp pulse compared to the general period of the square

wave. Since the markers appear only on the trailing edges of the squarewave trailing edges appears at approximately the zero degree point on wave this stage is known as zero degree markers. The output of this stage is input to one part of the NAND gate. The output from the marker stage is as shown in fig4.3c.

NAND GATE :

In the NAND gate stage the start push button grounds D5, R8 junction and places R9 to approximately ground potential. Under this condition TR3 stays at cut-off and point H has a potential of 15V. The point F and D4 is at ground potential for the major portion of the cycle but goes to 15V at the appearence of a marker. Unless both points F and G are raised above zero TR3 will conduct. When the push button is pressed, point G goes up to 15V and the circuit responds only at the next marker pulse. (It is to be noted

that time delay between the successive marker pulses is only

20 milli seconds and hence the time delay between pressing

the button and a response from the NAND gate cannot be

perceived physically). At this instant point H goes low

delivering an output pulse. The input through the push

button to the NAND gate is shown in fig4.3d. The output at

point H is shown in fig4.3e.

MONOSTABLE MULTIVIBRATOR :

This is a standard monostable multivibrator. The

differentiating network using C4, R11 and D6 is used to

shape the trigger pulse. Under stable conditions TR4 is in

saturated condition with TR5 OFF. When the point H goes down

to zero under the influence of the NAND gate output C4

discharges through D6 switching 'OFF' TR4 and switches TR5

to conduction through R14 (TR4 goes 'OFF' at the incoming

pulse momentarily only but it is kept 'OFF' till C6 obtains

the out in voltage at its point J end). With TR5 conducting

TR6 is drives 'OFF' and the short circuit across C7 is

lifted. Once the timing cycle of the mono has beem completed

C7 is once again grounded (ie after about 150 milliseconds).

The waveform at the output of the monostable multivibrator

is given in fig4.3f.

TIMER :

The timer used here workes with an R.C network and

level detector. R16 and TR6 form the coupling network

between the mono and timer and its function has been

explained in the previous stage. The emitter voltage of TR7

is fixed by the potentiometer and hence for TR7 to conduct

its base potential must cross the short emitter potential.

The instant TR6 opens the short across C7 it starts charging

through R17 and when the potential across C7 rises above

cut-in voltage of TR7 it conducts. The time delay can be

varied by varying the level of the emitter voltage of TR7.

TRIGGER AMPLIFIER :

This consists of a feed back network R22, D7 and amplifier components R21, R23 and TR8. During the period TR7 is 'OFF' TR8 is 'OFF' and point P is at zero potential when TR7 goes to conduction TR8 follows to conduct and P goes positive. The resistor and diode R22 and D7 inject positive current to the base of TR7 and drives TR7 to complete saturation. This regeneration is necessary to increase the speed of switching and P almost instantly goes to +15V. This fast trigger pulse is fed to the gate. This is shown in waveform in fig4.3i.

THYRISTOR AND CONTACTOR :

In the circuit shown fig4.1, R24 and D8 provide a link to the gate current from point P. The relay operates once the tyristor gives Auxiliary heavy duty contacts may be added to the spare contact on the relay.

4.2 ANALYSIS OF CIRCUIT DESIGN :

For the purpose of calculations it has been assumed that a saturated transistor has a collector and base voltage equal to its emitter voltage. It is also assumed that a forward liased diode has negligible voltage across it.

Selected data of the semi-conductors are included at the end of this report. See as appendix.

The on state current has been fixed as 1.5mA. Therefore the value of R5 becomes 15/1.5 = 10K. The D.C current gain at saturation is 10 for the transistors used. Therefore the base current should be atleeat 1.5/10 = 0.15mA at the smallest voltage across the base and emitter. It is assumed that the voltage is about 0.8V. Since the base emitter itself would require 0.8V drop across it, the total voltage at driving source would be 1.6V and therefore the value of R4 = $1.6/0.15*10^{-3}$= 10.6K approximately. Hence 12K

resistor is used as R4.

The marker pulse width is about 60milliseconds. It depends on the values capacitor and resistor R6 and C3. R6 is fixed as 100K to drive 0.15mA in TR2 base. TR2 collector current is 1.5mA as for TR1. Therefore the value of C2 is calculated as $C2=60x10^{-6}/100x10^{3}x07.x10^{-6}$. The nearest practical value is about 100PF. The NAND gate has 10K as load and 100K as base load.

The monostable multivibrator was designed with stability in mind. The stability was to be high and was not expected to operate or charge state for short transients in the power lines or under pick up conditions from stray field. The collector current is assumed to take a high value as 10mA. The corresponding base resistor comes to 15K but due to high collector currents this has been brought down to 10K. The period of unstable state is not critical and this period can be approximately calculated as below.

$$t = 0.7 * C * R$$

$$= 0.7 * 25 * 10^{-6} * 10 * 10^3$$

$$= 175 \text{ ms.}$$

Capacitor C5 is provided to delay the charge state. It was fixed experimentally. The base of TR6 is connected through R16 which drives about 15/100+1.5 = 0.15mA (Approx)

The time constant of the timer is about $0.7*C*R = 0.7*56*2.2*10^6*10^3 = 84$ milliseconds. The first cycle is missed, the available time duration is 64milliseconds. Only the next 20milliseconds duration is necessary to operate at any point. Therefore the charge on the capacitor need not be run upto the maximum voltage. The analysis of the voltage levels can be theoretically calculated by the charge equation written below :

$$V = E [1 - e^{-t/RC}]$$

Where,

V = Voltage across capacitor

E = Applied voltage

The voltage level that the emitter of TR7 should reverse can now be calculated. After skipping the first cycle, the voltage across the capacitor would be say Vo, at the end of the second cycle let this voltage be V1. Then the potentiometer low and high points would be Vo and V1.

Now Vo = [1 - e $(18*10^{-3}$ / $56*10^3*2.2*10^{-3})$]

Now Cr = 123 $*$ 10^{-3}

to = 18milliseconds

(20 milliseconds - 2 milliseconds for circuit delay)

(to = tp, time at the end of I cycle = 18 milliseconds.)

to / Cr = $(18*10^{-3})$ / $(123*10^{-3})$

= 18 / 123

= 0.146

$e^{-0.146}$ = 0.88

Therefore 15(1-0.88) = 1.8V

Therefore Vo = 1.8V

The end of second cycle would be often (18+20)milliseconds.

Therefore t1 = 38 milliseconds

$$t1 \ / \ Cr \ = \ (38 \times 10^{-3}) \ / \ (123 \times 10^{-3})$$

$$= \ 0.309$$

$$e^{-0.309} \ = \ 0.734$$

Therefore V1 = 15(1-0.734)

V1 = 4V.

For proper coverage of the band of voltage change on the centre leg of the pot must be 1.8 volts to 4 volts; a little over lapping on either side of the voltage band would be better.

The range decided would be 1.5 to 4.2 . The quiesent current of the resister chain R19, P1 and R20 is decided as 5mA.

For proper stability at the pot low point the emitter must be at 1.5 volts. Therefore the low resistance is equal to $1.5/5*10^{-3}$ = 300 ohms(approx). The high point should be 4.2volts.

Total resistance = $4.2/5*10^{-3}$ = 840 ohms.

Therefore the pot should be about 840-330 = 500(approx) Since the total resistance change is 15/5 = 3kohms.The remaining value of R19 = 2.2.kohm.

Little trimming at the time of testing is necessary to obtain proper calibration spacing and centering.

The design of TR8 circuit is standard with 1K as base resistors and 1.5K as collector load. Any convenient value of R22 as long as it is for less than 56 is suitable. The source resistor to the thyrister gate current is 1.5 (Assume shorted TR8).

Assume a total drop of 1.6 volts across D8 and thyristar gate.

The gate current = $(1.5-1.6)/(1.5 \times 10^3)$ = 0.008 Amps.

Since the maximum gate current is 15mA, this is within specification.

POWER SUPPLY :

The transformer T in addition to providing the sample wave also provides the necessary power for operating system. Diodes D1, D2, D3 and D4 acts as a full wave bridge rectifier system with R2 and C2 as an R.C. Filter. R3 provides the necessary resistor along with R2 to act as a battery for the stabilizer Zener diode ZD1. The load of relay is about 30mA, the circuits about 20mA. The Zener current is about 100mA. Thus the total current would be more or less 150mA. R1 and C1 acts as spike suppressors in the event of high transient voltages appearing on the power

lines. The A.C. RMS voltage is about 24 volts and most of

the drop is across R2 and R3.

4.3 PCB DESIGN :

The PCB diagram has been drawn as shown in the fig 5.1.

The eatching has been done on the copper clad sheet, and the

components has been mounted on it.

4.4 CABINET DESIGN :

To select a suitable point on the voltage wave form,

the circuit explained above has been incorporated. The

cabinet has been designed such that the PCB and the

transformer are mounted inside, and the accessories, the

reset switch ON-OFF switch, fuse, voltmeter and the

calibrating pot has to be fixed in the front of the cabinet

such that they can be accessed easily.

An isometric design of the cabinet is drawn first. It should show the front panel and controls then a development drawing is drawn for the given size. The drawing is shown in fig 4.4. A cabinet should have easy accessability for the service.

4.5 OPERATING PROCEDURE :

The PCB, transformer and other accessories have been mounted on the cabinet.

First the supply is switched ON, and then the pot is rotated to select the desined point on the voltage waveform. This can be seen by connecting a CRO at the point which is brought out of the cabinet through the sockets at the bottom of cabinet. And when the thyristor goes into conduction the connected relay operates which is shown by the glow of a bulb. One reset switch when pressed resets the thyristor firing angle and the other one resets the relay. Thus the testing is performed.
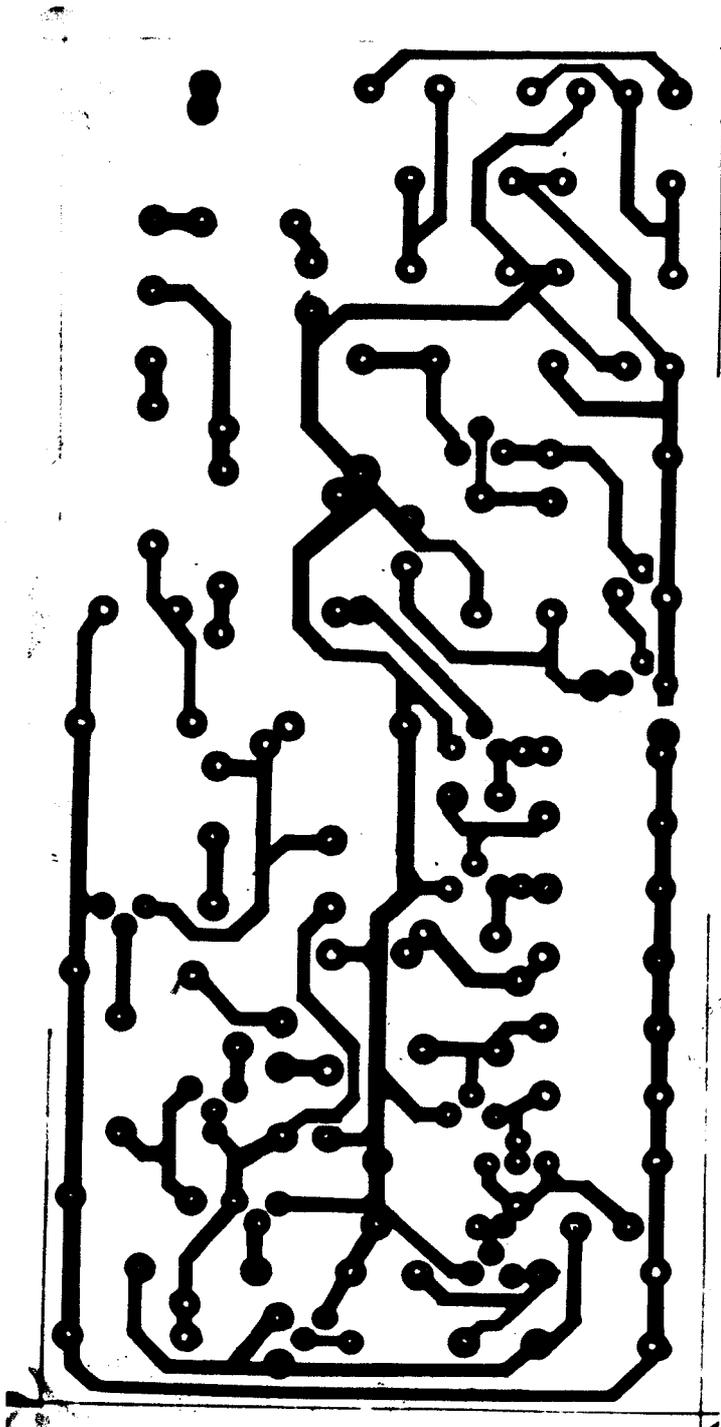
FIG 4.2. PCB LAYOUT
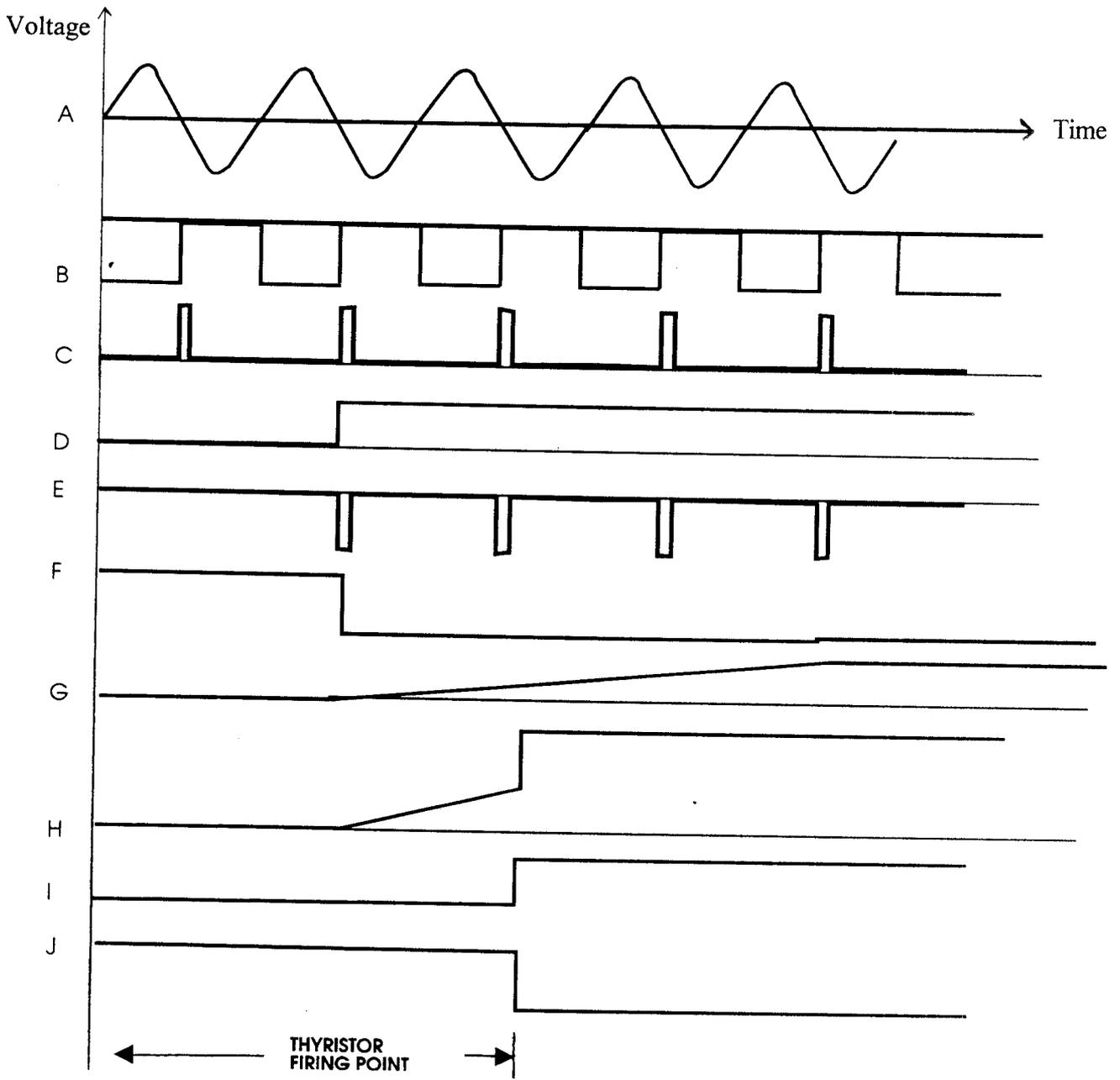
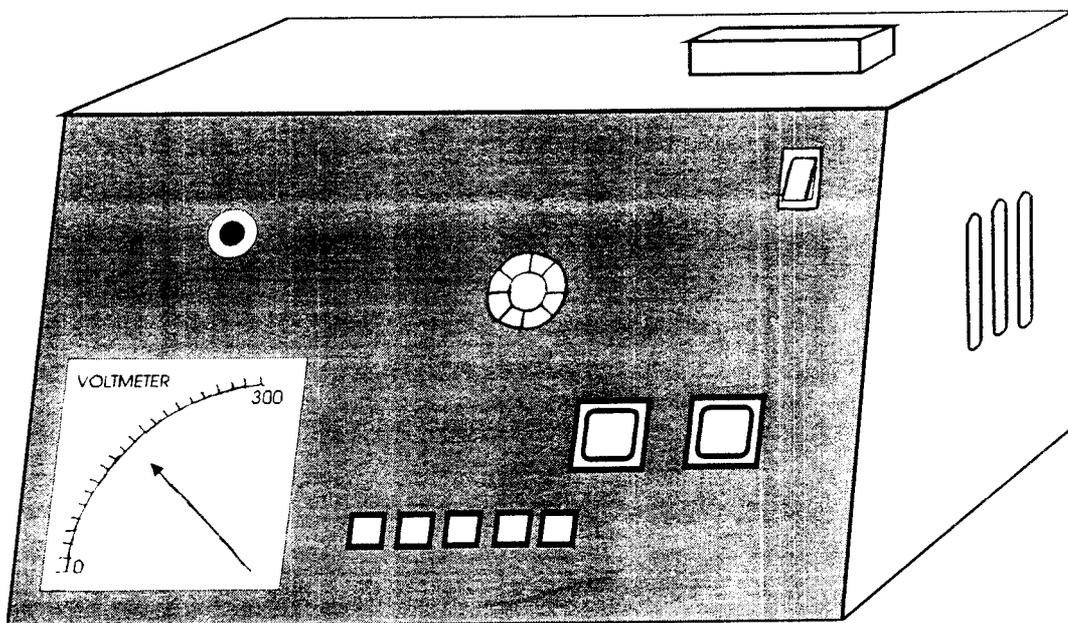SIGNAL FLOW DIAGRAM

FIG 4.3

Fig 4.4   CABINET DIAGRAM

CHAPTER V

CONCLUSION

In this project a device has been constructed that is cheap and elegant in operation to be used as an important auxillary to circuit breakes testing which is very important in successful operation of power systems.

Selecting precisely a point on the voltage wave when the circuit breaker is to be opened or closed for testing purposes has been a need felt by testing labs and factories as this has become a stipulation by ISI.

An electronic circuit designed in stages to achieve this has been constructed. The cost of the unit comes to Rs.1500/. Because of its importance and demand it can become very expensive in future.

The output is tested with the help of a relay. It has been stored in a storage oscilloscope for providing its effectiveness.

In this project the precision of getting the desired point-on-the-wave is checked by a relay operation. However when used to actuate a relay to operate a circuit breaker then the time of delay due to the operating time of circuit breaker is to be taken into account. A corresponding calibration can be done to relate the point on the curve and the opening or closing time of circuit breaker using POT.

The authors feel that the whole arrangement can be digitally simulated using personal computer system and with suitable interface it can be used to get the point on the curve to operate the relay.

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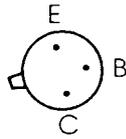9. P.C.SEN, " Power Electronics ", Tata McGraw Hill publishing company Ltd, New Delhi, 1981.

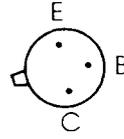# APPENDIX

Pin Diagram of Diode IN 4007

C ▭ A
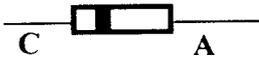
C - Cathode
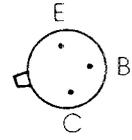A - Anode

Pin Diagram of Thyristor BC 107

E - Emitter
B - Base
C - Collector

Pin Diagram of Thyristor BC 177

E - Emitter
B - Base
C - Collector

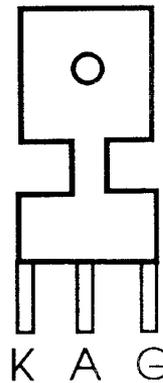**Pin Diagram of Thyristor 2N657**

E - Emitter
B - Base
C - Collector

SCR
NEC 2P4M

Vroff	If	Vf	dv/dt	Max temp. Junction
400	2	2.2	10	110

Gate (Vsc)

A	V	Ih	Ioff
200m	800m	3m	100m

Pin Diagram of NEC 2P4M

K   A   G

K - Cathode
A - Anode
G - Gate

Nippan Electrical Co. Ltd
1753, Shimonumake, Nakahairala
Kauasaki City, Japan