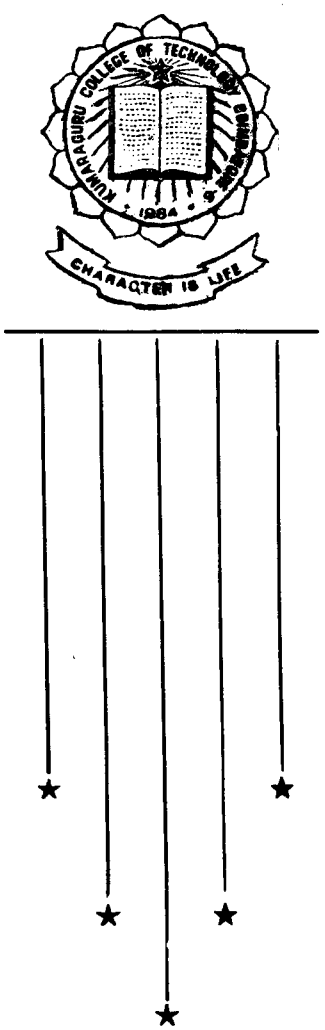
Control - Cum - Indication Panel for a Refrigeration Compressor

Project Report 1996 - '97



Submitted 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

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Certificate

This is to certify that the Report entiled

Control - Cum - Indication Panel
for a Refrigeration Compressor

has been submitted by

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In partial fulfilment for the award of Bachelor of Engineering
in Electrical and Electronics Engineering Branch
of Bharathiar University, Coimbatore - 641 046
during the academic year 1996 - '97

Guide

Head of the Department

Date :

Certified that the candidate was examined by us in the project work Viva-Voce Examination held on _____ and the University Register Number was _____

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21st March 1997

TO WHOMSOEVER IT MAY CONCERN

This is to certify that the following Final year BE (Electrical & Electronics), Students of Kumaraguru College of Technology, Coimbatore have done their project work entitled **"Control - Cum - Indication panel for a Refrigeration Compressor"** in Plant Maintenance Department, in our organisation from July 1996 to February 1997.

1. **Ms R Anudha**
2. **Mr M Khaja Mohideen**
3. **Mr C Vijayakumar**
4. **Mr P Satish Kumar**

During this period, their attendance and conduct were found to be **good.**

We wish them the very best in their future endeavours.

ANTHONY THIAGARAJAN
ASST. MANAGER - HRD

Acknowledgement

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We would like to express our sincere thanks and profound gratitude to **Mr.V.CHANDRASEKARAN** M.E., MISTE., for his invaluable guidance and constant encouragement throughout the completion of this project work.

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We also would like to thank our beloved Principal **Dr.S.SUBRAMANIAN** B.E., M.Sc.,(Engg.), Ph.D., SMIEEE, for providing us with necessary facilities for carrying out this project work.

We wholeheartedly express our sincere thanks and profound gratitude to **Mr.K.RAJAN,** Manager and **Mr.G.SIVASALAPATHY** B.E., Assistant Manager of the Plant Maintenance Department of **PREMIER INSTRUMENTS AND CONTROLS LIMITED** for their constant help throughout the project work.

We are grateful to **LT.COL.PURUSHOTHAMAN,** DGM, HRD for sponsoring the project work. We are also thankful to the staff and our friends who gave us the moral support during the period of our project work.

Synopsis

SYNOPSIS

In large industries,the need for air conditioning arises for various printing and production processing units. There are many practical problems involved in monitoring the various units in the system. Air conditioning systems have to be monitored in order to protect the compressor from operating under adverse conditions. The parameters such as water pressure, refrigerant pressure, oil pressure, refrigerant temperature should be within safe limits. The violation of the above parameters have to be indicated and checked, otherwise it will lead to failure of the compressor.

So a control-cum-indication panel becomes essential for the safe operation of the air conditioning system. In this project it is proposed to design and fabricate a control panel to monitor the various parameters like refrigerant output temperature, pressure, input temperature, input pressure, water input pressure to the condenser, compressor oil pressure.

In the event of violation of the parameter limits, the trip signal is given to the relay. The trip signal operates the relay and make it to reduce the compressor pressure and switch it off. The parameter that has been violated is indicated on the panel board by a bulb. This helps in the identification and quick rectification of the problem. This panel is fabricated for 40 Tonne Reciprocating compressor with suction and discharge pressures of 30 and 280 Pounds per square inch respectively. Under the normal conditions the condenser water pressure will be greater than 1 Kg/sq.cm. This panel board can be used for the chiller plants also.

In this panel board we make use of 3 C/O MPC type relays (C/O - Change Over, M - Miniature, P - Plug in type, C-Covered) are used. This unit is fabricated for the Plant Maintenance Department of PREMIER INSTRUMENTS AND CONTROLS (PRICOL), Coimbatore at the industry itself.

Contents

CONTENTS

PHOTOGRAPHS

REFERENCES

APPENDIX

- DETAILS OF COMPRESSOR
- DETAILS OF WATER PUMP
- RELAY DETAILS
- DIAGRAMS

Introduction

1. INTRODUCTION

An Air-Conditioning Plant consists of Compressor, Heat Exchanger, Air Handling Unit, Cooling Tower, Feedwater Tank and other accessories. The heart of the refrigeration system (i.e.) the compressor has to be protected from operating under adverse conditions, when there is a violation of the operating parameters.

A Control - cum Indication Panel is hence necessary to ensure the safe operation of the Compressor. There are two circuits necessary for the safe operation of the Compressor. One is used for simplifying the complex starting sequence and the other is used for continuously monitoring the operating parameters.

The Control circuit is designed with the help of relays. When there is a violation occurring in the operating parameters, the panel board switches off the compressor and indicates the violated parameter. A Reset Key is provided to normalise the relay contacts.

This Panel board would be of great use in industries as it monitors a number of parameters continuously, while simultaneously eliminating the need for manpower to monitor various guages.

Description of AC Plant

2. DESCRIPTION OF AC PLANT

2.1 INTRODUCTION :

An Air-conditioned plant consists of Compressor, Heat exchanger,Expansion devices,Air handling unit (AHU),Cooling tower,Water pump and Feed water tank. The compressor in the plant sucks the low pressure Freon-22 or Genetron-22 (R-22) vapour from the Air handling unit andcompresses it to give a high pressure, high temperature R-22 vapour. This is cooled in the heat exchanger and becomes high pressure liquid.

This high pressure liquid is still cooled by reducing the pressure through expansion device. From the expansion device the chilled liquid passes through the various tubes of the AHU. Hence the liquid absorbs heat from the atmospheric air with the help of blower and becomes R-22 vapour. This again goes to the Compressor and the process is repeated to maintain air conditioning. The water for the heat exchanger is fed from the tank of the cooling tower with the help of water pump through pot strainer. The water out of the heat exchanger goes to the sprayer of the cooling tower. Here it is sprayed on to the walls of the cooling tower and it gets collected in the tank below. The shortage water is fed by the float arrangement in the collector tank from a feed tank.

2.2. PLANT DETAILS :

Block diagram and Description of the AC plants shown in Fig 2.1

2.2.1 COMPRESSOR :

The compressor is a carrier make, 50 HP,four cylinder reciprocating compressor. Under normal conditions the suction pressure is greater than or equal to 30 pounds per square inch (Psi). The name plate details of the compressor is given in the appendix. In the four cylinders one is kept always loaded in order to maintain the temperature of the air conditioned space. The other cylinders are loaded depending upon the temperature settings. If the temperature falls below the set value,the R-22 vapour is automatically loaded onto the remaining three cylinders of the compressor. The compressor is an oil cooled compressor. The oil for the lubrication and cooling is givenin the crank case, the oil flow is controlled by a mechanical relay called oil relay. The oil used here is 'Servo freeze 68'. The discharge pressure of the compressor under normal conditions is always less than or equal to 280 Psi. The Compressor diagram is shown in Fig 2.2.

In the compressor the suction pressure (L.P) and discharge pressure (H.P) are the parameters. The meters connected are H.P, L.P, oil pressure (O.P) and coefficient of oil performance (C.O.P).

2.2.2 HEAT EXCHANGER OR CONDENSER :

The schematic representation of the Heat Exchanger is shown in Fig 2.3. The condenser is a shell tube condenser. The R-22goes through the tubes of the condenser while the water passes through the shell of the condenser. The R-22

vapour passes through the heat exchanger at approximately 250 Deg.C. The input water temperature will slightly be lesser than the room temperature. The heat exchange takes place between shell and tube (i.e) between vapour and water and becomes liquid at approximately 41.6 Deg.C. The pressure remains constant. The water from the condenser goes to the cooling tower. To maintain the cooling the water pressure should not be less than 1 Kg per sq.cm. The pressure of the water entering the condenser is monitored by the water pressure switch.The parameter to be monitored here is the water pressure.

2.2.3 EXPANSION DEVICES :

The Expansion device comprises of Expansion Valves and solenoid control, The Expansion valve is nothing but an ordinary valve with a small orifice and expansion tube. When high pressure R-22 passes through the small orifice and then expands suddenly, the temperature falls down. The flow of the refrigerant is controlled by the solenoid. If there is any leakage in the refrigerant piping then the pressure will be reduced and this is sensed by the solenoid and shuts the flow to the AHU. Expansion devices are shown in Fig 2.4.

2.2.4 AIR HANDLING UNIT :

The Air Handling Unit consists of three main parts.

They are :

- Cooling Tubes
- Air Filter
- Blower

a) COOLING TUBES :

The Cooling Coils are large number of parallel tubes through which the chilled refrigerant flows. Aluminium sheets are fixed on to it perpendicularly in order to increase the contact area and mechanical strength. The temperature of R-22 is initially 1 to 2 Deg.C while passing through the tubes. When the air flows over these tubes the R-22 absorbs heat to become R-22 vapour. These vapours gets collected at the end of the tube and flows to the suction of the compressor. The Cooling Tubes are indicated in Fig 2.6.

b) AIR FILTER :

The Air Filter is a damped nylon air filter. The return duct feeds the air for the filter. The air is filtered from dust and smoke. The filtered air passes over the cooling tubes. The Air Filter is shown in Fig 2.5.

c) BLOWER :

The Blower is driven by a 3 phase, 11 KW / 15 HP,1450 rpm Induction Motor. The Blower has three sets of blades mounted on a single shaft. The details of the Blower

are given in the Appendix. The Blower sucks the air from the return duct over the cooling coil. The air gets cooled and is fed to the supply duct of the Blower. This supply duct goes to the Air Conditioned room.

2.2.5 COOLING TOWER :

The Cooling Tower is an atmospheric spray type to which the water comes from the condenser. The sprayer is placed at the top of the Cooling Tower. The water temperature is reduced to the atmospheric temperature and gets collected at the tank below. If the water in the tank is reduced than the required level then the float arrangement automatically maintains it from the feed tank. The Cooling Tower is indicated in Fig 2.7.

2.2.6 WATER PUMP :

The Water Pump is a Beacon make, monobloc type,5.5 KW / 7.5 HP pump. This pumps the water from the tank through the Pot Strainer to the Heat Exchanger. The Water Pump details are given in the Appendix. The Water Discharge Pressure is maintained at 1 kg / sq.cm.

2.2.7 POT STRAINER :

Pot Strainer is nothing but a nylon dust collector.It has a huge nylon mesh kept wound inside its Pot which collects the dust and allows filtered water to flow to the pump's suction line.

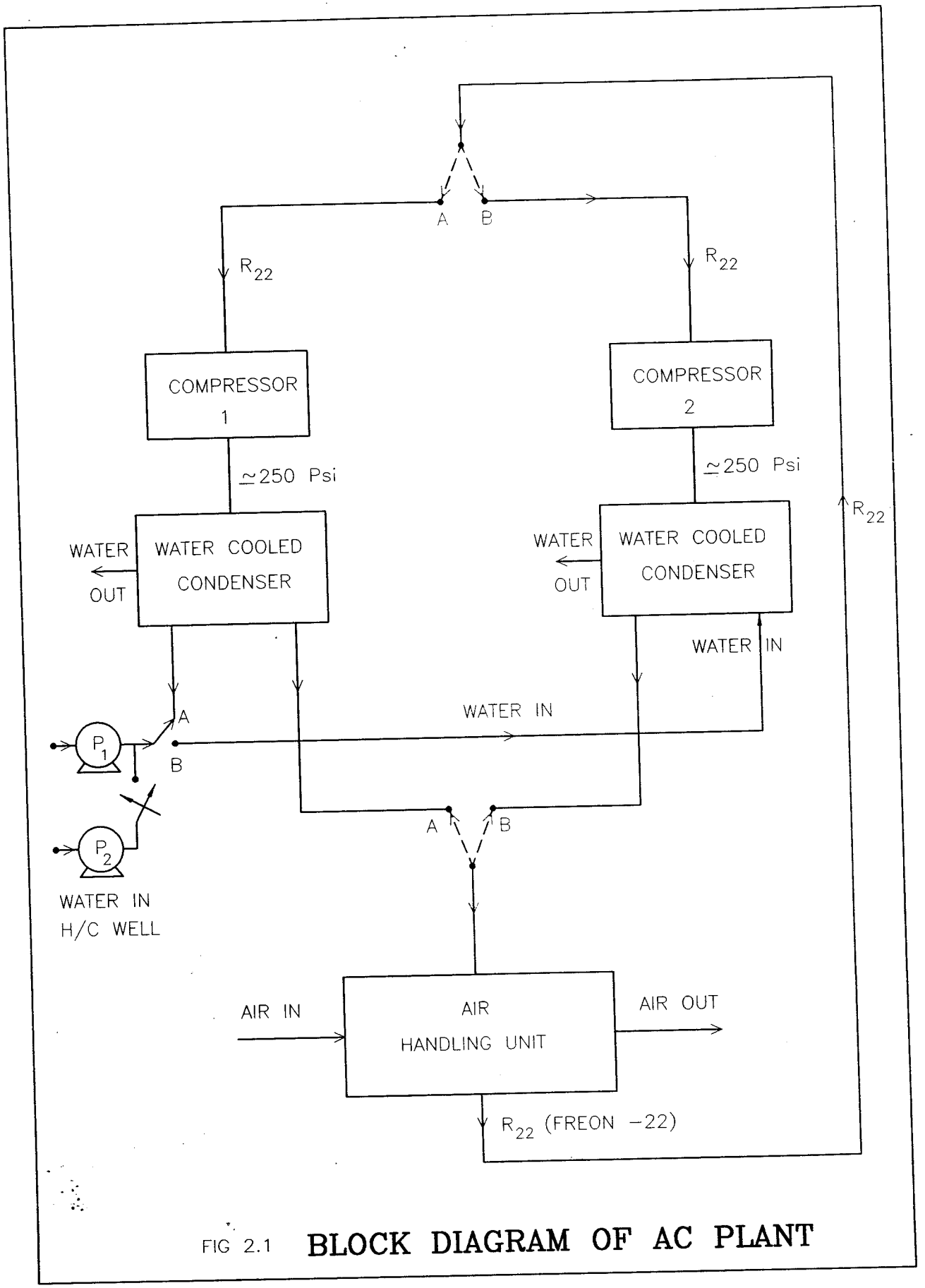


FIG 2.1 **BLOCK DIAGRAM OF AC PLANT**

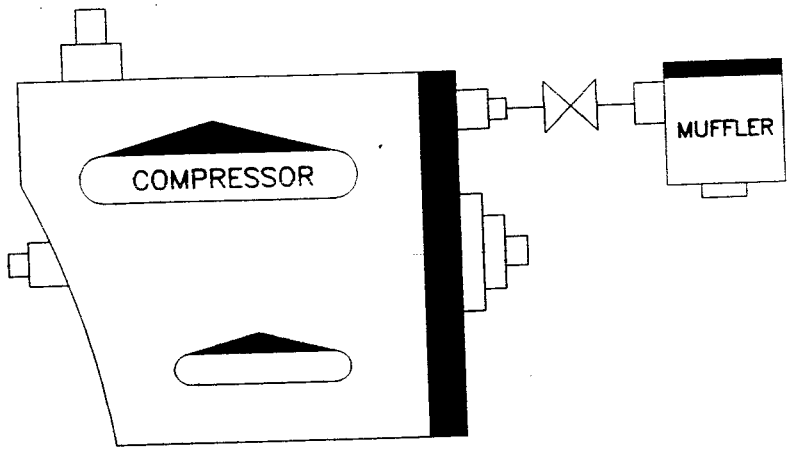


FIG 2.2 SCHEMATIC OF COMPRESSOR

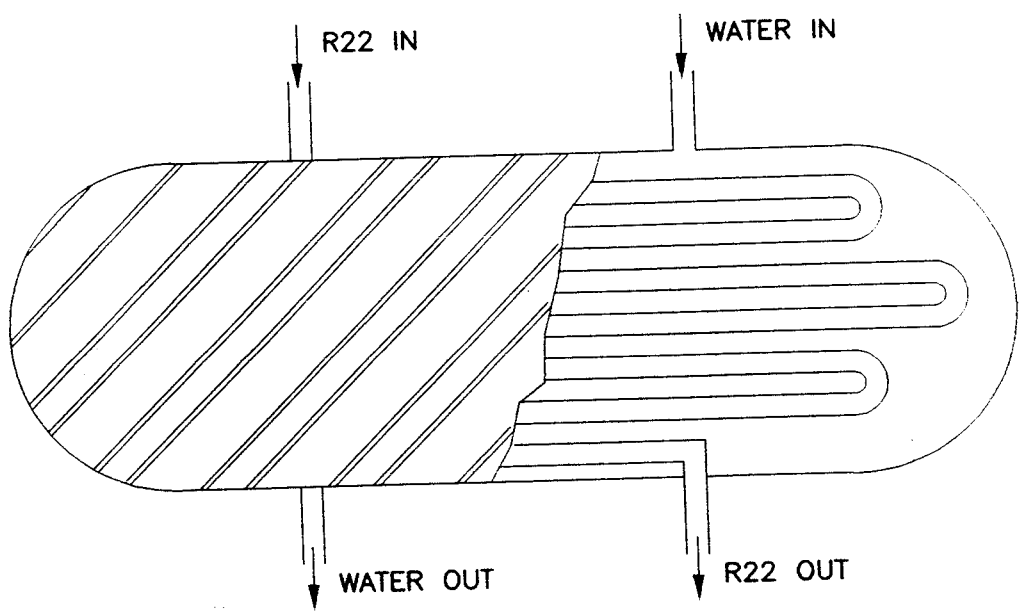


FIG 2.3 SCHEMATIC OF CONDENSER

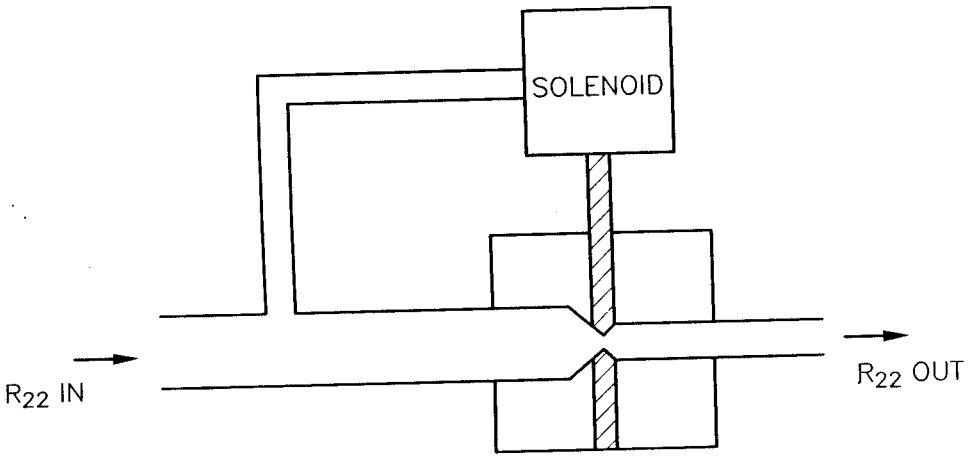


FIG 2.4 **EXPANSION DEVICES**

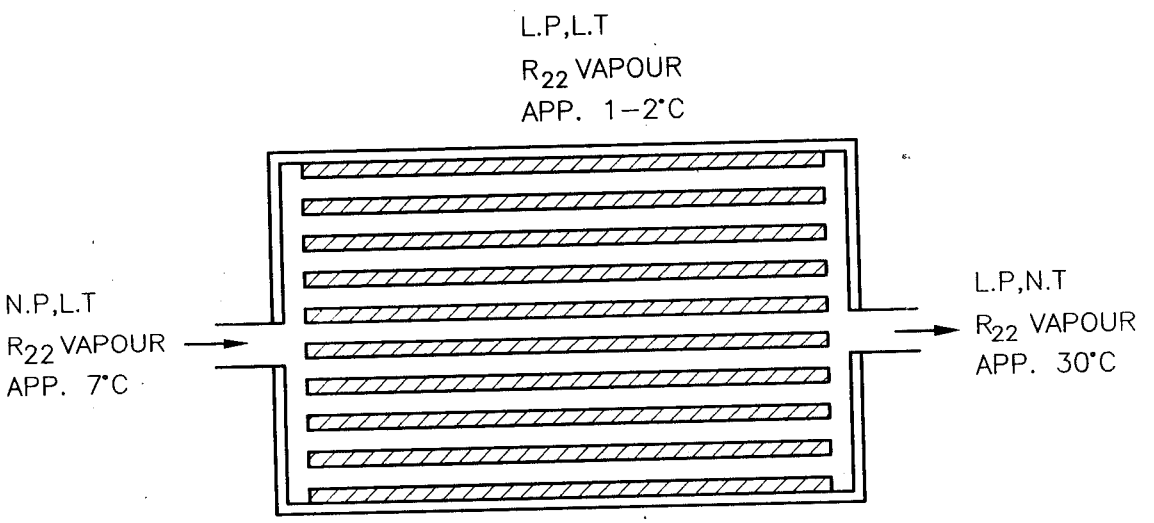


FIG 2.5 **COOLING TUBES**

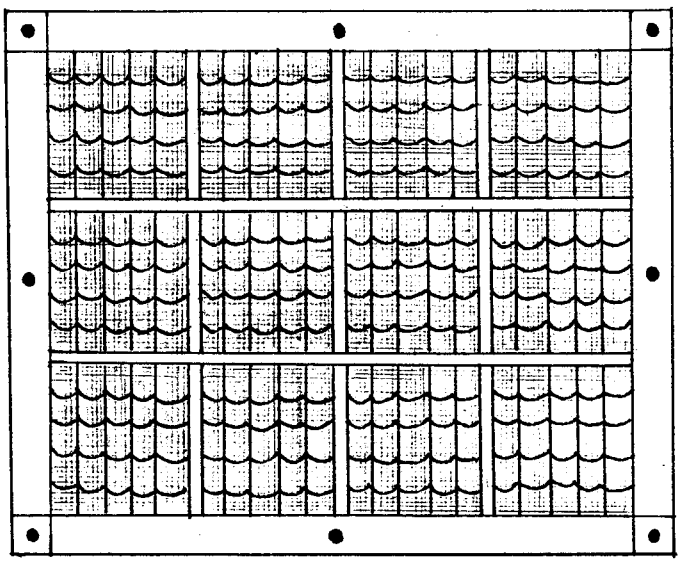


FIG : 2.6 AIR FILTER

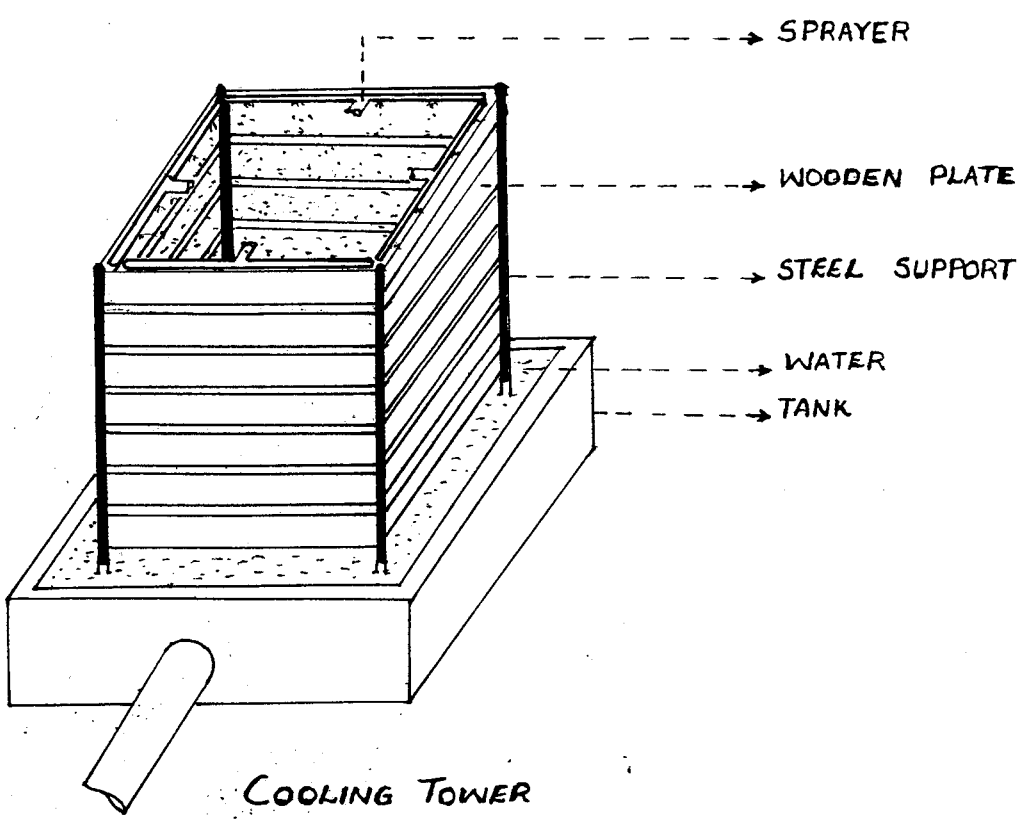


FIG : 2.7 COOLING TOWER

Control Parameters

3. CONTROL PARAMETERS

3.1 PARAMETERS :

The parameters of the AC plant have to be within specified limits for the safe operation of the Compressor. If any of the parameters is violated then the Compressor is unloaded and the panel board switches off the Compressor and indicates the violated parameter.

The parameters of the AC plant are,

- Compressor Discharge Pressure
- Compressor Suction Pressure
- Compressor Oil Pressure
- Condenser Water Input Pressure

The parameters of the AC plant are indicated in Fig 3.1. The panel board is designed to be used for AC plantwith Cooling Tower and/or with Chiller Plant.

The parameters that comes in the Chiller Plant are,

- Refrigerant Input Temperature
- Refrigerant Output Temperature
- Refrigerant Input Pressure
- Refrigerant Output Pressure
- Water Input Temperature

- Water Output Temperature
- Compressor Oil Temperature
- Compressor Suction Temperature
- Compressor Discharge Temperature

The Chiller Plant's schematic diagram is shown in Fig 3.2. These parameters are to be within safe limits. If the limits are violated we need certain arrangements to activate the relay to switch off the compressor and to indicate it.Considering the AC plant with atmospheric cooling tower, the parameters are monitored continuously using the pressure switches for suction and discharge pressure, water pressure switch for water pressure and fan start switch for air handling unit.If any parameter limit is violated then the trip signal goes to the relay.

3.2 PARAMETER CONTROL :

The water pressure switch is connected in the feed line of the heat exchanger. The water pump feeds the water from the cooling tower tank to the heat exchanger. The pressure of this water should not fall below 1 Kg / cm^2. If the pressure falls below this limit then the heat exchange between the water and R-22 will not be efficient. This will lead to the increase in the temperature of the compressor head. If the water pressure falls below 1 Kg / cm^2 then the water pressure switch closes.This switch energises the relay coil by closing the supply contact to the relay coil. The relay now operates to open the supply to the compressor and closes the supply to the bulb. The pressure switches are connected to the suction and discharge lines of the

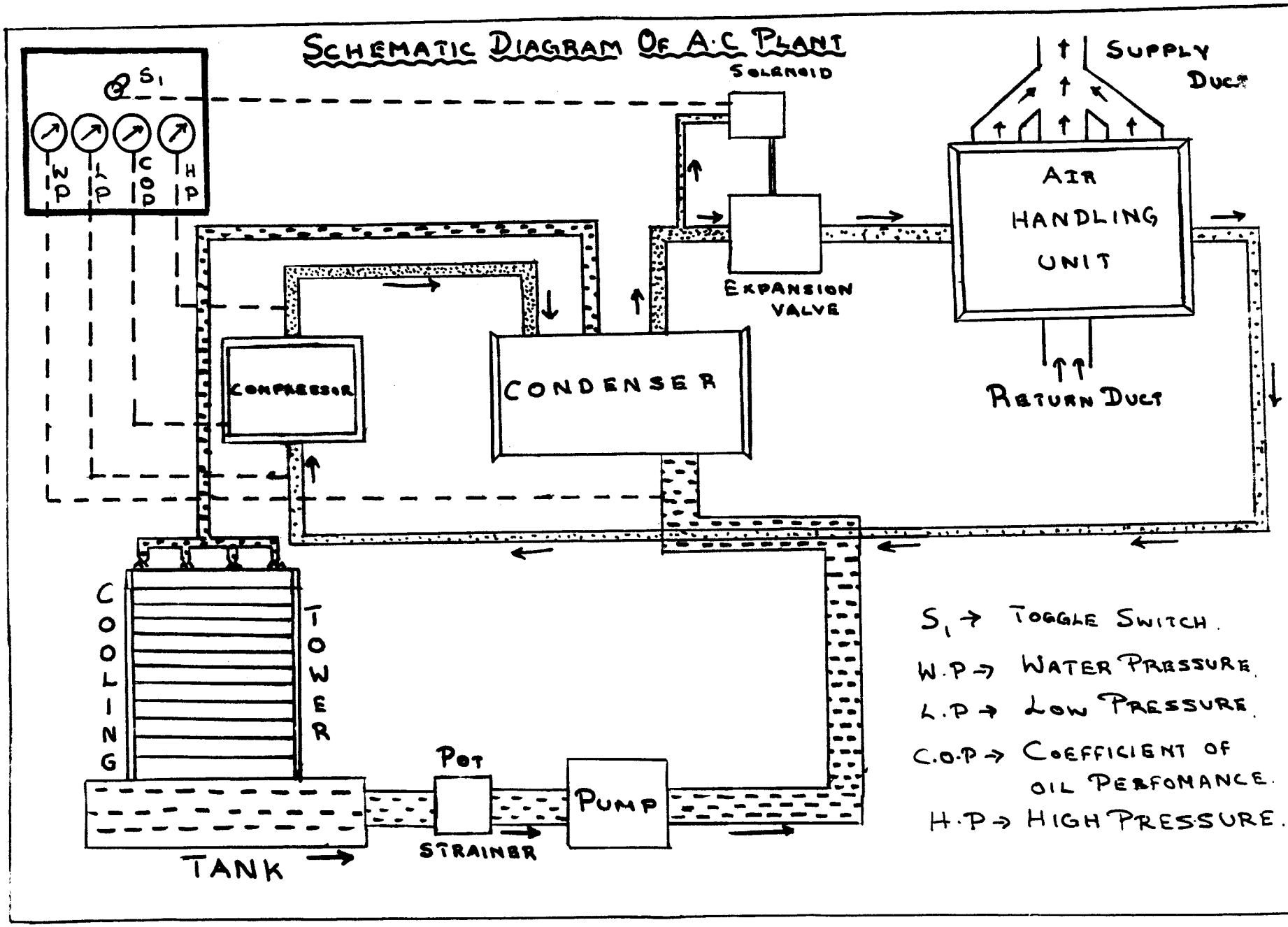
compressor. The suction pressure should not fall below 30 psi while the discharge pressure should not exceed 280 psi. If the suction pressure falls below 30 psi then the pressure switch operates the relay to switch off the Compressor and to indicate. If the discharge pressure exceeds 280 psi then the pressure switch connected to the discharge line closes the DC supply to the relay, this energises the relay which opens the supply to the compressor and closes the supply to the corresponding indicator bulb. The various limits of the parameters are given in the Appendix.

3.3 EFFECT OF VIOLATION :

The parameters,the operating ranges,reasons of violation and their effect are clearly stated in the table 3.1 given below.

S.NO	PARAMETER	LIMIT	REASON FOR VIOLATION (Causes & Remedy)	EFFECT OF VIOLATION
1.	Water input pressure to the condenser	≥ 1kg/cm^2	* Low water level in the cooling tower tank due to the	* Inefficient cooling of the refrigerant. * Cracks in the tubes failure of the of the condenser. float arrangement. * Failure in the pump. * Leakage in the pump (suction or discharge)
2.	Suction pressure of the compressor.	≥ 30 Psi	* Leakage in the suction line of the Compressor.	* Low discharge head of the compressor *In efficient cooling of the refrigerant.
3.	Discharge pressure of the compressor.	≤ 280 Psi	* Increase in suction pressure of the compressor *Malfunction of the expansion valve orifice.	*Cracks in the discharge line. * Failure of the expansion devices.
4.	Compressor oil pressure	Between minimum and maximum	* Leakage in the oil indicator. * Improper maintenance.	* Failure of the compressor.

SCHEMATIC DIAGRAM OF A.C PLANT



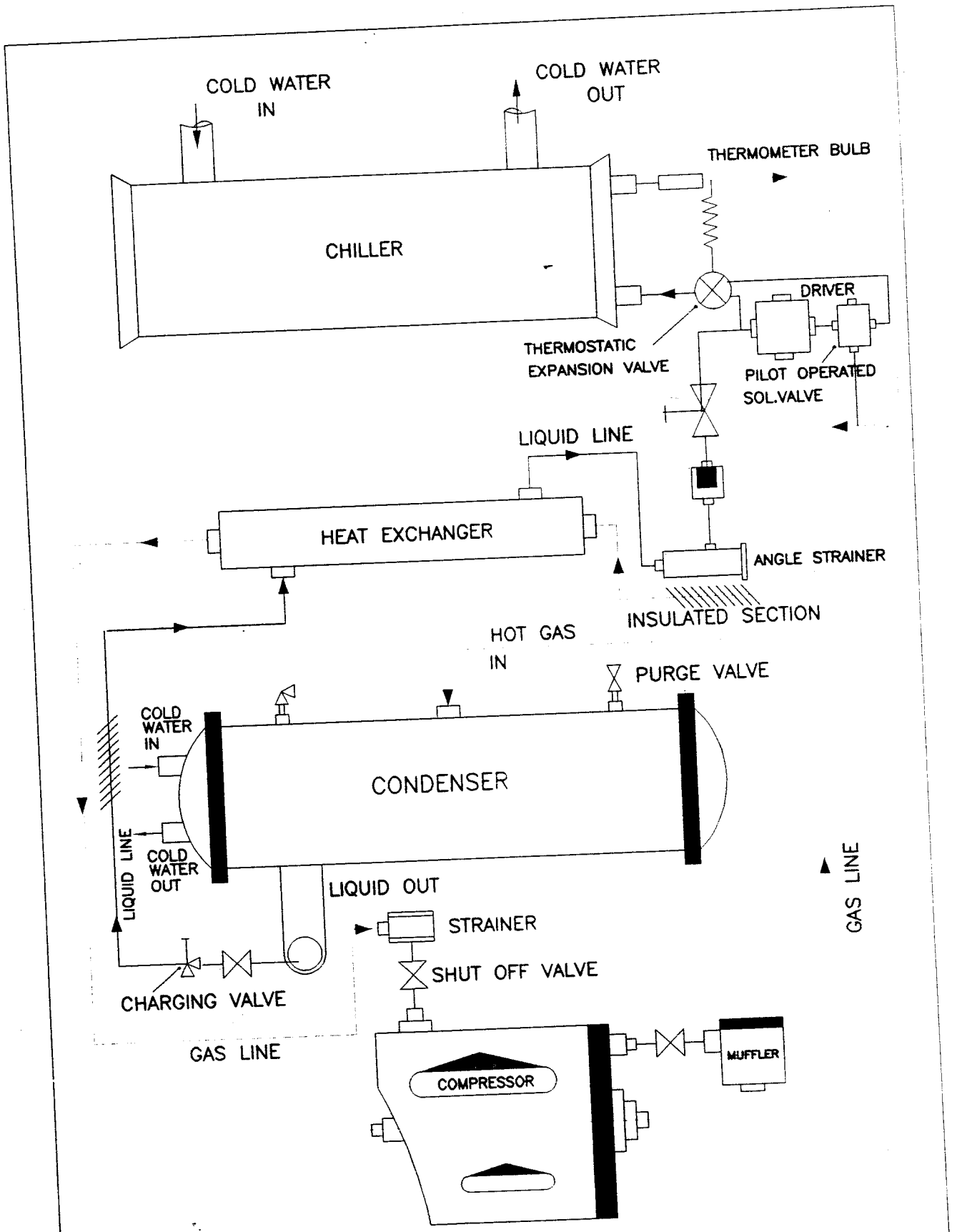


FIG 3.2 SCHEMATIC DIAGRAM OF CHILLER PLANT

Need for Relays

4. DESCRIPTION OF RELAYS

4.1 NEED FOR RELAY :

Relays are used to protect the equipments in industries. Relays are used to cut off the supply promptly to any element of the power system which undergoes short circuit or starts functioning abnormally. Relays also helps to localise the fault (i.e.) it tries to confine the faults to a particular location and isolate the fault from the healthy part of thecircuit. It has to be understood that the relays only give a signal to the circuit breakers for tripping or isolating the faulty system. Relays try to give an indication of the type of fault and its location.

In short, protective relays are the devices that detect abnormal conditions in electrical circuits by measuring the electrical quantities which are different under faulty conditions. The basic electrical quantities which may change during fault conditions are voltage, current, phase angle and frequency. Having detected the fault the relay operates to complete the trip circuit.

4.2 REQUIREMENTS OF PROTECTIVE RELAYING :

A well designed and efficient protective relaying should have the following.

- Speed
- Selectivity
- Sensitivity
- Simplicity
- Reliability
- Economy

4.2.1 SPEED :

Protective Relaying should disconnect a faulty element as quickly as possible. This is desirable for many reasons principal among which are ,

- Increases reliability
- Decreases the amount of damage

4.2.2 SELECTIVITY :

It is the ability of the protective systems to determine the point at which the fault occurs and select the nearest of the circuit breaker tripping of which will lead to clearing of fault with minimum or no damage to the system.

4.2.3 SENSITIVITY :

It is the capability of the relay to operate reliably under the actual conditions that produce the least operating tendency. These may be abnormalities in the normal operating conditions or the faults for which the protection has been designed. It is desirable to have the protection as sensitive as possible in order that it shall operate for low values of actuating quantity.

4.2.4 SIMPLICITY :

Simplicity of construction and good quality of relay,correctness of design and installation,qualified maintenance andsupervision are the main factors which influence protective relaying reliability. As a rule,the simple the protective scheme and the lesser number of relays,circuits and contacts it contains the greater will of reliability.

4.2.5 RELIABILITY :

It means that the protective relaying must be ready to function reliable and correct in operation at all times under any kind of fault and abnormal conditions of the power system for which it has been designed.

4.2.6 ECONOMY :

As with all good engineering designs, economics plays an important role. It is fertile to achieve all important generalrequirements together, so comparison becomes necessary.

4.3 CLASSIFICATION OF RELAYS :

Based on the principle of operation and depending upon their construction it may be classified as

- Electro-magnetic attraction type.
- Electro-magnetic induction type.
- Static relay.
- Moving coil relay.

4.3.1 ELECTRO-MAGNETIC ATTRACTION TYPE :

They operate by the virtue of plunger being drawn into a solenoid or an armature being attracted towards the poles of an electro-magnet such relays may be actuated by AC or DC quantities.

4.3.2 ELECTRO-MAGNETIC INDUCTION TYPE :

They use the principle of the induction motor in their operation. They are actuated by AC quantities only.

4.3.3 STATIC TYPE :

They have no moving parts and employ thermionic valves, transistors, resistances, capacitors, magnetic amplifiers to obtain operating characteristics.

4.3.4 MOVING COIL TYPE :

They operate on the same principle as the moving coil instruments.

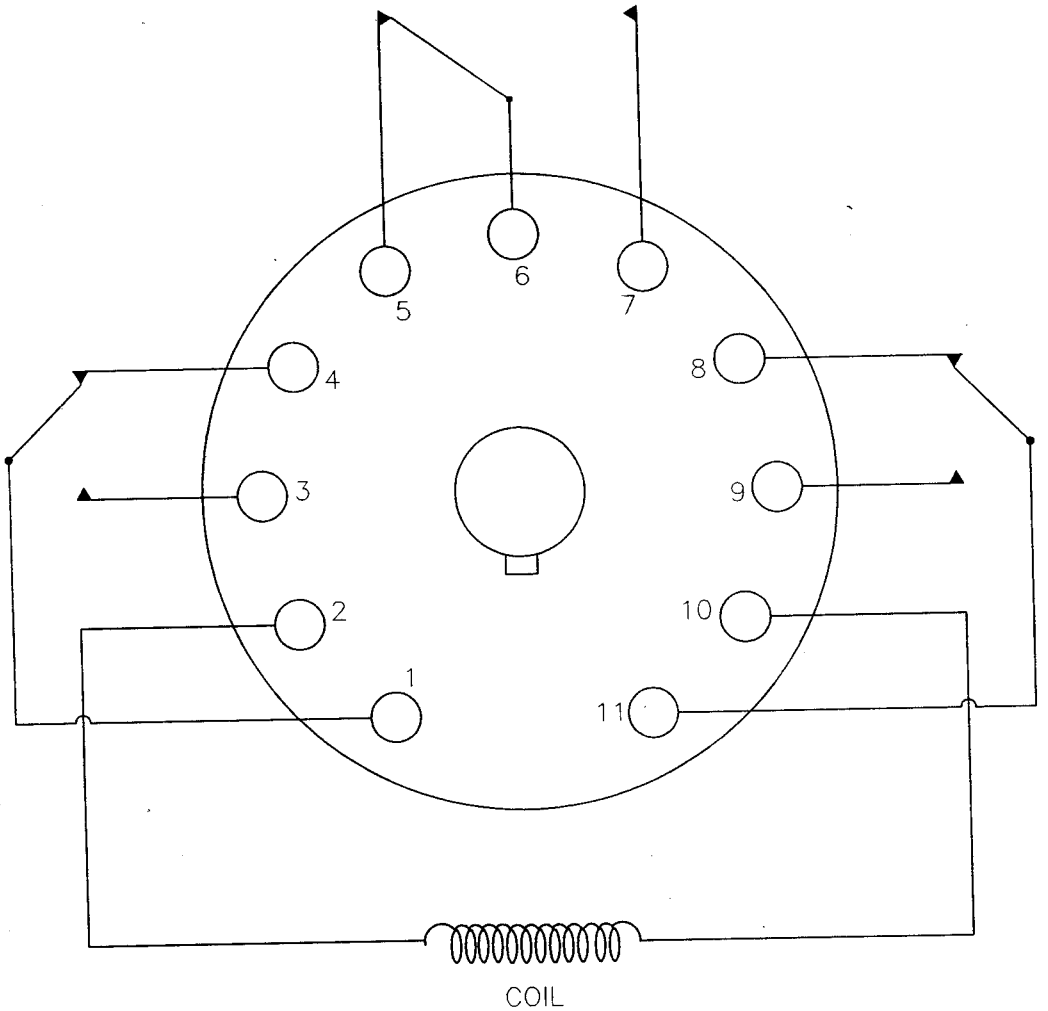
4.4 RELAY DETAILS :

The type of relay which we use in this control panel are electro-magnetic attraction type. They are miniature type relays that can operate for both AC and DC. The operating voltages are 24 volts DC and 230 volts AC. This relay is a 3 C/O (change over), MPC type (M - Miniature relay, P Plug-in mounting, C - Cover type enclosure). In this relay we have eleven points (i.e) three for each set of change over and two for supply to the coil. This relay was mainly chosen because it had 3 change over contacts. This can operate both for AC and DC. The coil configuration of the relays are shown in Fig 4.1. Pin numbers 2 and 10 are used for the supply coil. Pin number 4, 5 and 8 are normally closed points. Pin numbers 1, 6 and 11 are the common points. This relay can be plugged into a base like the IC bases. The groove in the relay and the base ensures that the relay is placed in the right position. The relay is very compact.

4.5 SPECIFICATIONS :

The specifications of the relay that is used in this control panel is given below.

SPECIFICATIONS	
Contact Material	Fine Silver
Initial contact resistance.	0.05 Ohms (Max.)
Ambient temperature.,	– 25° C to +55° C
Di-electric Strength	2 kV between contacts or coil to ground.
Insulation resistance	100 Megaohms min at 500 Volts DC 27°C and 65 % R.H.
Operate time	0.020 Sec.max at nominal voltage.
Release time	0.010 Sec.max at nominal voltage.
Life expectancy	10^6 operations at rated load.
Maximum weight	90 gms.



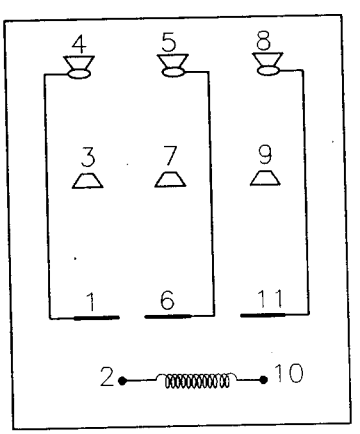


FIG 4.1 RELAY WIRING CONFIGURATION & LAYOUT

Design of Control Panel

5. DESIGN OF PANEL BOARD

5.1 MAIN CIRCUIT DESIGN :

The control panel main circuit is given in Fig 5.1. The design procedure is explained below. The main circuit is carefully designed such that the starting sequence is not violated under anycircumstances.

For the safe operation of the compressor, the starting sequence should be followed. This sequence is given below.

- The Compressor main control supply should be switched on.
- The Air handling unit blower should be switched on.
- The water pump should be switched on.
- The supply goes to the starter of the compressor and only then the compressor can be switched on.

The main control circuit ensures that the above sequence is maintained. This is obtained as follows.

The 'Y' phase is given to the main switch. If this is switched on the supply goes to the fan start switch (i.e) the blower fan. When this switch is switched on the supply goes to the compressor switch board. Now the compressor can be started.

5.2 SECONDARY CIRCUIT DESIGN :

The supply for the control circuit of the control panel is 24 volts DC. This supply is obtained by using 230 V/24 V step down transformer and a half wave rectifier as shown in fig.

The panel board's control circuit is designed such that the same panel board can be used for both the plants A and B as shown in the block diagram. In this, one is treated as standby. There are four relays for each compressor. The four relays are used to control the compressor operation based upon the parameter limits. The various parameter limits are given in the Appendix.

In the control circuit shown in Fig 5.2, the switch S1 is a 6 amps, 8 pole 2 way switch. If the switch is in position A it will control the compressor A. If it is in position B compressor B will be controlled. Consider the plant A in operation.

The four relays 7A, 7B, 7C and 7D are used to control the four parameters. In the same way the relays 4A, 4B, 4C and 4D operate for the compressor B.When the panel board is used for both AC plant and chiller plant the nine relays R1 to R9 operates for the nine parameters. Violation of the parameter limits will be indicated after the compressor is switched off by the respective relays. The Indication Panel connection is given in Fig 5.3.

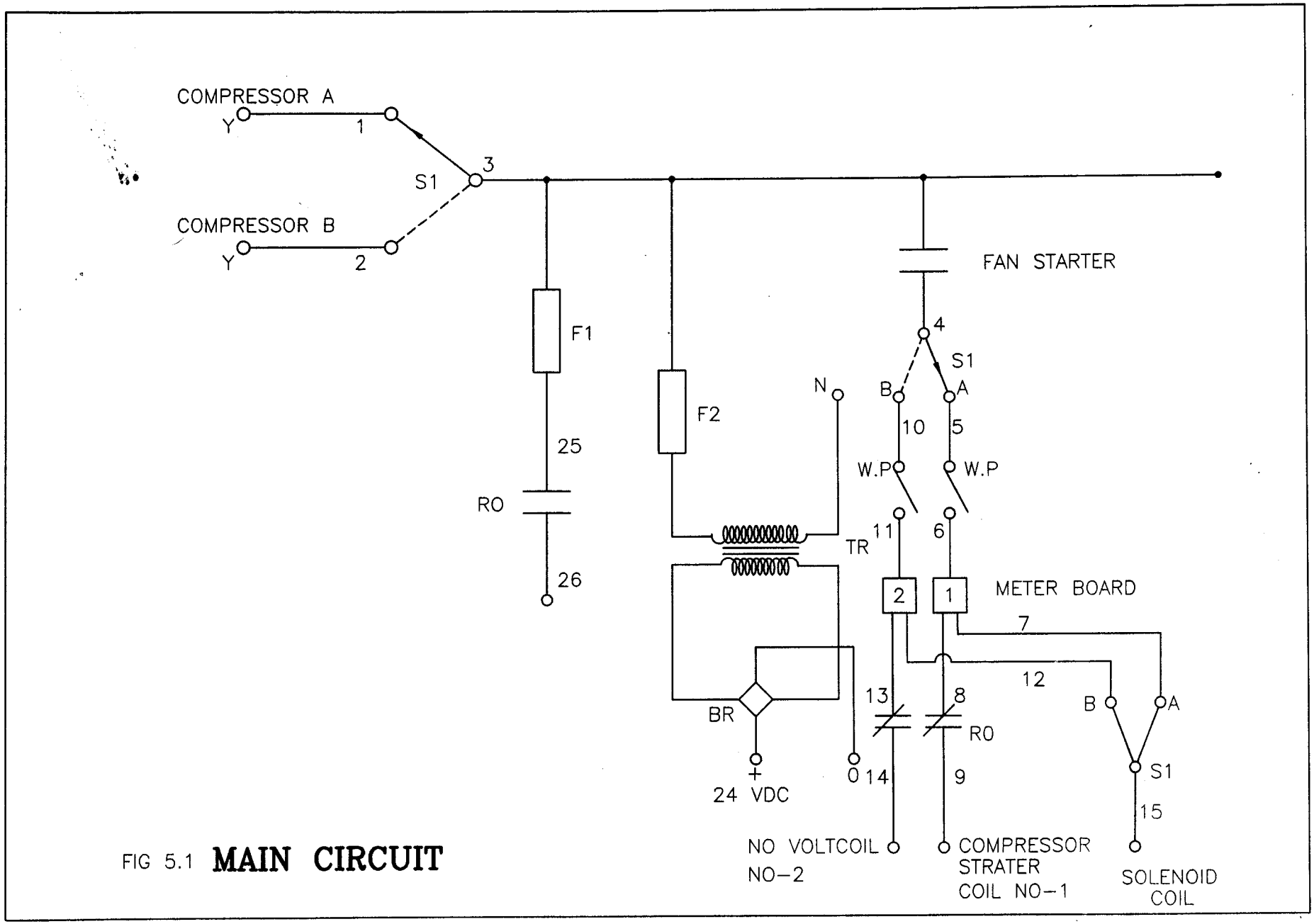


FIG 5.1 **MAIN CIRCUIT**

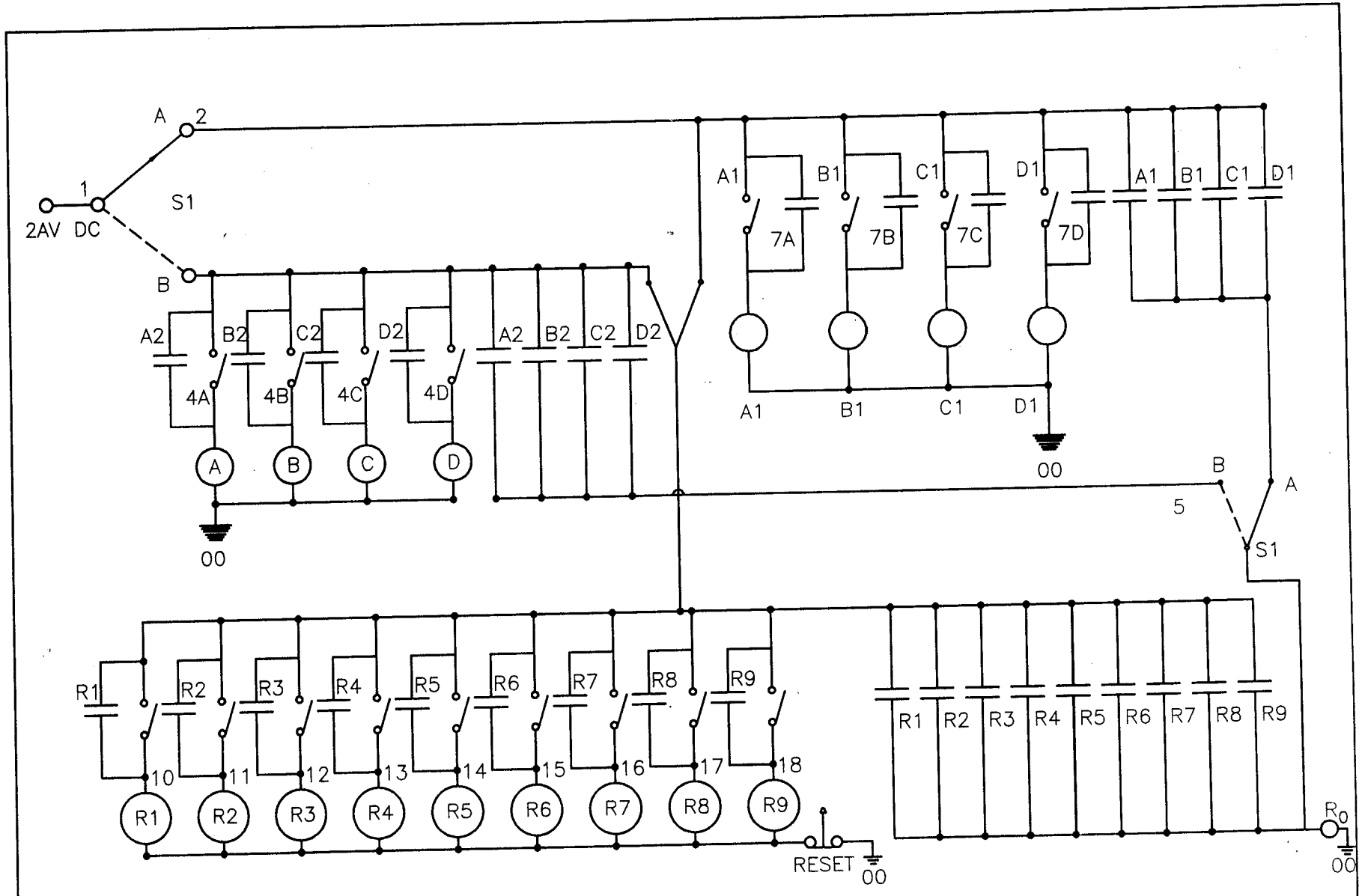


FIG 5.2 **CONTROL CIRCUIT**

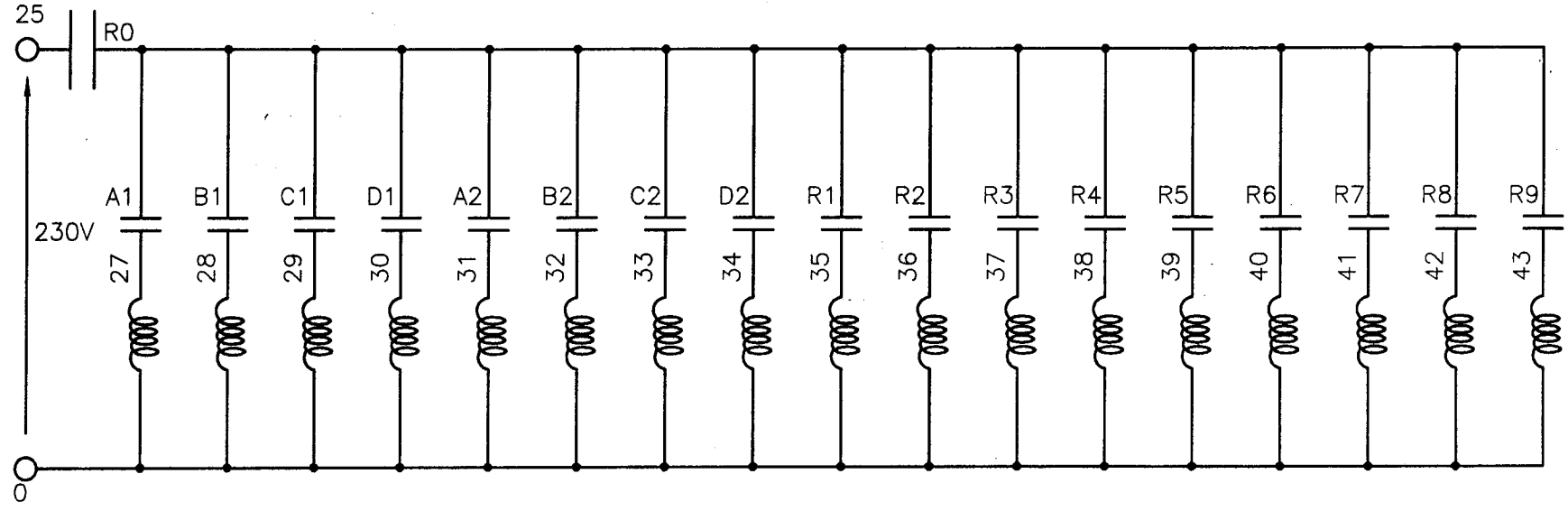


FIG 5.3 **INDICATION PANEL CIRCUIT**

Testing

6. TESTING

The panel board for 40 Tonne capacity Compressor unit has been fabricated and provisions are made to indicate Water suction pressure of Condenser, Compressor Oil pressure, Input Refrigerant temperature and pressure and Discharge Refrigerant temperature and pressure for any case of violation.

The panel board was fixed in the AC plant and was tested for its normal operating conditions. The panel works satisfactorily.

The simulation to test the panel for its operation under adverse conditions may be done using flush type of switches.

Conclusion

7. CONCLUSION

In the original setup, the compressor was protected from adverse operating conditions under manual supervision. When any violation occurred, the operator observes the change and switches off the unit in a proper sequence. This whole process has been automised with the help of relays.

The Control Panel for monitoring the compressor to protect it from adverse operating conditions has been designed and tested. It has been designed to monitor the AC Plant continuously with the help of relays. The relays give out a trip signal to the Expansion devices for unloading the cylinders, when any operating parameter exceeds its specified limits.

The Control circuit has been designed to monitor four parameters which can be extended. This panel has been designed to monitor one compressor while it can be extended to two or more. This panel can be used both for an AC plant or a chiller plant or for simultaneous monitoring.

With the world now switching to semi conductor technology, it is possible to greatly reduce the size and cost of this project by incorporating semiconductor relays in place of conventional relays. Also, by microprocessor interfacing technique online information about the various parameters can be obtained.

The control panel has been fabricated in PRICOL and tested successfully.

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Appendix

A P P E N D I X

I. COMPRESSOR UNIT :

1. CAPACITY	:	40 TONNES
2. MAKE	:	CARRIER MAKE
3. TYPE	:	5H40
4. CURRENT RATING	:	69 AMPS.
5. VOLTAGE RATING	:	415 V, A.C.
6. K.W/H.P	:	36.8 50
7. RPM	:	1440
8. INSULATION	:	CLASS 'E'
9. FREQUENCY	:	50 Hz.
10. CONNECTION	:	Y (STAR)
11. POWER FACTOR	:	0.83

II. WATER PUMP :

1. MAKE	:	BEACON (BEST & CO.,)
2. TYPE	:	MONOBLOC
3. CURRENT	:	11.5 AMPS.
4. VOLTAGE	:	420 V, A.C.
5. K.W./H.P	:	5.5 / 7.5
6. INSULATION	:	CLASS 'E'
7. SIZE	:	3DM4
8. PHASE	:	3

9. FREQUENCY	:	50 Hz.
10. RPM	:	2850
11. TEMPERATURE RISE	:	65 DEGREES C.
12. RATING	:	CONT.

III. PRESSURE GAUGE :

1. OPERATING PRESSURE	:	1 kg sq.cm.
2. SCALE RANGE	:	(0 - 150) lb/sq.in.

IV. AIR HANDLING UNIT :

1. MAKE	:	KIRLOSKAR
2. K.W H.P	:	11 15
3. CURRENT RATING	:	30 AMPS.
4. VOLTAGE RATING	:	415 V, A.C.
5. RPM	:	1450
6. PHASE	:	3
7. RATING	:	S1 (CONTINOUS)

V. CHILLER PLANT :

1. MAKE	:	KDS 1030++
2. IMPELLER DIAMETER	:	158 mm

3. SIZE	:	100 x 100 mm
4. HEAD	:	25 M
5. DISCHARGE	:	22 lps
6. INPUT KILOWATT	:	8.42
7. RPM	:	2800
8. HEAD RANGE	:	18 TO 29 M.
9. DISCHARGE RANGE	:	28 TO 15 lps.
10. MAXIMUM EFFICIENCY	:	64%
11. PHASE	:	3
12. FREQUENCY	:	50 Hz.
13. VOLTAGE RATING	:	415 V, A.C.
14. CONNECTION	:	DELTA
15. INSULATION	:	CLASS 'B'
16. K.W H.P	:	7.5 10
17. CURRENT RATING	:	15 AMPS.

VI. GAUGES :

I. COMPRESSOR:

		PRESSURE (Psi)	TEMPRATURE (Deg.C)
1. HIGH PRESSURE	:	(0 TO 300)	(-40 TO +120)
2. LOW PRESSURE	:	(-30 TO 150)	(-80 TO +25)
3. OUTPUT PRESSURE	:	(-30 TO 150)	(-80 TO +28)
4. C.O.P	:	(-30 TO 150)	(-80 TO +25)

II. STAND BY UNIT :

		PRESSURE (Psi)	TEMPRATURE (Deg.C)
1. HIGH PRESSURE	:	(0 TO 300)	(-30 TO +54)
2. LOW PRESSURE	:	(0 TO 300)	(-30 TO +55)
3. OUTPUT PRESSURE	:	(-30 TO 150)	(-80 TO +28)

III. WATER PUMP :

1. WATER PRESSURE : (0 TO 15) lb sq.in

IV. CHILLER PLANT PUMP :

1. WATER PRESSURE : (0 TO 150) lb sq.in
2. CHILLER PRESSURE : (0 TO 150) lb sq.in

VII. BAROMETER READINGS :

1. COMPRESSOR ROOM : 30 DEGREE C.
2. AIR HANDLING UNIT : DRY - 20 DEGREE C.
   WET - 16 DEGREE C.

VIII. RELAYS :

1. TYPE : MPC 3C O D
2. MAKE : PLA 96
3. CURRENT : 6 AMPS.
4. VOLTAGE : 24 V, D.C.
5. WEIGHT : 90 gms.
6. RESISTANCE : 500 OHMS (+ - 10%)

IX. BULBS :

1. MAKE	:	TECHNICH
2. WATTS	:	10 WATTS
3. VOLTAGE	:	230 V A.C.

X. SWITCHES :

1. SPDT SWITCH	:	5 A, 230 V, A.C.
2. SPST SWITCH	:	5 A, 230 V, A.C.

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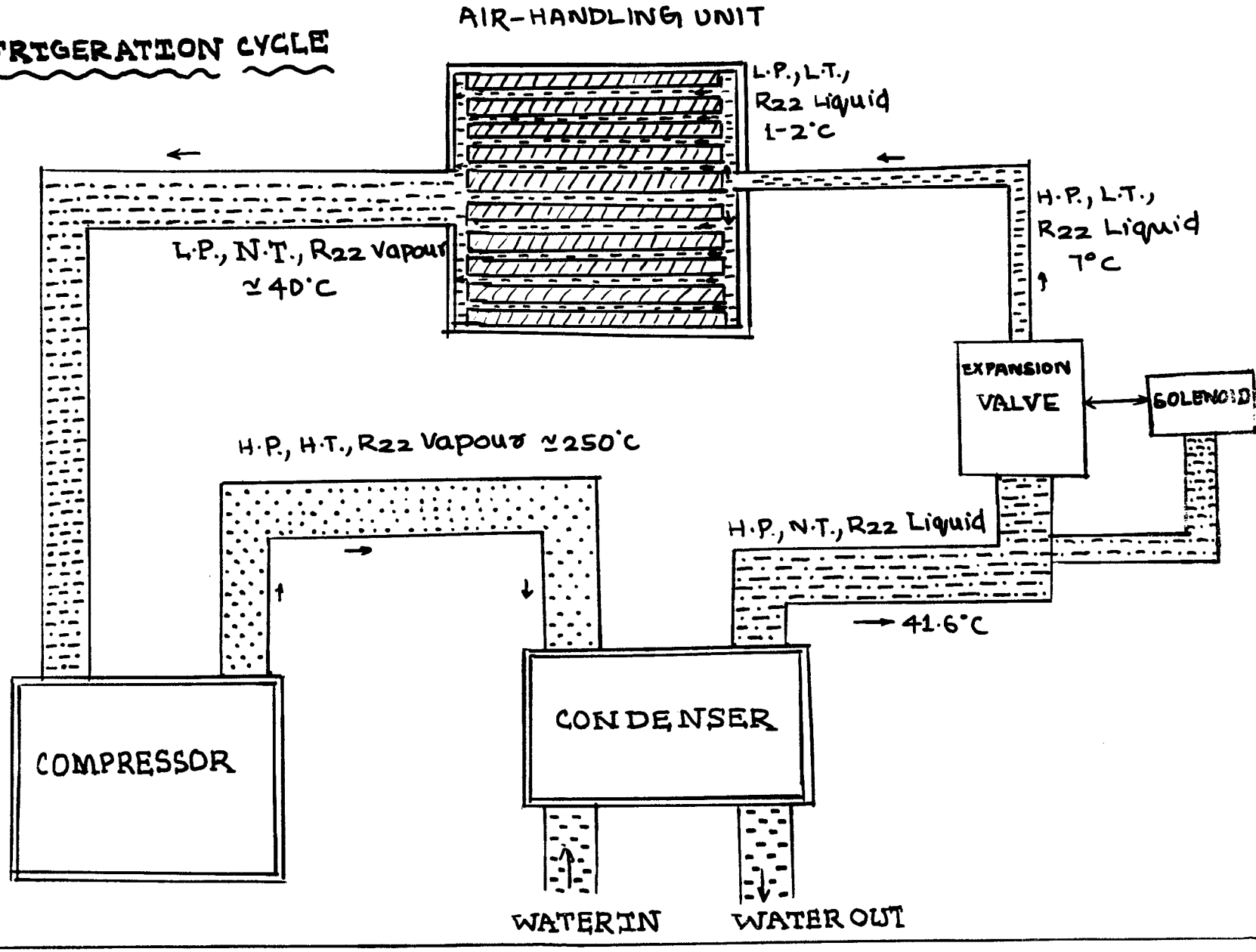
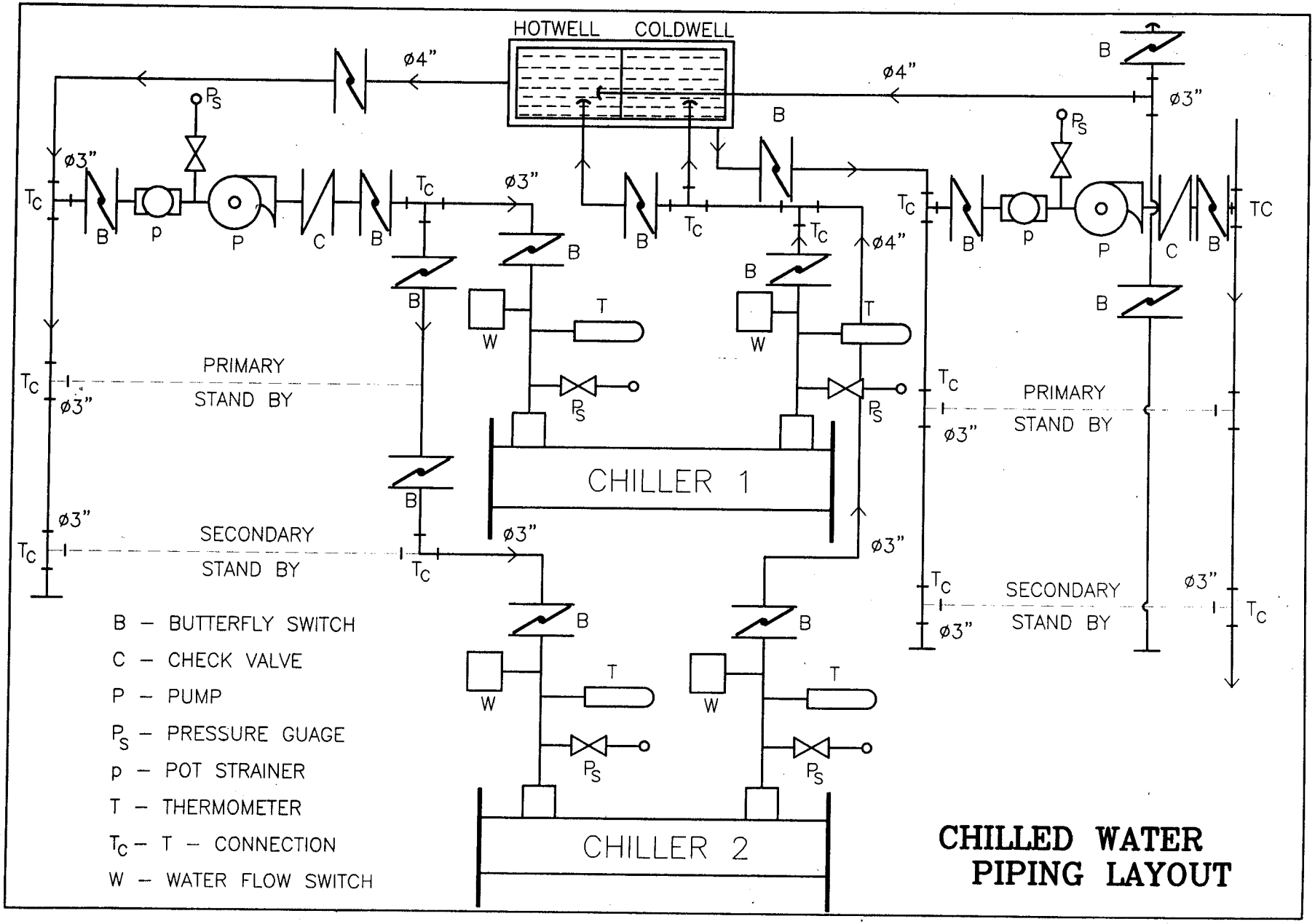
REFRIGERATION CYCLE




HOTWELL
COLDWELL
ø4"
ø3"
B
P
C
T
W
PS
TC
PRIMARY
STAND BY
SECONDARY
STAND BY
CHILLER 1
CHILLER 2
B – BUTTERFLY SWITCH
C – CHECK VALVE
P – PUMP
PS – PRESSURE GUAGE
p – POT STRAINER
T – THERMOMETER
TC – T – CONNECTION
W – WATER FLOW SWITCH
CHILLED WATER
PIPING LAYOUT