Control Panel For Injection Moulding Machine

Project Report

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Certificate

This is to certify that the Project Report entitled

Control Panel for Injection Moulding Machine

has been submitted by

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In partial fulfilment for the award of the degree of

Bachelor of Engineering

in Electrical and Electronics Engineering

Branch of the Bharathiar University

During the academic Year 1995-96

18/4/96

Guide

Head of the Department

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Certified that the candidate was Examined by us in the Project Work Viva-Voce Examination held on .... and the University Reg. Number was. ____________

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HRD-PROJECT-46
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TO WHOMSOEVER IT MAY CONCERN

This is to certify that the following final year BE (EEE) students from Kumaraguru College of Technology, Coimbatore-6 have completed their project in our organisation from July 95 to March 96.

1. **Mr D Mahesh Kumar**
2. **Mr T Paramaguru**
3. **Mr D Sundara Saravana Sampath Kumar**

The title of the project was **"Control Panel for Injection Moulding Machine"**.

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

We wish them the very best for a bright future.

ANTHONY THIAGARAJAN
ASST MANAGER - HRD

EN 29001/ISO 9001/BS 5750
APPROVED BY BVQI

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SYNOPSIS

To make injection moulded plastic parts, many important processing steps are involved-steps that must come together properly to produce parts consistently meeting performance requirements at the lowest cost. Lack of control of these important processing steps will result in less-than-desirable moulded parts.

Conventional technique of manufacturing control panels is to do it in an electromechanical, solid state or programmable way. Electromechanical panels lack accuracy and to the other extreme programmable panels require a heavy investment. Hence a compromise has to be made between accuracy and cost.

An attempt is made to develop a control panel with electromagnetic devices for contacts and solid state devices for timing and temperature control. To permit production of quality products with less effort at a lower cost is the principle of this project.

CONTENTS

CHAPTER I

INTRODUCTION:

Plastics is one of the worlds fastest growing industries, ranked as one of the few billion dollar industries. Approximately 32 percent by weight of all plastic processed goes through injection moulding machines.

With all this activity injection moulding plants continue to expand, new plants are built and modernization of plants continue to occur. The target of these plants is to produce injection moulded parts that meet the customer's performance requirements at a cost that insures a profit for the plant. Although economic success essentially depends upon external influences such as the market situation, competition and ecological considerations, attention must also be directed towards the possibilities existing within the plant.

Among the possibilities proper control of the machine plays a major role. It helps in producing a better, more consistent part, tighten tolerances while saving resin, reduce mould wear by eliminating overpacking, and save energy by cutting the time the hydraulic pump is operated.

Proper control of machine demands a high level of expertise from the moulder. The price that must be paid for the use of control equipment is not always just the capital cost. There is also the price of responsibility for using the control correctly and that takes time, patience and willingness to learn new ways of moulding good parts.

Conventional method of fabricating control panels is to do it in a electromechanical, solid state or microprocessor way. Each of these methods possess their own advantages and disadvantages. Modern trend is to mix these techniques to provide relatively higher advantages in an economical way.

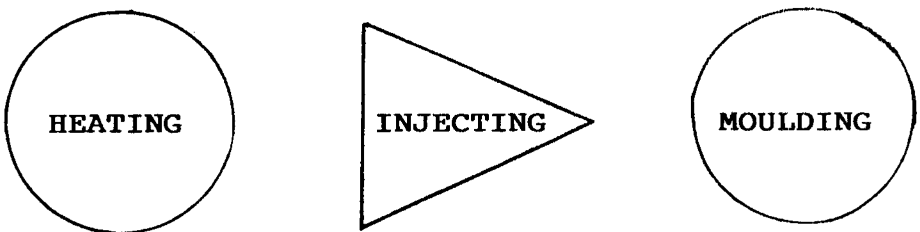
We present here a control panel realized with electromechanical devices for contacts, solid state devices for timing and temperature control.

CHAPTER 2

2. BASIC PROCESS DESCRIPTION

The term injection moulding is an oversimplified description of a quite complicated process that is controable within specified limits. This section summarizes the basic process.

Basic injection moulding cycle



Three basic operations exist :

1. Raising the temperature of plastic to a point where it will flow under pressure. This is usually done by simultaneously heating and masticating the granular solid until it forms a melt at an elevated and uniform temperature and uniform viscosity. This is accomplished in the cylinder of an injection moulding machine equipped with a reciprocating screw. The latter provides the mechanical working required in conjunction with the heating of the material. This overall process is called plasticizing of the material.

2. Allowing the plastic to solidify in the mould, which the machine keeps closed. The liquid, molten plastic from the injection cylinder of the injection machine is transferred

through various flow channels into the cavities of a mould, where it is finally shaped into the desired object by the confines of the mould cavity.

3. Opening the mould to eject the plastic after keeping the material confined under pressure as the heat is removed to soildify the plastic and freeze it permanently into the shape desired.

These three steps are the only operations in which the mechanical and thermal inputs of the injection equipment must be co-ordinated with the fundamental properties of the plastic being processed. These three operations are also the prime determinants of the productivity of the process, since manufacturing speed will depend on how fast we can heat the plastic to the moulding temperature, how fast we can inject it, and how long it takes to cool the product in the mould.

CHAPTER - 3

3.1. Terminologies associated with injection moulding machine :

3.1. 1. Clamping Unit

Portion of an injection moulding machine in which the mould is mounted, and which provides the motion and force to open and close the mould and to hold the mould closed with force during injection.

3.1. 2. Ejector (Knockout)

A provision in the clamping unit that actuates a mechanism within the mould to eject the moulded part from the mould. The ejection actuating force may be applied hydraulically or pneumatically by a cylinder attached to the moving platen, or mechanically by the opening stroke of moving platen.

3.1. 3. Moving platen or plate

That member of the clamping unit which is moved towards a stationery member. The moving section of mould is bolted to this moving platen.

3.1. 4. Stationery platen or plate

The fixed member of the clamping unit on which the stationery section of the mould is bolted. The member usually includes a mould mounting pattern of bolt holes or "T" slots.

3.1. 5. Toggle Clamp

A clamp unit with a toggle mechanism directly connected to the moving platen. A hydraulic cylinder or some mechanical force device, is connected to the toggle system to exert the opening and closing force and hold the mold closed during injection. The clamping force to hold the mould closed during injection is provided by mechanical advantage of toggle.

3.1. 6. Injection plasticizing unit

That portion of an injection moulding machine which converts a plastic material from a solid phase to a homogeneous semi liquid phase by raising its temperature. This unit maintains the material at a present temperature and force it through the injection unit nozzle into a mould.

3.1. 7. Two stage plunger unit

An injection and plasticizing unit in which the plasticizing is performed in a separate unit. The latter consists of a chamber to heat the plastic material by conduction and a plunger to push unmelted plastic material into the chamber into a second stage injection unit. During the injection cycle the shooting plunger forces the plastic melt from the injection chamber out through the nozzle.

3.1. 8. Screw

A helically flighted shaft that when rotated within the barrel mechanism works and advances the material being processed.

3.2. The Machine

An injection moulding machine is a machine for converting, processing and forming of raw plastic material of powder, pellets, or regrind into a part of desired shape and configuration.

Hard plastic granules are delivered to a hopper, from which they are fed through a throat into a rotating screw. The screw moves and compresses the material through a heated chamber where the granules soften to such a degree that they become fluid. The screw in addition behaves as a plunger and injects the fluid material into the tightly closed mould. The mould is maintained at a relatively cool temperature that will cause the plastic to become rigid after a set length of cure time. At the end of cure time the operator causes the gate to open, the parts are rejected from the mould, the mould is checked to see that it is fully clear of plastic, the gate is closed again and the cycle is started.

3.3. Moulding machine function

A simplified description of moulding machine function is as shown :

	ELECTRICAL	HYDRAULIC	MECHANICAL
1.	Motor switch "ON"	Pump pressurizes system	
2.	Close operator's gate and start cycle.	Oil flows to clamp cylinder from hydraulic manifold.	Clamp closes.
3.	Closing clamp trips limit switch directing oil to inject	Oil flows to injection cylinder.	Injection RAM forward to inject.
4.	Injection times out	Oil flows to screw drive motor.	Screw pumps itself back as parts cool in mold.
5,	Clamp cooling times out and screw trips shot size limit switch.	Oil flows to clamp cylinder rod.	Screw stops rotating and clamp opens.
6.	Ejection limit switch is tripped	Oil flows to ejector cylinder	Part is ejected from mould.
7.	Recycle timer times out.	Start cycle etc.	

CHAPTER 4

4.1. NEED FOR CONTROL

i) With controls properly installed and applied the performance of the plastics in the machine can be controlled within limits to produce zero defect parts meeting performance requirements at the lowest moulding cost.

ii) Inflation has driven up the cost of everything, time has become more valuable - smaller time increment are worth more.

A cycle that is on the average 1 percent slow in one year will cost more than one man-week's production.

Lost time : 1 percent slow

Standard cycle	:	10 secs	20 secs	60 secs
Actual time	:	10.1	10.2	60.6
Lost time (5000 hr year)	:	50 hr	50 hr	50 hr

1 Percent on the standard cycles listed is only a fraction of second. Hence it is critical to optimize the cycle time.

To reduce moulding cycle time and produce quality controlled or useful parts, there is a need for more precise control in the injection moulding operation.

Hence process control helps in producing a better, more consistent part, tighten tolerances while saving resin, reduce mould wear by eliminating overpacking, and save energy by cutting the time the hydraulic pump is operated.

Purchasing a more sophisticated process control system is not a fool proof solution to moulding quality problems. To solve part-reject problems requires a full understanding of the real causes, which may not be as obvious as first appeal. Failure to identify the contributing factors may send the moulder on a time consuming quest for "the perfect part".

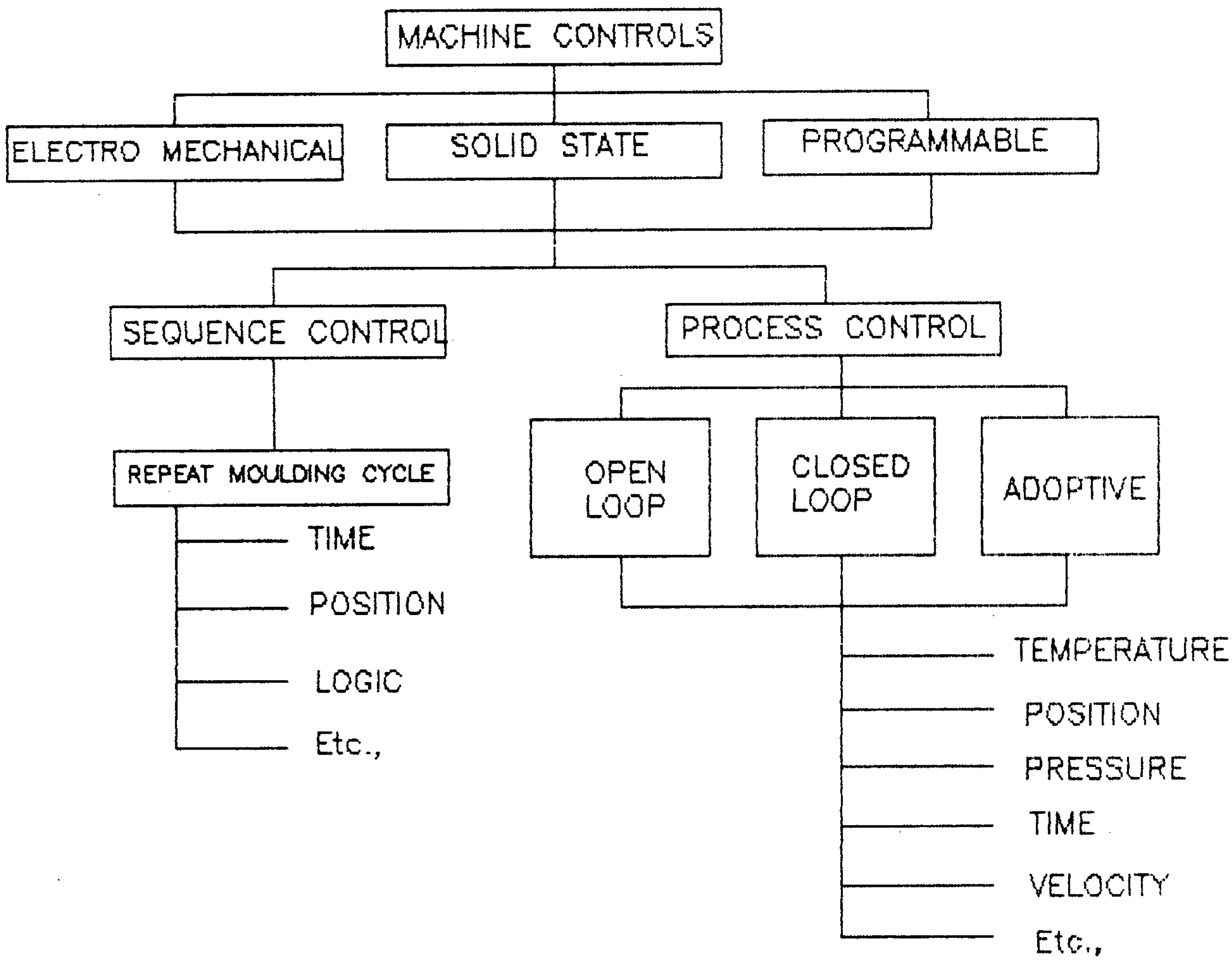


Fig 4.3 OVERVIEW OF CONTROL TECHNIQUES FOR INJECTION MOULDING MACHINES

4.4 Advantages and Disadvantages of each type of control technique :

A) Electromagnetic Controllers

ADVANTAGES

i) Electromagnetic contractors have high reliability, due to a) precision, manufacture b) few reliable components in their construction, c) experience gained in manufacturing and testing.

ii) Cost of electromagnetic contractors are at present less than their counter parts.

iii) Maintenance is easier. No special knowledge and training is needed.

iv) Fixing and wiring are easier.

DISADVANTAGES

i) Accuracy is less when compared to their counterparts.

ii) Involves moving contacts.

iii) Space requirement is more.

iv) Power consumption is higher.

B) Solid State Controllers

ADVANTAGES

i) Solid state components have low power consumption.

ii) These are compact devices.

iii) They do not have moving contacts.

DISADVANTAGES

i) Involves complex printed circuit board and the trouble shooting becomes difficult.

ii) Higher cost than equivalent electromechanical counterparts.

iii) Voltages spikes may sometimes turn on the devices.

C) Programmable Controllers

ADVANTAGES

i) Very high accuracy.

ii) These are not hard wired like the electromagnetic and solid state devices and it results in greater flexibility in setting the parameters.

iii) Very low power consumption.

iv) They occupy less space and have no moving contacts.

DISADVANTAGES

i) The machinery must be as good as the control device. It does little good to have timers that read in hundredths of seconds if the machine itself does not have servo mechanisms that match the microprocessor's precision.

ii) Involves very heavy investment.

iii) The machine operator requires knowledge about using the controller which requires training and experience.

4.5. Mixed Technique Controller for Injection moulding machine:

From the above discussion it appears that each technique possesses certain advantages with some constraints.

A more acceptable method, in line with cost restraints and providing relatively higher advantages is to mix the above techniques for obtaining best features.

CHAPTER 5

5. COMPONENTS OF CONTROL PANEL

The basic building blocks of the control panel are :

5.1 Contactors

A contactor is a mechanical switching device having one position of rest operated otherwise than by hand, capable of making, carrying and breaking overload conditions, the speed of make and break being independent of the operator.

Figure (5.1) shows details of electromagnetic contactor with its contacts and coil. The contactor is shown having three main contacts and two auxillary contacts. The main contacts are used in switching ON and OFF the power circuit whereas the auxillary contacts are used in the control circuit. The contactor coil is to be energised from a source of supply. Contactors are available for different voltage ratings, either a.c or d.c and contact combinations.

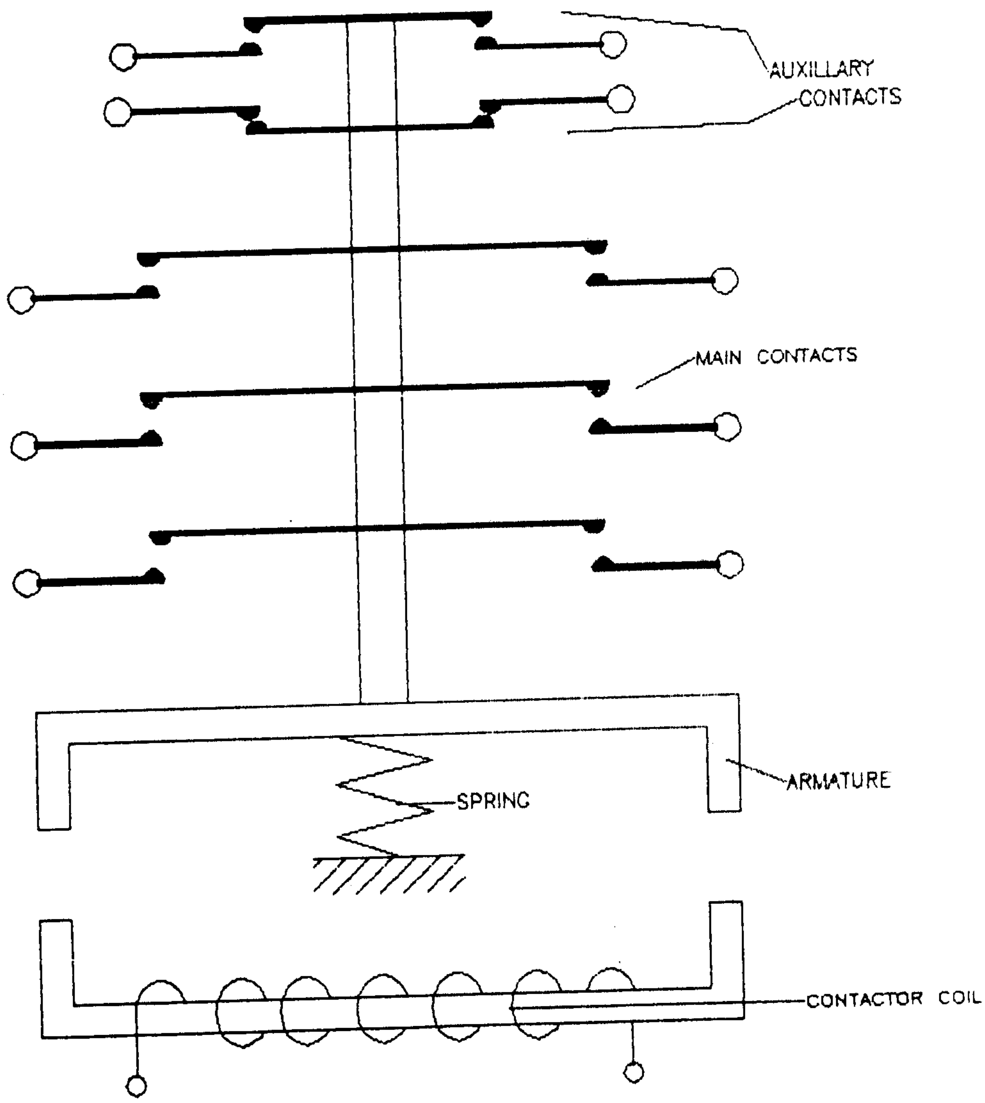


Fig 5.1 DETAILS OF AN

ELECTROMAGNETIC TYPE CONTACTOR

5.2 Overload Relays

Figure (5.2) a) shows the details of a thermal overload relay which is to be used in control circuits for protection purpose against overloads. In this thermal overload, relay, a bimetallic strip is provided.

A heating coil is wound on the strip which carries the line current of the circuit. In case of overload current flowing through the coil, the bimetal bends considerably and opens a normally closed contact or closes a normally open contact. The opening or closing of the contact of the relay, during overload can be utilized in tripping off the circuit in which this relay has been employed.

The thermal overload relay is to be used in association with a contactor as shown in figure (5.2) b) for motor protection.

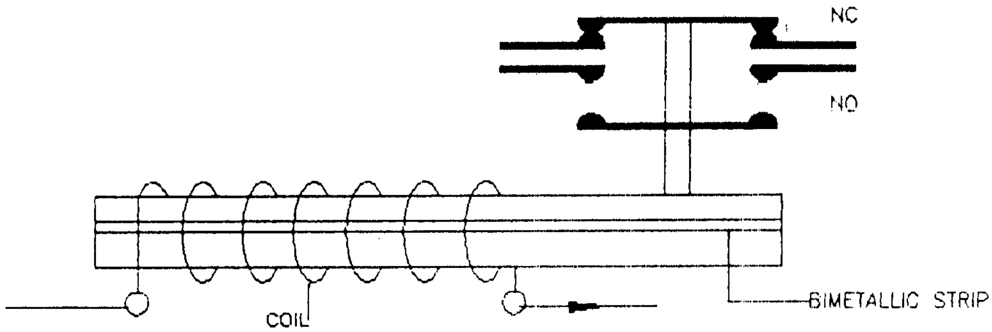


Fig 5.2(a) DETAILS OF A THERMAL OVERLOAD RELAY

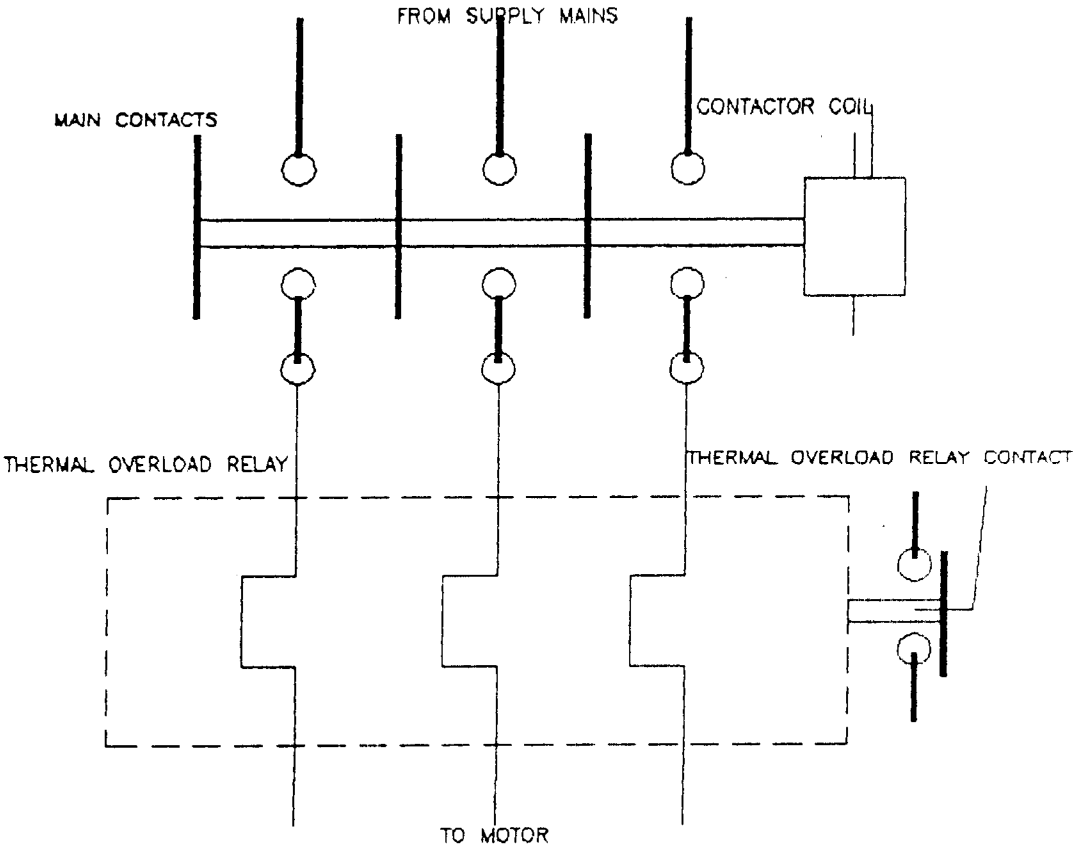


Fig 5.2(b) CONNECTION DIAGRAM OF CONTACTOR TERIMINALS

WITH THE TERIMINALS OF A THERMAL OVERLOAD RELAY

5 . 3. Programmable Timer

The HEF4541B is a programmable timer which consists of a 16 stage binary counter, an integerated osciallator to be used with external timing components, an automatic POWER ON reset and output control logic. The frequency of the oscillator is determined by the external component Rt and Ct within the frequency range 1HZ to 100Hz.

A low on the auto reset input (AR) resets the counter independently of all other inputs. A high at the input ar turns off the power ON reset to provide a low quiescent power dissipation of the timer.

The 16stage counter divides the oscillator frequency by 2^8, 2^{10}, 2^{12} or 2^{16} depending on state of address inputs A0, A1. Figure (5.3) shows the functional diagram.

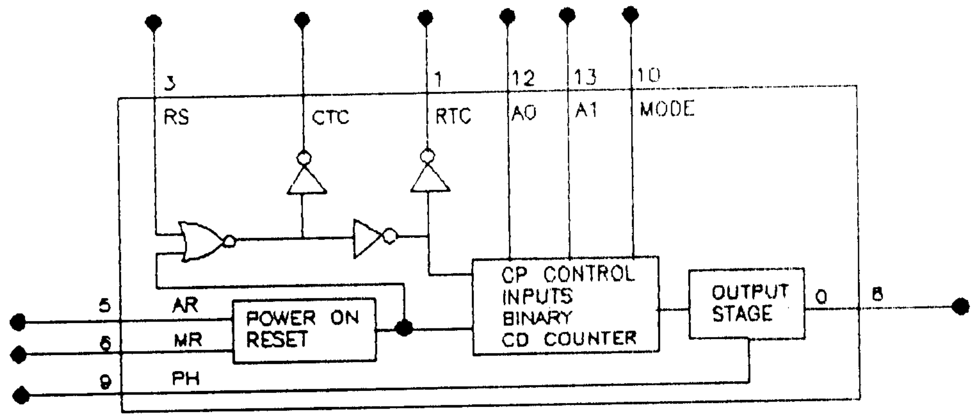


Fig 5.3 FUNCTIONAL DIAGRAM OF PROGRAMMABLE TIMER

A0, A1	-	**Address inputs**
MODE	-	**Mode select input**
AR	-	**Auto reset input**
MR	-	**Master reset input**
PH	-	**Phase input**
Rtc	-	**External resistor connection [Rt]**
Ctc	-	**External capacitor connection [Ct]**
Rs	-	**External resistor connection [Rs] or external clock input.**

PINNING DETAILS

5.4. Temperature Controller

The viscasity of melt is an important factor in moulding. Hence temperature control requires in depth attention.

The details of a temperature control is shown in the figure (5.4). A thermocouple senses the temperature and converts it into an equivalent voltage. A temperature setting potentiometer, which is a part of voltage divider network sets a reference voltage. This voltage is compared with the amplified thermocouple output, which is further amplified and activates a relay if there is a difference between these two. The relay contacts in turn issues commands to the main contactor which connects or disconnects the supply to heater coils.

Digital readout is provided by the diver IC 7107.

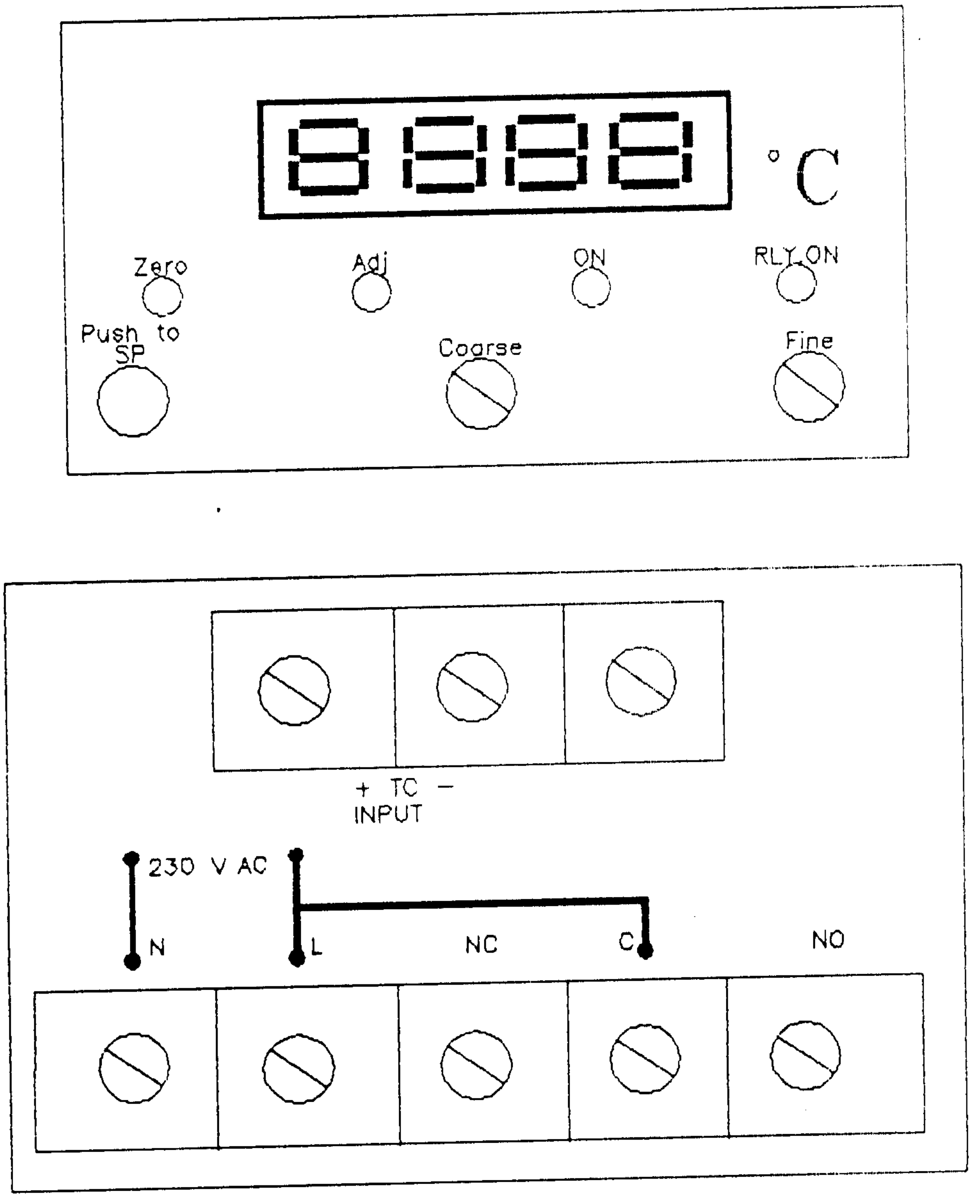


Fig 5.4 DETAILS OF A TEMPERATURE CONTROLLER

5.5 Other components

5.5. 1. Transformer

A step down transformer (230/24V) is employed to bring down the voltage to that suitable for control circuitory.

5.5. 2. Rectifier

A bridge rectifier to convert the 24v transformer output into d.c., is used.

5.5. 3. Capacitor

A 1000 μF capacitor is utilised to reduce the ripple of rectifier output.

5.5. 4. Push buttons, Mode Selectors, indicators, Fuses for protection, a metal sheet for fixing components, rails for mounting components, wires for connection, channels for laying wires, metallic box for enclosing the components form the rest.

CHAPTER 6

6.1. REQUIREMENTS OF DESI

'When megamanufacturers make milestones by creating cute, compact controlpanels why go for your panel?'- A question of such a fashion is answered below:

1. Usually injection moulding departments employ an electrician to maintain the control panels. So the panels should not involve complex PCB's which make trouble shooting difficult.

2. Microprocessor based control panels have relatively no maintanence. These machines involve large investment which for all cases can be opted for. Hence a lower cost control panel and providing very nearly the same advantages is necessary.

3. Machine operators usually prefer to have some controls for easiness in operation rather than the conventional facility provided by manufacturer. For example, an operator prefers to refill the machine by pressing a limit switch than by the push button. In such cases an alteration in wiring is essential. The control panel should be accessible for alterations.

4. The control panel should be easier to fabricate.

5. The net cost involved should be less than other types of panels.

6.2. COMPONENTS AND THEIR CATEGORY:

6.2.1. TIMING CIRCUIT:

To reduce mould cycle time is one of the objectives of design. As the machine itself is not too accurate a very high degree of accuracy upto microprocessor based level is not required as it will drive up the cost.

With cost constraints and to obtain very nearly the same advantages a HEF4541B a programmable timer with some solidstate associated circuitory is employed.

6.2.2. FOR RELAYING NEEDS:

Electromagnetic contactors are employed. These are best suitable for such a situation due to the following reasons: Solid state relays involves complex printed circuit boards in which trouble shotting is difficult once it develops a fault. These devices also drive up the cost when compared to electromagnetic equivalents. Maintanence and trouble shooting is easier in electromag -netic contactors and no expertise is need for them. Further it doesn't necessitates laying PCB'S which is a complex procedure. A rail mounting is sufficient to fix these contactors.

6.2.3 TEMPERATURE CONTROL:

The Viscosity of melt determines whether an acceptable moulded part is produced. Viscosity is a function of temperature of plastics, and temperature is a result of externally applied heat. Hence for quality products a Technique to keepthe temperature very close to set point is important.

For this digital temperature controllers which hold the setpoint within 2 to 5 degrees is used.

Thus solidstate timing, electromagnetic contactors and digital temperature controllers form a perfect component mix.

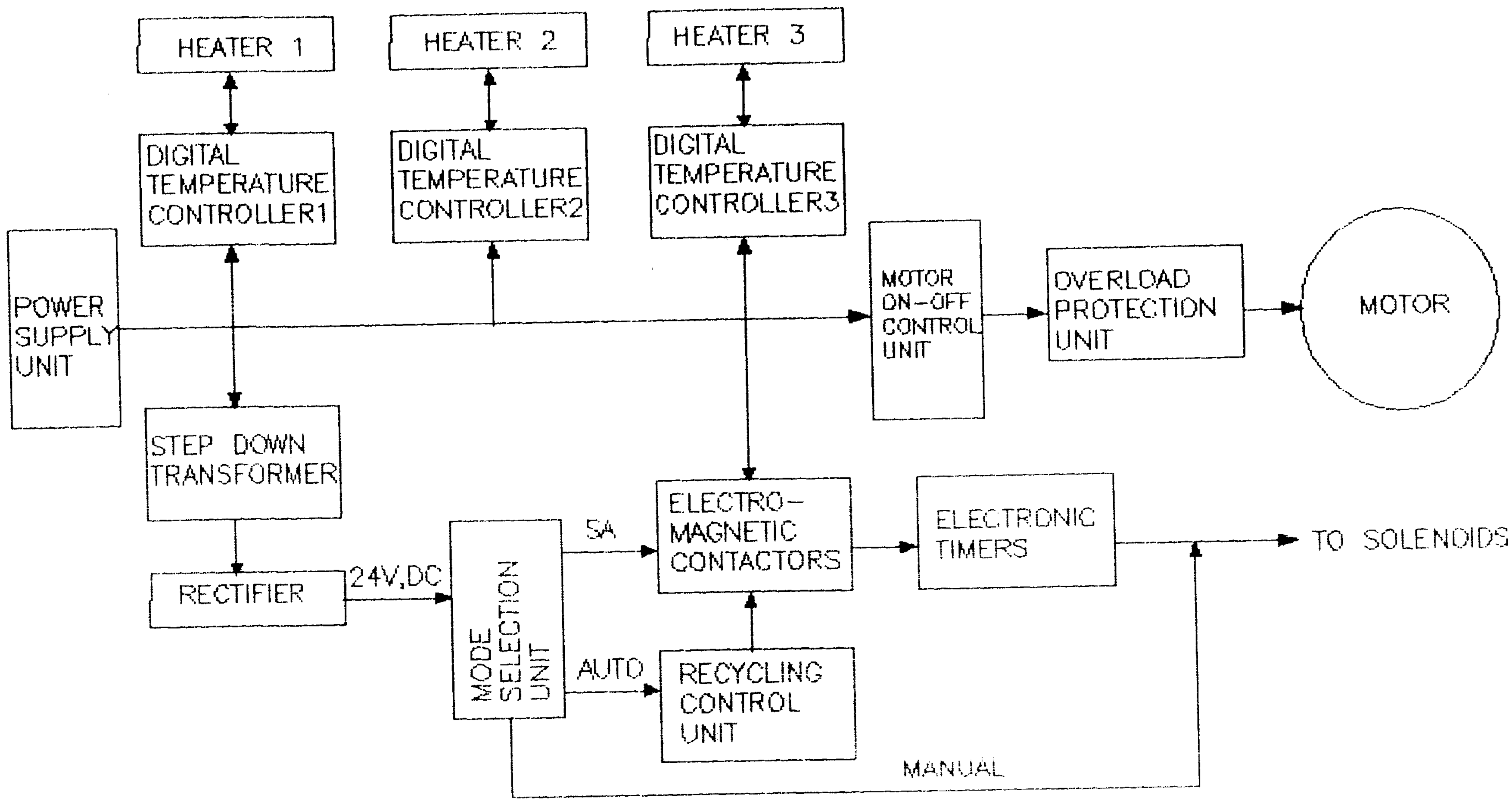


Fig 6.1 BASIC BLOCK DIAGRAM OF CONTROL PANEL

6.3. DESIGN FEATURES OF CONTROL CIRCUIT

6.3.1. MOTOR ON-OFF CONTROL CIRCUIT WITH OVERLOAD PROTECTION:

Three phase induction motors can be started direct-on-line, ie. by supplying the rated three phase voltage to the motor terminals at the time of starting. This can be done by using a triple pole switch. To incoporate motor protection against overloads a thermal overload relay and a contactor unit is to be used instead of triple pole switch. The contactor can be energised or de energised by pressing seperate push buttons for starting or stopping the motor.

The schematic diagram is shown in figure (6.2.) . When the control circuit is energised by pressing the 'TURN ON' push button, the motor gets 3-phase supply through the contacts of the electromagnetic contactor which are normally upen. the motor is protected against overload by a thermal overload relay which open circuits the motor when overloaded.

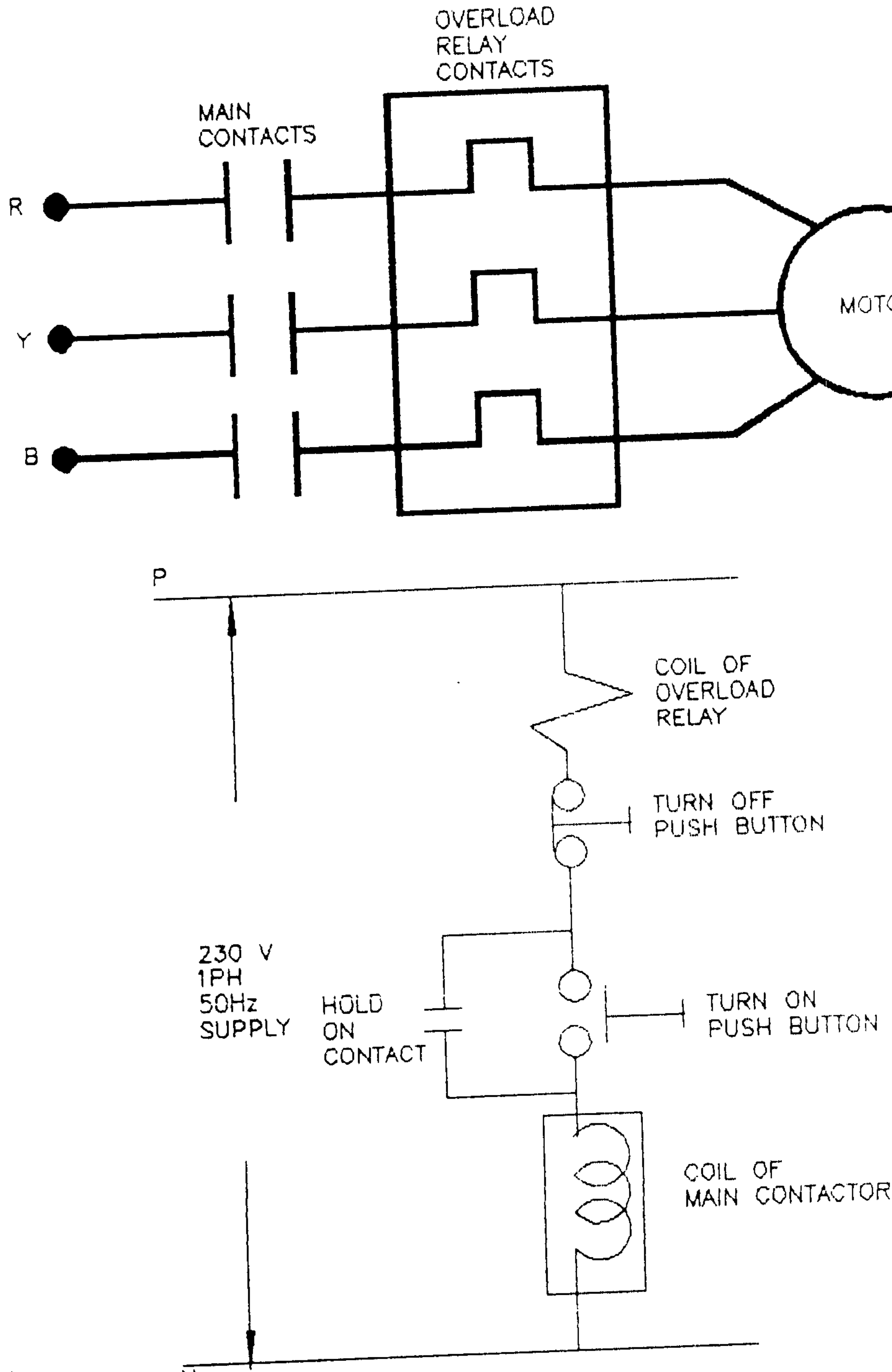


Fig 6.2 MOTOR ON-OFF CONTROL CIRCUIT WITH OVERLOAD PROTECTION

Catridge fuses are provided on the power circuit for the protection of the motor. Moreover, in case of short circuit as the thermal overload relay is too slow, the contactor will not have sufficient capacity of breaking short circuit current. A hold on contact for the start push button through a NO contact of the contactor as the push button makes momentary contact only.

When it is desired to stop the motor, the TURN OFF push button is pressed which de energises the control circuit. Thus, the main contact through which the motor was getting supply and also the hold-on contact get opened. The motor can be restarted by pressing the TURN ON push button.

In the event of power failure, the contactor becomes de-energised and the motor stops automatically and will not start running when the power supply is restored.

6.3.2. HEATER CONTROL CIRCUIT:

The schematic diagram to maintain the desired temperature to melt the plastic is shown in figure (6.3.2.). There is a heater selector switch which determines whether heating is required in that particular zone. The heater coils are connected to power supply through the main contacts which are normally open.

The required temperature is set in the temperature controller. The temperature controller possesses a contact which closes when the temperature is below the set point and opens when the temperature is at set point. This contact in turn energises or de-energises the main contactor coil thereby connecting or disconnecting the heater coil from the power supply. Three such units are present in an injection moulding machine to provide effective temperature control.

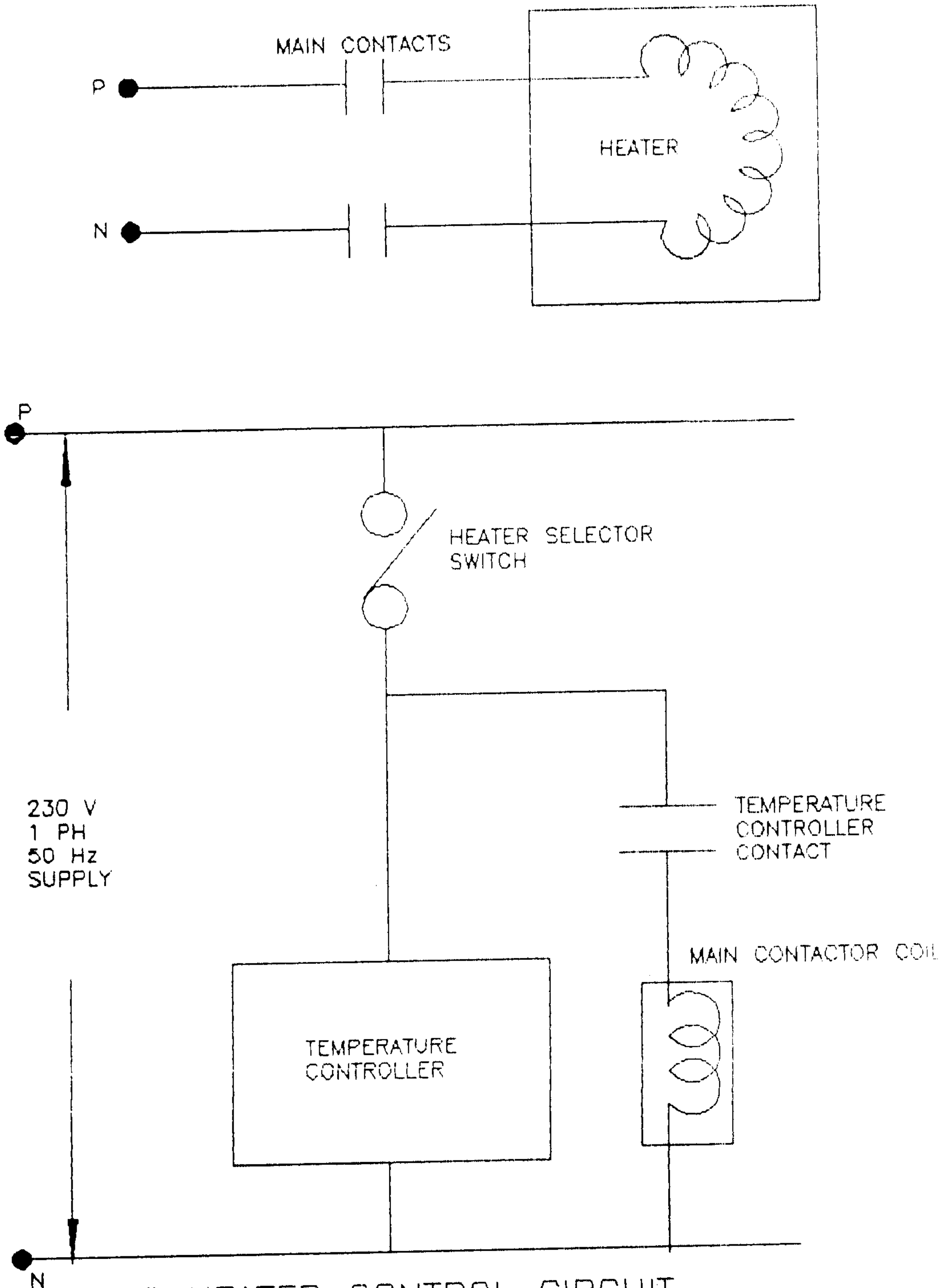


Fig 6.3 HEATER CONTROL CIRCUIT

6.3.3. MANUAL OPERATION CONTROL CIRCUIT:

Manual Operation is one in which each function and the timing of each function are controlled manually by an operator. Obviously the control circuit for such an arrangement is to provide independent push button switches for each operation.

The schematic diagram of control circuit for manual operation is shown in figure (6.4.3.). Indicators and diodes for creating non return paths are also provided. When a push button is pressed by the operator it excites two solenoid valves, one for that particular and another a common valve. Excitation for solenoid valves have to be provided till that particular operation is completed. Refilling as a special case doesn't excite the common valve.

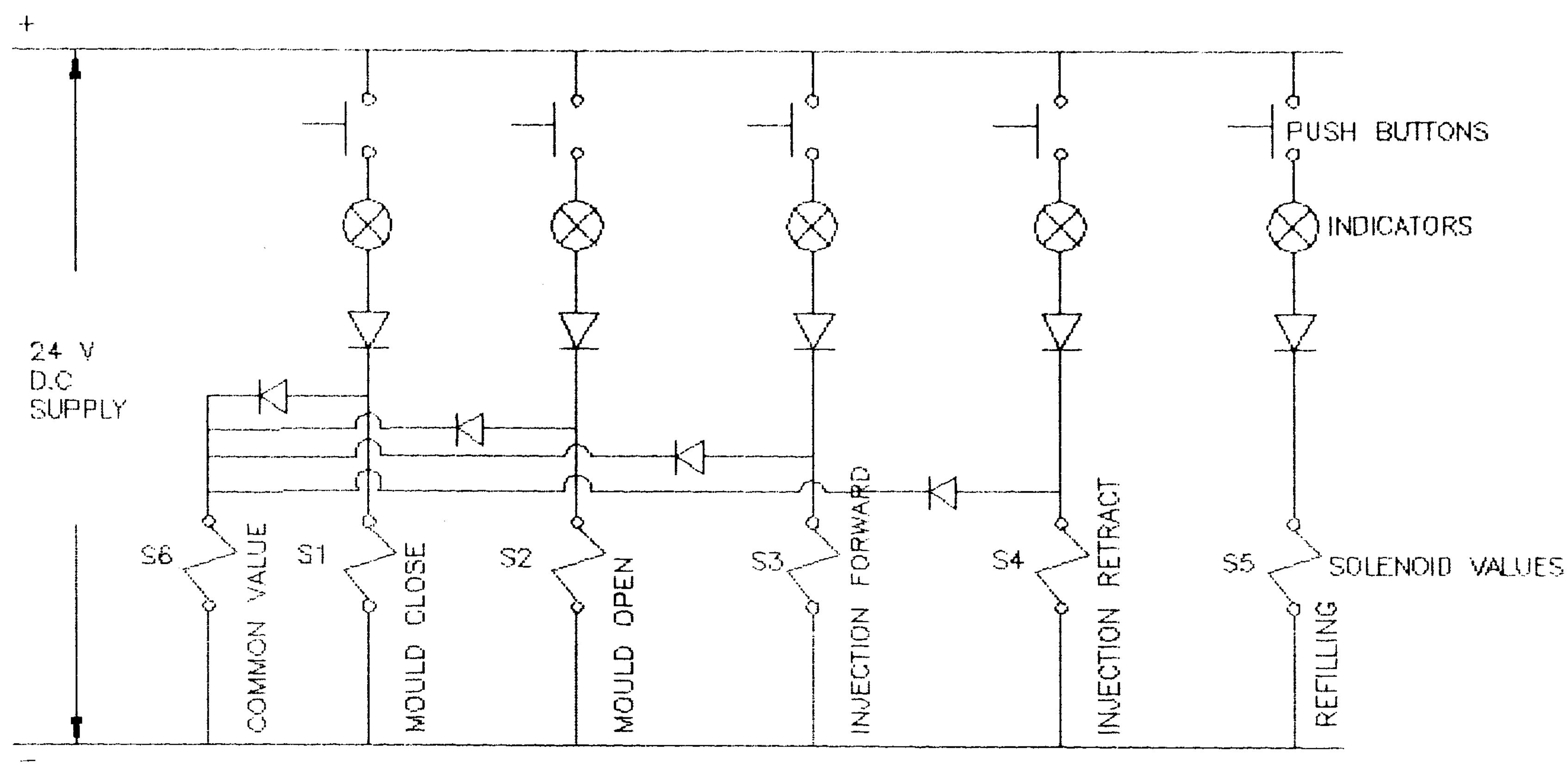


Fig 6.4 CONTROL CIRCUIT FOR MANUAL OPERATION

6.3.4. AUTOMATIC MODE OF OPERATION:

Automatic mode of operation is one in which the machine performs a complete cycle of programmed moulding functions repetitively, and stops only if there is a machine or mould mal-functions or is manually interrupted.

The schematic diagram of control circuit which inititates automatic mode of operation is shown in figure (6.5.). A mode selector switch connects or disconnects the auto mode enhancing circuit. Closing of contact of pulsating control signifies the end of a cycle. Closing of contact of last operation ie., mould olpen implies that initial conditions have been restored. This provided excitation to a contactor which in turn initiates a 'RECYCLING TIMER' which provides the required delay between two cycles. End of delay time initiates the next cycle.

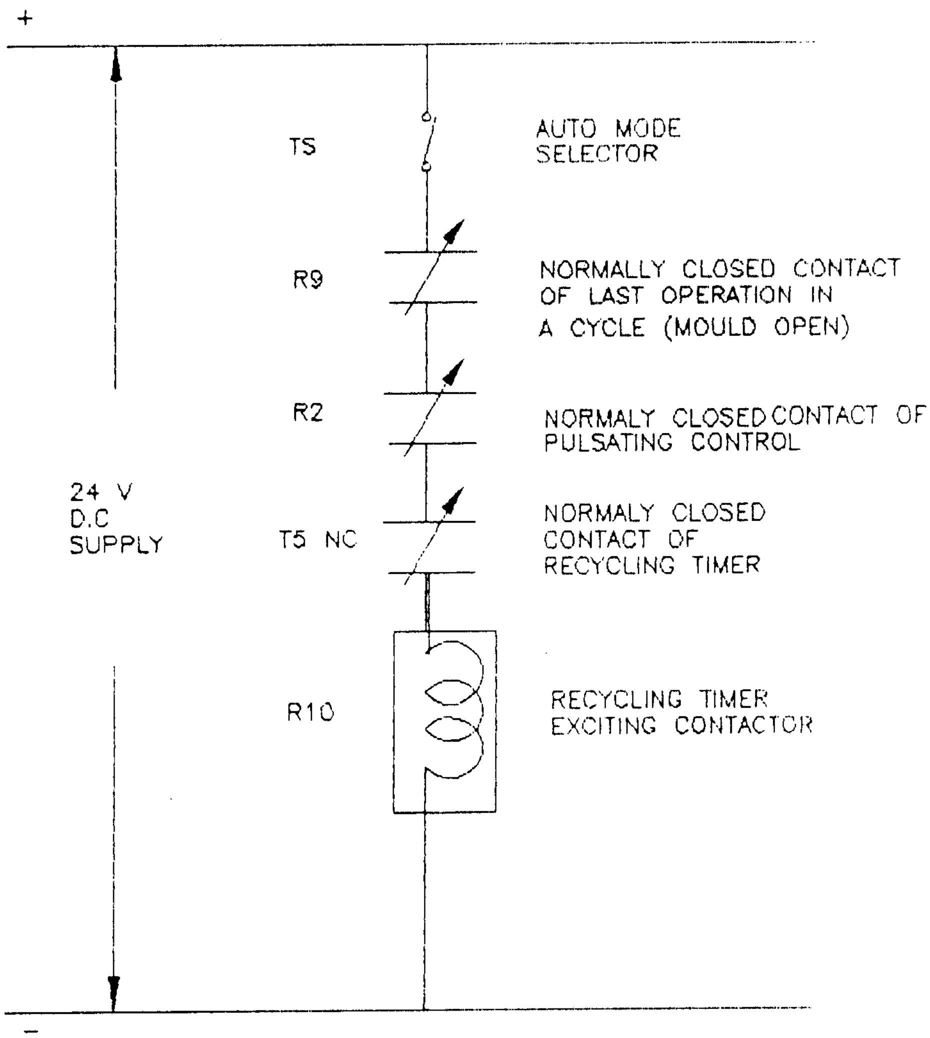


Fig 6.5 AUTOMATIC MODE CONTROL CIRCUIT

6.4. FUNCTIONS OF TIMERS, LIMIT SWITCHES AND CONTACTORS:

6.4.1. FUNCTIONS OF TIMERS:

The function performed by each of the five timers employed are as follows:

Timer 1:(T1)

This timer controls the 'INJECTION FORWARD' time ie., the time for which the screw ram has to travel in the forward direction.

Timer 2: (T2)

Timer T2 is responsible for providing cooling time in each cycle. This cooling time is allowed at the end of injection retraction.

Timer 3 : (T3)

Timer T3 controls the refilling time. This interval is provided between injection forward and retract operations.

Timer 4: (T4)

Timer T4 is the 'Overall Cycle timer'. Timing out of T4 signifies the end of one complete cycle.

Timer 5: (T5)

This is the 'DELAY TIMER'. While operating in automatic mode this time provides a time delay between two cycles.

6.4.2. FUNCTIONS OF LIMIT SWITCHES:

The position and function of limit switches employed for effective control are as follows:

Limit Switch 1 (LS1)

A normally closed limit switch situated behind the clamping unit. It opens when the clamp moves forward.

Limit Switch 2 (LS2)

A limit switch whose position determines the termination of injection forward. It is a normally closed one and opens on completion of forward movement of ram.

Limit Switch 2A & 2B (LS2A & LS2B):

They are similar limit switches which are normally open and gets closed when the mould closes.

Limit Switch 3 (LS3):

A normally open limit switch, closing of which signifies the end of injection forward.

Limit Switch 4 (LS4);

It is a normaly closed limit switch Retracting ram opens this switch.

Limit Switch 5 (LS5):

This is a normally open limit switch situated behind the clamping. When the clamp closes LS5 opens.

Limit Switch 6 (LS6):

Similar in position and function as limit switch 1. An additional switch to protect in case of malfunctioning of limit switch 1.

Limit Switch 7 (LS7) & (LS8):

These are operators gate actuated limit switches and they are of normally open type. Closing the gates actuates these limit switches that in turn brings about rapid forward movement of clamp.

These limit switches have to be properly co-ordinated with the rest of the circuit for effective control of the machine.

6.4.3. FUNCTIONS OF CONTACTORS:

The functions performed by the power and control contactors employed are given below:

Power Contactor C_1:

Contactor C_1 connects the motor to three phase supply when energised. It also enables push button starting by providing a hold ON contact.

Power contactors TH1, TH2 & TH3:

These contactors connect each of the three heaters to one phase of the supply. Coils of these contactors get energised or deenergised depending on the commands issued by the temperature controllers.

CONTROL CONTACTORS:

i) R1:

Closing of operators gate provides excitation to R1. Only upon excitation of R1 the entire conrol circuit is connected to the supply.

ii) R2:

It is a pulsating control contactor. Energising R2 initiates the 'OVERALL CYCLE TIMER' and marks the beginning of a new cycle.

iii) LS1R:

This contactor gets energised when limit switch LS1 is closed. Energising of LS1R connects only the mould close operation and disconnects rest of the circuit.

iv) R3:

It is mould close control contactor.

v) R4:

Contactor R4 when energised initiates the 'INJECTION CONTROL TIMER'.

vi) R5:

It is injection forward control contacor. Forward movement of clamping unit and initiation of injection control timer energises the R5 contactor.

vii) R6:

R6 is the refilling controller. Completion of injection forward ie., activation of limit switch LS3 energised R6. A 'REFILLING CONTROL TIMER' is also initiated.

viii) R7:

Timing out of 'REFILLING CONTROL TIMER' energises R7 which is the injection retraction control contactor.

ix) R8:

Energising of retraction control contactor (R7) in turn energises R8 the cooling time control contactor. This contactor connects the coil of 'Cooling time control timer' to the supply.

x) R9:

It is the mould open control contactor and signifies the last operation within a cycle.

xi) R10:

R10 is the autocycle initiator. It also energises a 'DELAY TIMER' the timing out which marks the beginning of a new cycle.

xii)R11:

Manual mode of operation energises this contactor. All the timers, auto circuit & semi auto control circuit are isolated when it is operating in manual mode.

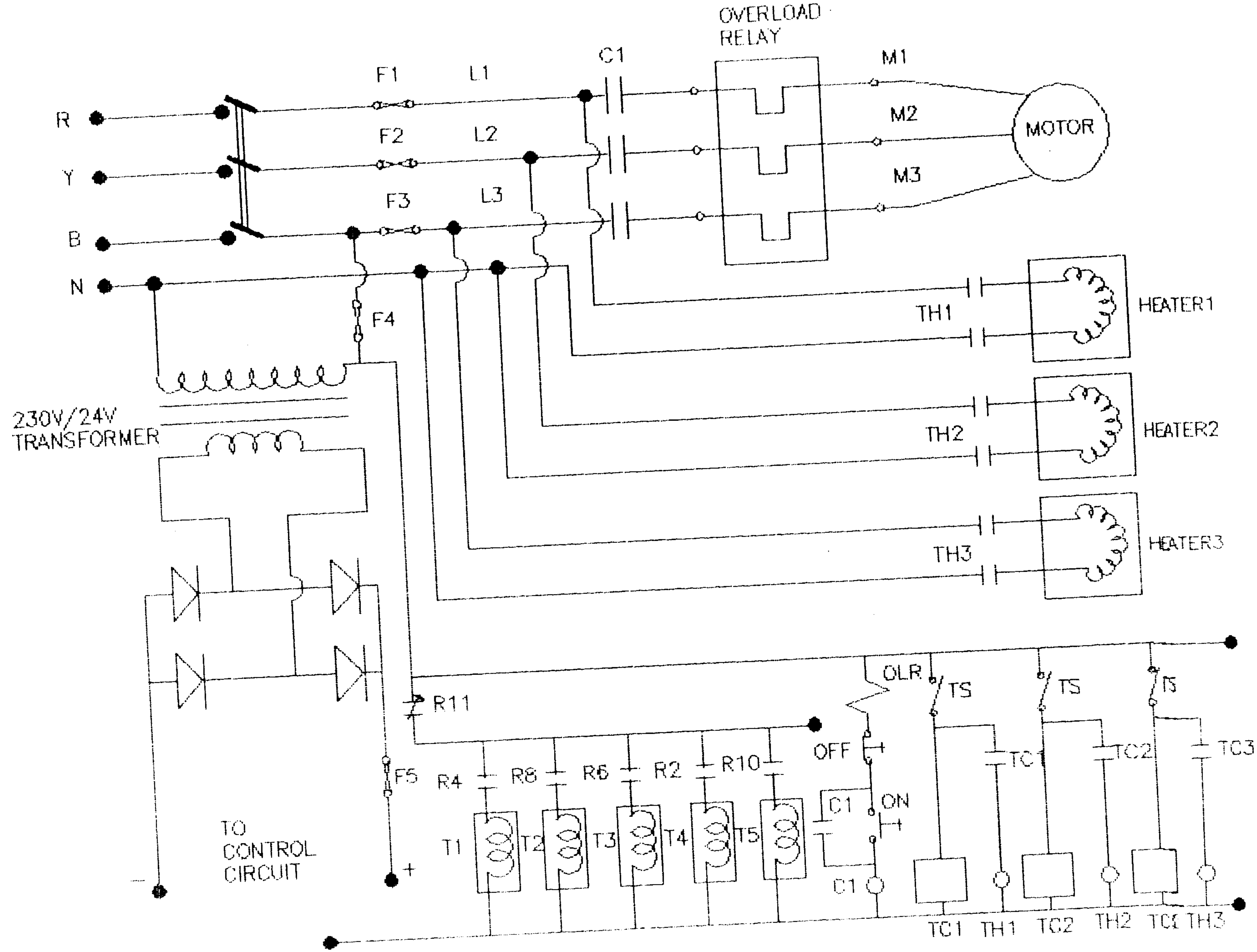


Fig 6.6 COMPLETE POWER CIRCUIT

THE COMPLETE CONTROL CIRCUIT

6.5. THE SEQUENCE IN A CYCLE:

A condensed version of overall operations is given below:

a) Closing the gates actuates a limit switch that in turn brings about rapid forward movement of the clamp. An 'OVERALL CYCLE TIMER' is started by this limit switch.

b) Forward movement of the clamp initiates the following: It actuates two limit switches which connects the injection control circuit; an 'INJECTION CONTROL TIMER' is started.

c) Starting of 'INJECTION CONTROL TIMER' makes the screw-ram to travel forward for injection.

d) Timing out of 'Injection Control timer' transfers control through a set of limit switches and 'REFILLING TIMER' is started.

e) Injection retraction the next operation occurs when refilling has finished ie., the timing out 'refilling timer'.

f) Backward movement of screw ram activates a limit switch which in turn starts a 'COOLING TIME CONTROL TIMER'.

g) Once the parts cool in the mould, ie., cooling controller timing out, it brings about slow opening of the clamp.

h) The 'OVERALL CYCLE TIMER' times out thereby stopping the cycle. The operators gate has to be opened and closed to initiate the next cycle. This is the case for Semi Automatic cycle.

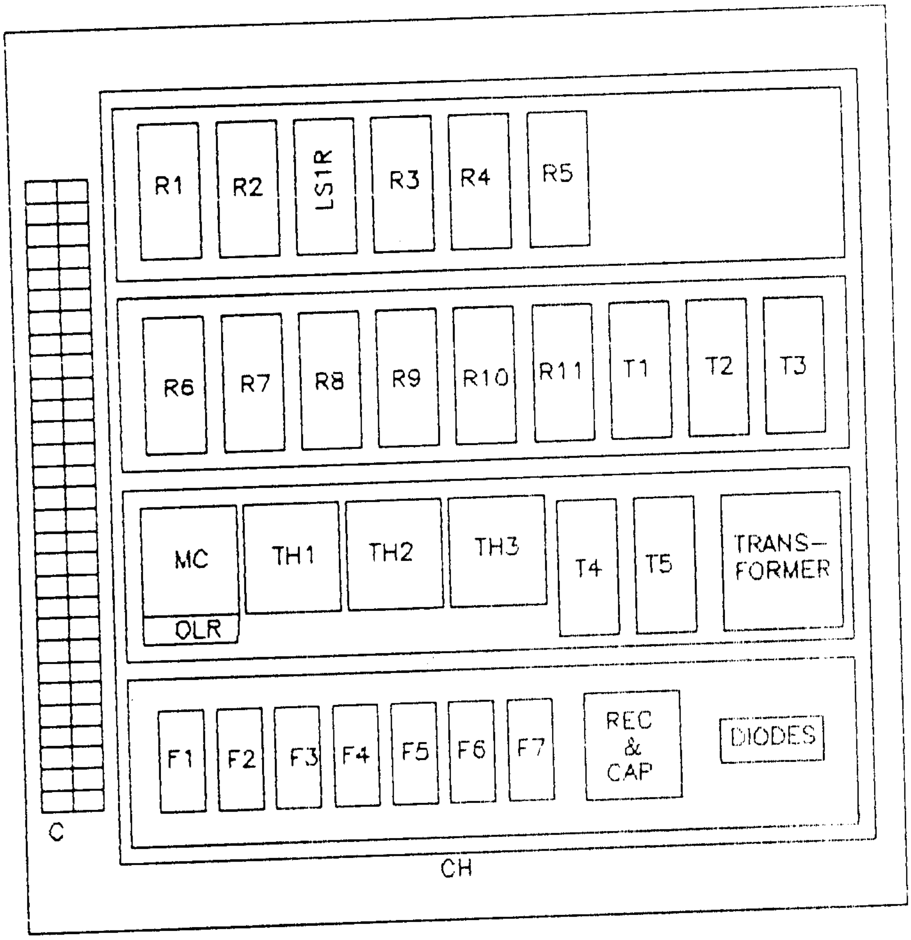
i) In case of automatic mode of operation a 'DELAY TIMER' takes over and the next cycle is initiated after a preset delay.

All the limit switches and timers carry out their commands in an orderly manner, and any interference with this systematic arrangement by pushing a control button will throw the plan out of order. Repeating the cycle in a consistent manner is obviously the major responsibility of the machine operator.

7. FABRICATION OF CONTROL PANEL:

The result of design necessitates the following component requirements:

	SPECIFICATION OF MATERIAL	NO
1.	24V D.C.Contactors	12
2.	230V A.C. Contactors	4
3.	6-60 Sec Timers	5
4.	230/24V transformer	1
5.	Mode selector	1
6.	push button switches	8
7.	Toggle switches	4
8.	Digital temperature controller	3
9.	1000μF capacitor	1
10.	Bridge rectifier	1
11.	Diodes	15
12.	Overload relay	1
13.	Fuse carriers	7
14.	Control panel box	7
15.	Channels, 14/0.3 wires 23/0.3 wires and connectors.	-



R1 .. R11	–	24 V D.C CONTACTORS
MC,TH1,TH2,TH3	–	230 V A.C CONTACTORS
T1 .. T5	–	6 – 60 SEC TIMERS
F1 .. F7	–	FUSES
C	–	CONNECTORS
CH	–	CHANNELS
REC & CAP	–	RECTIFIER & CAPACITOR
OLR	–	OVERLOAD RELAY

Fig 7.1 ARRANGEMENT OF COMPONENTS IN THE CONTROL PANEL

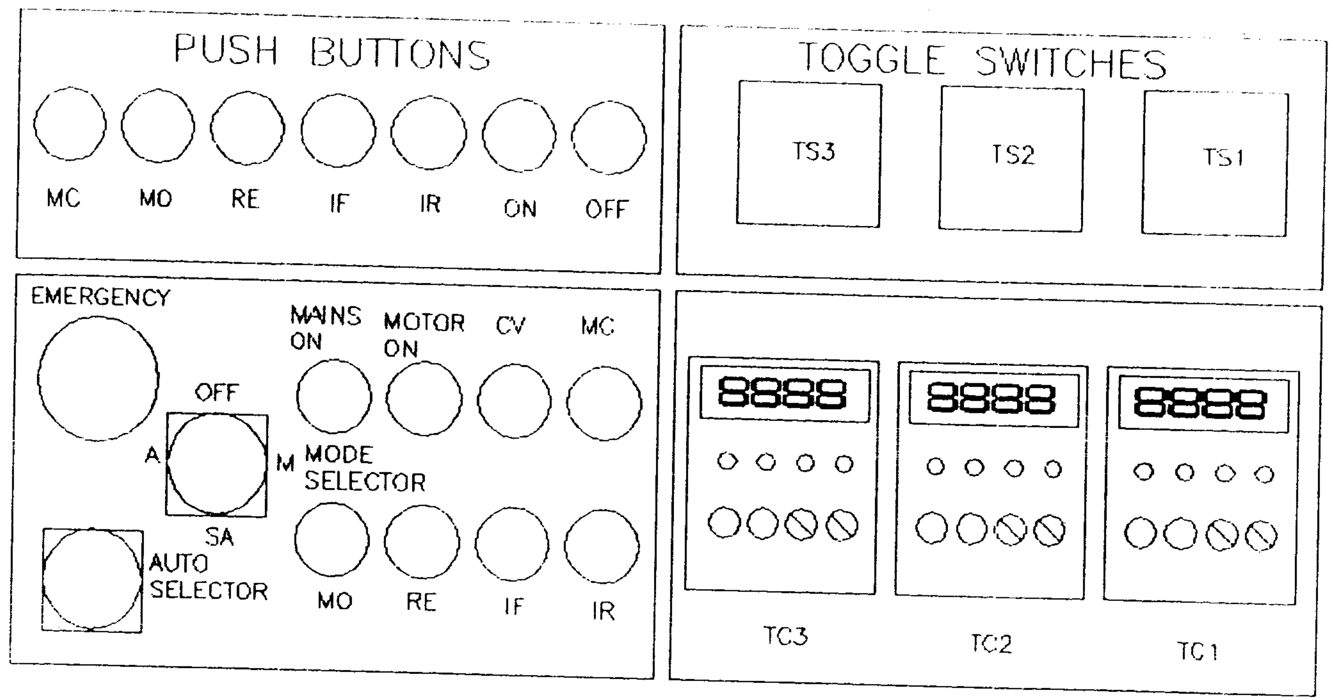


Fig 7.2 ARRANGEMENT OF SELECTORS

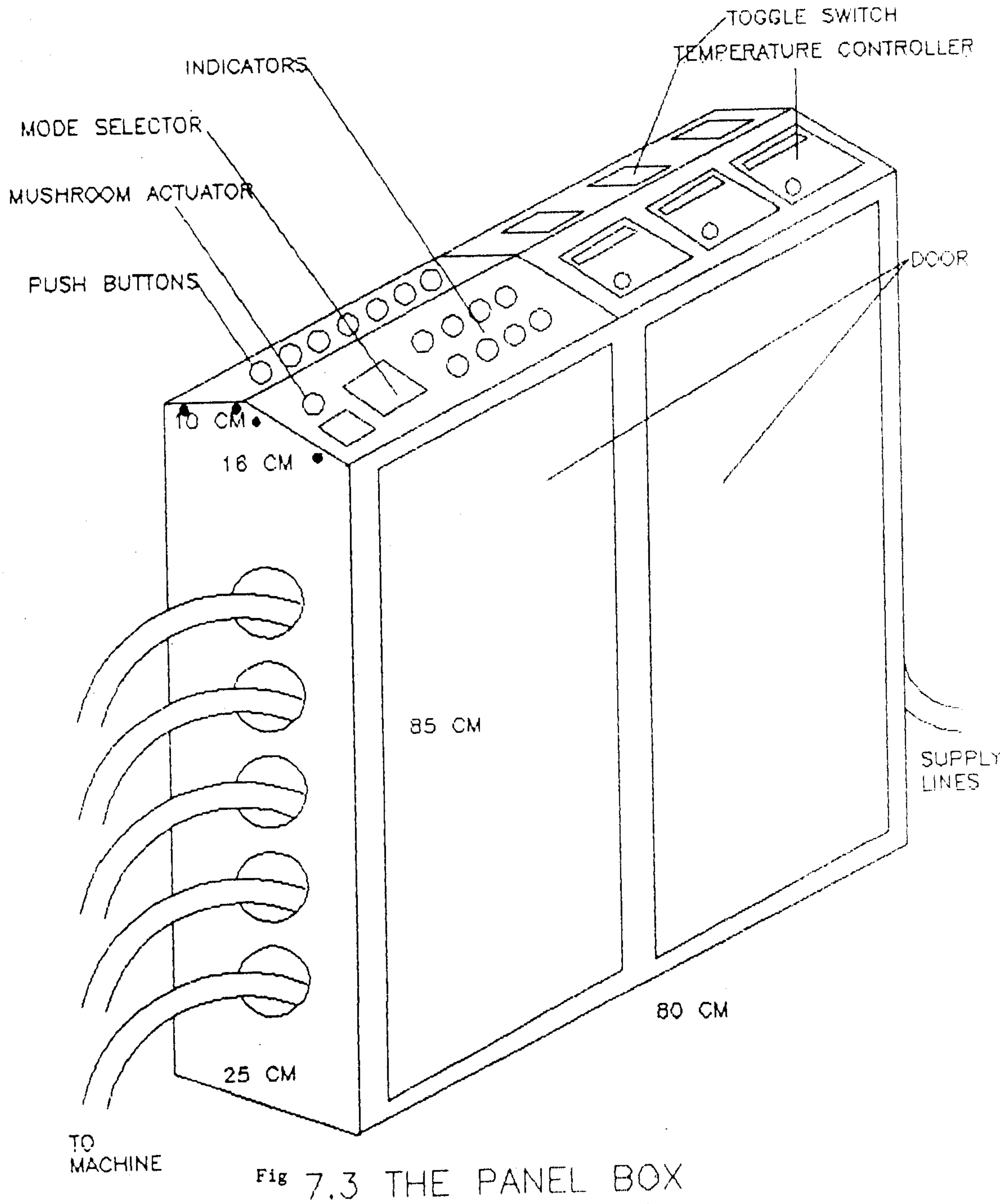


Fig 7.3 THE PANEL BOX

CHAPTER 8

8. COST ESTIMATION:

The following table gives the cost of various electrical materials employed in manufacturing the control panel:

Sr. No.	Specification of material	Unit	Qty requi -red	Rate Rs.	Per	Total Cost Rs.
1.	24 V D.C. contactors	No	12	900	each	10800
2.	230V A.C.contactors	No	4	700	each	2800
3.	Overload relay	No	1	400	each	400
4.	6-60 secs timer	No	5	1000	each	5000
5.	Add in blocks	No	5	150	each	750
6.	230/24V transformer	No	1	300	each	300
7.	1000 F capacitor and rectifier	No	1	-	-	200
8.	Temperature controller	No	3	2500	each	7500
9.	Fuse carriers, 14/0.3 wire and 23/0.3 wire	-	-	-	-	1000
10.	control panel box	-	-	-	-	1800
11.	Switches and indicators	-	-	-	-	1500
12.	Miscallaneous	-	-	-	-	500
					Total	32550

CHAPTER 9

ADVANTAGES :

The control panel fabricated provides the following advantages :

1. Three modes of operation are provided namely,

    a) Manual mode

    b) Semi Automatic mode

    c) Fully Automatic mode

a) Manual mode:

Mode of operation in which each function and the timing of each functions are controlled manually by an operator.

b) Semi Automatic mode:

Operation in which machine performs a complete cycle of programmed moulding functions automatically and then stops. It then requires an operator to manually start another complete cycle.

c) Automatic mode:

Operation in which machine performs a complete cycle of programmed moulding functions repetitively and stops only if there is a machine or mould malfunctions or is manually interrupted.

2. The control panel provides independent temperature control for three Zones of heating unit so as to prepare melt at desired temperature.

3. Independent time control for the following operations are provided.

1. To Control 'OVERALL CYCLE'
2. A timer for 'REFILLING'
3. 'INJECTION CONTROL ' timer
4. To provide 'COOLING'.
5. For a 'DELAY' between cycles.

Control panels which lackthis facility necessitates proper positioning of limit switches. Repeatability is of lower degree in such a case. Here if timing is determined once, it can be fixed for any future cycles.

4. Provides Overload protection for motor.

5. Facilities are provided to release pressure on mould under faulty operation.

6. Maintanence and trouble shooting is very simple.

7. Operating the panel is easy.

CHAPTER 10

CONCLUSION

A modern control panel with electromagnetic contacts, solid state timing and temperature control is designed, fabricated and tested. This control panel offers most of the modern control technique advantages with an acceptable level in line with cost constraints. When properly installed and applied, the performance of plastics in the machine can be controlled within limits to produce Zero defect parts meeting performance requirements with less effort at lowest moulding cost. The limits have to be set on the basis of testing and evaluation of moulded parts.

CHAPTER 11

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