AUTOMATIC DIESEL GENERATOR STARTING AND CHANGEOVER

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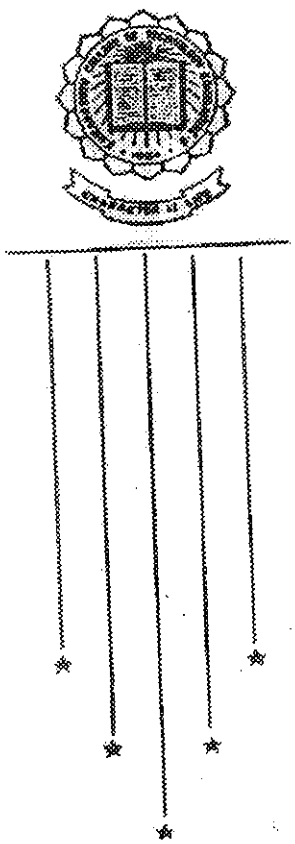

1998 - 99

PROJECT REPORT.

Submitted By

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Sponsored By

TAMILNADU STATE COUNCIL FOR SCIENCE AND TECHNOLOGY (TNSCST)

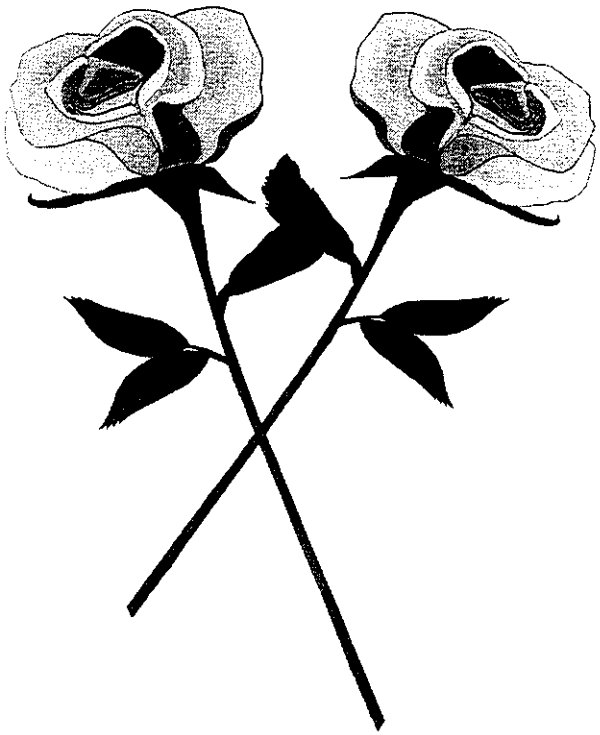
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

BACHELOR OF ENGINEERING IN ELECTRICAL & ELECTRONICS ENGINEERING BRANCH

OF THE BHARATHIAR UNIVERSITY.

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY



Certificate

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE - 641 006.

CERTIFICATE P-338

This is to certify that the Project entitled

AUTOMATIC DIESEL GENERATOR STARTING AND CHANGEOVER.

has been submitted by

Mr. G.Vijaya Vasanthan	95EEE55.
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In partial fulfilment of the requirements for the award of degree of Bachelor of Engineering in the Electrical & Electronics Engineering branch of the Bharathiar University, Coimbatore - 641 046 during the academic year 1998-99.

.....
Guide

Date : 17/3/99.

.....
Professor and Head

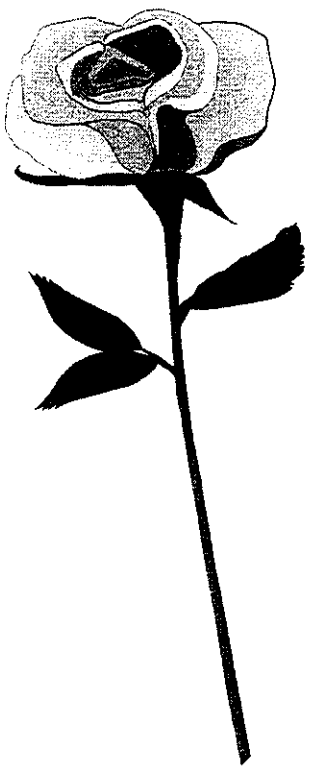
PROFESSOR & HEAD
Dept. of Electrical & Electronics Engg
Kumaraguru College of Tech., Coimbatore

Certified that the candidate with University Register No. .....
was examined in project work Viva-Voce Examination held on .....

.....
Internal Examiner

.....
External Examiner

Dedicated to Our Beloved Parents



Acknowledgement

ACKNOWLEDGEMENT

We are greatly indebted to our guide Mrs. Rani Thottungal, M.A., M.E., M.I.S.T.E., Lecturer, Electrical and Electronics Department, who has been a source of encouragement with her valuable suggestions and timely advices during the execution of this project work.

We are greatly thankful and grateful to Dr. K.A. Palaniswamy, B.E., M.Sc. (Engg.),Ph.D., M.I.S.T.E., C.Eng.(I), F.I.E., Professor and Head of the Department of Electrical and Electronics Engineering, for his constant encouragement and facility provided to do the project work without any difficulty.

SYNOPSIS

This project deals with the development of an Automatic diesel Generator starter and a standby changeover system which can be used for a wide range of applications.

Many industries and hospitals today use a manual changeover system. The generators are usually kept far away, so that noise created by the generators donot disturb the workers in the industry (or) patients in the hospital, thereby taking more time for switching on and off of the generators manually.

The circuit designed here is a simple Electro-mechanical system, which automatically starts the stand-by Diesel Generator, when EB supply fails and vice versa. It also manually changes the Load from E.B. mains to generator and vice versa, depending on

the availability of the E.B supply.

It is to be noted that this circuit doesnot disturb the Existing manual changeover system, which will be highly usefull during breakdown and maintenance.

This circuit designed can be utilised for higher capacity generators, by only replacing the appropriately rated contactors.

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Introduction

CHAPTER - 1

INTRODUCTION

Many Industries, Hospital & star hotels even today use either a manual diesel generator starting and changeover system (or) partly remote control set-up. This method has its own disadvantages like extra man-power, wastage of time and also certain hazardous implications. In locations like hospitals and other important areas, wherein immediate changeover is very very important, this system is a failure.

Inorder to overcome the above cited difficulties, this project of automatic diesel generator starting, with 3-phase mains to

stand-by changeover helps to a great extent. The circuit designed in this project is a simple electro-mechanical system and is very easy to assemble, quite compact and works reliably. Flow chart of this system is shown in Fig. 1.1 Moreover it has the distinct advantage of not disturbing the existing manual changeover system and is cost-wise cheaper with respect to the highly expensive automatic starters for diesel generator and automatic changeover, which are available in the market.

1.1 ALGORITHM FOR AUTOMATIC DIESEL GENERATOR (D.G.)STARTER AND CHANGEOVER:-

1. Start

2. Check whether the EB mains supply is present.

3. If present, transfer the load to EB mains supply.

4.Then check whether the diesel generator is ON, if so switch off the diesel generator and go to 2.

5. If EB mains supply is absent, then check whether diesel generator is on, if not start the diesel generator and transfer the load (or) else just transfer the load and go to 2.

1.2 MAJOR CIRCUITS OF THE SYSTEM :

The major circuits involved in the design of Automatic Diesel generator starter and changeover are : -

1.2.1 SENSOR:-

The sensor is used to detect the presence (or) absence of the E.B mains supply.

1.2.2 TIMING CIRCUIT:-

This is a delay circuit to avoid the diesel generator from being started for very short duration i.e., disturbances of few seconds due to E.B. changeover (or) shunting.

1.2.3 CONTROL AND CHANGEOVER CIRCUIT:-

The 3 phase E.B supply, as well as the Diesel generator supply are connected to the load bus. Much care is to be taken to ensure that both donot supply the load at the sametime. This is done by suitable control circuits.

A simple block diagram of the system is shown in the Fig.1.2

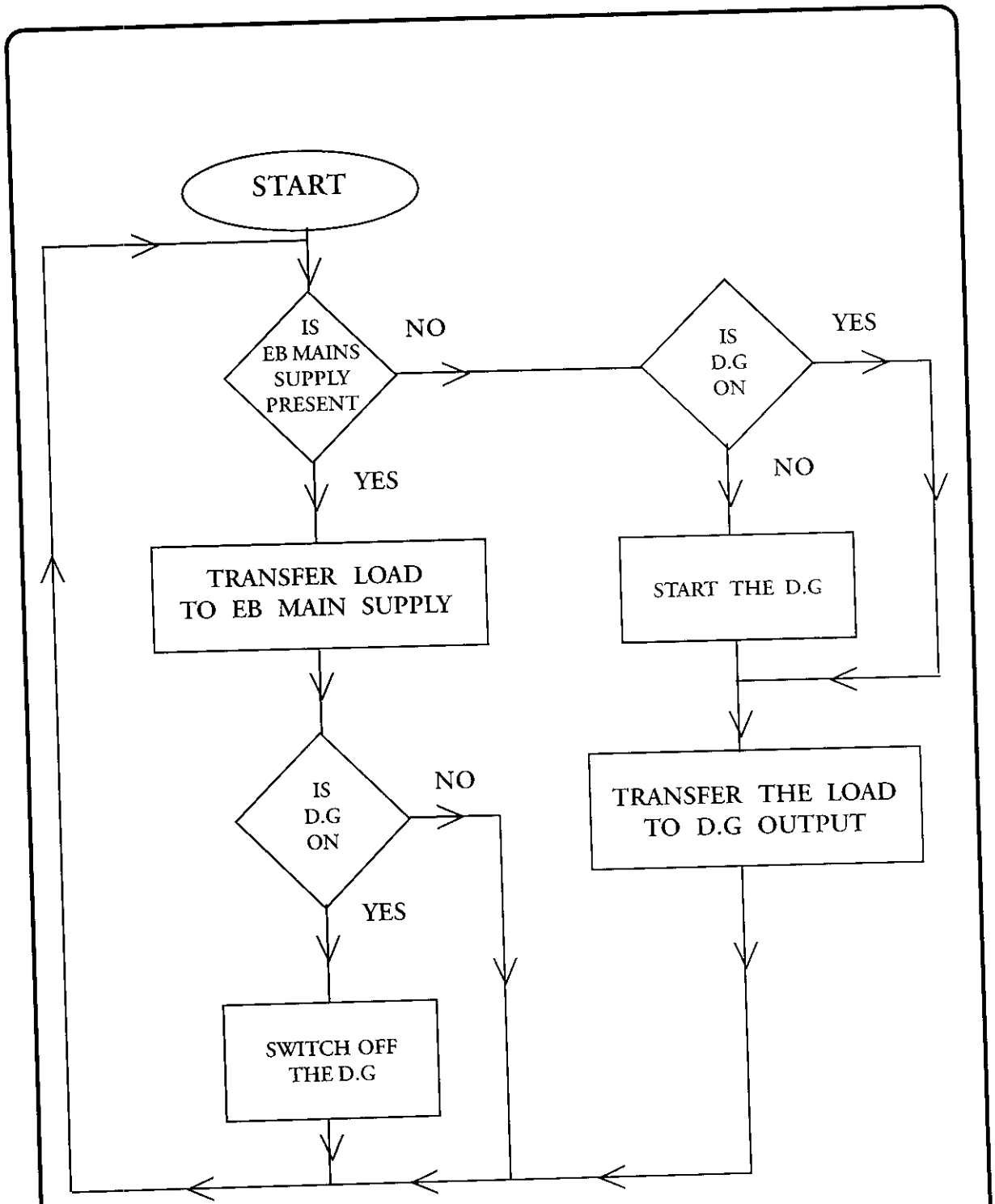


Fig. 1.1 Flow Chart of Automatic Diesel Generator (D.G) Starter & Changeover

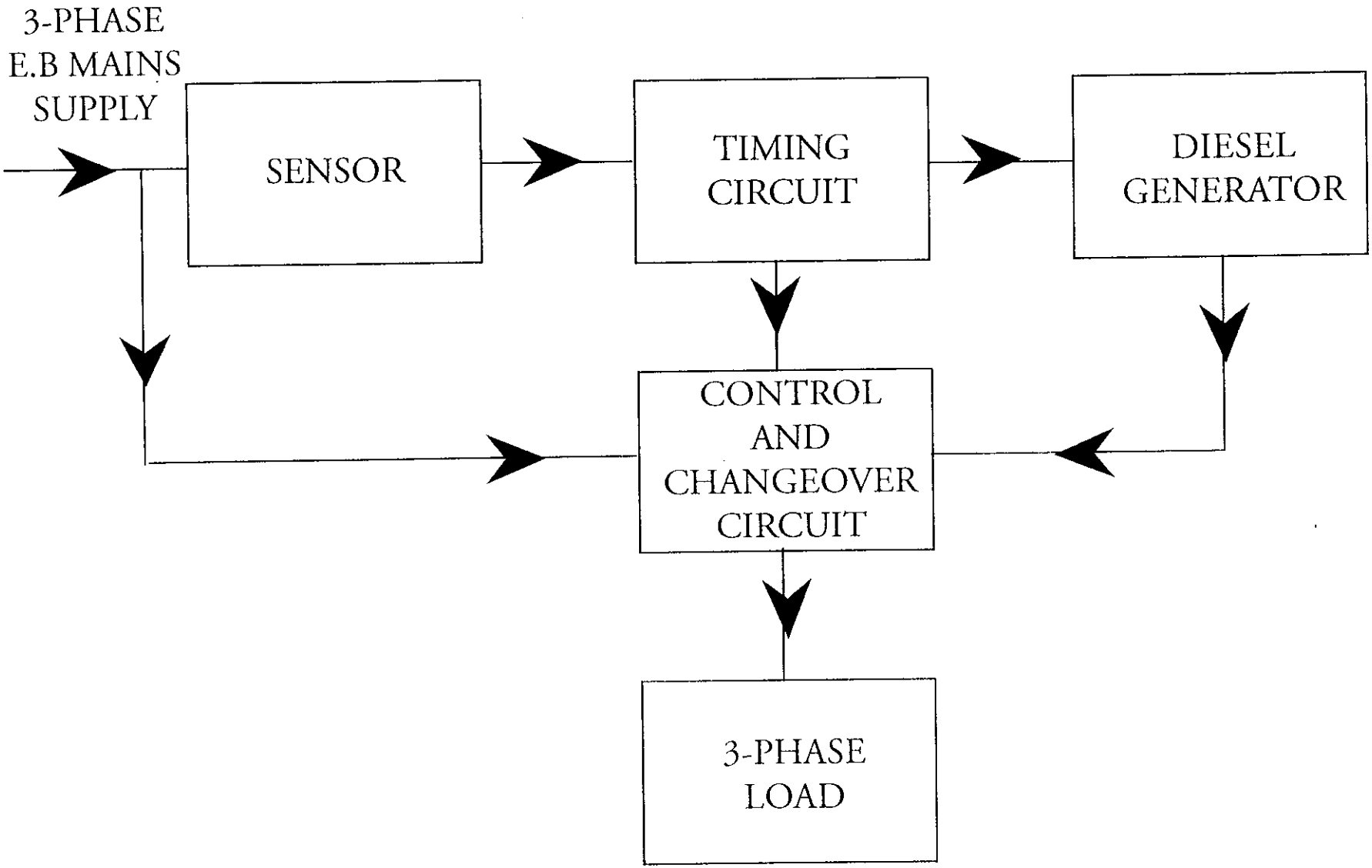
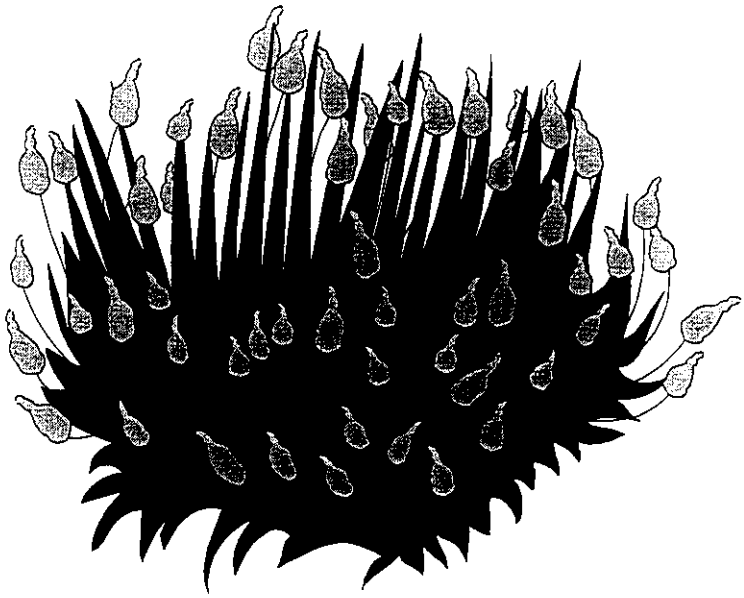


Fig. 1.2 : Block Diagram of Automatic Diesel Generator (D.G) Starter & Changeover



Design of Sensor

CHAPTER - 2

DESIGN OF SENSOR

The sensor is a device used to detect the presence or absence of E.B supply. There are various type of sensors like optical sensors, solid-state sensors, Electro-mechanical sensors etc., The sensor used in this project is Electro-mechanical sensor, because using this sensor, one relay is used as an Enabling device for the next relay and thus senses all the 3 phases.

The sensor used, is shown in Fig.2.1. It consists of 3 relays. Relays RL1, RL2, RL3 act as sensing elements for phases R,Y,B respectively Each relay functions as

an enabling device for the next relay. In this way the 3 relays form a logical AND gate electro-mechanically.

RL3 is energised when all 3 phases are present and thus the N/O (normally open) contact BB of the relay gets closed. This BB contact of relay is used in the changeover circuit. During the absence of any phase from E.B. mains, the contacts AA of RL3 are closed. This contact is used in the diesel Generator starting circuit.

2.1 WORKING OF SENSOR :-

The three phases R,Y,B are given as inputs to one end of the 230V / 6V step-down transformer. The other end of the transformers are connected to the neutral

through the relay contacts. Thus, only when the relay contacts gets closed, the neutral is connected to the transformers.

The R phase is given to the first transformer. The neutral is connected to the other end of the transformer. Thus an i/p of 230V is got at the primary of the transformer. This is stepped down to 6V at the secondary of the transformer and is given as inputs to the two diodes D1 and D2.

The Diodes acts as rectifiers. The rectified output is given to the capacitors, which acts as filters. The Diode D16 prevents chattering of the Relay contacts. Chattering is a phenomenon of opening and closing of relay contacts, due to momentary fluctuations of rectified output. When the Relay coil gets Energised, the N/O contact of the relay gets closed and thus connects the neutral to the second transformer. In a similar manner, the N/O

contacts of RL2 and RL3 gets closed and the BB contact of Relay RL3 gets closed. The closing of the BB contacts, prevents the starting of Diesel Generator, by disconnecting the battery supply to the self motor.

The design of the sensor is thus very reliable and quick. The last relay of the sensor is thus used to start the diesel generator incase of power failures.

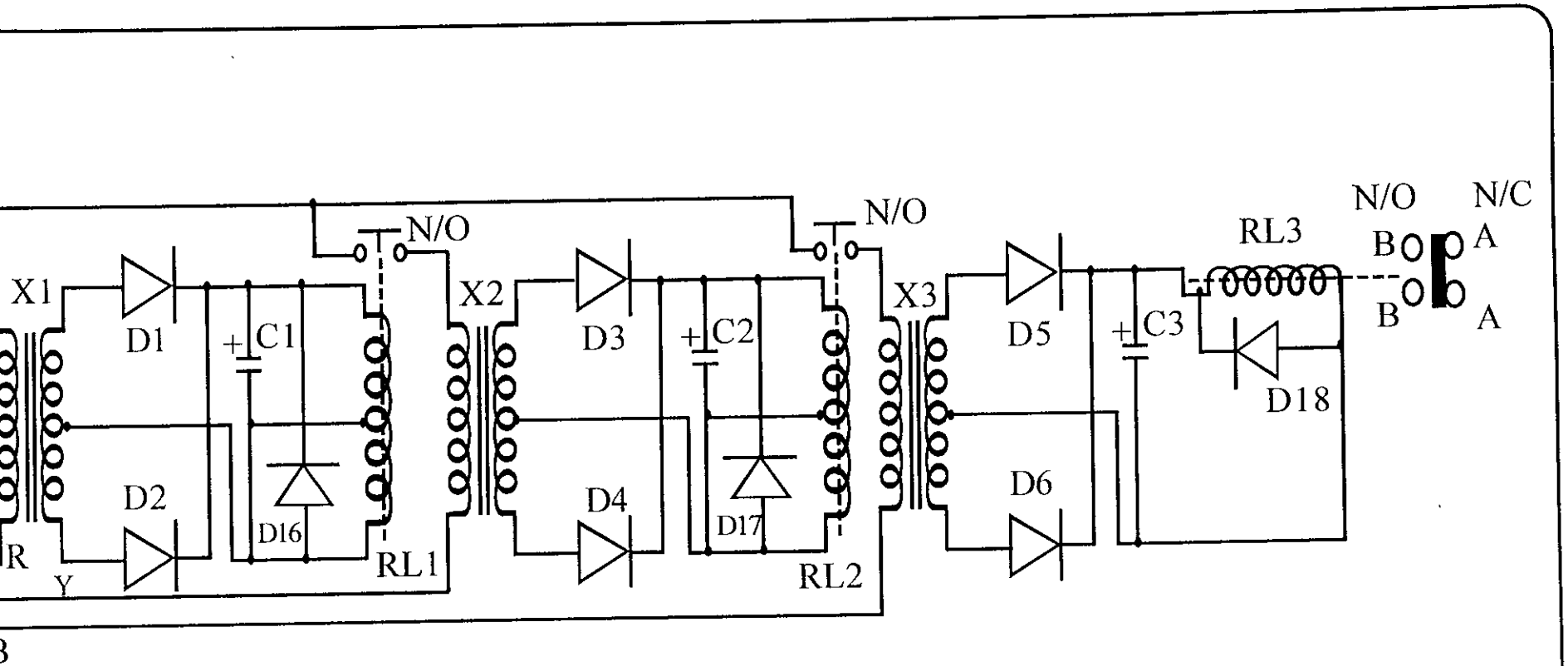
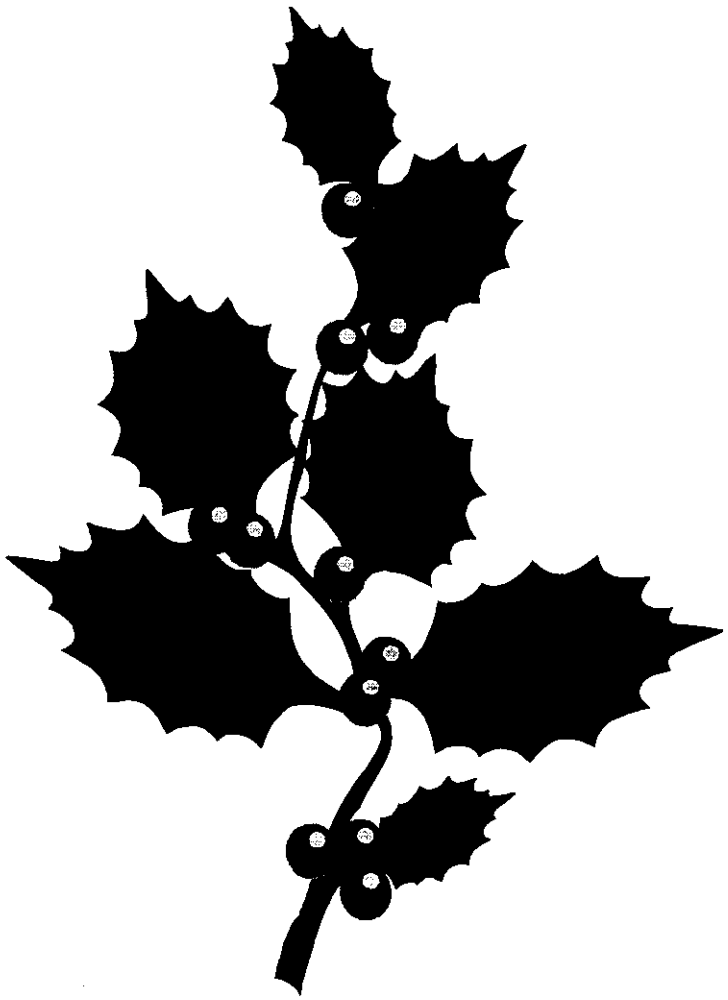


Fig. 2.1 Sensor



Design of Timing Circuit

CHAPTER -3

DESIGN OF TIMING CIRCUIT

Timing circuit is a circuit which is used to give an output, after a desired time delay. There are many types of timing circuits available. Most of them are available in IC form, which is compatible and easy to use. The timer that is used in this circuit is 555 IC timer.

The 555 timer is a highly stable device, for generating accurate time delay (or) oscillations. It can be used with a supply voltage range of +5V to +18V and can drive load upto 200mA. Because of this wide range of supply voltage, the 555 timer is versatile and easy to use in various applications. It is

compatible with both TTC and CMOS logic circuits.

The timer circuit designed, avoides the generator from responding to momentary fluctuations, of the EB mains. Fluctuation may be due to changeover at the EB substations, due to peak load shedding or peak load sharing. In these cases the supply will be off for a very short duration, during which the generator should not be started. Normally the generator is started only after a time gap of 5 seconds, after sensing the absence of EB mains supply.

When there is any failure of the EB supply, the sensor senses it. There is a battery in the circuit, which is made to connect with the self motor, through the relay RL4. This relay is controlled by the timing circuit (Fig. 3.1). The battery voltage of 24 volts is dropped across a diode to 12 volts and is given as input to the timing circuit. This 12V

volts is given as output, by the timing circuit, after a delay of 5 seconds. This output of the timing circuit, energises the relay RL4 which turns on the self motor. Thus the supply voltage to the self motor from the 24V battery, is controlled by an intermediate timing circuit. The self motor started inturn starts the diesel generator, coupled to it.

Normally a self motor is designed for low speeds. So the self motor should be disengaged from the diesel generator, once it is started. For this purpose we use a similar timer circuit, in series with timer 1(Fig.3.1). This timer is denoted as timer 5 (Fig.3.1). This is used to switch-off the self motor. The timing is adjusted, so that it switches off the self motor as soon as the generator starts. This adjustment is done using a potentiometer

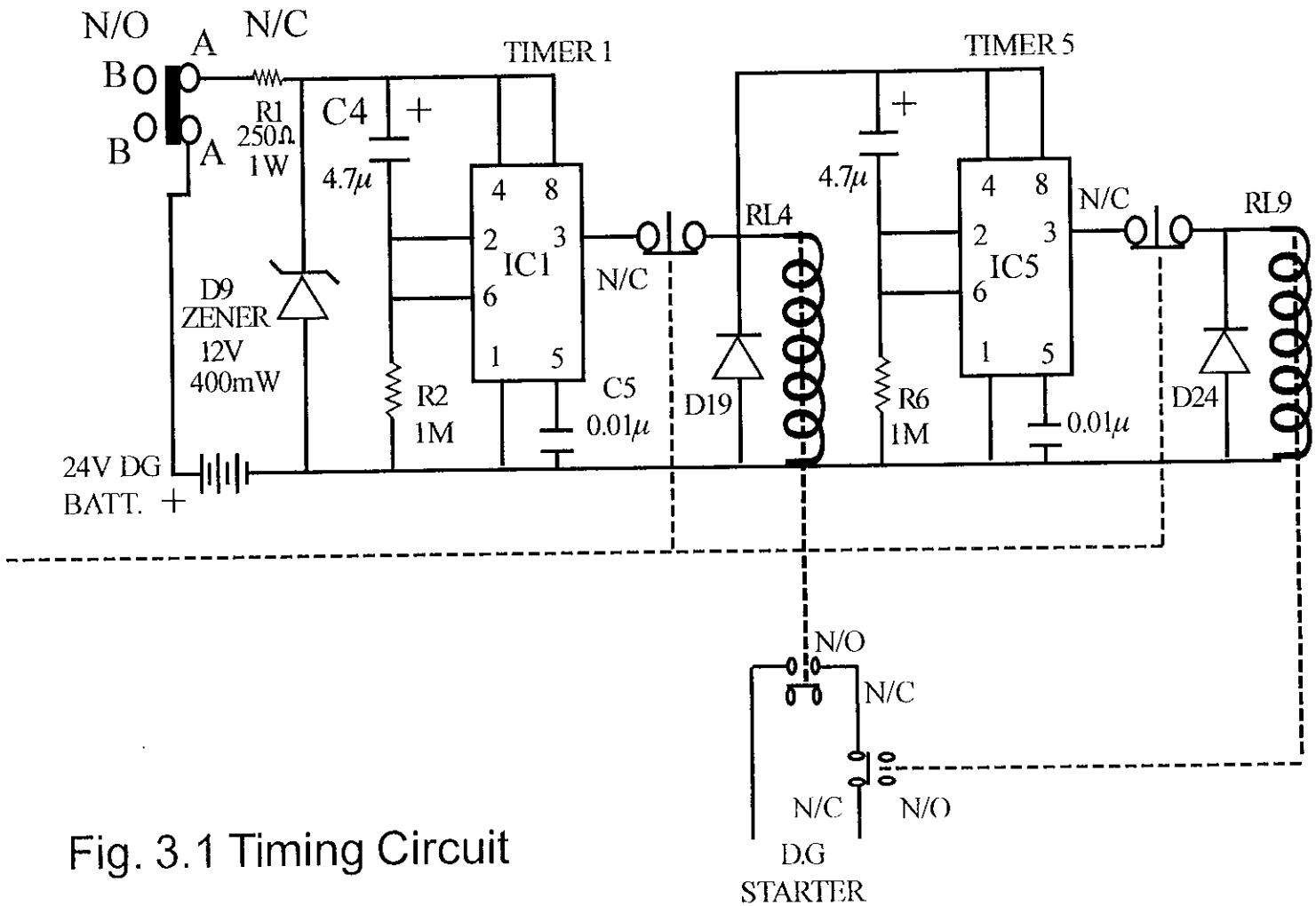


Fig. 3.1 Timing Circuit

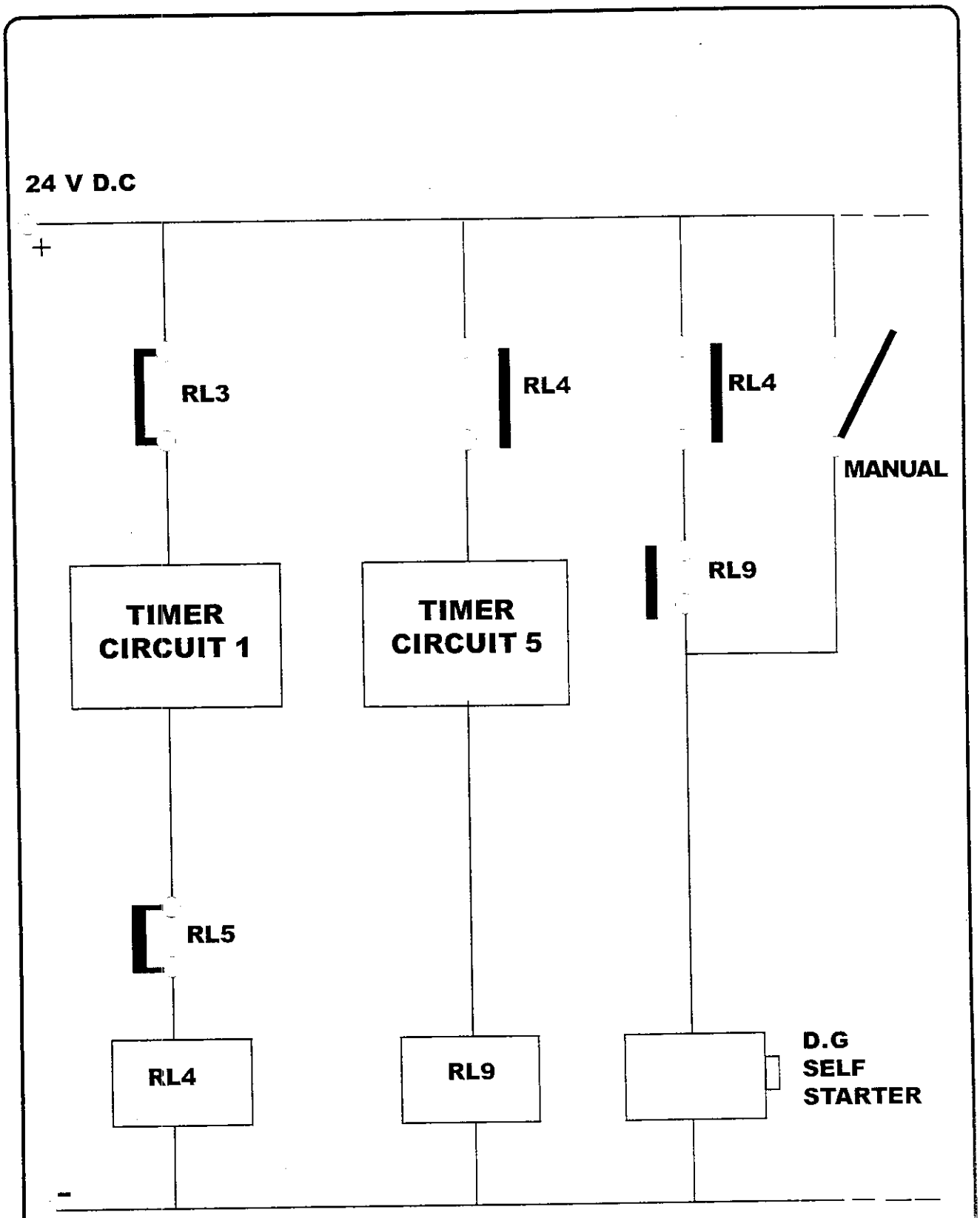
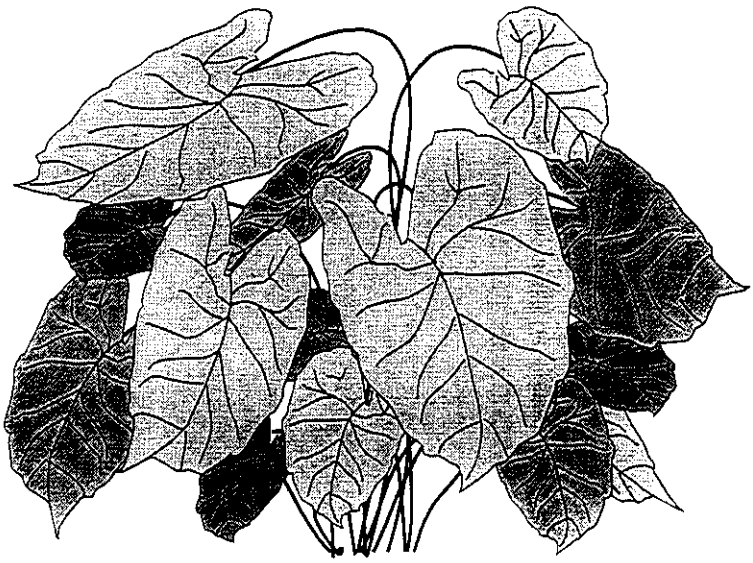


Fig. 3.2 Battery Circuit



Design of Changeover & Control Circuit

CHAPTER-4

DESIGN OF CHANGEOVER AND CONTROL CIRCUIT

Changeover is the process of transferring the load either from the EB mains supply to Diesel generator supply or the reverse process. Normally changeover from EB mains supply to Diesel generator supply is done when EB mains supply fails. The changeover from Diesel generator to EB mains supply is done when the EB mains resumes or when any maintenance work is done on the generators. Some types of changeovers used are manual changeovers, partly remote controlled changeovers, semi-automatic changeovers and automatic changeovers. The changeover system used here is automatic changeover system. The advantage of this automatic changeover system is that it uses electronic circuits to control the changeover

process. This makes the circuit very cheap compared to the changeover systems available in the market and is also very reliable.

4.1 CHANGEOVER SYSTEM :-

The design of an automatic changeover system is done with the help of two heavy duty electromagnetic contactors MS1 and MS2. These are controlled by some simple electronic circuitry.

The EB mains supply is given to the load through the magnetic contactor MS1 (Fig.4.2 & 4.3). The diesel generator supply is given to load through magnetic contactor MS2. The supply from EB and Diesel generator are normally given to a manual changeover switch. Here one end is connected to EB mains supply and the other end is connected to Diesel generator supply.The input for contactor MS1 (R,Y,B,N) is tapped from EB mains end

of the Manual changeover switch(Fig. 4.1). The input for contactor MS2 (R,Y,B,N) is tapped from Diesel generator end of Manual changeover switch. The outputs of both contactors have been paralleled and connected to common output points. This common output consisting of R,Y,B and N drives the load. Since both contactors must not supply power at the same time, Electronic circuits are used to control contactors such that, both do not supply power at the same time.

Both contactors MS1 and MS2 are identical with each other. The contactors have 4 N/O main contacts, 2 N/C auxillary contacts and 2 N/O auxillary contacts. Only one N/C auxillary contact is used from each contactor.

The system is so designed such that, the existing arrangement is not disturbed at all. This is done so because, if in case automatic changeover is not desired, then it can be by-passed by simply switching off the toggle switches TS1 and TS2.

4.2 ELECTRONIC CONTROL CIRCUIT :-

To control the contactors MS1 and MS2, electronic circuits are used (Fig. 4.2 & Fig. 4.3). For this, the circuit uses the relays RL6, RL7 and RL8. When all the three phases of E.B are present the contactor MS1 is designed to supply the load. To carry the load, the coil circuit of MS1 is closed by using relay RL6 and the XX contact of MS2. The coil circuit of MS1 will be closed only when the contactor MS2 is open. To energise MS1, both ends of coil are connected to R and Y phases respectively. This produces a voltage of 415V across coil terminals. This energises the contactor MS1.

The relay RL7 is energised through the BB contact of relay RL3. This contact BB is closed only when all the three phases of EB are present. When all the three phases are present, the contactor MS2 must be de-energised. For this purpose, RL7 controls the relay RL8, which inturn controls the coil circuit of the contactor MS2. If RL7 is

energised, then RL8 gets de-energised and therefore contactor MS2 is also de-energised. Once MS2 is de-energised, the coil circuit of MS1 is closed, hence enabling MS1 to supply the load.

In case, if the EB mains supply is absent, then RL6 gets de-energised. This inturn de-energises contactor MS1. The absence of supply from EB mains also de-energises RL7, whic closes the circuit of transformer X7. Now the diesel generator is started. The output from diesel generator is used to energise relay RL8 through transforme X7. Since, contactor MS1 is de-energised its contacts YY gets closed. These two factors, i.e., contacts YY being closed and relay RL8 being energised are required for the coil circuit of MS2 to close. Since the coil circuit of contactor MS2 gets closed, the contactor MS2 is energised. Now this contactor MS2 supplies the output.

4.3 CONDITIONS FOR CONTACTOR MS1 TO BE ENERGISED : -

*Toggle switch TS1 must be in ON position.

*Relay RL6 must be energised.

*Contactor MS2 must be in de-energised state.

*All the 3 phases of mains must be present i.e., contact BB of RL3 must be closed.

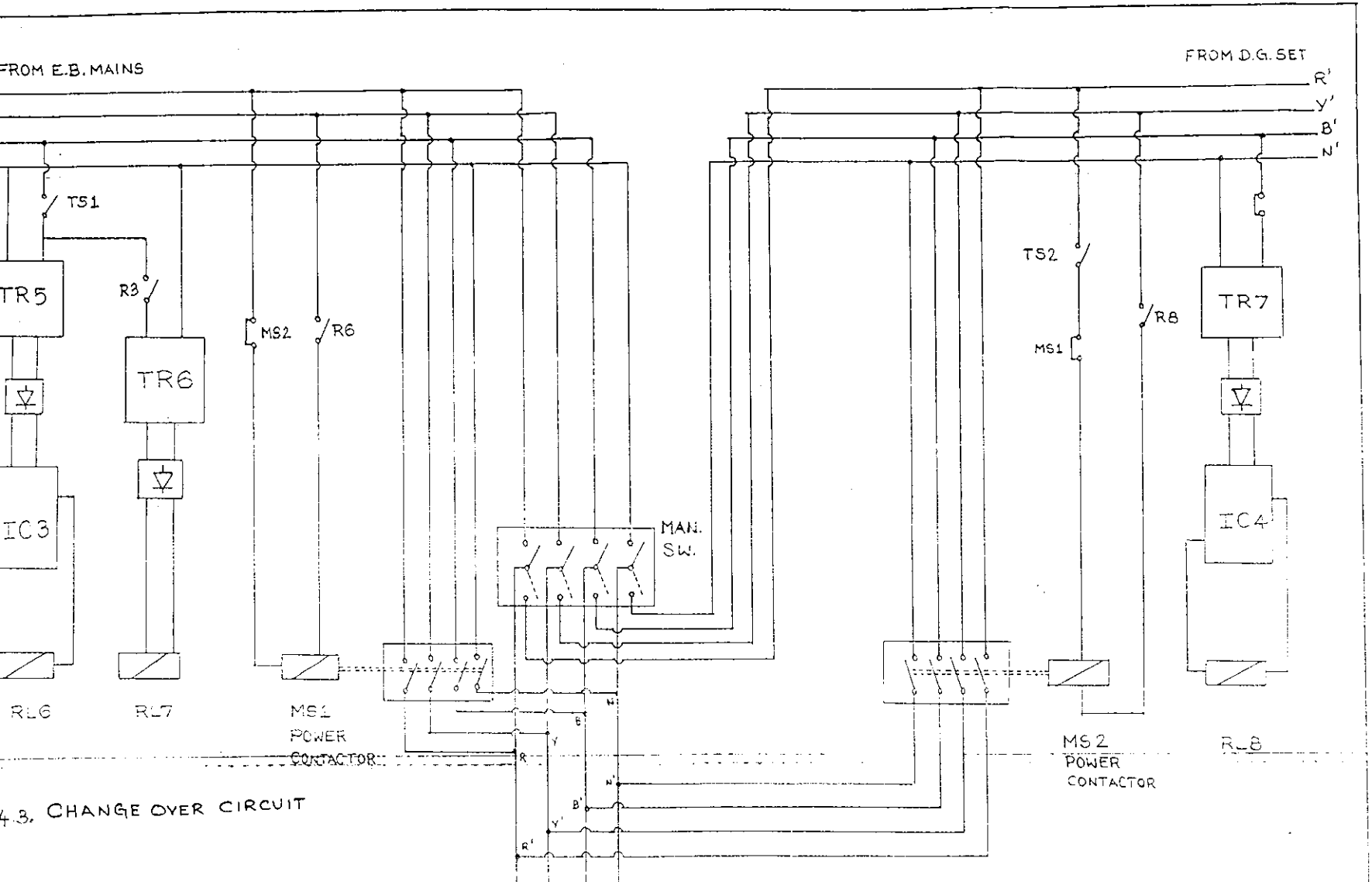
4.4 CONDITIONS OF CONTACTOR MS2 TO BE ENERGISED :-

* Toggle switch TS2 must be in ON condition.

* Atleast one of the three phases from EB mains must be absent i.e.,BB contact of relay RL3 must be open.

* Contactor MS1 must be in de-energised state.

* All three phases of D.G must be present.



4.3. CHANGE OVER CIRCUIT

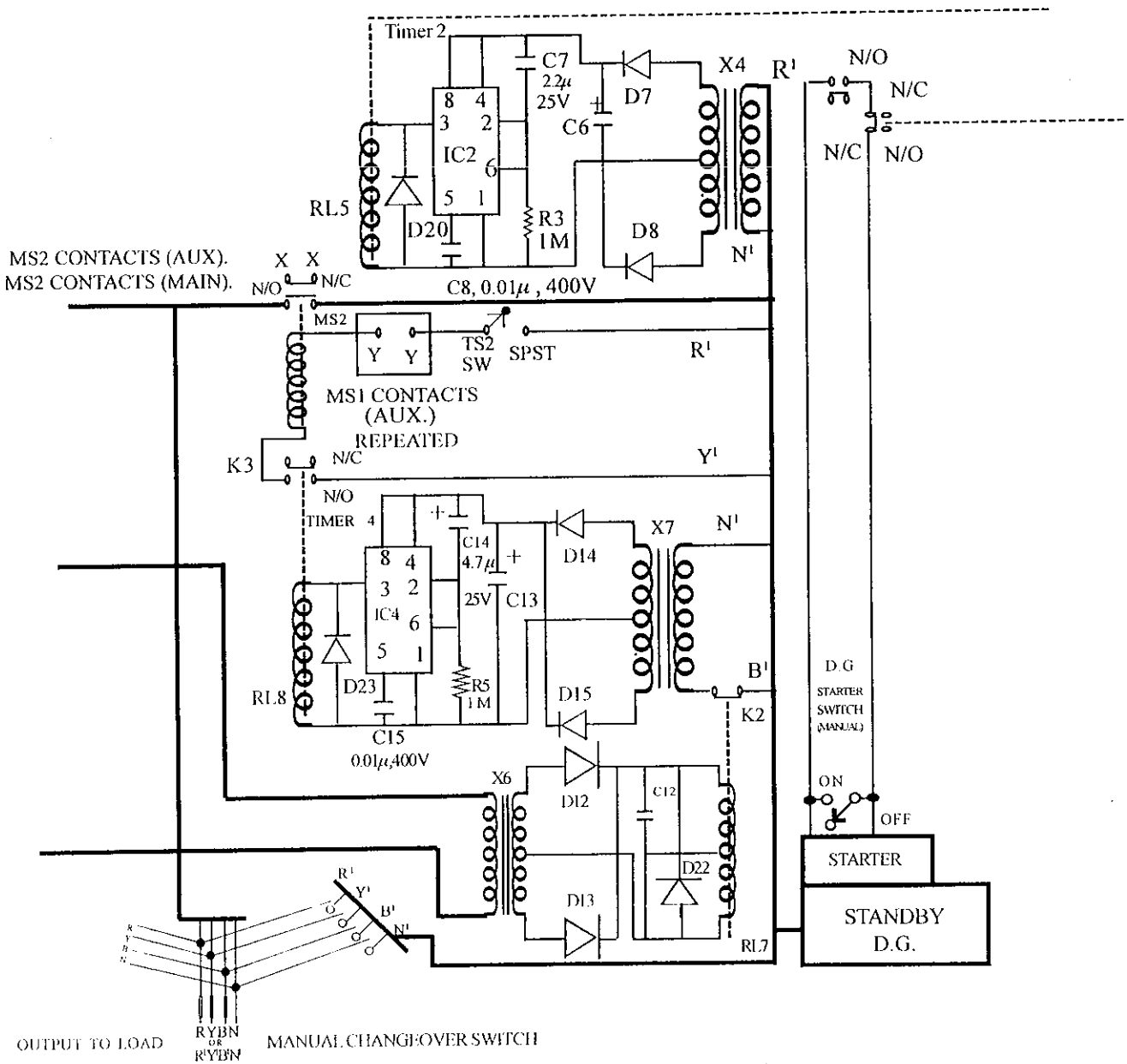


Fig. 4.2 Diesel Generator Circuit

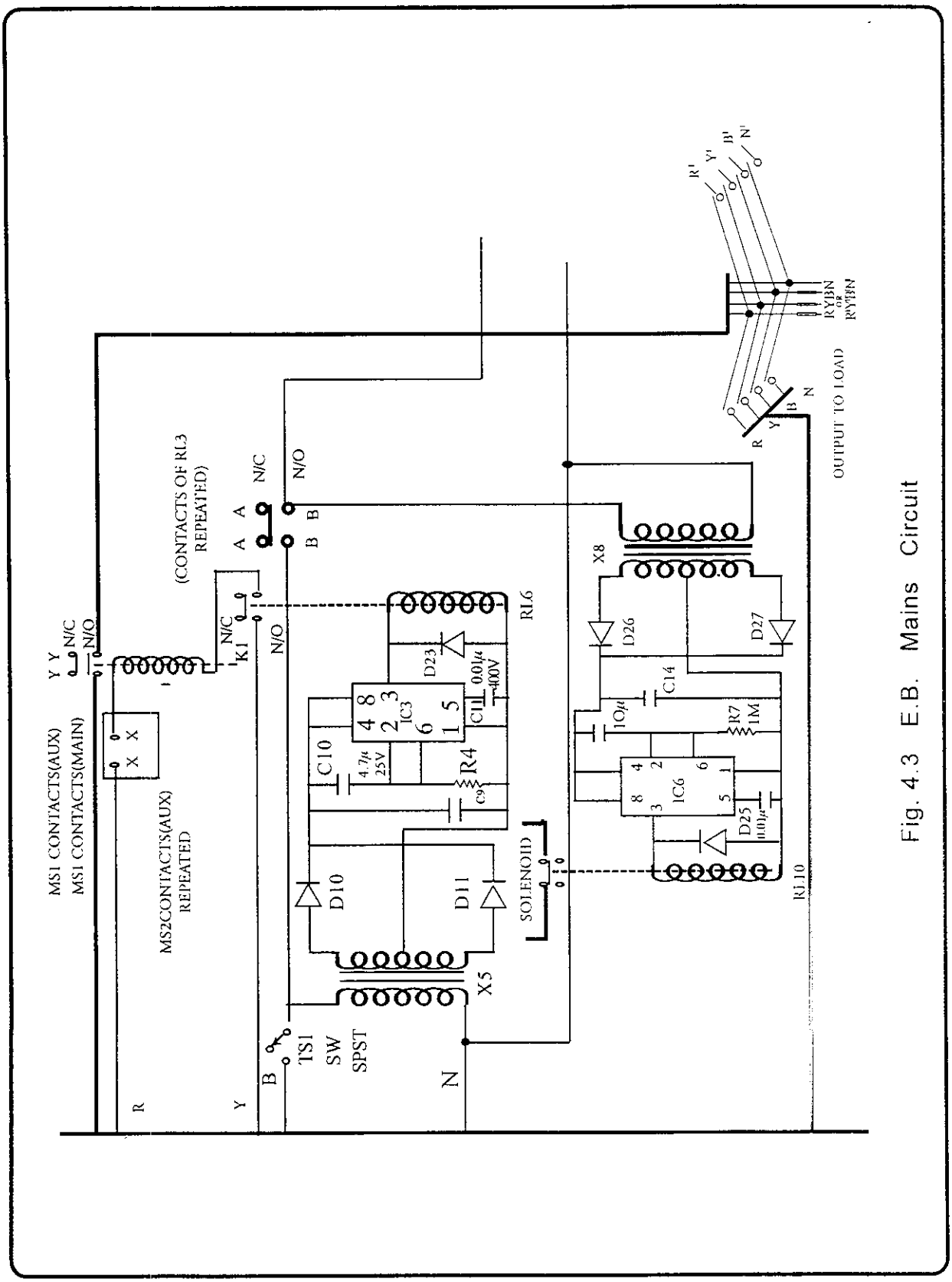
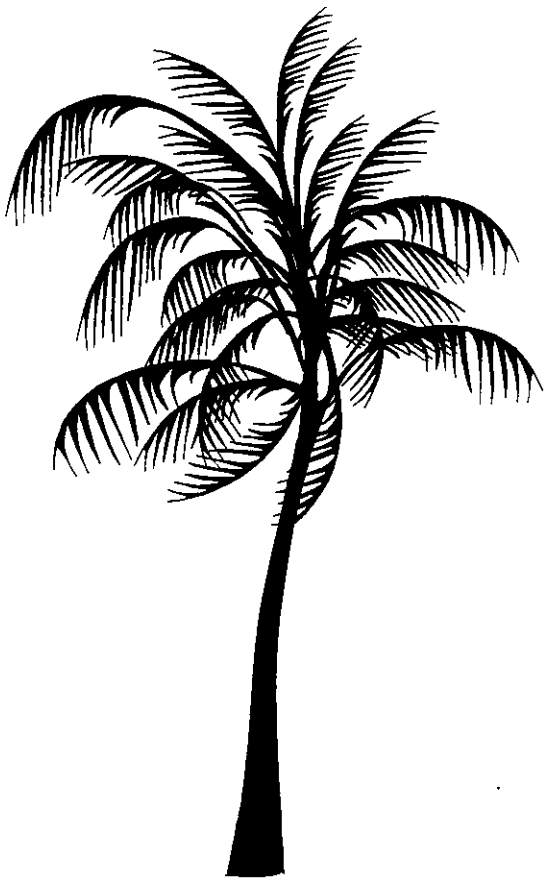


Fig. 4.3 E.B. Mains Circuit



Design of Switch-off Circuit

CHAPTER-5

DESIGN OF SWITCH OFF CIRCUIT

When the 3 phases of the E.B. mains supply resumes, the load is supplied by the EB mains itself. The load is transferred from the generator to EB mains by the changeover circuit. The generator now runs on no load. This is a wastage of fuel and money. A suitable switch-off circuit is to be designed so that, the generator is switched off, after the EB starts supplying the load. The switch-off circuit designed is shown in Fig 5.1.

The relay RL3 (Fig. 5.1) is energised only if all the 3 phases are present. Thus the contact BB of relay RL3 is used to close this switch-off circuit. The phase 'B' is connected to the transformer 'X8', (Fig. 5.1) through the 'BB' contact. The output of the transformer X8 is given to a delay timer.

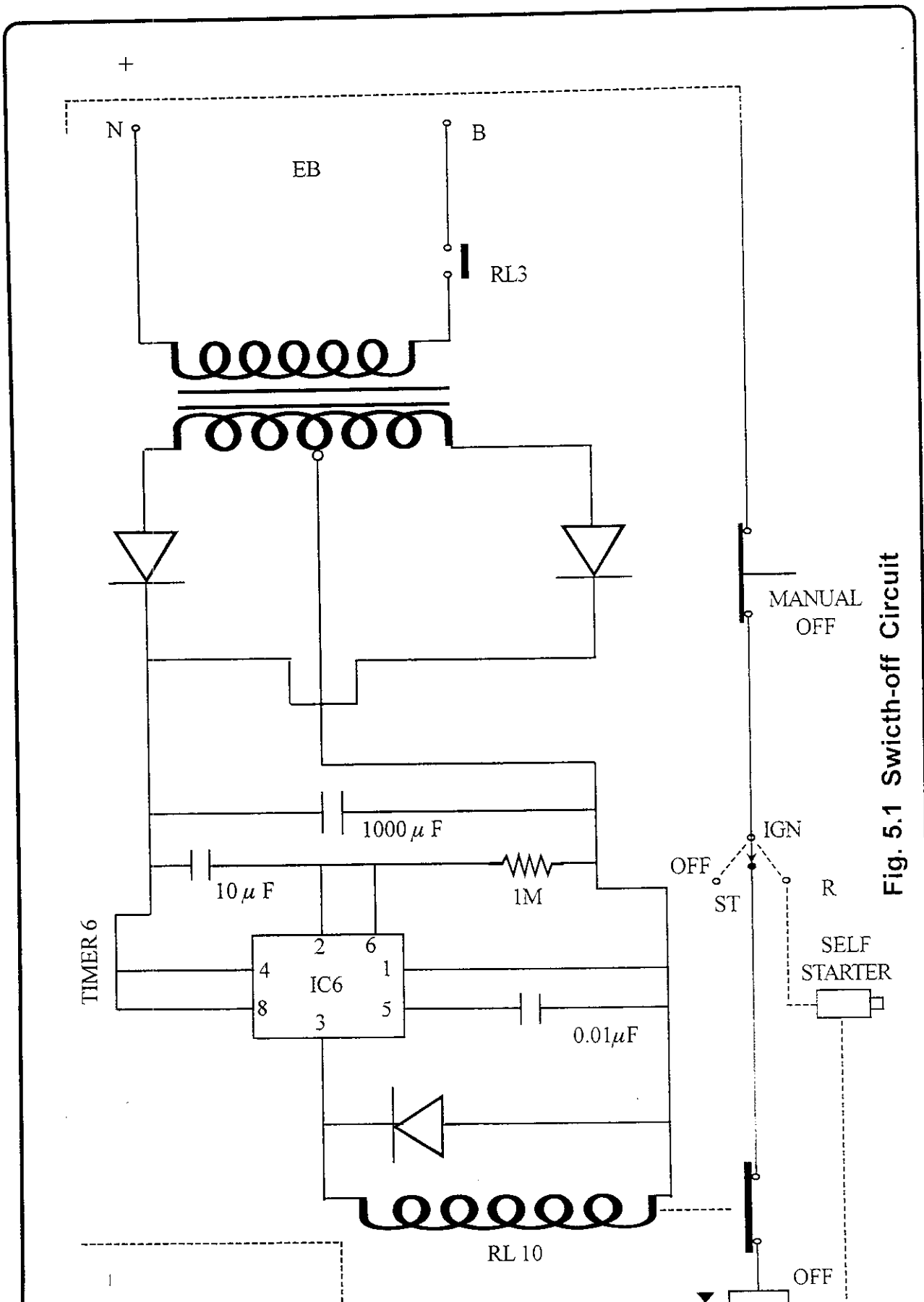
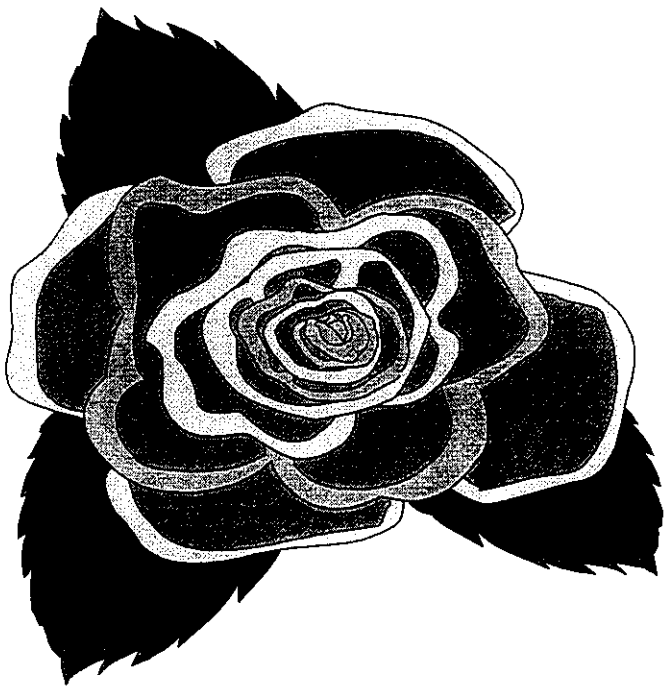


Fig. 5.1 Swicth-off Circuit



Fabrication & Testing of the Circuit

CHAPTER-6

FABRICATION AND TESTING

The sensor, timing, changeover, control circuits and the switch off circuits designed are fabricated into one single circuit as shown in Fig. 6.1.

The designed circuit was fitted on a 40x40 cm Hylum board. The sensor, timing, changeover, control circuits and switch off circuits were fabricated on this board. The PCB as in Fig. 6.2. includes all the electronic components (diodes, capacitors, Ic's and resistors). The transformers, contactors were mounted externally on the Hylum board. The relays were mounted on a general purpose board, because the contacts of relays were designed for high currents. For this reason the relays cannot be accomodated on the PCB. The connections are made to the PCB from the general purpose board

and other components of the circuit mounted on the hylum board. The hylum board along with all the components is mounted on a metal cabin. The metal cabin is about 49 cm in length, 45cm in breadth and 18 cm in height.

The front panel was designed with an ON-OFF switch, phase controlling switches, indicating lamps (LED's for indicating relay operation),potentiometers (as time controlling devices). The back side of the panel has provisions for wire outlets. The cabin also provides proper ventillation on the sides, which is used to dissipate the heat developed inside, when the circuit is in operation.

6.1 FRONT PANEL :-

The front panel consists of

(a) ON-OFF switch.

(b) Phase controlling switches.

(c) Indicating lamps.

(d) Potentiometers.

6.1.1 ON-OFF SWITCH :-

The ON-OFF switch is a provision for by-passing the automatic changeover system, during maintenance periods. It can be switched over to a manual changeover. When the equipment is in operation, it has to be put to the AUTO side indicated on the front panel.

6.1.2 PHASE CONTROLLING SWITCHES :-

Three phases, one for each phase R,Y,B have been provided on the front panel. These switches have been provided to demonstrate the usefulness of the circuit, when any one of the phases fails abruptly.

6.1.3 INDICATING LAMPS :-

These lamps are used to indicate the operation of the relay. These are displayed on panel board as shown in Fig. 6.3. If any one of the relay works, it is indicated by these indicating lamps (LED's).

6.1.4 POTENTIOMETERS :-

The timing circuit can be controlled by using these potentiometers. By varying the potentiometers the time delay can be changed suitably. This delay may be set according to the needs of the generator. Two potentiometers are provided on the front panel. They are indicated as POT1 and POT2. POT1 is used to set the starting time required for the generator used. POT2 is used to provide the appropriate time delay for switching off the generator.

6.2 OPERATING INSTRUCTIONS :-

The following instruction must be followed while switching ON the Automatic Diesel Generator starter and changeover circuit :-

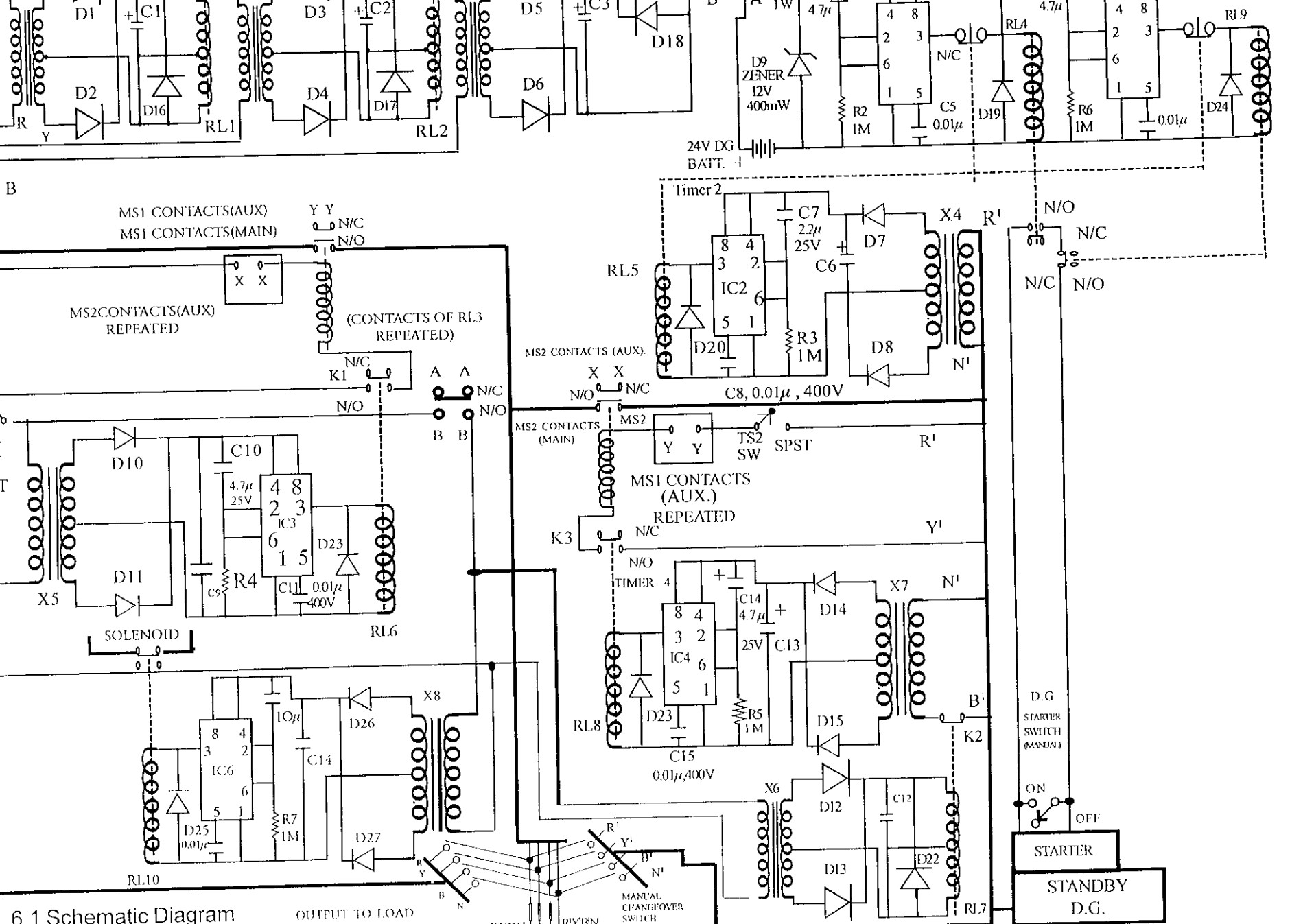
* Toggle switch should be in AUTO position.
* The R,Y,B phase switches should be in ON position.
* The two potentiometers are set to proper time delays.

6.3 TESTING :-

The above circuit was designed and elucidly fabricated. It was tested on a 62.5 KVA generator, available in the college premises. Three bulbs are used as loads to indicate the working of the circuit. Changeover and starting circuits were checked. The circuit worked successfully upto our exceptations, with no problems whatsoever.

6.4 COST ESTIMATION :-

S.No.	Particulars	Amount
1.	TRANSFORMERS	Rs. 200.00
2.	ELECTRONIC COMPONENTS & MISCELLENEOUS	Rs. 925.00
3.	PCB FABRICATION	Rs. 550.00
4.	RELAYS	Rs. 1440.00
5.	CONTACTORS	Rs. 1300.00
6.	CONTROL PANEL (METAL CABIN)	Rs. 700.00
7.	REPORT WORK	Rs. 3000.00
	TOTAL	Rs. 8115.00


D1
C1
D2
D16
RL1
D3
C2
D4
D17
RL2
D5
C3
D6
D18
D9
ZENER
12V
400mW
R2
1M
C5
0.01μ
RL4
D19
R6
1M
0.01μ
D24
RL9
24V DG
BATT.
MS1 CONTACTS(AUX)
MS1 CONTACTS(MAIN)
N/C
N/O
MS2CONTACTS(AUX)
REPEATED
(CONTACTS OF RL3
REPEATED)
K1
MS2 CONTACTS (AUX).
C8, 0.01μ , 400V
MS2 CONTACTS
(MAIN)
MS2
TS2
SW
SPST
MS1 CONTACTS
(AUX.)
REPEATED
K3
TIMER
SOLENOID
RL6
RL8
C15
0.01μ,400V
RL10
RL7
K2
MANUAL
CHANGEOVER
SWITCH
D.G
STARTER
SWITCH
(MANUAL)
ON
OFF
STARTER
STANDBY
D.G.
Timer 2
IC2
IC3
IC4
IC6
C7
2.2μ
25V
C6
D7
D8
D20
R3
1M
X4
X5
X6
X7
X8
D10
D11
C10
4.7μ
25V
R4
C9
C11
0.01μ
400V
D23
C14
4.7μ
25V
C13
R5
1M
D14
D15
D12
D13
C12
D22
10μ
D26
D27
R7
1M
D25
0.01μ
RL5
R1
N/O
N/C
R1
Y1
B1
N1
A
B
6.1 Schematic Diagram
OUTPUT TO LOAD

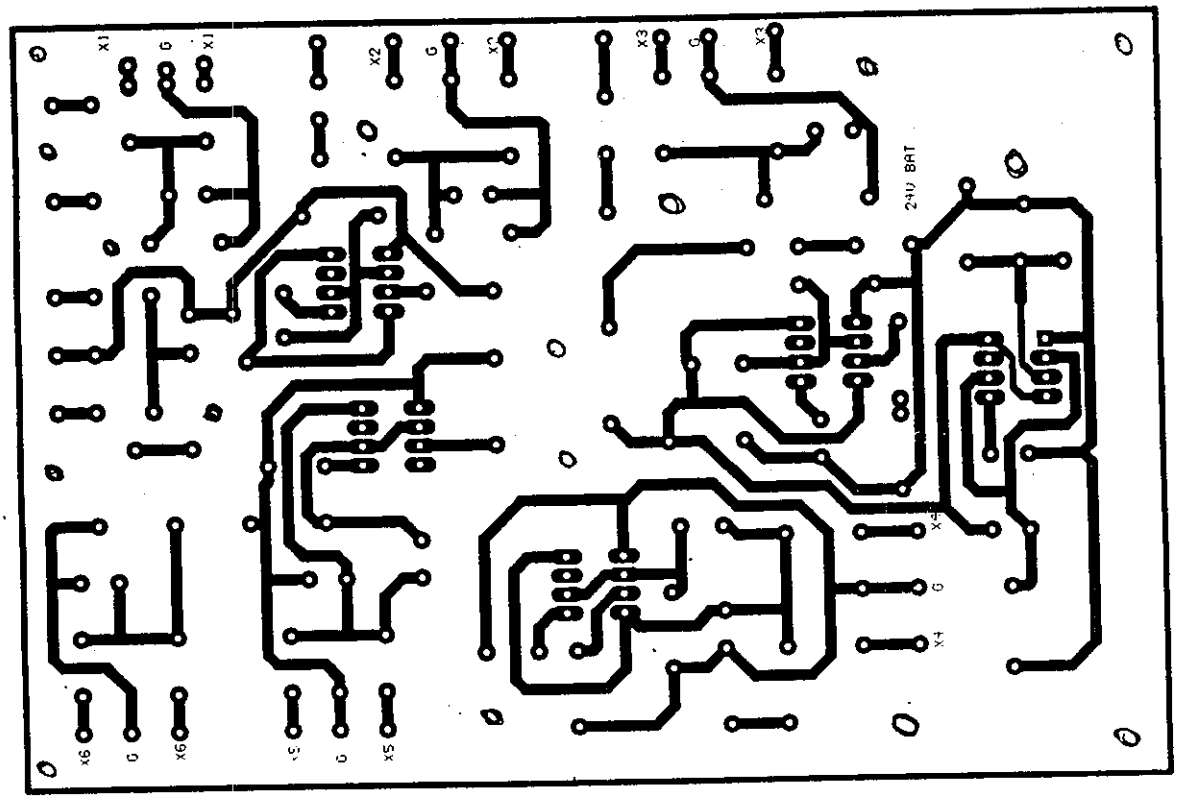


Fig. 6.2. PCB LAYOUT

Conclusion

CHAPTER-7

CONCLUSION

A new electro-mechanical system of automatic Diesel generator starting and 3 phase mains -to- standby changeover system has been developed. This system is economical and reliable for various applications.

The electronic circuitry in the system has been tested successfully and all the timers are working satisfactorily with appropriate delay periods, according to the design.

A suitable switch-off circuit has been developed and tested. Care must be taken for protection on the incoming and load side due to single phasing.

The frequent power failures & large voltage drops in India necessitates the use of Automatic Diesel generator starting and changeover system in countless number of establishments.

References

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Appendix

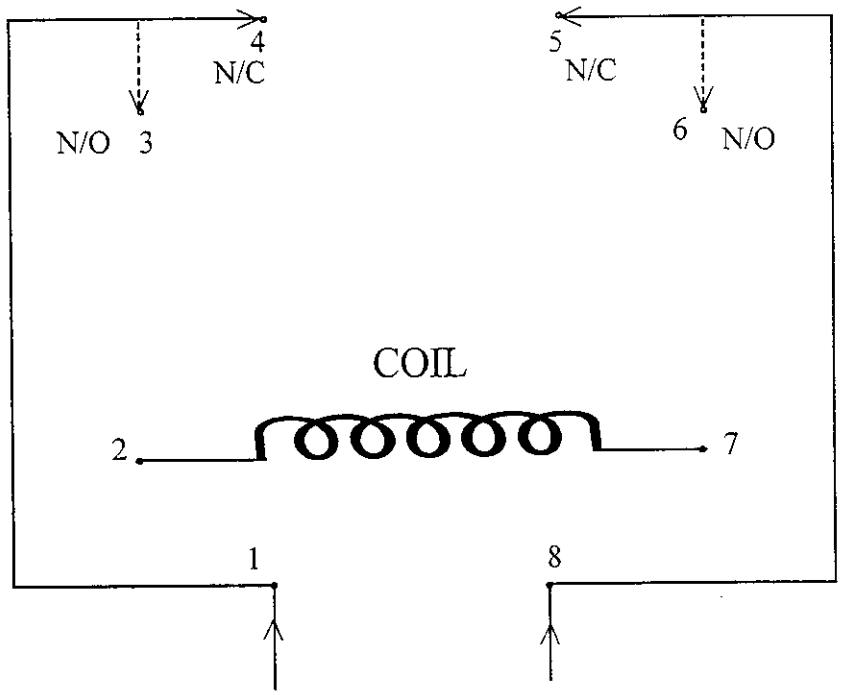
APPENDIX

RELAY DETAILS : -

1.	TYPE	:	ELECTRO-MECHANICAL.
2.	SUPPLY VOLTAGE	:	6V.
3.	COIL RESISTANCE	:	200 Ω.
4.	CONTACTS RATING	:	5A.
5.	CONTACTS TYPE	:	SPST, DPDT.

TIMER DETAILS :-

1.	TYPE	:	555 IC TIMER.
2.	MODE	:	MONOSTABLE.
3.	SUPPLY VOLTAGE	:	5V TO 18V.
4.	OPERATING TEMPERATURE		
	SE TYPE	:	-55°C TO +120°C.
	NE TYPE	:	0°C TO 70°C.
5.	TEMPERATURE STABILITY	:	50ppm / °C.
6.	SOURCE CURRENT CAPACITY	:	200mA
7.	TIMING DELAY	:	MICRO SECONDS TO HOURS



PIN DIAGRAM OF DPDT RELAY

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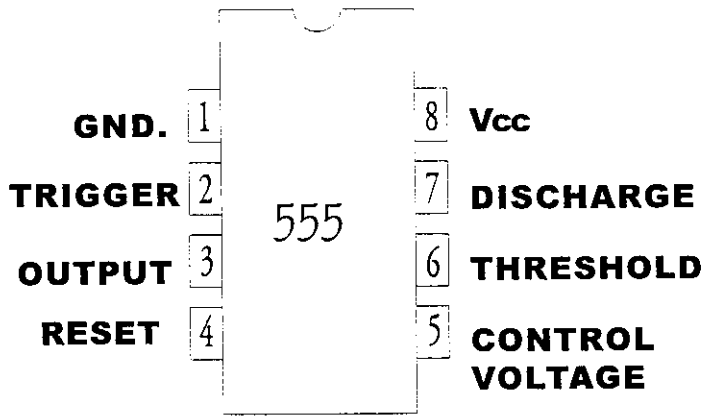

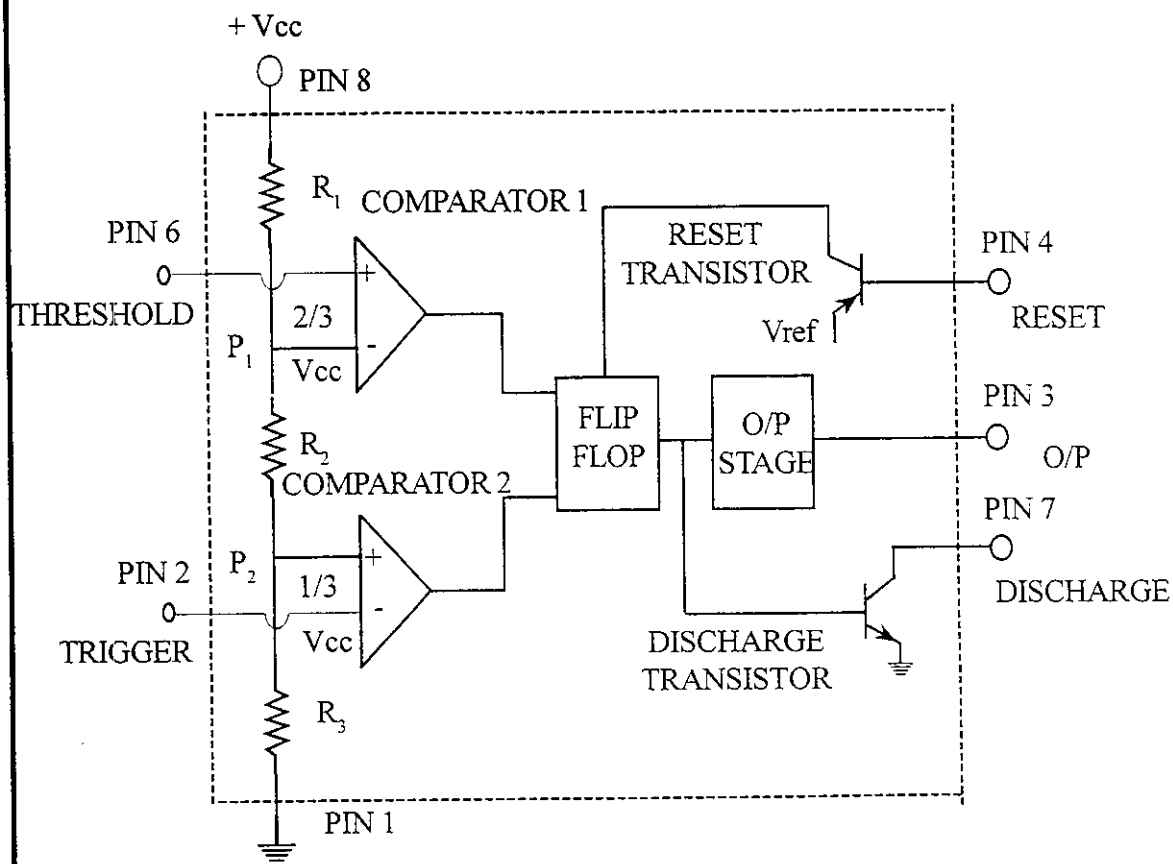

PIN & FUNCTIONAL DIAGRAM OF 555 TIMER