# FAULT DETECTION AND CIRCUIT ANALYSIS OF INSTRON 1603 FATIGUE TESTING MACHINE

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

**BACHELOR OF TECHNOLOGY**
**IN**
**ELECTRICAL ENGINEERING**

By:

**Romit Mohapatra (10602035)**
**&**
**Ashutosh Panda (10602062)**

Department Of Electrical Engineering
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*Under the guidance of:*

**Prof. B.D.Subudhi**
**&**
**Prof. Sandip Ghosh**

Department Of Electrical Engineering
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# National Institute of Technology
# Rourkela

## CERTIFICATE

This is to certify that the project entitled, **“FAULT DETECTION AND CIRCUIT ANALYSIS OF INSTRON 1603 FATIGUE TESTING MACHINE”** submitted by **Ashutosh Panda** and **Romit Mohapatra** is an authentic work carried out by both under our supervision and guidance for the partial fulfillment of the requirements for the award of **Bachelor of Technology Degree** in **Electrical Engineering** at **National Institute of Technology, Rourkela.**

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University / Institute for the award of any Degree or Diploma.

**Date- 07/05/2010** **( Prof. B.D. Subudhi )** **( Prof. Sandip Ghosh)**
**Rourkela** **Dept. of Electrical Engineering** **Dept. of Electrical Engineering**

# ACKNOWLEGEMENT

We deem it to be a privilege to have been the students of Department of Electrical Engineering in National Institute of Technology, Rourkela.

We would like to thank our Project Supervisors **Prof. B.D.Subudhi & Prof. Sandip Ghosh**, Department of Electrical Engineering, for their guidance, support, motivation and encouragement throughout the period in which this work was carried out. Their readiness for consultation at all times, their educative comments, their concern and assistance with practical things have been invaluable.

We are grateful to **Prof. B.D.Subudhi**, *Professor and Head*, Department of Electrical Engineering for providing necessary facilities in the department.

We would also like to thank all our friends who have been a constant source of motivation for us.

Above all we would like to thank God for giving us will and determination for doing our project

Dt. 07/05/2010

ROMIT MOHAPATRA (10602035)
ASHUTOSH PANDA (10602062)

# ABSTRACT

Instron 1603 is a fatigue testing machine imported from England in 1987. This machine works on electromagnetic principle. Instron is presently supplying 8000’s series which are Hydraulic Based machines. 1603 can be used for testing up to 120 Hz load cycle where as the present machines can be used until 10Hz load cycle, this is where 1603 scores over present machines but strategically company has stopped manufacturing and service to this machine. The machine present in our institute is not in working condition from the past 2 years, the reason behind this is misalignment of circuits, and this is where we pitch in to look into the problem and fix it. The team’s objective was basically concerned with understanding the machine in depth, to make a total record of the machine and to do a strategic design of the controller and other important circuits to run the machine.

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# CHAPTER – 1

# INTRODUCTION

The Instron Model 1603 EMR (Electro Magnetic Resonance) machine has been designed for high cycle fatigue testing of materials (mainly metals) which includes:

- Production of data for S/N curves.
- Pre-cracking of compact tension and bend specimens for fracture toughness determinations.
- Crack growth studies, i.e. number of load cycles per unit crack length increase.
- Fatigue of fastenings, i.e. bolts etc.
- Fatigue of components, i.e. welded joints, gear teeth, etc.

These tests may be carried out while cycling through zero loads, or about an entirely tensile or compressive mean load.

The test specimen is held vertically in a frame that has its design based on a resonant spring/mass system.

The principle of operation is that a cyclic load is produced in a specimen by exerting the natural resonance of a mass supported by a spring, of which the specimen is a part.

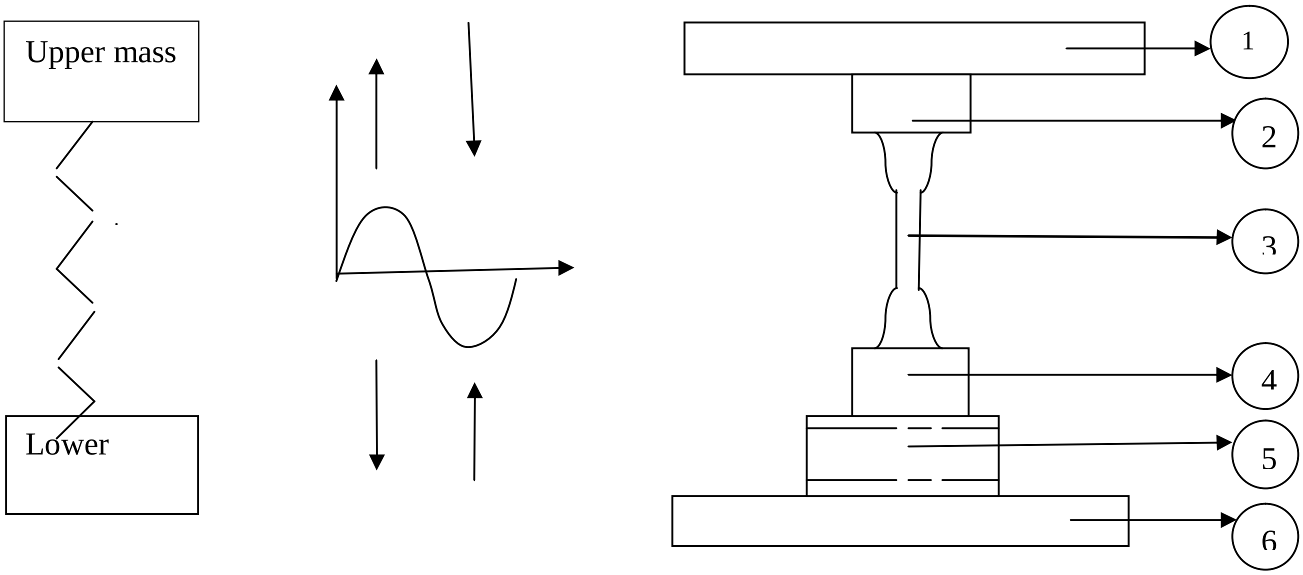

Fig- 1.1 (1)Upper Mass (2) Upper grip (3) Specimen (4) Lower grip (5) Lower cell (6) Lower mass

As the specimen, its grips and adaptors are part of the spring / mass system, the characteristics of these components largely dictate the performance of the machine during a test. The specimen can only be tested if it will respond as a spring, i.e. a metal tested within its elastic range. In the model 1603 Machine, the basic spring/ mass is suspended on support springs, an electro- magnet is positioned below the two masses to maintain oscillation at the natural resonant frequency.A position screw enables adjustment of the height of the upper specimen grip and can also, if necessary apply a mean load by deflection of the support springs.

The spring mass is maintained at resonance by magnet drive pulses , generated in a power amplifier , in synchronism with the natural frequency of the resonant system , using the load cell output as a timing waveform. The design of the power amplifier is novel and is the subject of a patent application. Normally the magnet would be powered by a large linear amplifier of about 1,000 W with a frequency spread of about 50-400 Hz. The power dissipation of such an amplifier results in considerable heat with consequent loss of reliability.

The amplifier of the Model 1603 EMR Machine works as a switching device with considerably reduced dissipation and makes a further power reduction by feeding back into the power supply the energy produced by the magnet back EMF. This results in a power consumption of only 150 W, approximately, to maintain the full load capabilities of the machine.

The mean load is automatically maintained on the specimen by four Achme screws at the corners of the support spring structure. The springs are belt driven from a reversible drive motor through worm gear boxes and the motor is energized in the required direction by a servo system which constantly compares the required mean load with the actual mean load and turns the screws to adjust for the difference.

**Fatigue:**

It has been found experimentally that when a material is subjected to repeated stresses, it fails at stress below the yield point stress. Such type of failure of material is known as Fatigue. The failure is caused by means of a progressive crack formation which are usually fine and of microscopic size. The failure may occur even without any prior indication. The fatigue of material is affected by the size of the component, relative magnitude of static and fluctuating loads and the number of load reversals.

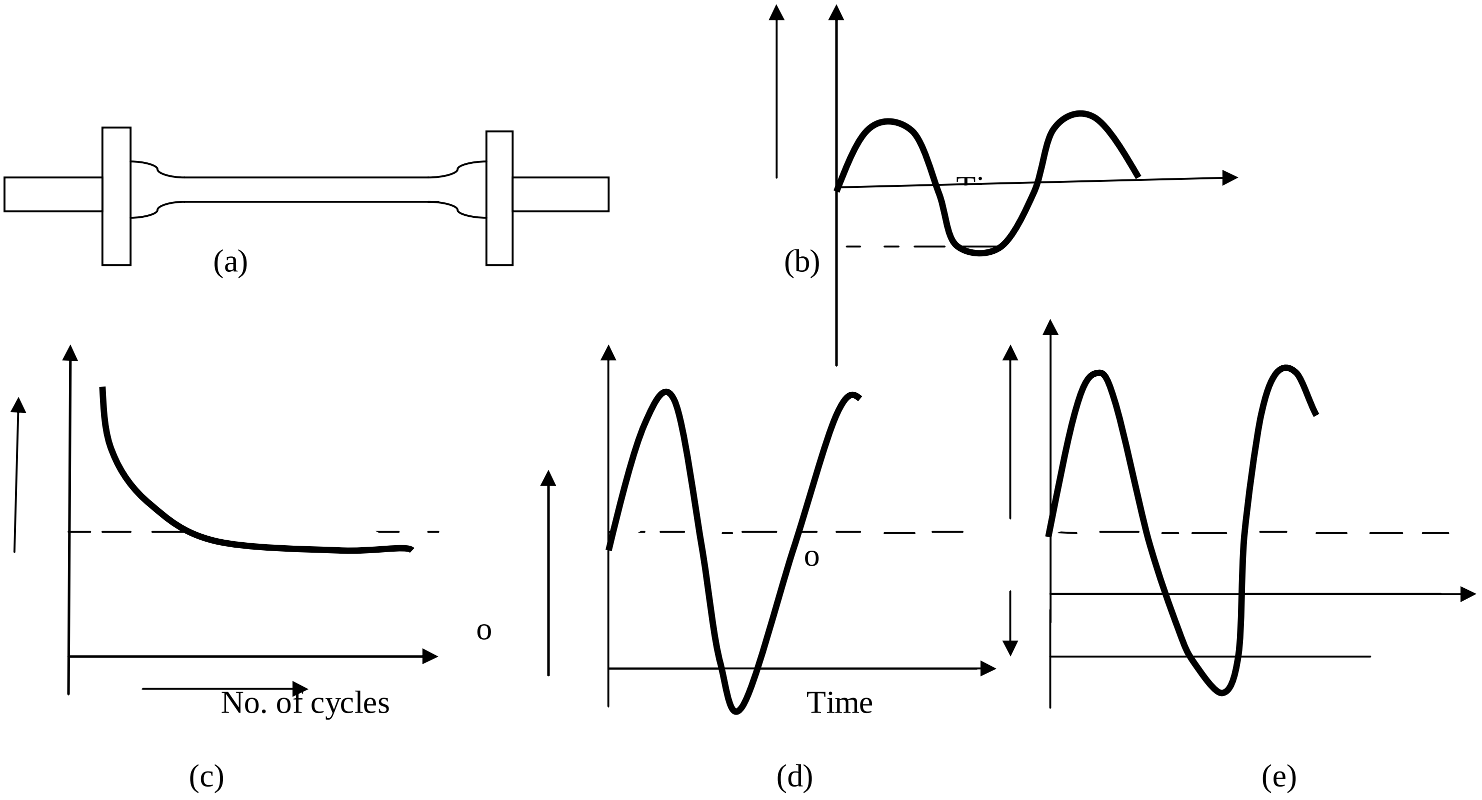

Fig. 1.2 Graphical representation

(a) ⇒ Standard specimen

(b) ⇒ Completely reverse

(c) ⇒ Endurance or fatigue Limit

(d) ⇒ Repeated stress

(e) ⇒ Fluctuating stress

A little consideration shows that if the stress is kept below a certain value as shown in figure (c) , the material will not fail whatever may be the No. of cycles. This stress, as represented by dotted line, is known as endurance or fatigue strength. It is defined as maximum fluctuating stress which a polished standard specimen can withstand without failure, for infinite number of cycles usually $10^7$ cycles.

It is estimated that 50-90% of structural failure is due to fatigue, thus there is a need for quality fatigue design tools. However, at this time a fatigue tool is not available which provides both flexibility and usefulness comparable to other types of analysis tools.

## Loading:

Fatigue, by definition, is caused by changing the load on a component overtime. Thus, unlike the static stress safety tools, which perform calculations for a single stress, fatigue damage occurs when the stress at a point changes over time. ANSYS can perform fatigue calculations for either constant amplitude loading or proportional non-constant amplitude loading. A scale factor can be applied to the base loading if desired. This option, located under the “Loading” section in the details view, is useful to see the effects of different finite element load magnitudes without having to re-run the stress analysis.

# CHAPTER-2

# SYSTEM DESCRIPTION

The model 1603 EMR machine frame (fig 2.1) comprises two masses separated by a stiff spring. The ‘spring’ consists of the specimen being tested, its gripping attachments and load cell. The spring/mass system is supported and guided by leaf springs. Each mass is attached to four leaf springs; the upper mass is attached to its support springs through two long columns. The two sets of support springs are separated by four Acme screws which pull together or push apart the nodal points of the upper and lower mass springs are to apply a compressive or tensile mean load when rotated by a servo motor through worm gears. The nodal points of the upper and lower mass springs are rigidly held to a cruciform and the use of two contra – oscillating masses eliminates the need for a heavy and cumbersome seismic block.

The frame assembly is isolated from the machine base by anti- vibration mounts between the plinth and the cruciform. These mounts ensure that very little vibration is passed through to the floor on which the machine stands. The machine covers are free – standing to avoid contact with the resonance frame.

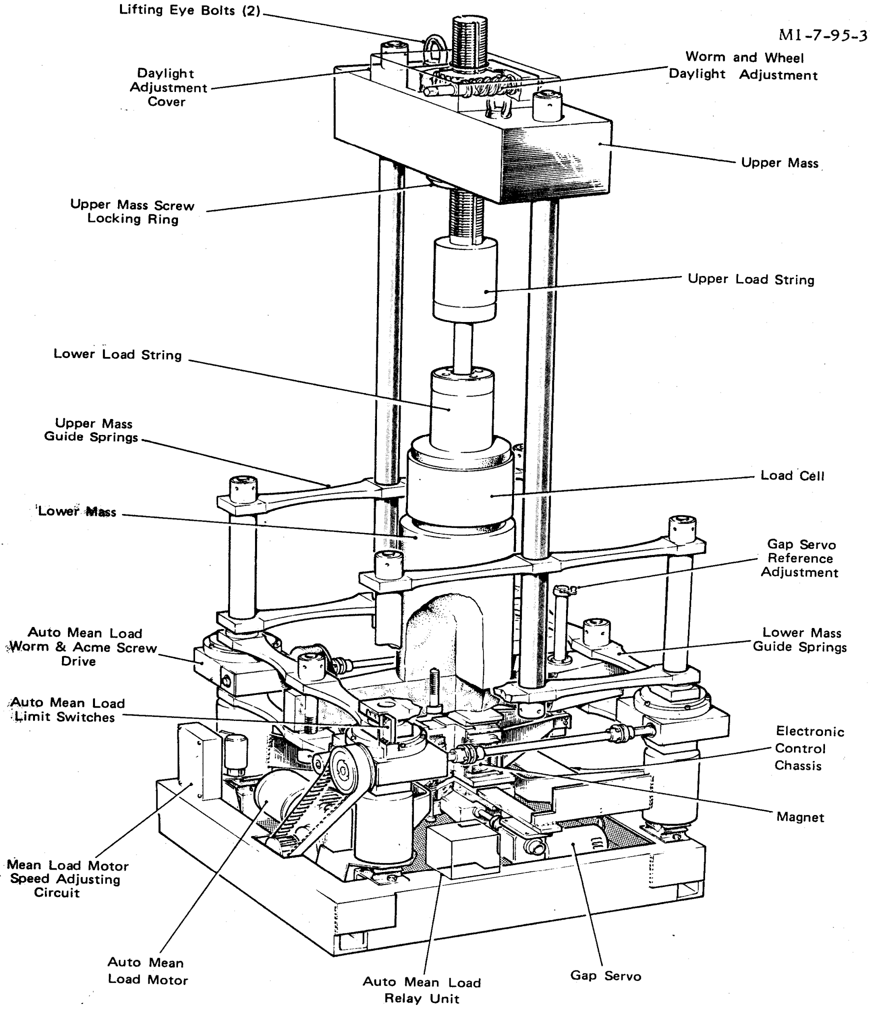

Figure 2.1 Components of auto mean load resonant frame; Courtesy Instron

The electro- magnet is fixed to the cruciform and positioned on a servo- driven wedge, enabling the air gap between the armature, attached to the lower mass, and the magnet to be controlled. When the magnet is energized, the air- gap closes applying a tensile load to the specimen. The magnet is energized by high current pulses generated at the natural frequency of the spring/mass assembly so that a resonant system is maintained.

A mean load is applied to the specimen by establishing a reference level on a potentiometer labeled ‘M.L.Demand’. A servo motor energized by a comparator amplifier in the base of the test frame drives the four Acme screws between the upper and lower mass support springs, so as to apply the required mean load in tension or compression. During a test the specimen under load will yield and, as a result, the mean load will tend to fall off. The servo, when set for automatic operation, will operate during the test to maintain the demanded load.

The application or change of mean load changes the gap between the faces of the electro- magnet and its armature. An LVDT (Linear Variable Differential Transducer) is mounted across the gap and senses the change. The LVDT output actuates the servo operated wedge to drive in or out to maintain a pre-selected air – gap. The selection of air–gap size is made by the operator based on the predicted specimen excursion for the load being applied. A graduated knob for setting the air-gap is sited on the lower mass.

The force developed by the magnet is controlled by the magnet is controlled by varying the pulse width of the drive signal to the power amplifier. Figure (2.2) shows the electronic control in the block diagram form. The object of the electronic control is to make the pulse width of the drive signal proportional to the magnitude of the peak load error signal generated by summing amplifier A7.

The output of the load cell is approximately proportional to the load applied to the specimen. This is input to a load cell amplifier in the console. The load cell amplifier magnifies the load signal in the range 0 to 10 volts, where 10 volts is the output for the maximum capacity of the load cell. The load cell amplifier output is applied to three stages of the controller circuit: a sine to square wave converter, a peak load detector, A2, and the mean level detector A3.

The sine to square wave converter provides a digital signal that is used to synchronize the control system to the dynamic load waveform. The converter has been designed to operate from load signals as low as 0.1% of the maximum load range.

The peak load detector A2 extracts the dynamic load value from the load cell amplifier output. This is summed with a peak load demand value in the summing amplifier A7 to produce an error signal.

The mean load detector A3 extracts the mean load from the load cell amplifier output. This is fed to the matter selector switch as is the peak load from A2 for display on the console digital voltmeter.

The output of the sine to square wave converter is applied to an exclusive-OR gate; the other input to the gate is logic 0 or 1, depending on the sign of the load error signal output by the summing amplifier A7. The effect of a logic level shift is to change the phase of the synchronizing signal at the output of the EX-OR gate by $180^0$ relative to the load signal. The synchronized drive resulting pulse is now in phase or $180^0$ out of phase with the load signal, the latter resulting in a magnet force which has damping effect on the resonant system. This prevents the load in the specimen exceeding the set demand enables the high 'Q' system to follow more effectively any programmed demand fed in from an external source. The programmable performance of the Model 1603 EMR Machine is another feature which makes it superior to any other spring/mass resonance machine currently available in the market. The output of the Ex-OR gate operates a transistor switch which resets the ramp generator A5 in synchronism with load signal.

The ramp generator circuit consists of a servo loop in which the rectified and smoothed ramp produced by A5 is compared with a D.C reference at A4 to give a D.C error voltage which is used to generate the ramp and to determine and control ramp amplitude. As stated before, ramp frequency is synchronized with dynamic load waveform.

The DC error voltage A4 is proportional to frequency and is scaled in amplifier A6 to produce a voltage between 1.00 V and 3.00 V to display on the panel meter as 100 to 300Hz.

The load cell amplifier output for a purely dynamic load is seen as a sine wave in which, by convention, the positive peak represents tension in the specimen whilst negative represents compression. For the magnet to generate a force which is driving the system, it is necessary to ensure it is switched on only when the gap is already closing as a result of the natural oscillation period. It is important that peak force coincides with the zero point on the load error signal. This pulse is used to trigger the power amplifier in the test frame but is gated to provide start/stop facilities.

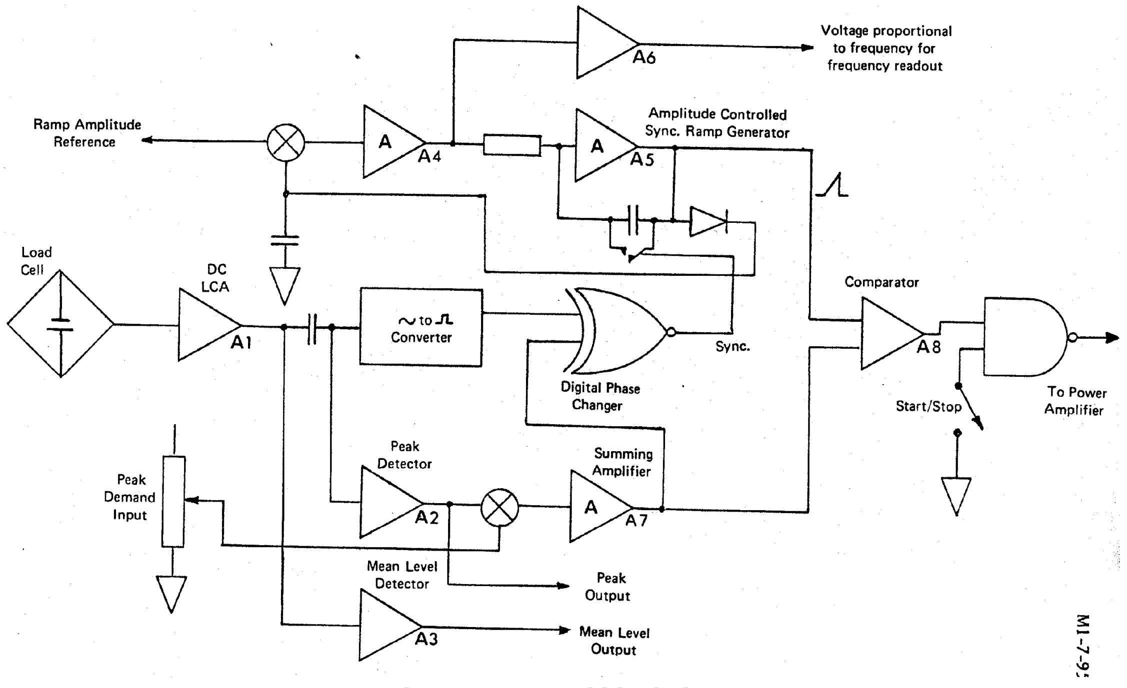

Figure 1.2 Electronic control block diagram; Courtesy Instron

In the resonating system, the load cell and grips, when under-going an acceleration force(G), exhibit a dynamic load in anti-phase to that applied to the specimen and equal to the specimen and equal to approximately half the weight of the cell and grips. A signal is generated in the dynamic compensation Module, Factored for G as measured by an accelerometer at the load cell, and applied to the dynamic load signal so as to give a true representation of the peak mean load. The console front panel is also fitted with a time/cycle counter. This gives a visual indication of the lapse of a preselected time or of prescribed number of cycles at the natural resonant frequency.

## SPECIFICATION:-

| | |
|---|---|
| Load capacity: | Dynamic Load ± 100KN |
| | Mean Load ± 100KN |
| Frequency Range: | 100Hz to approximately 300Hz |
| Maximum cyclic Extension: | 1mm for dynamic load of ±100 |

The maximum dynamic loads attainable will depend on damping losses in the specimen, grips and fixtures.

| | | |
|---|---|---|
| Load measurement Accuracy: | ± 0.5% of indicated force or ±0.2% of full scale, | |
| Load control Accuracy: | ± 1% | |
| Magnet Air Gap Control: | Accuracy | ±0.1mm |
| | (Automatic) | Range 0 to 5mm |
| Horizontal Daylight: | 580mm | |
| Vertical daylight: | Adjust | 100mm to 600mm |
| Load Frame: | Weight | 1500Kg |
| | Height | 2500mm |
| | Floor Area | 980 x 1000mm |

| | | |
|---|---|---|
| Control console: | Weight | 20kg |
| | Size | 510x350x280mm |
| Power Requirements: | 720maximum-1200W peak | |
| | 200 to 250 volts 50Hz or 110V 60Hz single phase | |

**Automatic Mean Level Control System:**

| | |
|---|---|
| Mean load control: | Accuracy ± 1% |
| Maximum Travel: | ±10mm |
| Speed: | ±1 to ± 10mm/min |

**Signal Inputs:**

| | |
|---|---|
| Frequency: | +0.01V per Hz |
| Synchro: | 50mV for 1% |
| Accuracy: | ± 1% of value |
| Mean Load | ± 0.01 V DC for 1% range |
| Dynamic Load | |
| Peak Load maximum | |
| Peak Load minimum | |

**External inputs:**

| | |
|---|---|
| Mean level: | 0 to -10V for 0 to +100% |
| Dynamic Level: | +10V to -10V for -100% to +100% |

# CHAPTER – 3

# IDENTIFICATION OF SUB-COMPONENTS OF THE MACHINE

To fix any machine one should be thorough about its functionality and architecture. There are certain points in the machine where in the voltage and impedance is tested to know the healthiness of the circuit. The machine supplier never reveals the architecture of the machine. Instron is a very expensive machine and the service to the machine is up to the mercy of the supplier when the machine is used for long time. To understand the functionality of the machine subcomponents and its architecture the machine was dismantled by carefully feruling the wires so that the machine can be reassembled .The reverse engineering started with this process.

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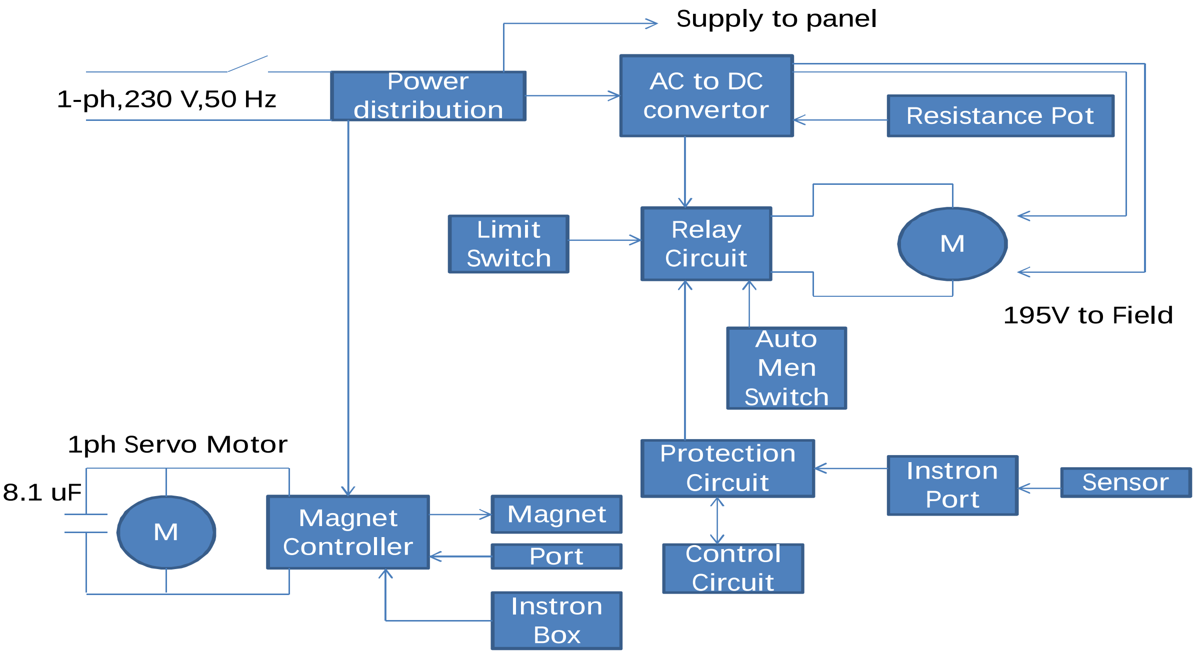

Figure 3.1 Power Flow Diagram

Figure (3.1) shows the power flow diagram of the machine.The single phase 230V, 50Hz supply is distributed to Panel (which consist of circuit boards), converter and magnet controller

## **Converter**:

This is converting AC power to DC power which will be supplied to armature and field coils of the DC traction motor. The field is directly connected to the convertor which is getting 195V supply and the armature is connected through relay circuit and the voltage can be varied using Resistance Pot provided in the machine. This can vary the speed of the motor through armature voltage control.

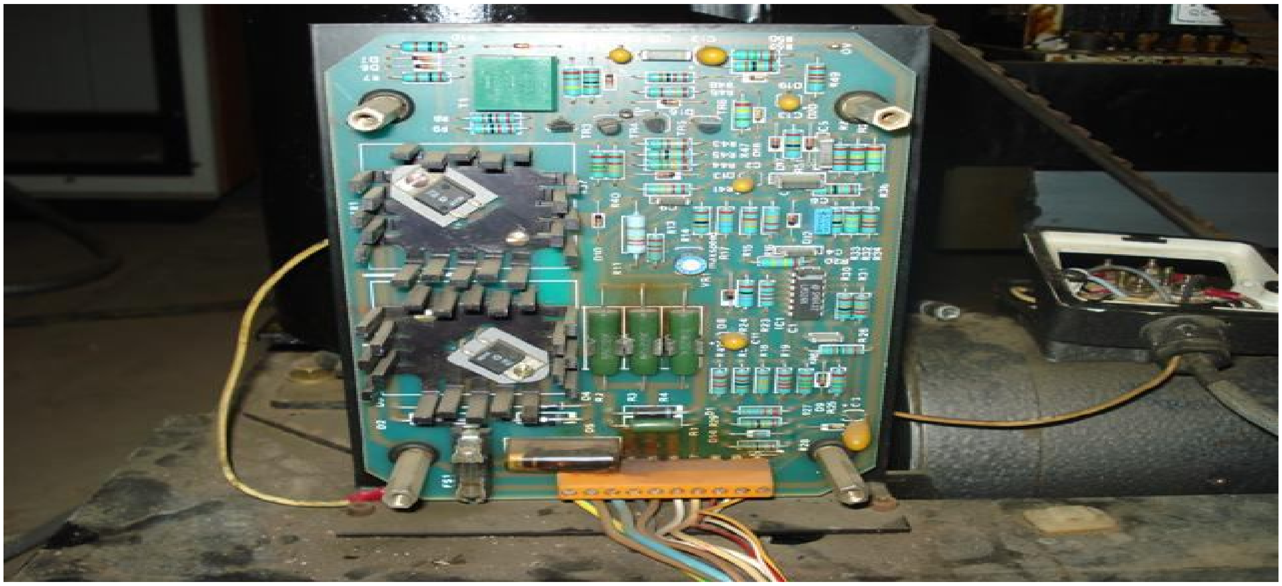

Figure 3.2 converter

## **Limit switch**:

when the machine is given tensile load then a lower displacement limit exist for the load cell below which the machine may get damaged, similarly upper displacement limit exist for compression loading. These limits are been sensed by limit switches and the information is fed to relay circuit to stop the DC motor.

## **Auto Men Switch**:

This switch is used to direct the machine in automatic mode where in the load is applied to the job as preset and the motor adjusts the load cell automatically to get the desired load in the job or the machine can also be operated in manual mode where in the load cell can be moved in desired direction using respective switches provided.

Figure 3.3 Auto Men switch

Figure 3.4 Motor switch for AC series Motor

## Relay circuit:

This basically consists of 2 relays of 15 V, 1A DC which will be used to control upward and downward motion of the lower load cell coupled to the motor with a mechanical arrangement. It is receiving DC power from the converter which has to be fed to the DC Motor armature. The polarity of the supply will decide the direction of rotation of the motor. It receives information from Limit switch and Auto Men Switch and protection circuit. A logic circuit is present to process information from Limit Switch, Auto Men switch and protection circuit. The 15V DC voltage required for relay and electronics devices in logic circuit is received from protection circuit.

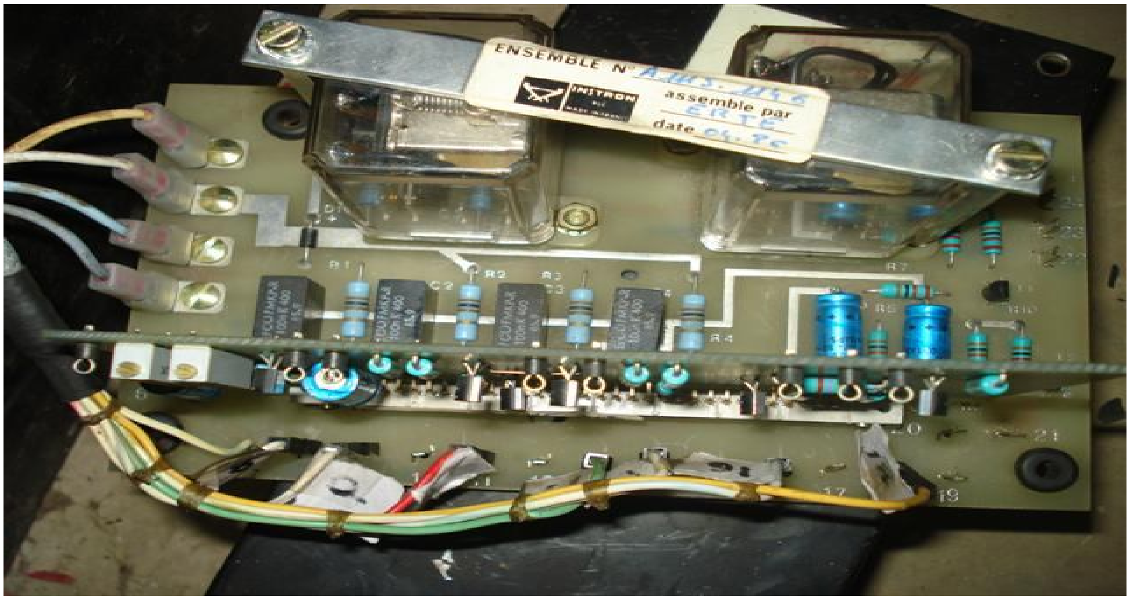

Figure 3.5 Auto mean load Relay circuit

## **DC Motor**:

This is separately exited DC motor manufactured by HELY,France. The rating of the motor is as follows: Power: 245 W, Rotation per min: 3000 T/mn Rated armature voltage:180V Rated field voltage :195 V maximum armature current:1.7A maximum field current: 0.19A.The field is exited from convertor and armature by relay circuit.

## **Single phase servo motor**:

This is exited from magnet controller and used for adjusting the air gap in the magnet. The rating of the motor are, Voltage: 220 V, Frequency: 50 Hz, Rotation per min: 1340 T/mn Current: 0.41 A Capacitor rating: 8.2uF, Insulation class:B

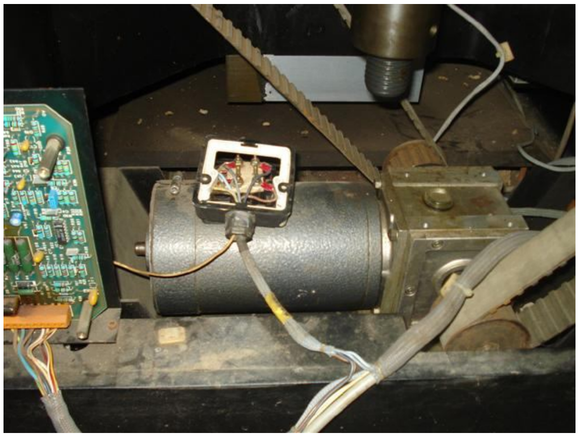
Figure 3.6 DC Motor

Figure 3.7 single phase AC series motor

## **Protection Circuit**:

This is communicating with control circuit. The user can set the parameters required for the experiment. Shown in the figure are the various features available that can be configured. The circuit mainly consists of 7 cards.


Figure 3.8 Protection Circuit

## Control Circuit:

The machine can be started and stopped from here. This has various display as shown in the figure which display load, frequency. This machine consists of four logic cards. The +15V and -15V DC source required for the logic circuits and the various other chips in the control circuit, protection circuit, relay circuit and magnet controller is generated here.

Figure 3.9 Controller Circuit

## Magnet:

This is used in the fatigue testing operation. This is basically a electromagnet which is receiving pulses from magnet controller. The rating of electromagnet is yet to be known.

## Sensor:

There are two sensors mounted on the load cell. One is giving information about load which it gives in terms of voltage ranging from -10V to 10 V, the other sensor is giving the information about the frequency of operation in terms of voltage ranging from 0-5V.

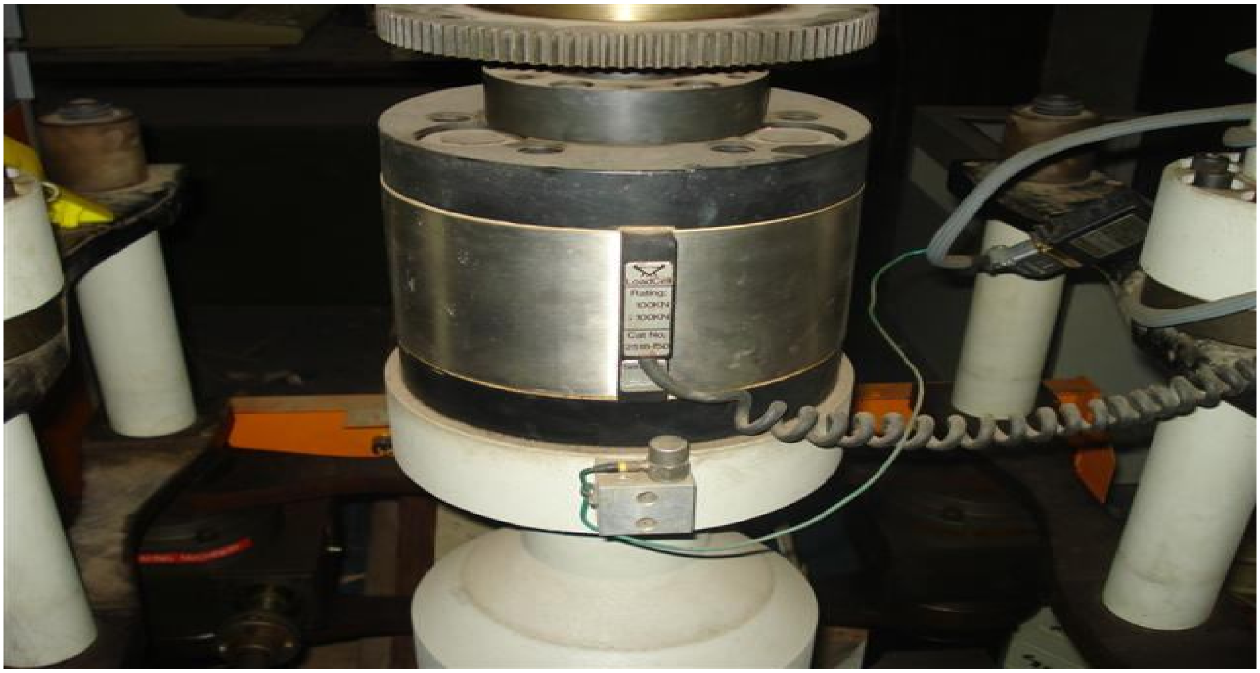

Figure 3.10 sensors mounted on load cell

## **Magnet controller**:

The circuit is shown in the figure. This has a power amplifier (T8610) and power diode mounted on heat sink which is supplying electric pulse to the electromagnet.

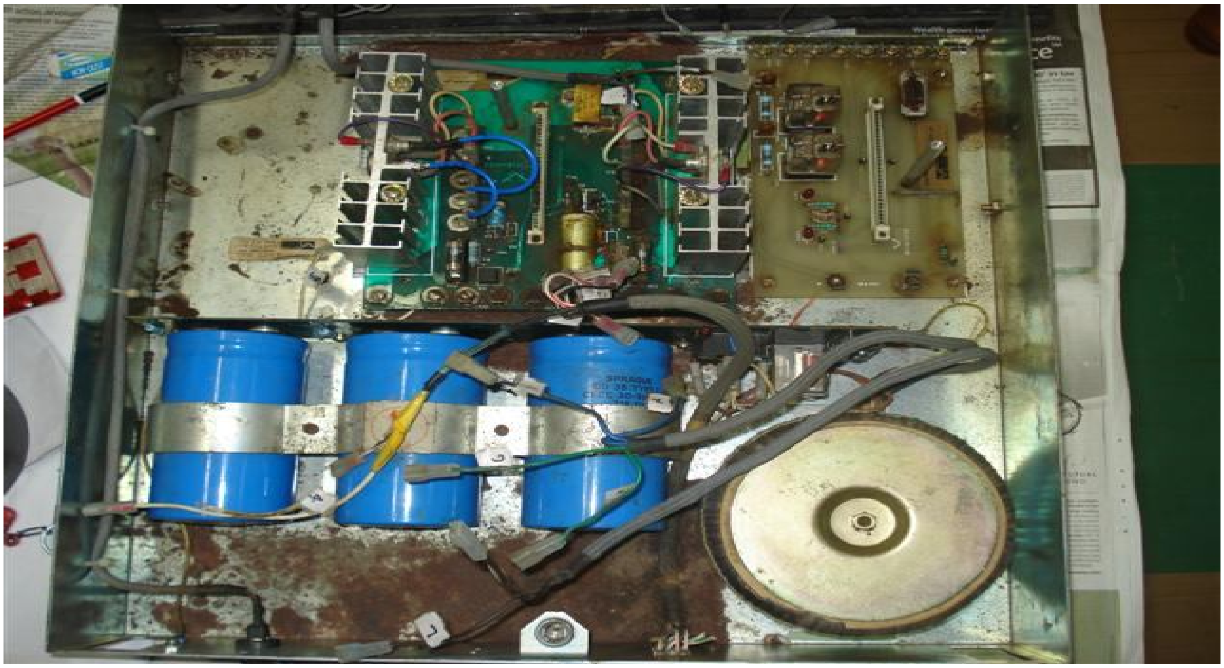

Figure 3.11 Magnet controller

The circuit diagrams of the various cards are as shown below:

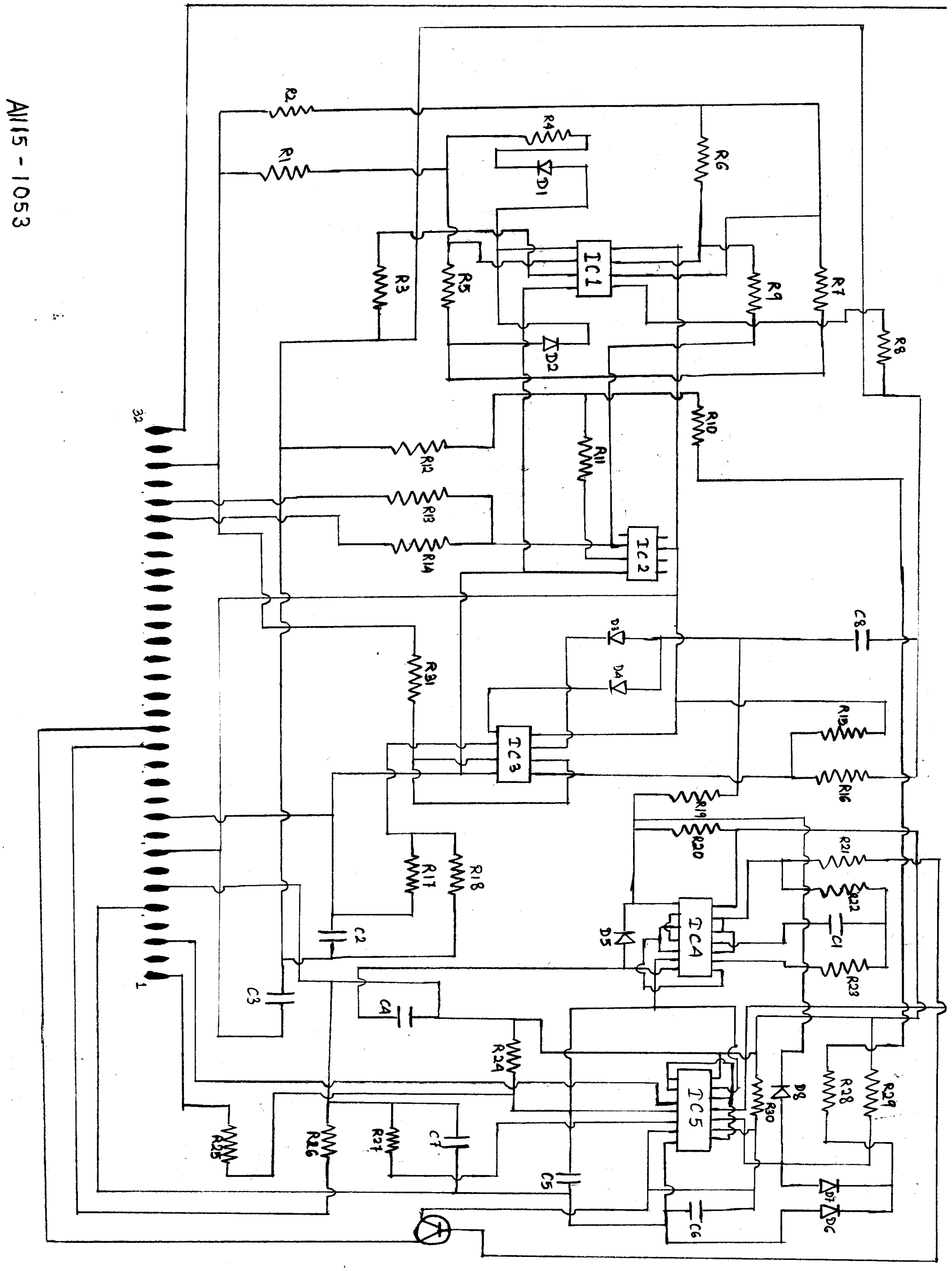

Fig 3.12 Circuit diagram of A1115-1053

# SPECIFICATIONS OF A1115-1053 :

R1- 51 KΩ

R2- 100 KΩ

R3- 17 KΩ

R4- 51 KΩ

R5- 51 KΩ

R6- 100 KΩ

R7- 51 KΩ

R8- 22 KΩ

R9- 10 KΩ

R10- 1 MΩ

R11- 2.7 KΩ

R12- 10 Ω

R13- 10 KΩ

R14- 7.5 KΩ

R15- 3.3 KΩ

R16- 10 KΩ

R17- 3.3 KΩ

R18- 10 KΩ

R19- 2.2 KΩ

R20- 2.2 KΩ

R21- 10 KΩ

R22- 51 KΩ

R23- 51 KΩ

R24- 2.2 KΩ

R25- 47 Ω

R26- 18 Ω

R27- 2.2 KΩ

R28- 2.4 KΩ

R29- 2.2 KΩ

C1- 2 μF/63 V

C2- 100 nF /50 V

C3- 100 nF/50 V

C4- 10 nF/50 V

C5- 100 nF/50 V

C6- 100 nF/50 V

C7- 100 nF/50 V

C8- 100 nF/50 V

IC1- 2480C

IC2- L8613  MC-1741C

IC3- L8519  MC-1458CP

IC4- P8504  MM-5611BN  CD-4011BCN

IC5- 340C  SN-7403N

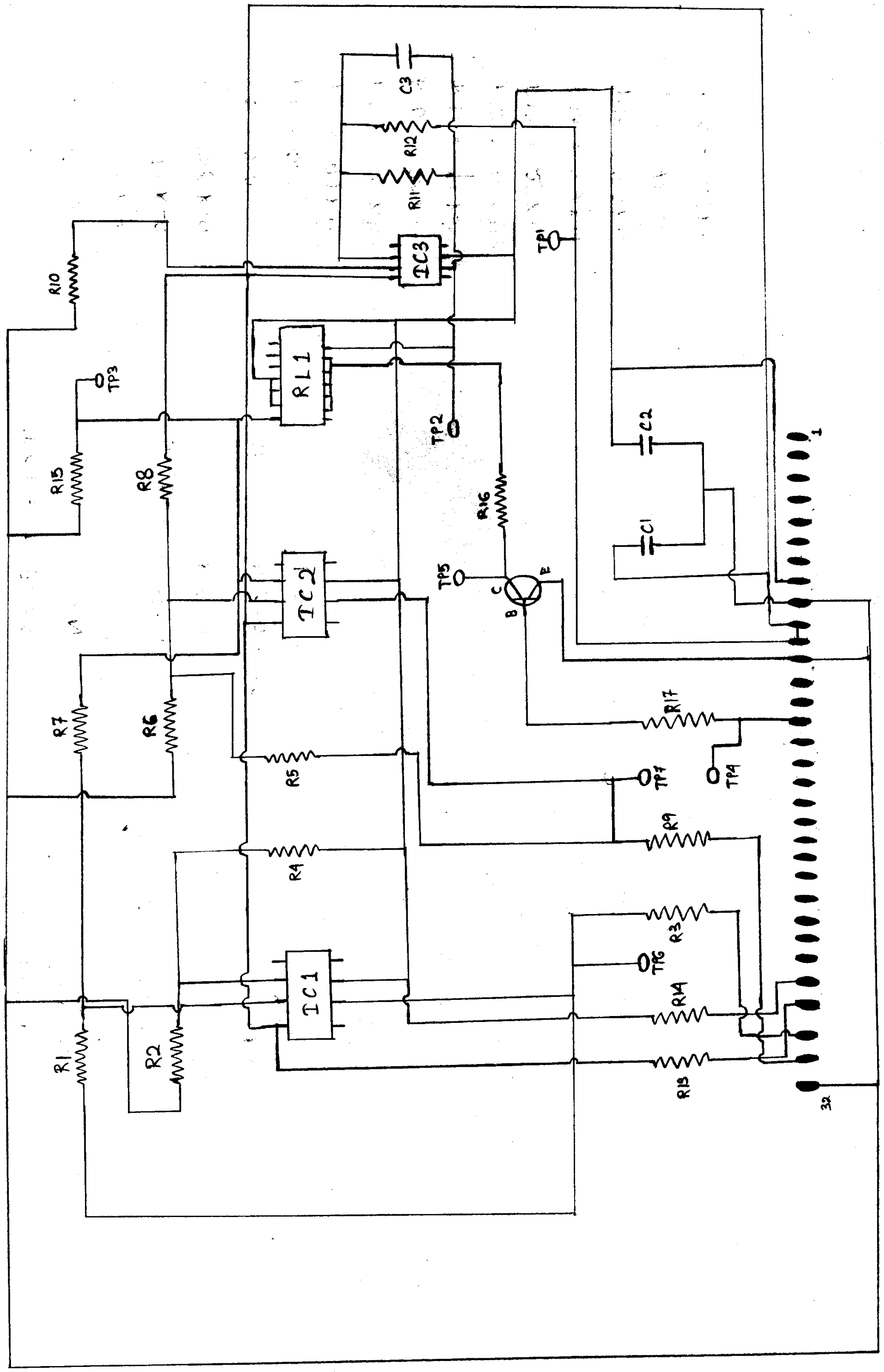

Fig. 3.14 Circuit diagram of A1115-1124

## SPECIFICATIONS OF A1115-1124 :

R1- 330 KΩ

R2- 220 KΩ

R3- 2 KΩ

R4- 9.1 KΩ

R5- 330 KΩ

R6- 220 Ω

R7- 220 Ω

R8- 9.1 KΩ

R9- 2 KΩ

R10- 24 KΩ

R11- 51 KΩ

R12- 51 KΩ

R13- 2.2 KΩ

R14- 2.2 KΩ

R15- 3.3 KΩ

R16- 750 Ω

R17- 3.7 KΩ

IC1- M8408 741CN

IC2- MC1741 K8610

IC3- MC1741CP L8613

C1- 100 nF/50V

C2- 100 nF/50V

C3- 4 µF/7K63/65.1

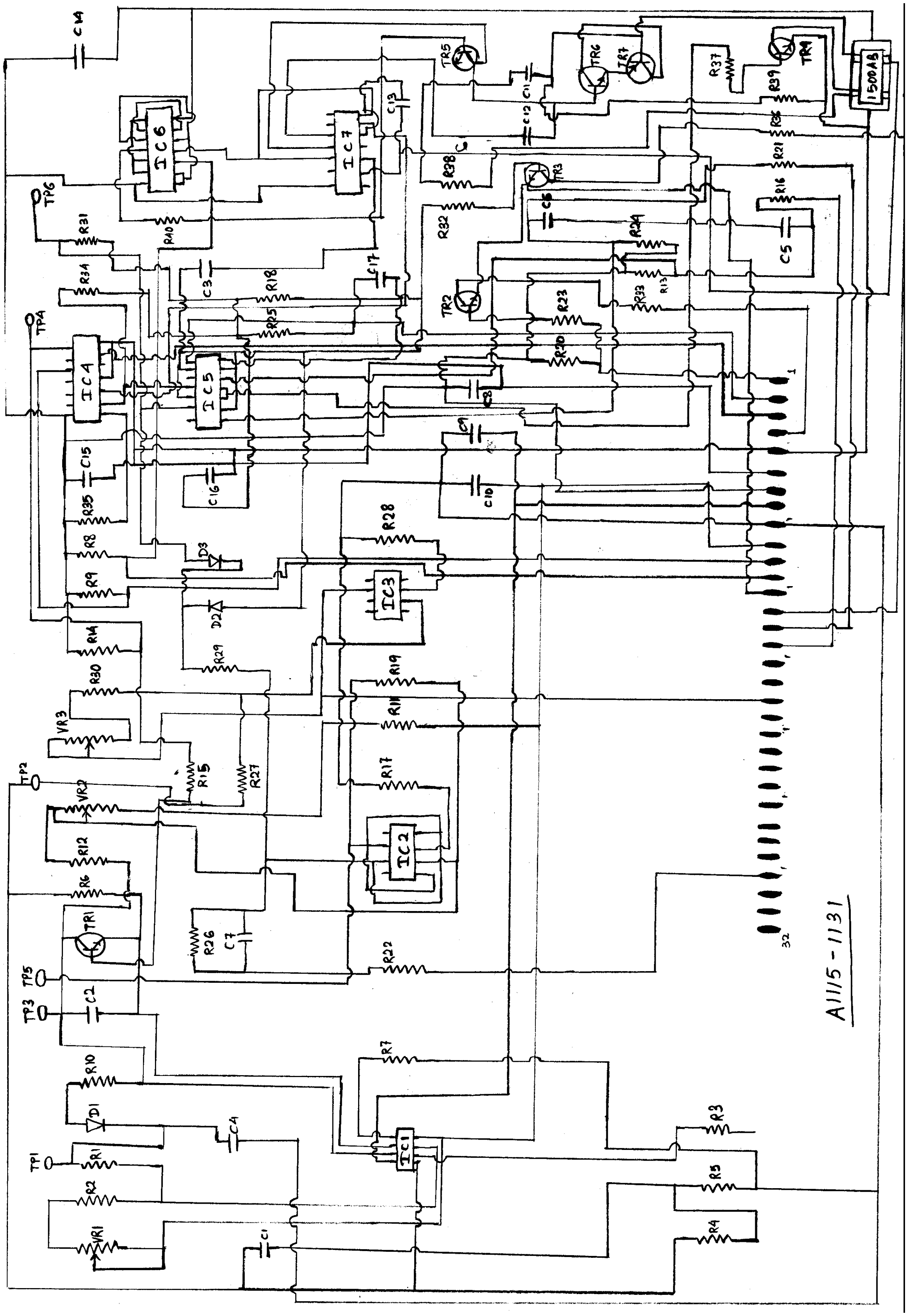

Fig.3.15 Circuit diagram of A1115-1131

# SPECIFICATIONS OF A1115-1131:-

R1- 100 KΩ

R2- 150 KΩ

R3- 67 KΩ

R4- 100 KΩ

R5- 5.1 KΩ

R6- 10 KΩ

R7- 10 KΩ

R8- 2.2 KΩ

R9- 2.2 KΩ

R10- 2 KΩ

R11- 120 KΩ

R12- 100 KΩ

R13- 2.2 KΩ

R14- 670 Ω

R15- 2 KΩ

R16- 47 Ω

R17- 36 KΩ

R18- 6.7 MΩ

R19- 100 KΩ

R20- 670 Ω

R21- 47 Ω

R22- 220 Ω

R23- 330 Ω

R24- 2.2 KΩ

R25- 2.2 KΩ

R26- 460 KΩ

R27- 39 KΩ

R28- 16 KΩ

R29- 2.4 KΩ

R30- 15 KΩ

R31- 2.2 KΩ

R32- 330 Ω

R33- 100 Ω

R34- 2.2 KΩ

R35- 2.2 KΩ

R36- 100 Ω

R37- 1.2 KΩ

R38- 100 Ω

R39- 51 KΩ

R40- 1.2 KΩ

VR1- 100 kΩ

VR2- 50 kΩ

VR3- 10 kΩ

C1- 1 µF/100V

C2- 0.1 µF/10/250

C3- 100 µF/25V

C4- 111 µF/111V

C5- 100 nF/50V

C6- 100 nF/50V

C7- 470 Pf

C8- 100 nF/50V

C9- 100 nF/50V

C10- 100 nF/50V

C11- 47 µF/25V

C12- 0.1 µF/10/250

C13- 10 nF/50V

C14- 10 nF/50V

C15- 10 nF/50V

C16- 10 nF/50V

C17- 47 nF

IC1- MC1458CP  L8509

IC2- 2458DC  406

IC3- M 8408  741CN

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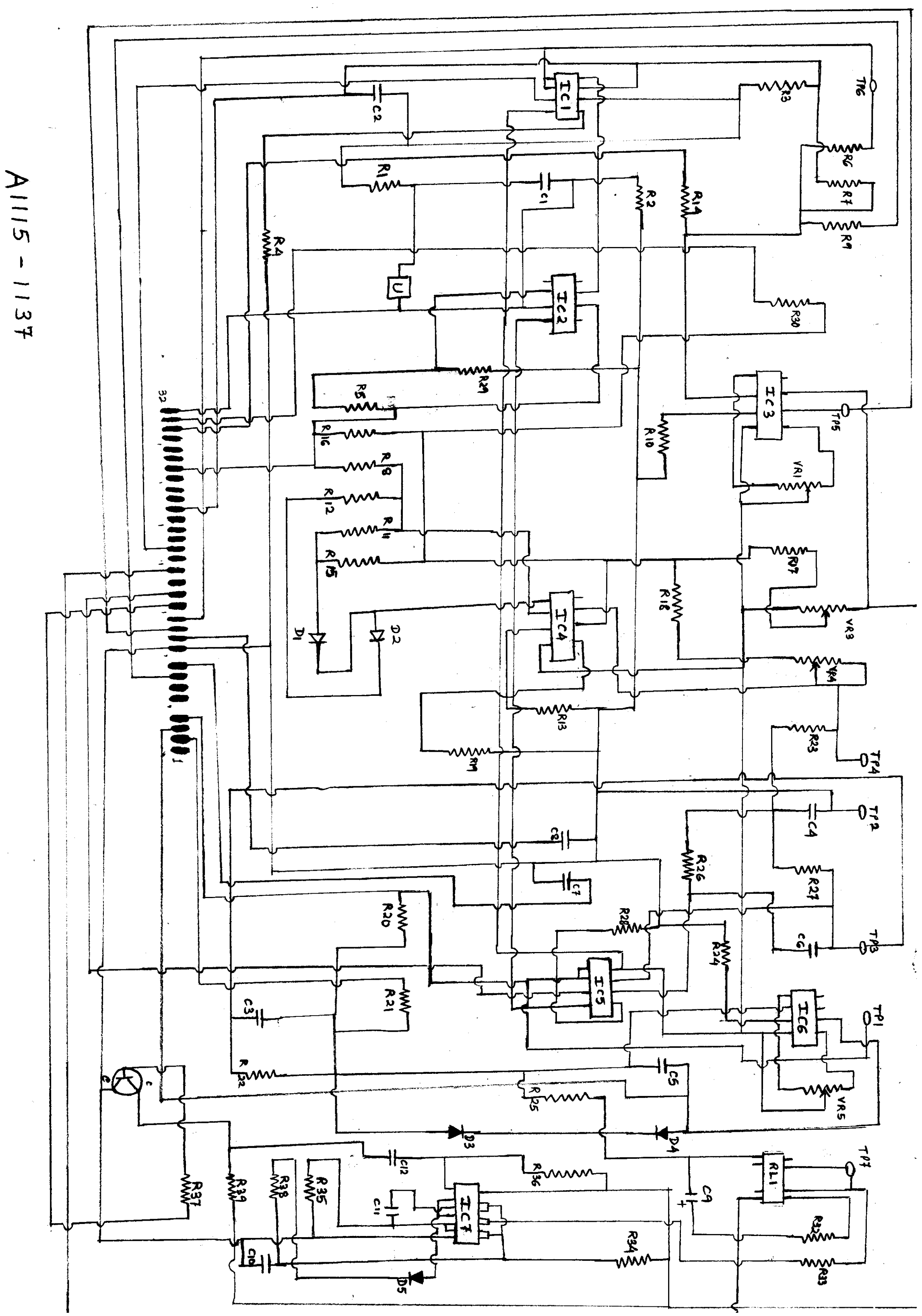

Fig. 3.16 Circuit diagram of A1115-1137

# SPECIFICATIONS OF A1115-1137:-

R1- 50 KΩ

R2- 51 KΩ

R3- 100 KΩ

R4- 51 KΩ

R5- 100 KΩ

R6- 10 KΩ

R7- 10 KΩ

R8- 10 KΩ

R9- 10 KΩ

R10- 3.3 KΩ

R11- 10 KΩ

R12- 10 KΩ

R13- 4.7 KΩ

R14- 10 KΩ

R15- 10 KΩ

R16- 20 KΩ

R17- 1 MΩ

R18- 10 KΩ

R19- 4.7 KΩ

R20- 10 KΩ

R21- 10 KΩ

R22- 10 KΩ

R23- 13 KΩ

R24- 3.3 KΩ

R25- 10 KΩ

R26- 8 KΩ

R27- 1 KΩ

R28- 15 KΩ

R29- 100 KΩ

R30- 33 KΩ

R31- 10 KΩ

R32- 20 Ω

R33- 670 Ω

R34- 51 KΩ

R35- 670 KΩ

R36- 100 KΩ

R37- 3.3 KΩ

R38- 2.7 KΩ

C1- 1 μF/10/100  344 21105

C2- 1 μF/5K/100  382623

C3- 2 μF/2K/63  FF CO KMR  843

C4- 1 μF/10/100  344 21105

C5- 0.1 μF/250  MKT

C6- 0.69 μF/10/100  344 21684

C7- 100 nF/50V

C8- 100 nF/50V

C9- 10 μF/25V

C10- 2 μF/2T/63V

C10- 2 μF/2T/63V

C11- 10 nF/50V

C12- 47 μF

IC1- MC1458N S8302

IC2- MC1741 CP1 K8610

IC3- MC1741 CP1 K8610

IC4- MC1458N S8150

IC5- MC1458N L8519

IC6- MC1741 CPI K8610

IC7- MC14011BCL Z 8422

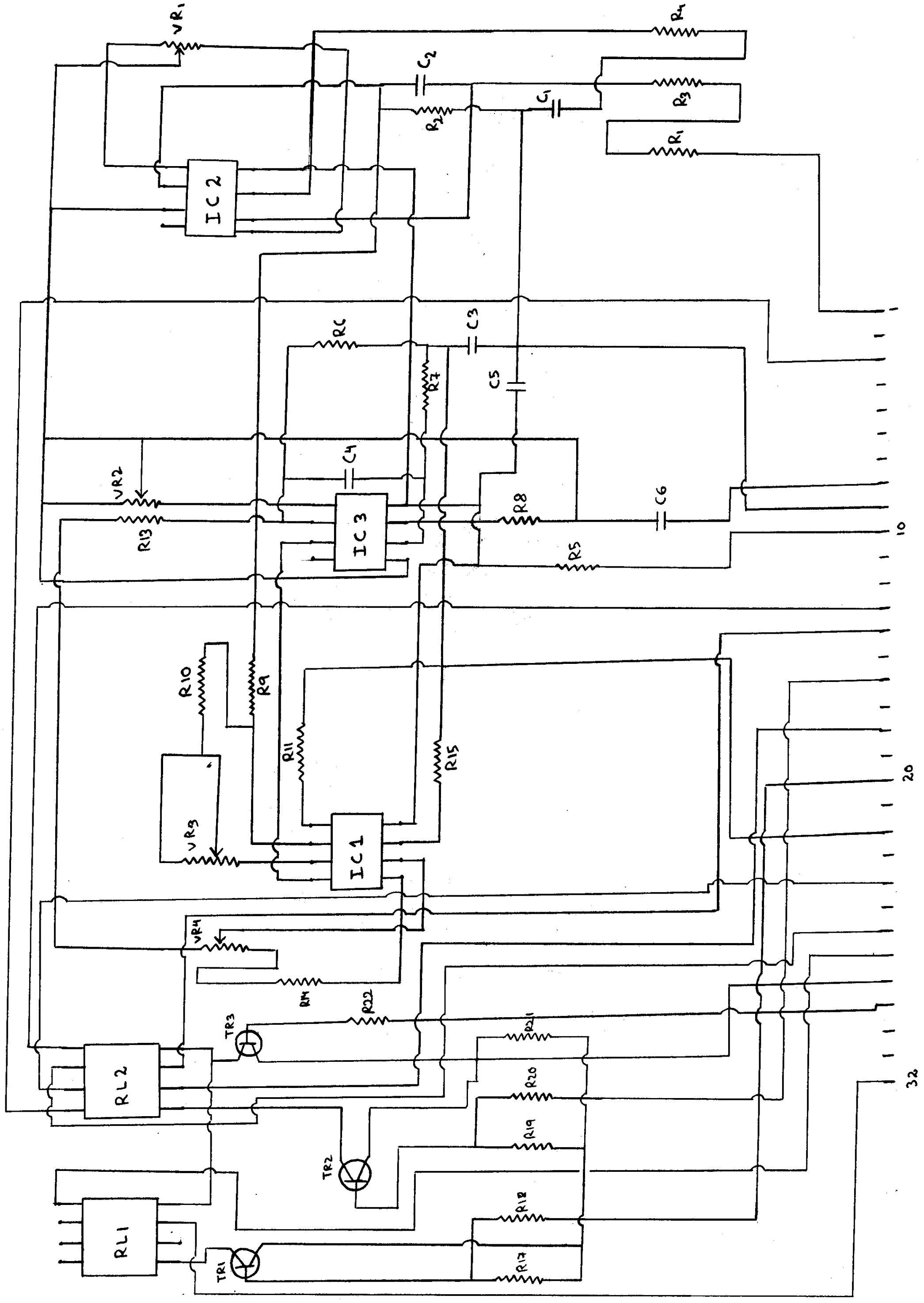

Fig. 3.17 Circuit diagram of A1115-1141

## SPECIFICATION OF A1115-1141 :

R1- 220 KΩ

R2- 120 KΩ

R3- 72 KΩ

R4- 10 KΩ

R5- 220 KΩ

R6- 120 KΩ

R7- 72 KΩ

R8- 10 KΩ

R9- 39 KΩ

R10- 61 KΩ

R11- 10 KΩ

R12- Connecting wire

R13- 39 KΩ

R14- 61 KΩ

R15- 10 KΩ

R16- Connecting wire

R17- 10 KΩ

R18- 2.2 KΩ

R19- 10 KΩ

R20- 2.2 KΩ

R21- 1 KΩ

R22- 1 KΩ

VR1- 20 KΩ

VR2- 20 KΩ

VR3- 10 KΩ

VR4- 10 KΩ

IC1- 344 SFC 2458 DC

IC2- LF 356H T8538

IC3- LF 356H T8538

C1- 1 µF/10/100 344-21105

C2- 0.22 µF/10/100 944-21224

C3- 1 µF/10/100 344-21105

C4- 0.22 µF/10/100 944-21224

C5- 100nF/50v

C6- 100nF/50V

RL1- HAMLIN HE822 C05-10 8505

RL2- HAMLIN HE822 C05-10 8517

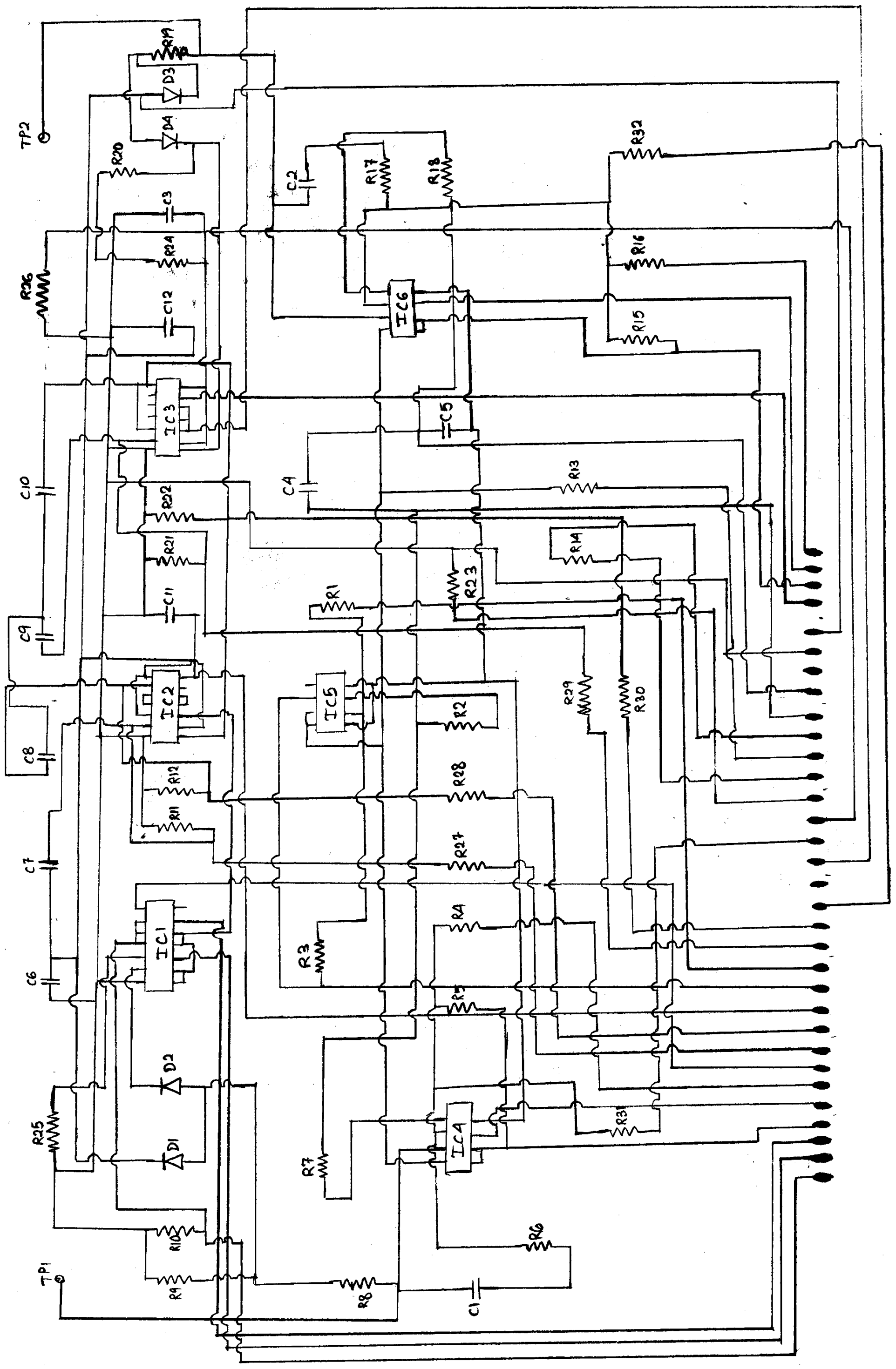

Fig. 3.18 Circuit diagram of D1115-1060

# SPECIFICATIONS OF D1115-1060:-

R1- 100 KΩ

R2- 51 KΩ

R3- 100 KΩ

R4- 100 KΩ

R5- 100 KΩ

R6- 10 KΩ

R7- 33 KΩ

R8- 2.4 KΩ

R9- 2.2 KΩ

R10- 2.2 KΩ

R11- 2.2 KΩ

R12- 2.2 KΩ

R13- 1.2 KΩ

R14- 1.2 KΩ

R15- 100 KΩ

R16- 100 KΩ

R17- 10 KΩ

R18- 33 KΩ

R19- 2.4 KΩ

R20- 2.2 KΩ

R21- 2.2 KΩ

R22- 2.2 KΩ

R23- 170 Ω

R24- 170 Ω

R25- 2.2 KΩ

R26- 2.2 KΩ

R27- 47 Ω

R28- 47 Ω

R29- 47 Ω

R30- 47 Ω

R31- 100 KΩ

R32- 100 KΩ

IC1- 340C SN7403N

IC2- P8444

IC3- DM7400N

IC4- SFC 2458DC 406

IC5- MC174 MCP L8315

C1- 0.01K/400V

C2- 0.01K/400V

C3- 100nF/50V

C4- 100nF/50V

C5- 100nF/50V

C6- 10nF/50V

C7- 100nF/50V

C8- 100nF/50V

C9- 100nF/50V

C10- 100nF/50V

C11- 10nF/50V

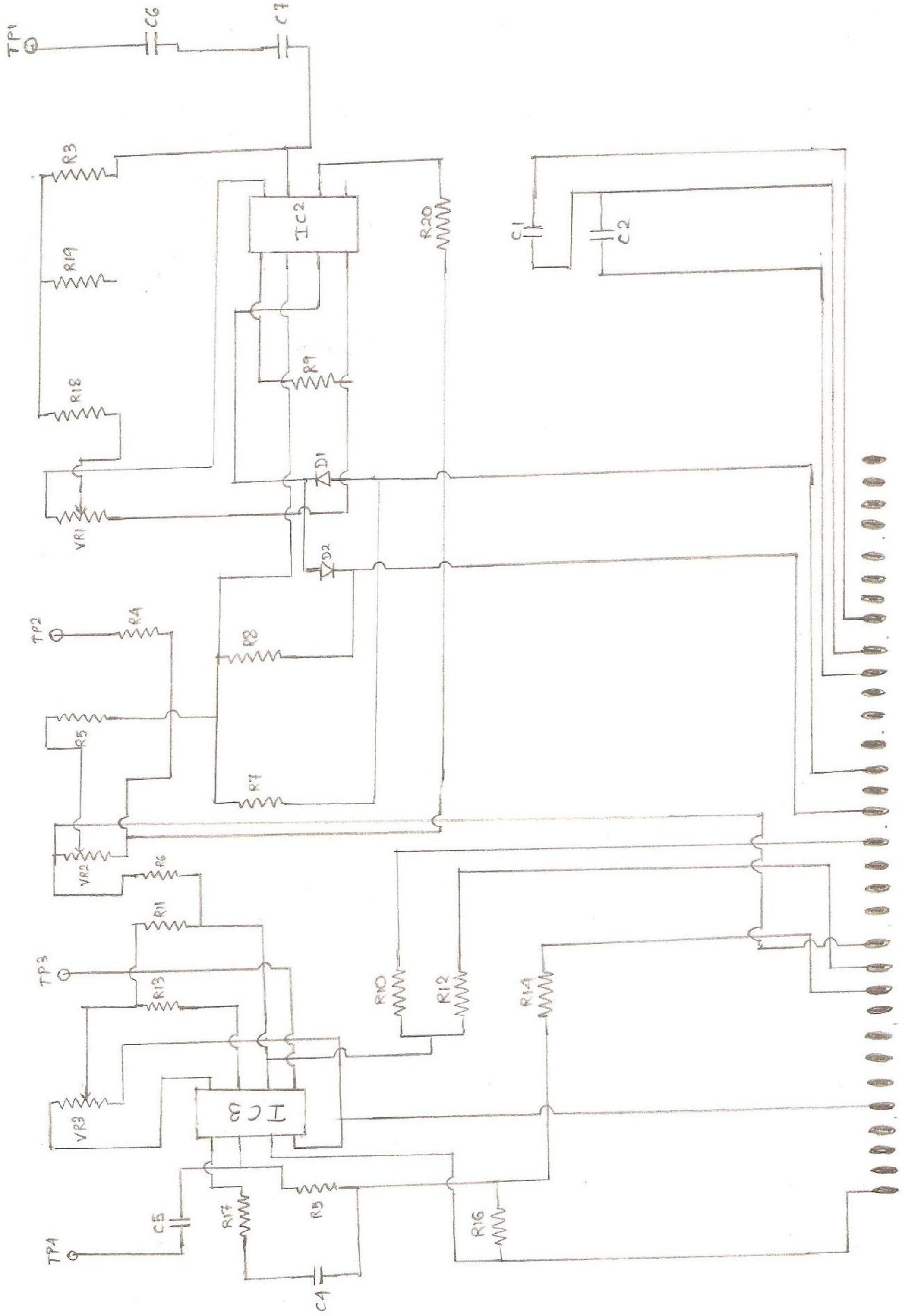

Fig. 3.19 Circuit diagram of D1115-1090

# SPECIFICATIONS OF D1115-1090:

R1- 10 KΩ

R2- 20 KΩ

R3- 100 KΩ

R4- 1 KΩ

R5- 10 KΩ

R6- 20 KΩ

R7- 10 KΩ

R8- 10 KΩ

R9- 4.7 KΩ

R10- 10 KΩ

R11- 86 Ω

R12- 3 KΩ

R13- 4.7 KΩ

R14- 140 KΩ

R15- 210 KΩ

R16- 210 KΩ

R17- 160 KΩ

R18- 1 MΩ

R19- 1 KΩ

R20- 100 KΩ

C1- 100 nF/50 V

C2- 100 nF/50 V

C3- 100 nF/50 V

C4- 1 μF/10/100 (344 21105)

C5- 0.68 μF/10/100 (344 21684)

C6- 111 μF/111 V

C7- 111 μF/111 V

VR1- 10 KΩ

VR2- 20 KΩ

VR3- 10 KΩ

The magnetic controller circuits are as shown below.

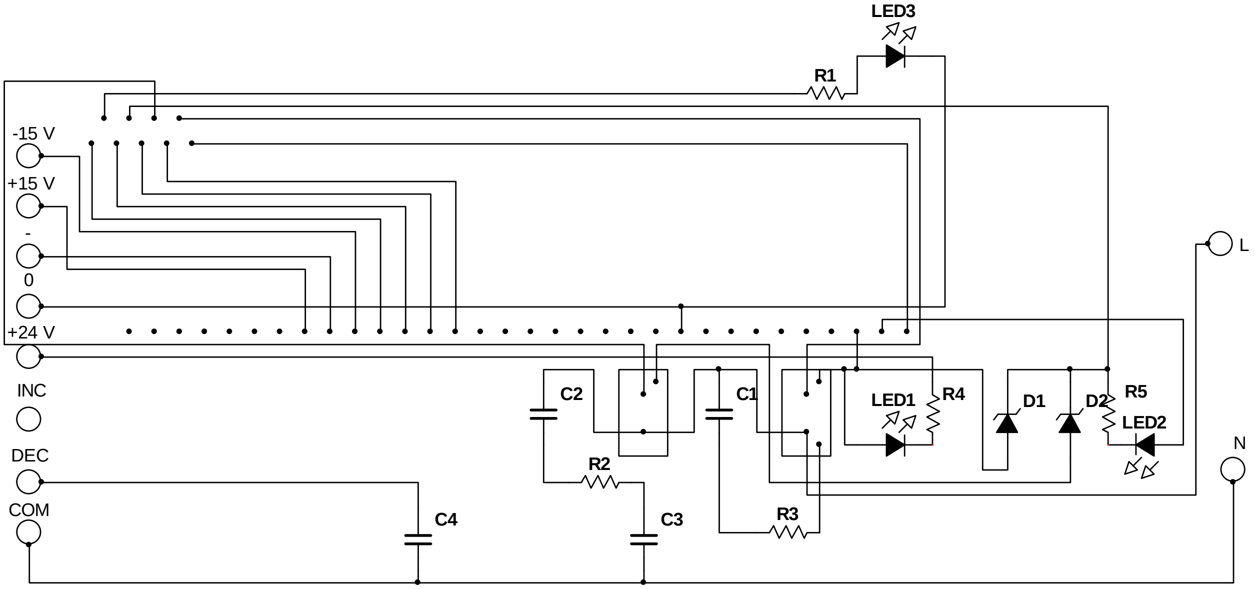

Fig. 3.20 Circuit diagram of D1115-1113

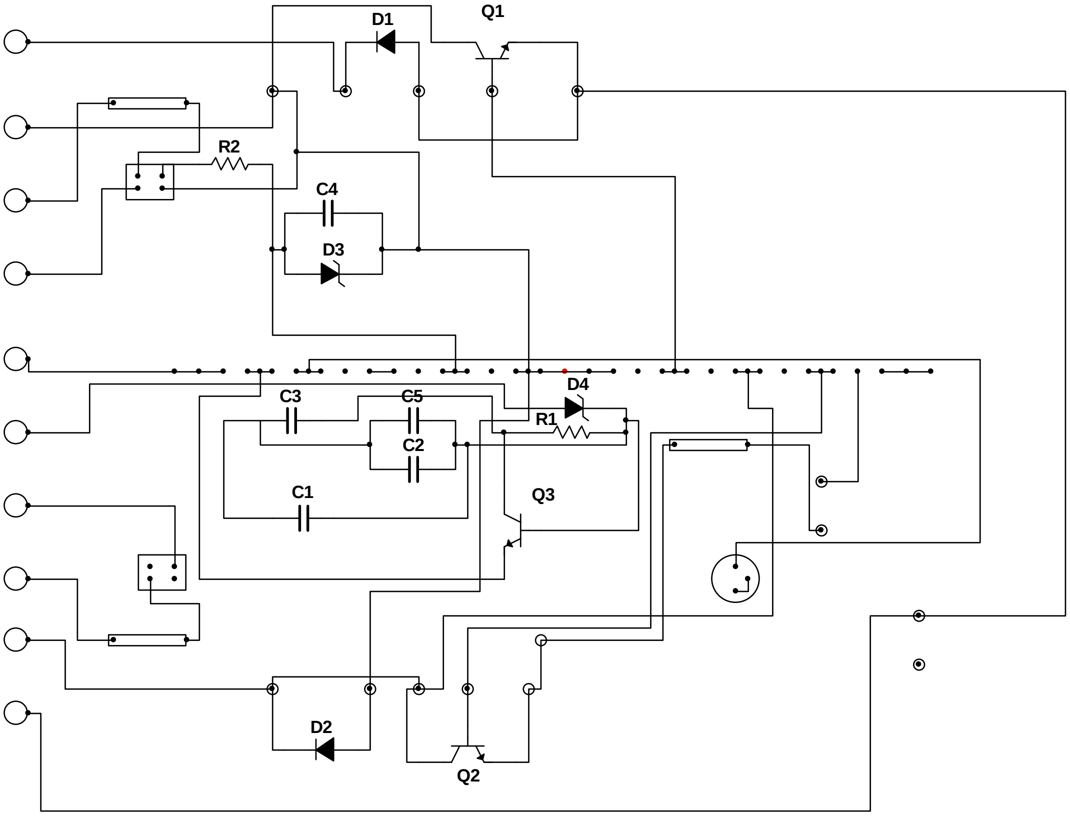

Fig. 3.21 Magnet controller I

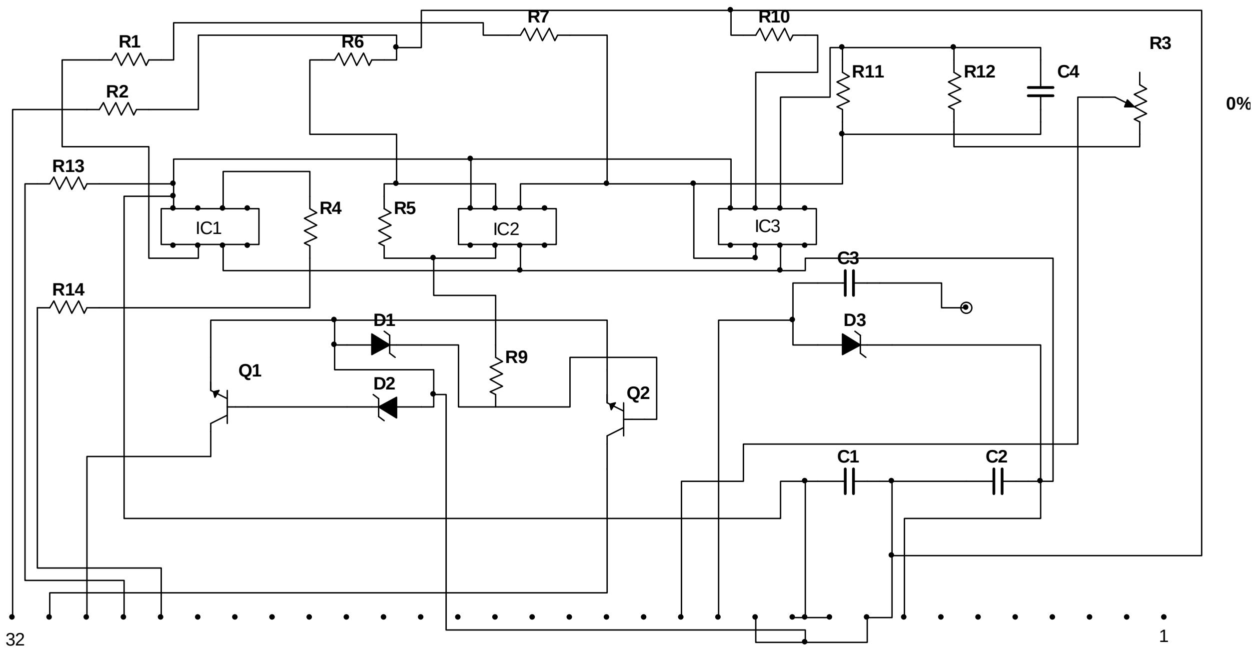

Figure 2.22 Magnet controller II

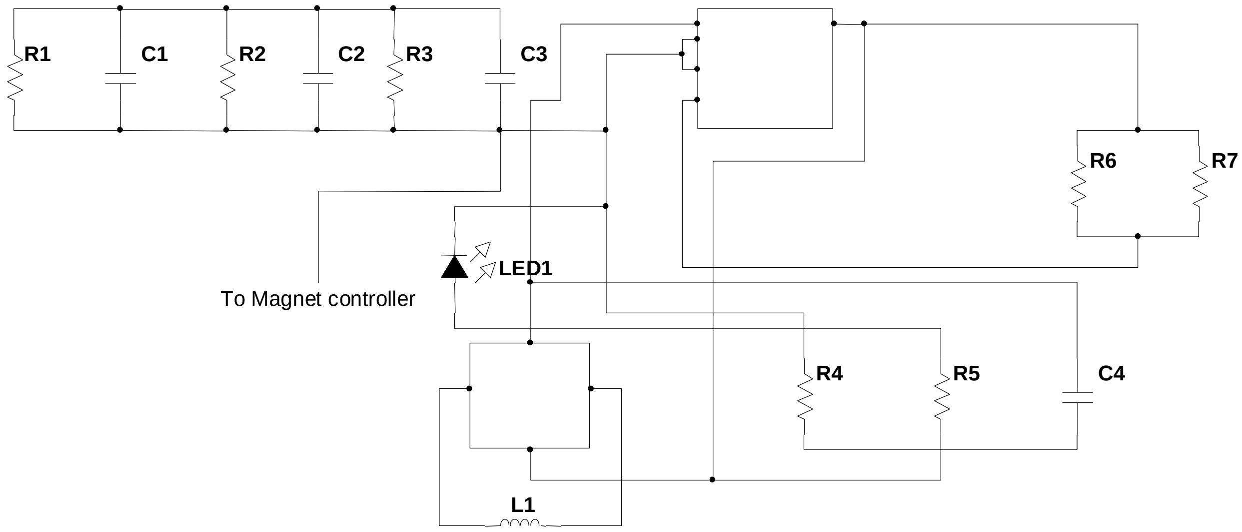

Figure 3.23 Magnet controller III

## Faults detected and its solution:-

1) AC SERIES MOTOR:

| FAULT | STATUS | SOLUTION |
|---|---|---|
| There was open circuit in the field winding. | SOLVED | Rewinding was done. The winding was concentrated type winding |
| The jumper from the field winding 1 to field winding 2 was burnt | SOLVED | A new jumper was connected from F1 to F2 |
| The connections from the switch meant to change the direction of rotation were broken, The rating plate of the motor was not found. | SOLVED | The logic behind the reversal of the motor was solved assuming it as a AC series motor because the motor was not split phase type. |

2) MAGNETIC CONTROLLER:

| FAULT | STATUS | SOLUTION |
|---|---|---|
| There are mainly three different circuit boards. These double printed circuit boards were rusted. | SOLVED | The circuit board was washed with the petrol and the rust was reduced using thinner. |

| | | |
|---|---|---|
| There were open circuits between the electrical components. | SOLVED | The open circuit was solved using the rated current wires with fine soldering. |
| Some resistances and the capacitances were not found to be equal to its rated value | SOLVED | The faulty components were replaced with new one |

3) PROTECTION CIRCUIT

| | | |
|---|---|---|
| 40 pin DATA cable along with two ports were damaged | SOLVED | These were replaced with new ones. |
| The circuit board was rusted | SOLVED | The circuit board was washed with the petrol and the rust was reduced using thinner. |

# CHAPTER – 4

# CONCLUSION AND REFERENCE

## CONCLUSION:

In this report all the circuit diagrams of control circuit, protection circuit, magnetic controller circuit and various other electronic cards were studied and an attempt has been made to represent them. Several open circuits and other faults were detected and necessary actions were taken to solve the same. As it is an old machine, no information regarding the circuits was available on the internet. The only aid available to us was the INSTRON lab manual. Many things in the project were beyond our scope. But we were able to detect the faults and finally we could run the machine for tensile and compression tests. Hopefully the circuit diagrams and the reports prepared by us will be of great help to carry out the future work on this machine.

## REFERENCES:

[1] Handbook, Instron 1603 material testing machine.

[2] G.Belloni, E.Gariboldi, A. Lo Conte, M.Tono, and P.speranzoso

“On the Experimental Calibration of a Potential Drop System for Crack Length Measurements in a Compact Tension Specimen ”,Journal of Testing and Evaluation.Vol.30, No.6