Automatic Industrial Vigilance System

PROJECT WORK

Submitted in partial fulfilment of the requirements

for the award of degree of

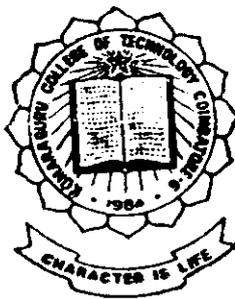## BACHELOR OF ENGINEERING

in Electrical & Electronics Engineering

of the Bharathiar University, Coimbatore-641 046

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1991 - 92

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CERTIFICATE

This is to Certify that the project entitled

Automatic Industrial Vigilance System

has been Submitted by

Mr. ....

In partial fulfilment of the requirements

for the award of the degree of

BACHELOR OF ENGINEERING

in Electrical and Electronics Engineering

Branch of the Bharathiar University, Coimbatore-641 046

During the academic year 1991 - '92

Guide

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Certified that the Candidate was examined by us in the Project-work

Viva-Voce Examination held on..

and the University Register Number was..

Internal Examiner

External Examiner

Acknowledgement

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Synopsis

SYNOPSIS

This project aims at fabrication and testing of an **Automatic Industrial Vigilance System.** It is an 8085 microprocessor based system. The design consideration are mainly to overcome the lapses behind industrial explosions and fires.

This innovative system mainly intended for **Petrochemical complexes & Boiler based inudstries** such as Thermal power plants etc. This versatile unit includes the following:

1. Pressure Control Unit
2. Flame Control Unit.

The main principle involved in these units is the Analog Data Acquisition System & the closed loop control system. The pressure quantity which is continuous-time, dynamic system has Dynamic operating points, when kthe input varies with time to yield nominal response.

This physical quantity is converted into electrical quantity by suitable sensors & transducers. The processor is programmed such that the measured data are compared with the required data and suitable

control strategies are formulated to attain the requirements.

The control circuitry is carefully inter-faced with peripheral circuits of the microprocessor.

This sytem won't disturb the normal operating conditions of the circuit. During the abnormal condition also the system makes the excess pressure to let it out & the normal condition is maintained.

The circuit designed for flame monitoring automatically cuts off the input fuel during the absence of flame.

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Introduction

CHAPTER - I

INTRODUCTION

The need for Automation in an industry is being realised in recent years. The micro computer controlled 'Automatic Industrial Vigilance System' is fully designed for plant security in various industries. It reduces manual supervision & plays vital role in petrochemical complexes & semi conductor complexes.

The main idea behind this vigilance system, is the Digital Data Acquisition System and the closed-loop feed back control logics. The continuous-time processing systems such as pressure, and flame level are to be monitored & controlled by a vigilance system.

Each physical quantities are sensed by separate Transducer elements, which converts them into electrical quantities and which are then governed by centralised monitoring unit. Thus it is necessary to find suitable transducers to evaluate such physical quantities. Suitable data processing units has been provided sto manipulate incoming analog signals. Necessary control stratege has been implemented in order to achieve the required results. The complete details of the system is shown in fig.1.1.

give rise to uncontrolled vapour cloud Explosions (UVCE).

2. Explosions recorded in many cases had figures of all types of hydrocarbons and hydrogen. It is the Benzene and cyclohexone type of compounds which are under strain and more prone to UVCE. Ethylene is more sensitive because of higher flame acceleration.

3. In 93 percent of cases, ignition had taken place, with remaining seven percent it did not because of chance. Expert opinion on UVCE is that, in case of vapour cloud, blast and fire are inevitable.

4. Explosive releases of hydrocarbons originate from storage tanks, spheres, transport tankers, over heating and over pressure, while they were being processed.

The only way in which an uncontrolled vapour cloud explosion can be prevented is to preclude vapour release and this calls for good design of equipment, proper maintenance and safe operating practices.

Pressure Control Unit

CHAPTER - II

PRESSURE CONTROL UNIT

2.1 Process Profile

Microprocessor based system are very useful in processing analog signals which commonly occur in instrumentation system. The data acquisition system consists of pressure transducer, and digitizers using which the microprocessor acquires data from the process. The data logging system has ADC (0809). The pressure which is to be monitored in a process is stored as a light bit data in the register of the microprocessor. The output voltage is caliberated in proportion to the applied pressure by using pressure Transducer. Then the caliberated analog voltages are converted in hexadecimal numbers. So the user can directly feed the value in hexadecimal numbers.

When the pressure exceeds the required limit the transducer output will also increase & thus the arrived data is compared with the reference data and control signal (+5v) is fed to activate the relay circuitry. The relay circuitry will switch ON the solenoid valves and the excess pressure will be outlet. Thus the pressure is monitored at the required level. The functional block diagram for pressure control unit is shown in fig.2.1.
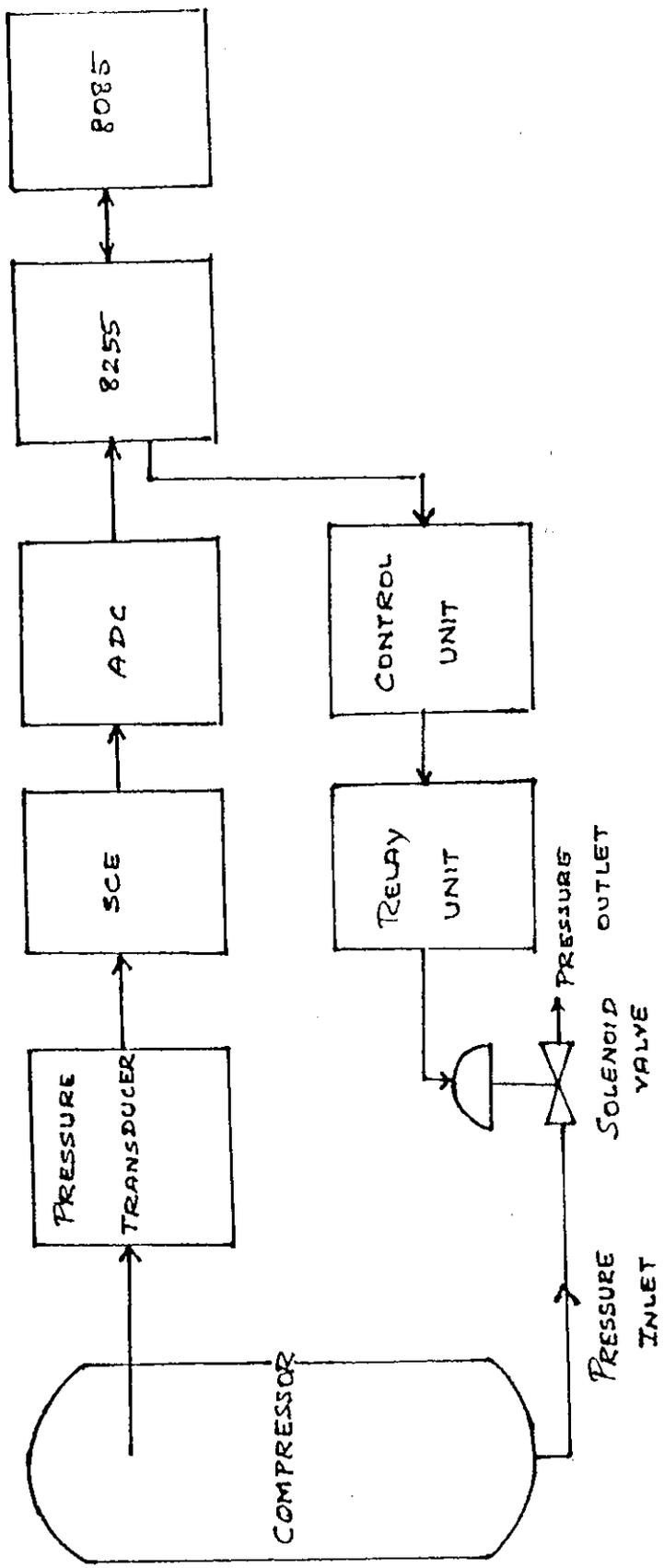
Fig 2.1 FUNCTIONAL BLOCK DIAGRAM FOR

PRESSURE CONTROL UNIT

2.2 Pressure Transducer

Pressure is an important measure in science and industry. Generally a mechanical device provides a displacement in response to a pressure change. This inturn is translated into an electrical signal by means of a displacement transducer to render it suitable for use in microprocessor controlled systems. Pressure is also on important measurand in many industrial applications as it is used to derive fluid flow rates and liquid levels. Pressure changes are usually considered to occur faster than temperature changes, but slower than most other variables. Sampling rates as low as 0.2 Hz (5 sec. sample period) are common.

This conventional pressure transducer will convert the energy from the measurand system to energy proportional to the measurand.

We can better classify pressure transducer into three different categories.

1.   Mechanical transducers

2.   Electro-mechanical transducers

3.   Electronic transducers

In case of Mechanical type of pressure transducers, the fluid pressure is directly converted into linear displacement (or) deflections on caliberated scale. From these readings we can directly find out the pressure quantity in any process (or) chambers.

The second type of pressure transducer denotes the electro-mechanical version of pressure transducer system. In this system, the mechanical displacements of the previous type of instrument is converted into linear variation of electrical output quantities. In such cases the displacements are transformed into linear electrical resistance variation (or) linear impedance variation either inductive (or) capacitive regarding the usage. Thus linear variation in the resistance will cause corresponding linear output voltage variations in the cicuit. We are adopting electro-mechanical transducer in our project.

2.3 Operation Profile

Practical implementations of the pressure transducer is shown in the fig.2.2.

In the Fig.2.2, there is a barometer arrangement which is used as a mechanical type of pressure
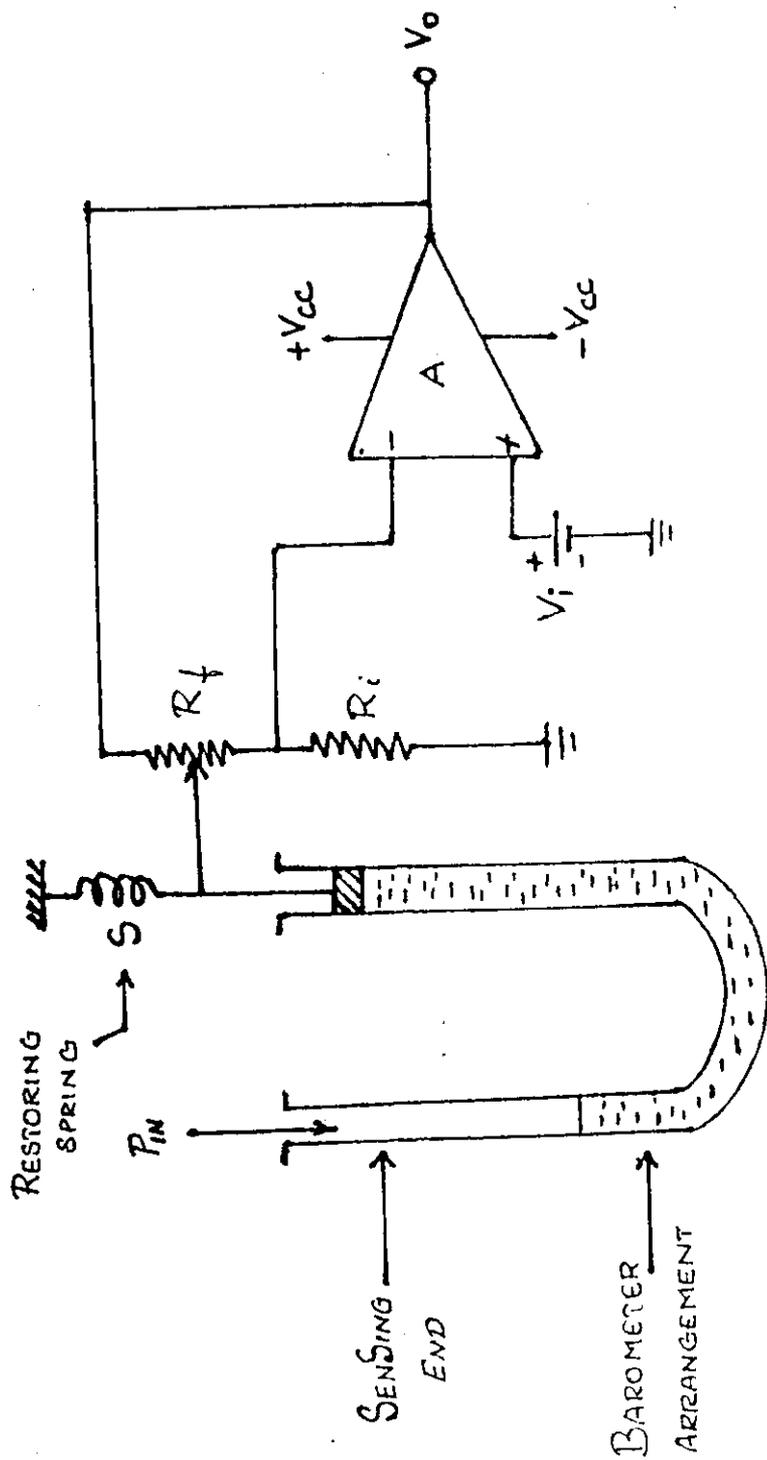
$Fig\ 2.2$ PRESSURE TRANSDUCER CIRCUIT DETAILS

transducer. The open end is exposed to pressure sensing, normally pressure chamber. The other end transfers the force applied in the sensing and through hydraulic fluid, normally lubricating oil is used. A moving jockey which is connected with the piston head moves along the linearly variable potentiometer. There is a restoring spring (s) which restores automatically when the pressure released from the sensing end. Thus the linear movement causes the resistance variation along the potentiometer heads. An operational Amplifier (MA 741) is used as the signal conditioning equipment for the pressure transducer system. The gain of the OP-AMP is determined by the value of the feedback resistance whose value can be varied by the applied pressure in the barometer end.

The gain of the OP-AMP unit is calculated as below. Since the configuration used in our circuit is non-inverting amplifier unit. The voltage (V_i) is fed at the non-inverting terminal of the OP-AMP.

Let 'R_i' be the input impedance.

& 'R_f' be the feedback resistance.

The output voltage can be derived as,

$$V_o = V_i \times (R_f/R_i)$$

here (R_f/R_i) is called amplification factor (A)

But we need the output range extending from 0v to 5V. Selecting V_i as 1.5V, the input resistance (or) impedance is R_i = 1 K and the potentiometer range is selected as 0-10K (linear type). Thus, the gain of the amplifier can be written as,

$$A = (R_f/R_i) = (10K/1K) = 10.$$

So the maximum value of amplification factor is limited to 10. In order to limit the output voltage in the range of 0-5V, a separate limiting resistor is connected in series with the output terminal.

2.4 Sensitivity and Repeatability Considerations

The performance characteristics of the pressure transducer unit can be interpritted in fig.2.3.

Normally the output form the transducer circuit is expected to be linear with applied pressure. But in practical applications the output will not be linear in nature, it is sometimes deviated from the expected linearity region. This phenomenon is called as Hysterisis effect in its output.

Still the hysterisis curve will not be similar in both the direction, the reverse path is assumed slight deviated from its forward force applications and hence the ratio between linearity & hysterisis nature is given as

$$L/H = [D_{i(max)} + D_{2(max)}]/\text{Span} \times 100$$

Here the variable D_1 can be defined as the amount of deviation in output voltage from its linear operating zone, and $D_{1(max)}$ is the maximum possible deviation in the Hysterisis curve from its linear operating region. Similarly $D_{2(max)}$ is the maximum
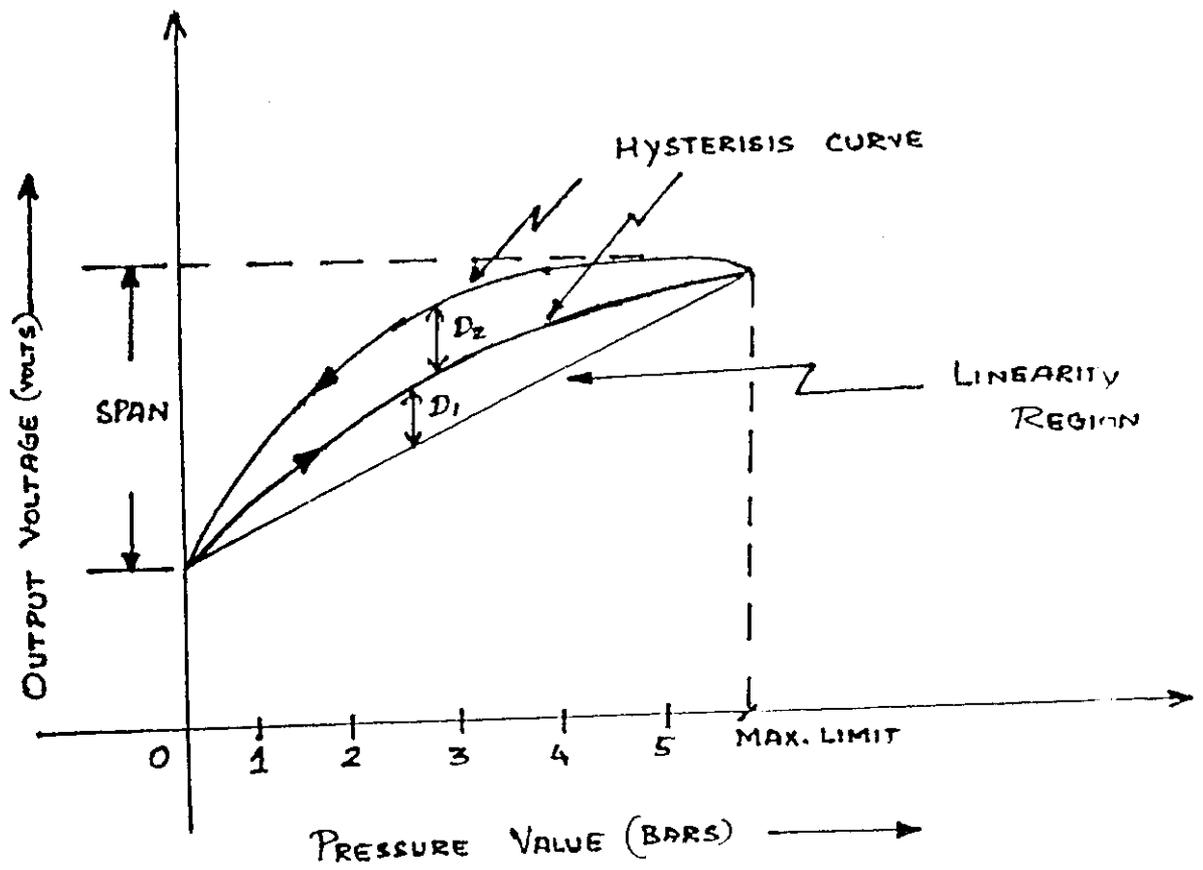
Fig 2.3 Linearity & Hysterisis Curve

possible deviation in the return path of hysterisis curve from its forward path.

The effective function of a transducer will be appreciable when the linearity to hysterisis (L/H) ratio is much minimised, though it is not possible to achieve a 100% effective pressure transducer system with electro-mechanical type of configuration.

2.5 Control Circuitry

The control circuit consists of a switching transistor, a control relay, a damping diode and a spike quencher circuit.

The fig.2.4 illustrates all the circuit elements in detail. The supply voltage for the switching transistor Vcc = 12V.

2.6 Cicuit Operation

The required pressure to be maintained in a particular system is stored in the microprocessor interms of hexadecimal value, calculated from the output voltage of the opamp. When the pressure value increases beyond the required limit, the corresponding output

Fig 24 Pressure Control Circuitry
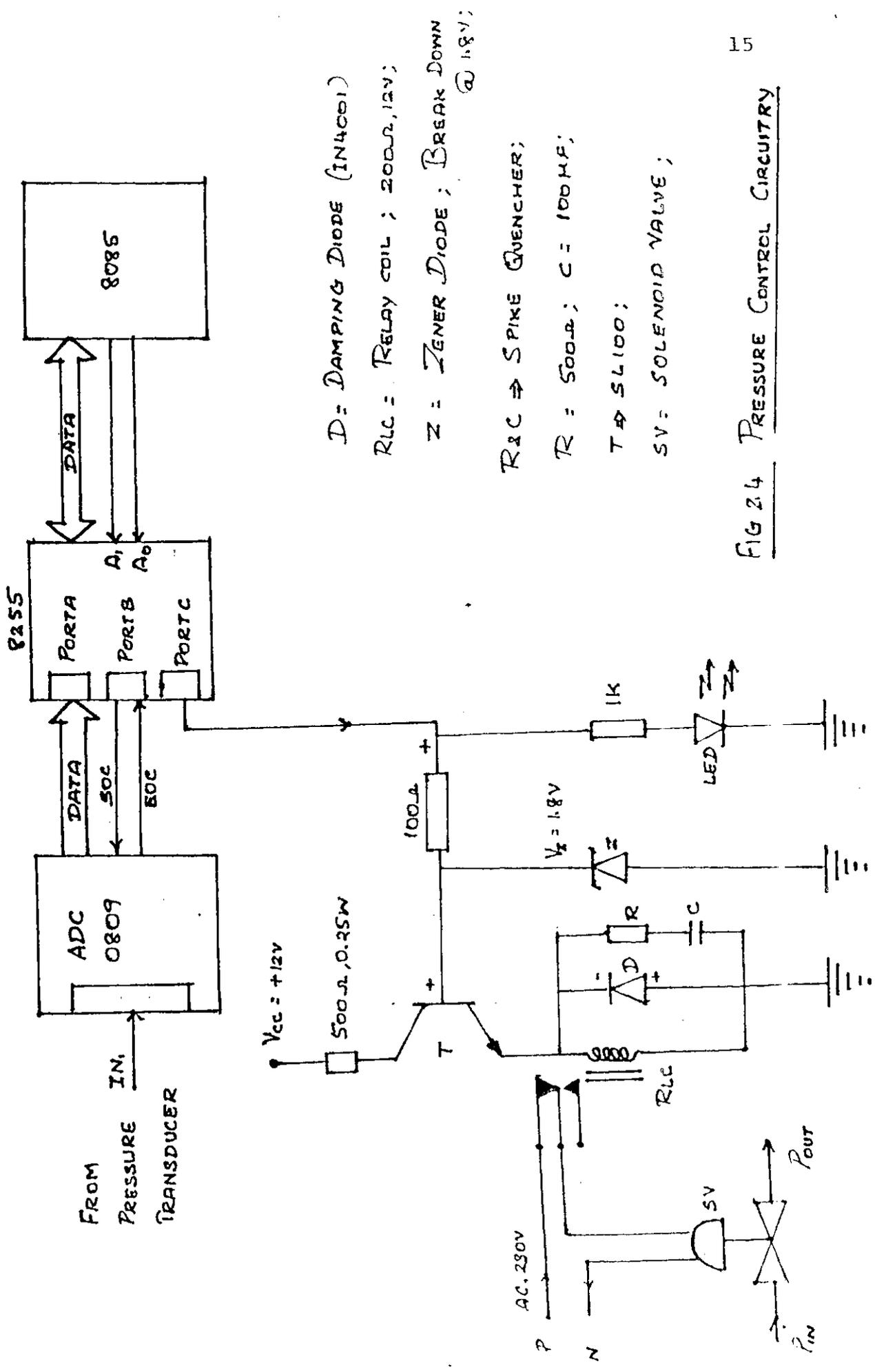
D = Damping Diode (1N4001)

RₗC = Relay coil ; 200Ω, 12V;

Z = Zener Diode ; Break Down @ 1.8V;

R₂C ⇒ Spike Quencher;

R : 500Ω ; C = 100μF;

T ⇒ SL100;

SV = Solenoid Valve ;

voltage of the opamp also increases, since the output voltage depends on the feedback resistor (R_f), which varies with varying pressure. When the output voltage of the op-amp increases the corresponding hexadecimal is compared with the reference value and if it is greater than the reference value the microprocessor gives a control signal to the base of a transistor.

As soon as the base becomes positive and transistor turns 'ON', the collector current flows through the transistor thereby energising the relay coil. This relay operates, which inturn operates the solenoid valve by connecting a.c. supply to the solenoid valve.

The solenoid valve is normally closed. When it is activated it gets opened and the excess pressure from the system is made to go out.

As soon as the required pressure is attained in the system, the microprocessor stops sending the control signal to the transistor base, which inturn closes the solenoid valve.

Across the relay coils, there is a damping diode and spike quencher circuit. The damping diode

is nothing but a PN silicon junction diode which acts as a degenerating element for the induced e.m.f. across the relay coil. It provides a reverse path for the residual magnetising current, during the relay operation. The spike quencher (or) killer degenerates the sharp spikes during frequent operation of the relay circuit. The resistor and capacitor elements in series acts as a filter circuit for damped spikes.

2.7 Control Relay Structure

The internal structural details of an electromagnet relay has been showed in the fig.2.6.

There is an electromagnet and pole reed arrangement whose displacement is restored by a restoring spring. The pole reed is attracted by the electromagnet head while the relay coil has been energised. Since the coil is activated the normally connected point is turned to normally opened position. When the relay coil has been deenergised, the pole reed is brought back to its initial position by the restoring spring (s). There are provisions for mounting the relay on a PCB or board by using fixing srews and nuts. The whole unit has been enclosed with
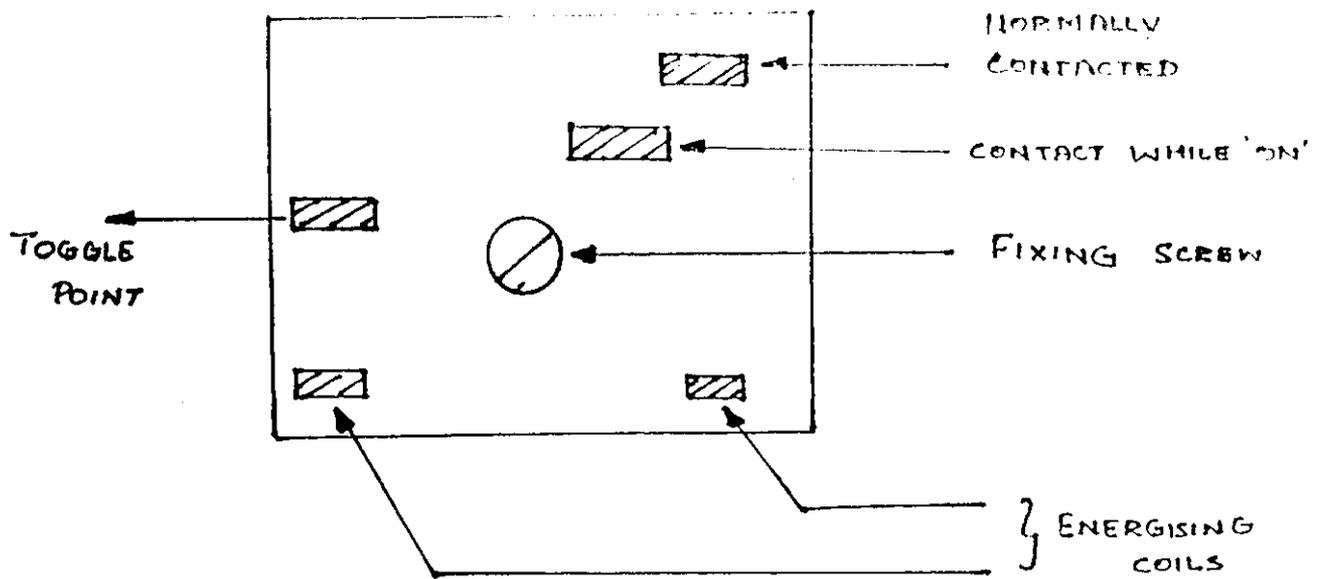
FIG 2.5   FRONT VIEW
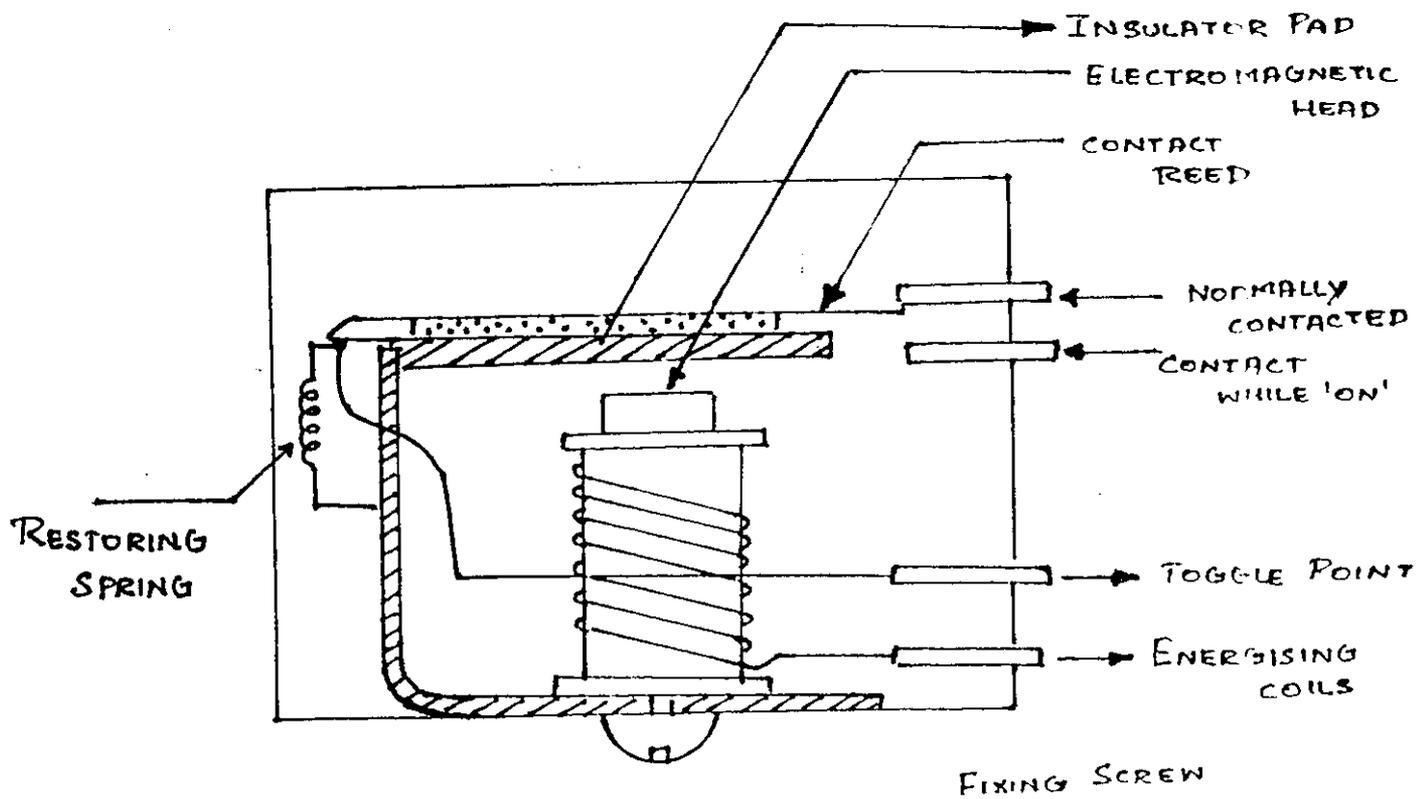
FIG 2.6   CROSS-SECTIONAL VIEW OF
ELECTROMAGNETIC RELAY

a dielectric plastic chasis to prevent electric shock.

2.8 Solenoid Valve

It is one of the primary control equipment in most of the industrial control system. It consists of an electromagnet and ferro core arrangement with mechanical nozzle unit. When the electromagnet is energised by applying supply voltage (230V), the nozzle opens as the ferro core is attracted by the electro-magnet and returns back to its initial position when supply voltage is removed.

Flame Control and Alarming System

CHAPTER III

FLAME CONTROL AND ALARMING SYSTEM

Now-a-days fire hazards are threatening the future prospects of any industrial concern. The possibility of fire breaker is proned only due to insufficient vigilance over the continuous running process, such as petroleum refineries, LPG gas cracking plants, large semi-conductor complexes and heavy boiler industries.

Of course manual vigilance over a whole plant is not considered for best maintenance sytem. For the sake of industrial safety in continuous time processing units, automatic vigilance systems are considered best over all type of industrial safety procedure concerned.

Fire in industrial curcumstances are mainly due to over accumulation of organic and inorganic wastes within the complex. In some cases failure in the flames will cause hazardous accident in the premises. In these cases, the flame failure will cause unnoticed accumulated fuel waste around the burner and in case

if we ignite it again, severe explosion (or) fire may occur. So our project will watch all the flames from failure during operations.

3.1 Optical Transducer (Flame Sensor)

There are some semi-conductor devices whose characteristics are proned to the light intensity. Light Dependent Resistor (LDR) is one of such devices which is used here as a photo sensing element. It has negative co-efficient of resistance with the intensity of light. It means that the resistance of the LDR will decrease when the intensity of light rays increases and viceversa. Utilising this property, flame sensor (or) optical transducer is fabricated (See fig.3.2).

3.2 Circuit Operations

The dual Nand-Schmitt trigger IC is used as the pulse generating device. The Resistor R_1 is designed to set the upper triggering point (UTP) for the Schmitt trigger. When the light falls on the LDR, its resistance goes low and the conductivity increases in proportion to the intensity of light rays. Thus the lower trigger point (LTP) of the Schmitt
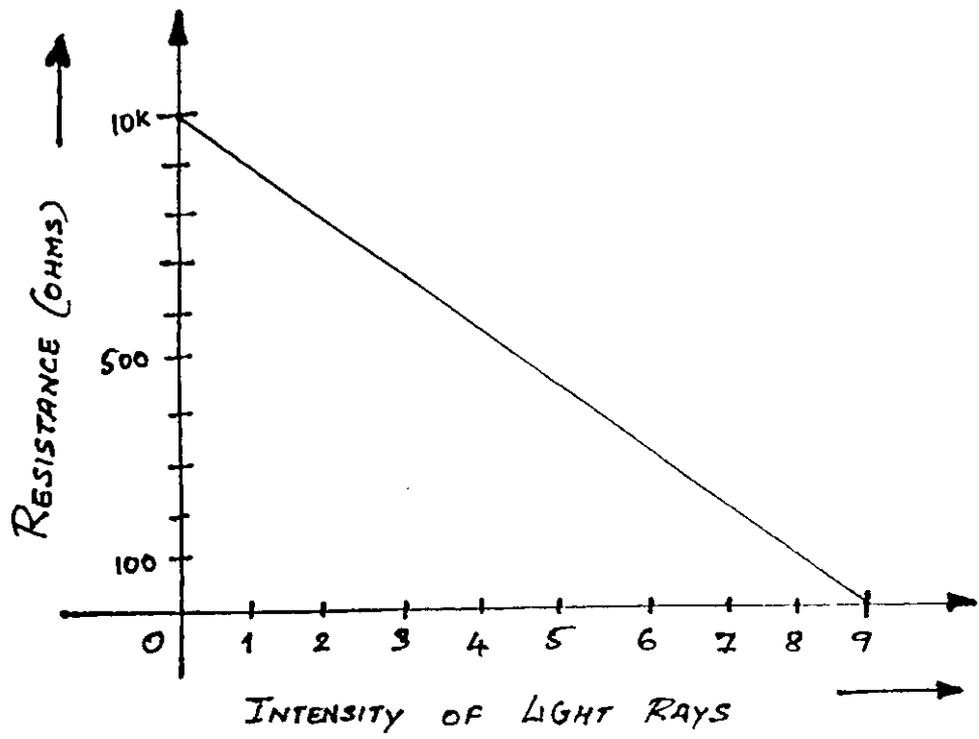
FIG 3.1   LDR CHARACTERISTICS
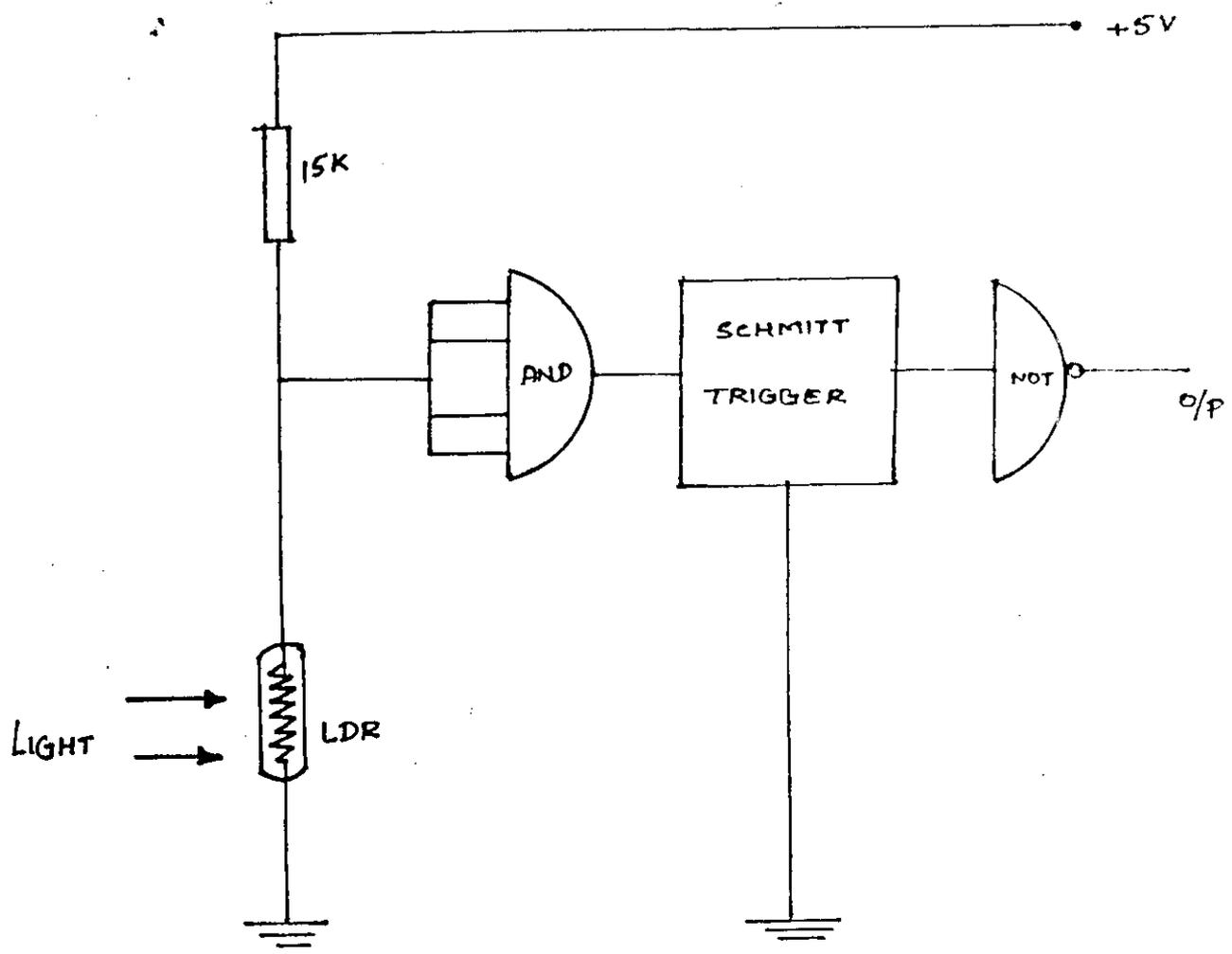
FIG 3.2   OPTICAL SENSOR CIRCUIT

Trigger is reached. Now the output of the Schmitt trigger is zero volts. It is fed at the input of the inverter gate. So +5V is available at the output.

If the light ray is absent, the resistance of the LDR will go higher and the Schmitt trigger is biased with the upper trigger point (UTP). Now the Schmitt trigger output will be +5V and the inverter gate will give zero volts at the output terminal.

The optical sensor output is fed to the part A of 8255 (ie., PA_0) The functional block diagram is shown in fig.3.3

The light sensing element (LDR) is mounted inside the flame chamber so that it can directly sense the light rays from the flame burners. Usually when the flame fails during the operation of the boiler, the furnace oil will still flow into the flame burner and evaporates. So petroleum vapours will form a cloud around the flame chamber. If we ignite the burner now, disastrous explosion can occur.

To prevent these uncontrolled vapour cloud explosions (UVCE), the flame monitoring system stops the fuel supply to the burners, when the flame goes
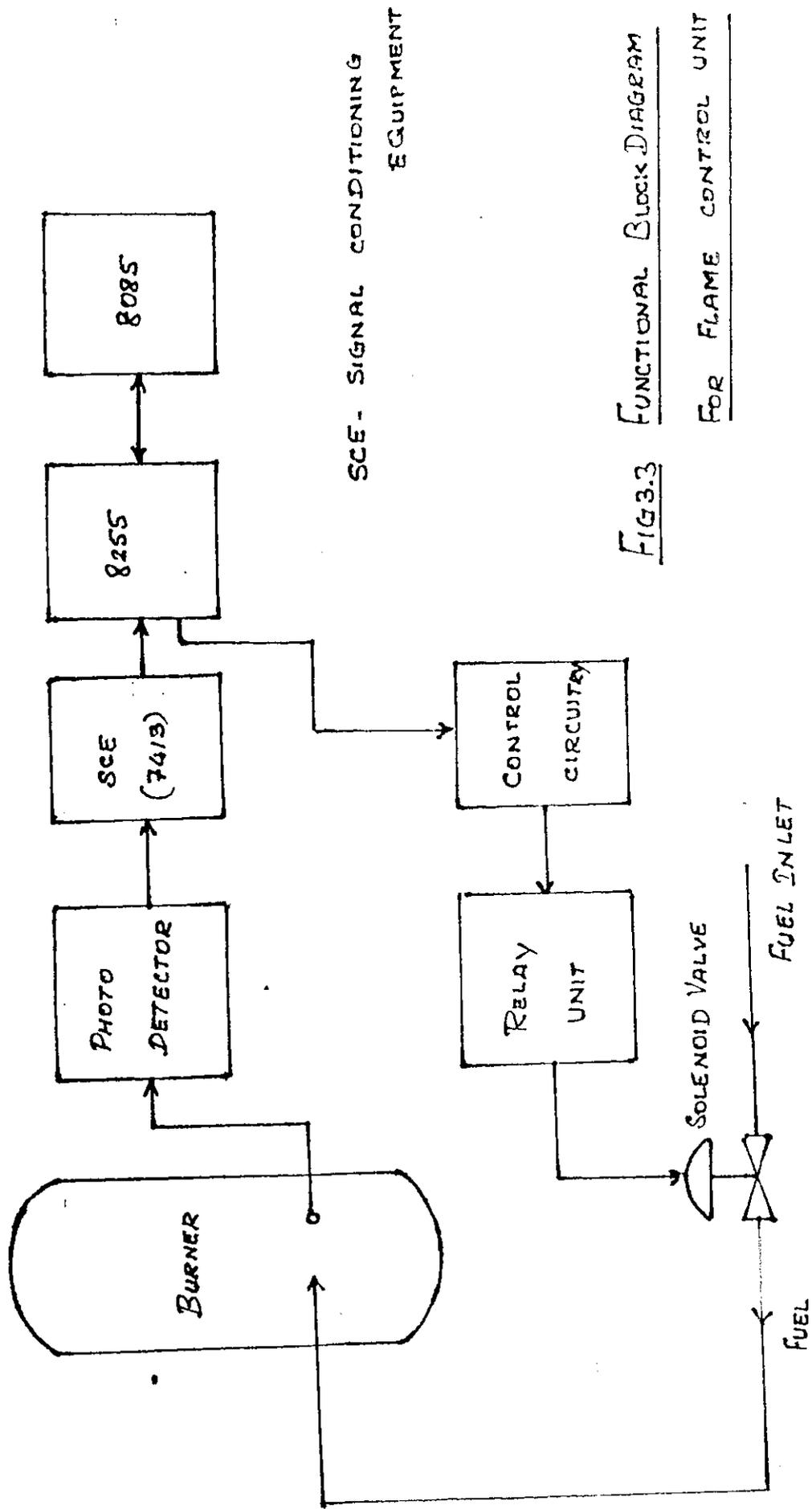
SCE - SIGNAL CONDITIONING EQUIPMENT

Fig 3.3 FUNCTIONAL BLOCK DIAGRAM

FOR FLAME CONTROL UNIT

off. This is illustrated in fig.3.4. Here the stop

valves are usually solenoid valves which can be

energised by a.c. main supply. In our project only

flame detection is possible. The pin configuration of

IC 7413 (Schmitt Trigger) is shown in fig.3.5.

+5V

15K

IC 7413

LIGHT FROM BURNER

8255

8085
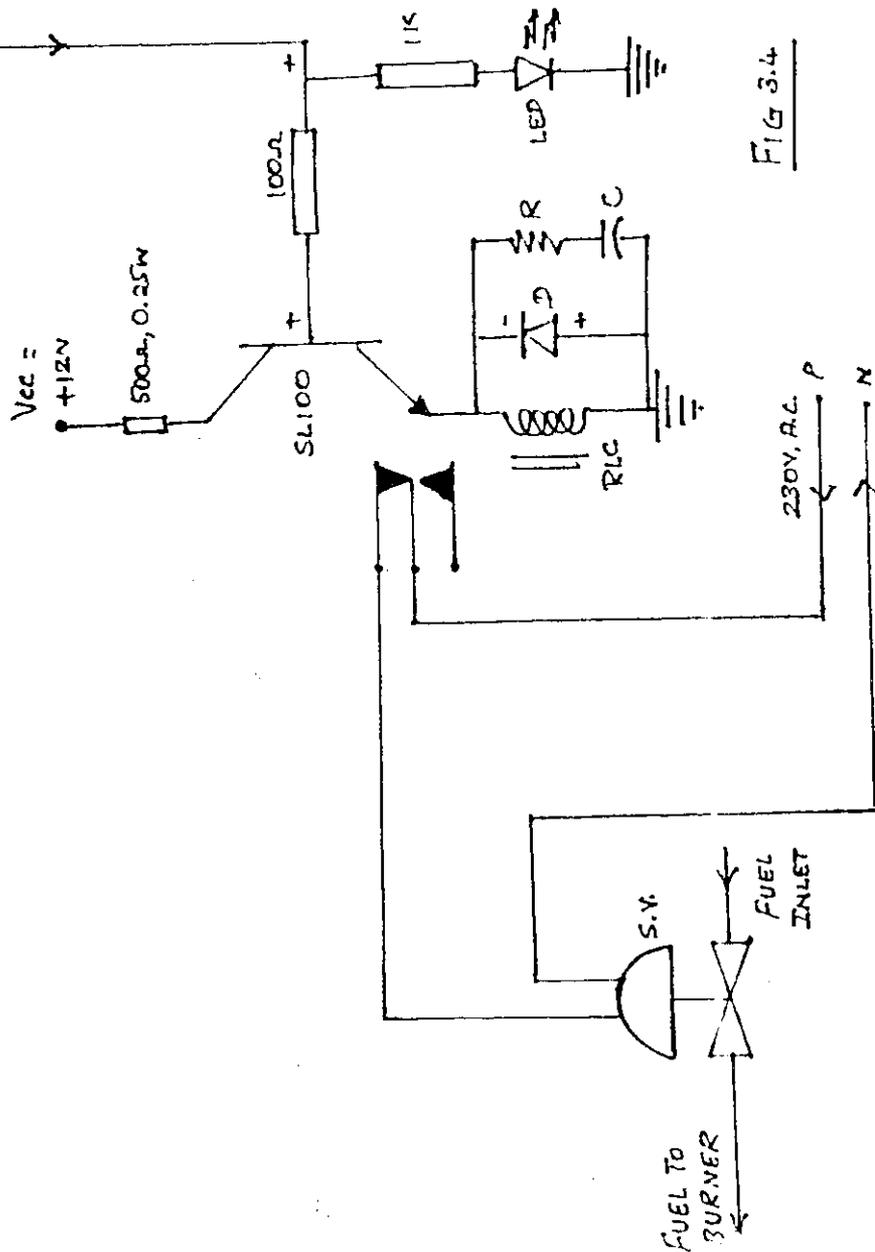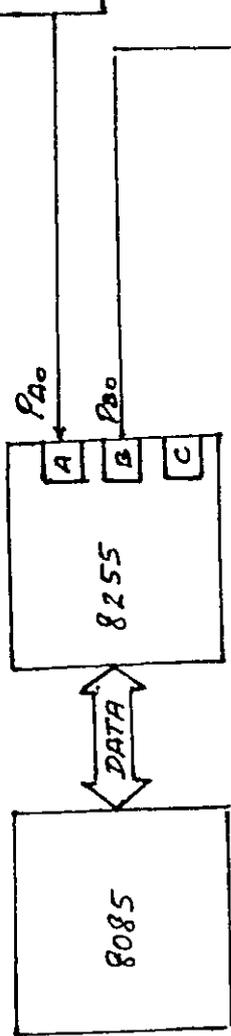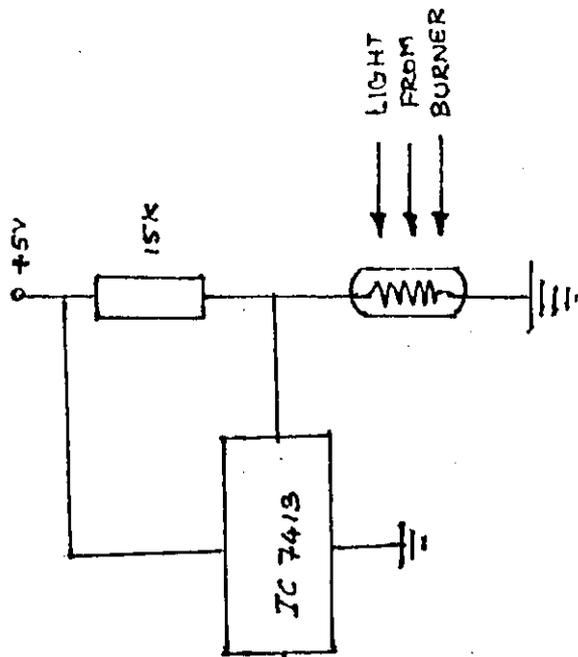
DATA

RLC = RELAY COIL; 200Ω; 12V;

D= DAMPING DIODE (2N4001)

R&C ⇒ SPIKE QUENCHER;

R = 500Ω; C = 100µF;

T ⇒ SL100

S.V. ⇒ SOLENOID VALVE

1K

LED

100Ω

500Ω, 0.25W

Vcc = +12V

SL100

R

C

RLC

230V, A.C.

P

N

S.V.

FUEL INLET

FUEL TO BURNER

FIG 3.4   RELAY CONTROL CIRCUITRY
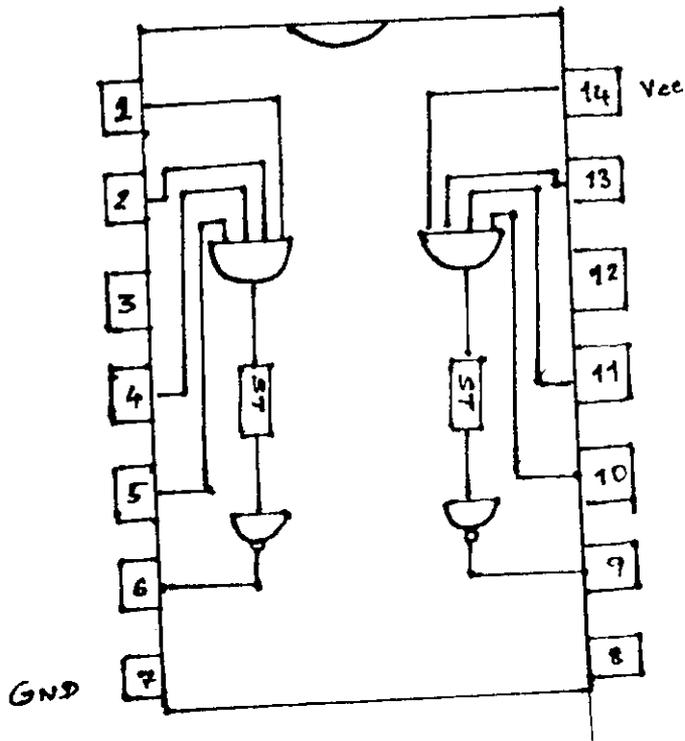
FIG 3.5   PIN DIAGRAM OF IC 7413

Data Logging System

CHAPTER IV

DATA LOGGING SECTION

The Data Logging Section consists of an Analog to Digital converter ADC 0809 with necessary hardware as shown in fig. 4.1 . The ADC 0808/0809 is an 8 bit A/D converter with 8 channel multiplexer. It is an monolithic CMOS device. The A/D converter uses successive approximation as the conversion techniques. It does not require external zero and full scale adjustments. The converter features a high impedance chopper stablized comparator, a 256 R resistor ladder with analog switch tree and a successive approximation register.

4.1. Channel Selection of ADC 0808/0809

ANALOG CHANNEL	ADDRESS		
	C	B	A
IN_0	0	0	0
IN_1	0	0	1
IN_2	0	1	0
IN_3	0	1	1
IN_4	1	0	0
IN_5	1	0	1
IN_6	1	1	0
IN_7	1	1	1

The device contains an 8 channel single ended analog signal multiplexer. A particular input channel is selected by using the Address decoder.

The table shows the input states for the Address lines A, B and C to select any channel. The address is latched into the decoder and selects the desired channel input.

4.2 Brief Operation of A/D Converter

The pin configuration of ADC 0809 is shown in fig.4.2. The timing diagram details of ADC 0809 is shown in fig. 4.3 . The block diagram of a successive approximation A/D converter. It consists of three major elements; the D/A converter, the successive approximation register (SAR) and the comparator. The conversion technique involves comparing the output of the D/A converter (V_o) with the analog input signal V_{in}. The digital input to the DAC is generated using successive approximation method. When the DAC output matches the analog signal, the input to the DAC is the equivalent digital signal.

The successive approximation conversion process can be accomplished through either the software or hardware approach. In the software approach an A/D converter is designed using a D/A converter, and
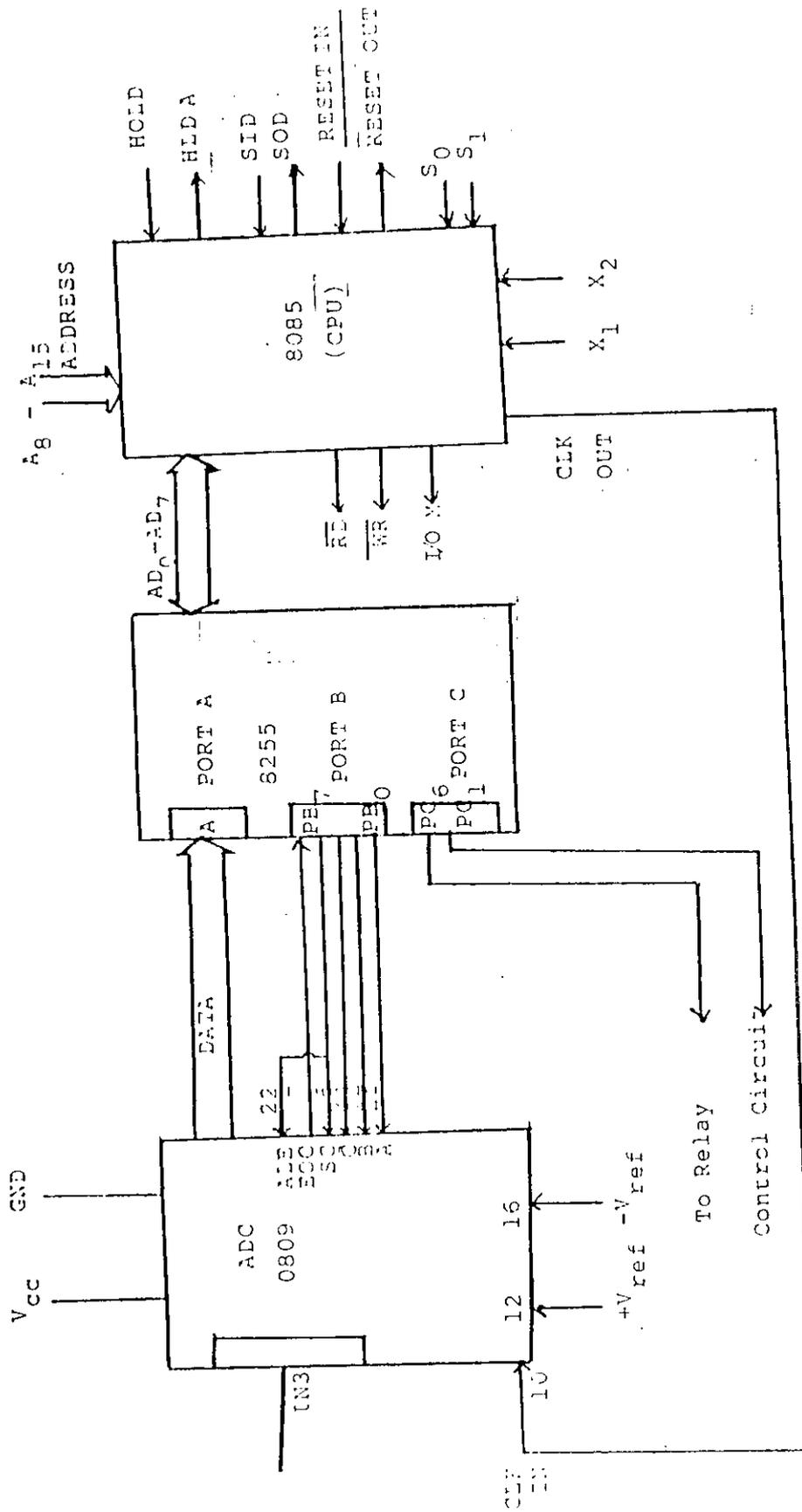
Fig. 4.1 Block Diagram of System
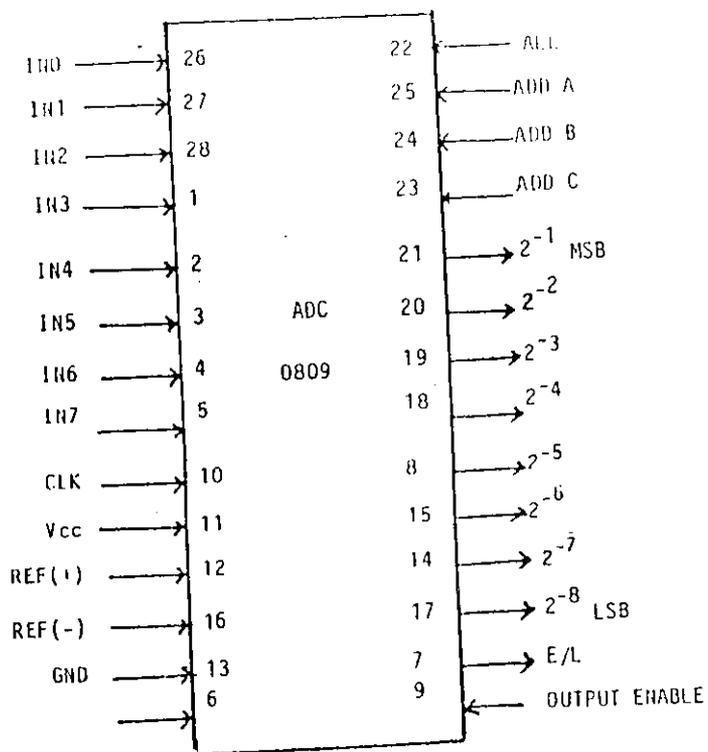
FIG:- 4.2   SCHEMATIC DIAGRAM OF ADC0809
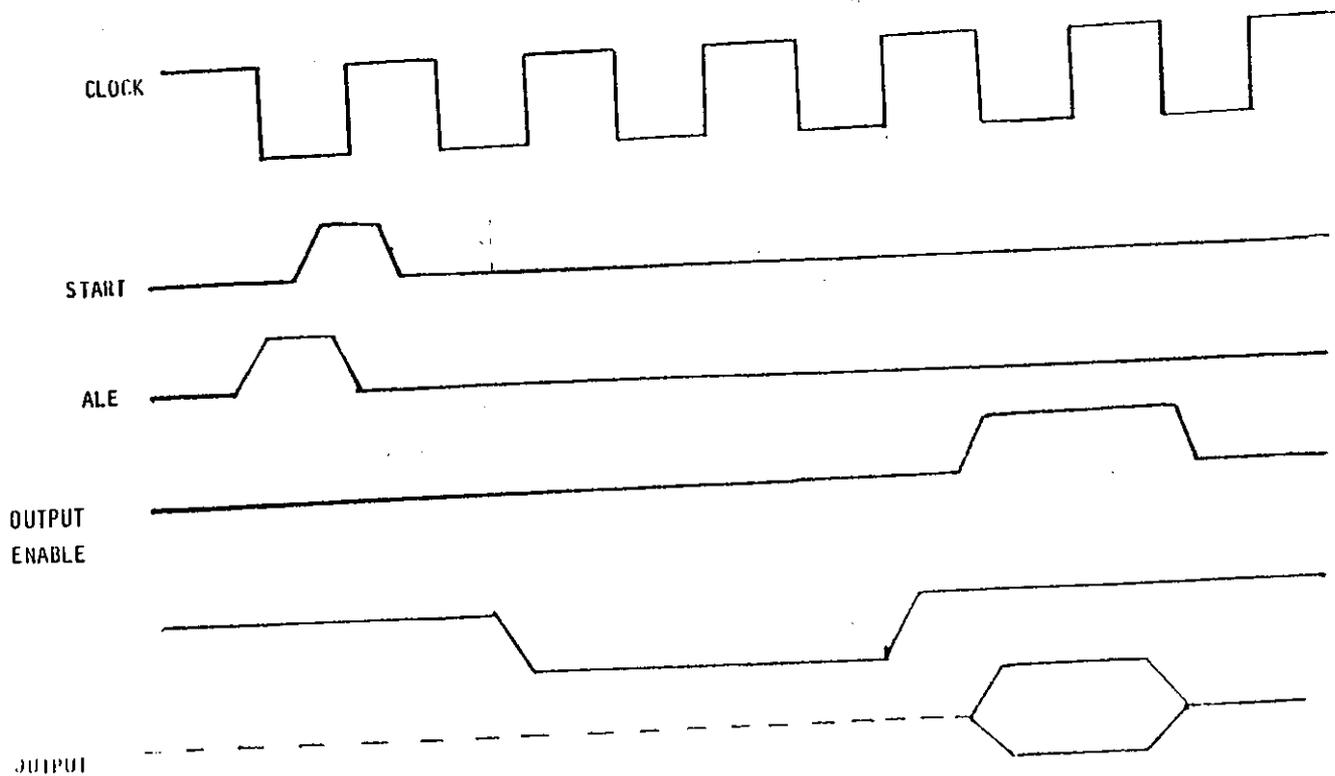
FIG:- 4.3 TIMING DIAGRAM OF ADC0809

BLOCK DIAGRAM OF ADC 0809
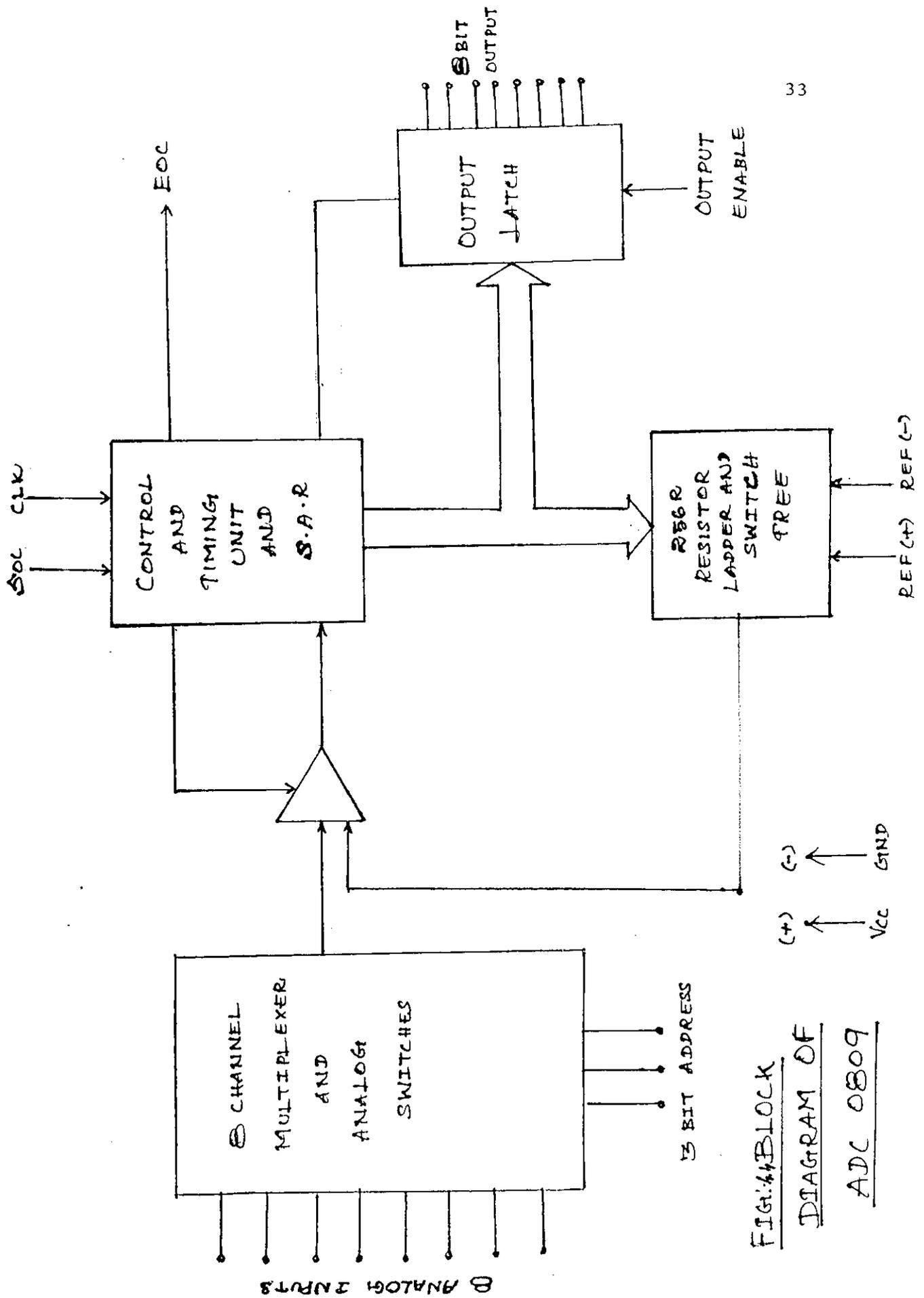
FIG:4:BLOCK DIAGRAM OF ADC 0809

the microprocessor plays the role of the counter and the SAR. The conversion process begins when processor sends start of conversion (SOC) signal to the ADC 0808 and when EOC (End of Conversion) signal is high, the digital data is transferred to the 8085 processor. The data is saved in the accumulator. The block diagram of ADC 0809 is shown in fig.4.4.

Interface Circuitry

CHAPTER V

INTERFACE CIRCUITRY

5.1   Features of 8255A/8255A-5

*   24 programmable Input output pins.

*   Completely TTL COMPATIBLE

*   Fully compatible with INTEL lip families.

*   Improved training characteristics.

*   Direct Bit Set/Reset capability easing control
        application interface

*   Reduces system package count

*   IImproved DC driving capability.

*   Available express - STD temperature range.

                          - Extended temperature range.

        The intel 8255A is a general purpose program-
mable input output device designed for the use of
intel microprocessor.   It has 24 input output pins
which may be individually programmed in 2 groups of
12 and used in 3 major modes of operation.   In the
first mode each group of 12 input output pins may
be programmed in sets of 4 to be input cr output.
In the second mode, each group may be programmed to
have 8 lines of input or output of the remaining 4

pins, 3 are used for hand shaking and interrupt control signals. The third mode of operation is a bidirectional bus mode which uses 2 lines for a bidirectional bus, and 5 lines, borrowing one from the other group for handshaking.

5.2 8255A Functional Description

General

The 8255A is a programmable peripheral interface device designed for use in intel microcomputer system. Its function is that of a general purpose I/O component to interface peripheral equipment to the microcomputer system Bus. The functional configuration of the 8255A is programmed by the system software so that normally no external logic is necessary to interface peripheral devices or structure.

Data Bus Transfer

A 3 state bidirectional 8 bit buffer is used to interface the 8255A to the system data Bus. Data is transmitted by the buffer upon execution of input or output instruction by the cpu. Control words and status information are also transfered through the data bus buffer.

Read/Write Control Logic

The function of this block is to manage all of the internal and external transfers. It accepts inputs from the cpu Address and Control buses and in turn issues commands to both of the central groups (C.S)

Chip Select (CS)

A "low" on this input pin enables the communication between the 8255A and the cpu (RD).

Read (RD)

A "low" on this input pin enables the 8255A to send the data or status information to the cpu on the data Bus. In essence, it allows the cpu to "read from" the 8255A.

Write (WR)

A "low" on this input pin enables the cpu to write data or control words into the 8255A (A_0 and A_1)

Port Select 0 and port select 1

These input signals in conjuction with the RD and WR inputs, control the selection of one of

the three ports or the control word registers. They are normally connected to the least significant bits of the address bus (A_0 and A_1).

Reset (Reset)

A "high" on this input clear the control register and all ports (A, B, C) are set the input mode.

5.3 Group A and Group B controls

The functional configuration of each port is programmed by system software. In essence the cpu output sends a control word to the 8255A. The control word contains information such as "Mode".1 "Bitset", "Bit Reset", etc..., that initializes the functional configuration of the 8255A. Each of the control logic receives "control words" from the internal data bus and issues the proper commands to its associated ports.

Control group A - Port A and Port C upper (C7-C4)
Control group B - Port B and Port C lower (C3-C0)

No read operation of the control word register is allowed.

5.4   Ports of 8255

Ports A, B and C

The 8255A contains three 8 bit ports (A,B&C).
All can be configured in a wide variety of functional
characteristics by the system software but each has
its own special features or "personality" to further
enhance the power and flexibility of the 8255A.

Port A   One 8 bit data output latch/buffer and one
8 bit data input latch.

Port B   One 8 bit data input/output latch/buffer
and one 8 bit data input buffer.

Port C   One 8 bit data output latch/buffer and one
8 bit data input buffer (no latch for input).   This
port can be devided into two 4 bit ports under the
mode control.   Each 4 bit port contains a 4 bit latch
and it can be used for the control signal outputs
and status signals input in conjuction with ports
A and B.

5.5 8255A Operational Description (Control Word Format for I/O mode)

Mode Selection

There are three basic modes of operation that can be selected by the system software;

Mode 0.... Basic Input/output

Mode 1.... Strobed input/output

Mode 2.... Bi-directional bus.

When the reset input goes "high" all ports will be set to the input mode. After the reset is removed the 8255A can remain in the input mode with no additional initialization required. During the execution of the system program any of the other modes may be selected using a single output instruction. This allows a single 8255A to service a variety of peripheral devices with a simple software maintenance routine.

Simple Software Maintenance Routine

The modes for Port A and Port B can be separately defined, while Port C is divided into two portions as required by the Port A and Port B defined.

All of the output registers, including the status Flip-Flops, will be reset whenever the mode is changed. Modes may be combined so that their functional definition can be "tailored" to almost any I/O structure. For instance, Group B can be programmed in mode 0 to monitor simple switch closings or display computational results. Group A could be programmed in Mode 1 to monitor a Key Board or tape reader on an interrupt driver basis. The mode definition and possible mode combination may sum confusing at first but after a cursory service of the complete device operation a simple, logical Input ouput approach will surface. The design of the 8255A has taken into account things such as efficient PC board layout. Control signal definition V_s PC layout and complete functional flexibility to support almost any peripheral device with no external logic. Such design represents the maximum use of the available pins.

REFERENCE DIAGRAMS

PIN CONFIGURATION

PA3	1		40	PA4
PA2	2		39	PA5
PA1	3		38	PA6
PA0	4		37	PA7
$\overline{RD}$	5		36	$\overline{WR}$
$\overline{CS}$	6		35	RESET
GND	7		34	D0
A1	8		33	D1
A0	9		32	D2
PC7	10	8255A	31	D3
PC6	11		30	D4
PC5	12		29	D5
PC4	13		28	D6
PC0	14		27	D7
PC1	15		26	Vcc
PC2	16		25	PB7
PC3	17		24	PB6
PB0	18		23	PB5
PB1	19		22	PB4
PB2	20		21	PB3
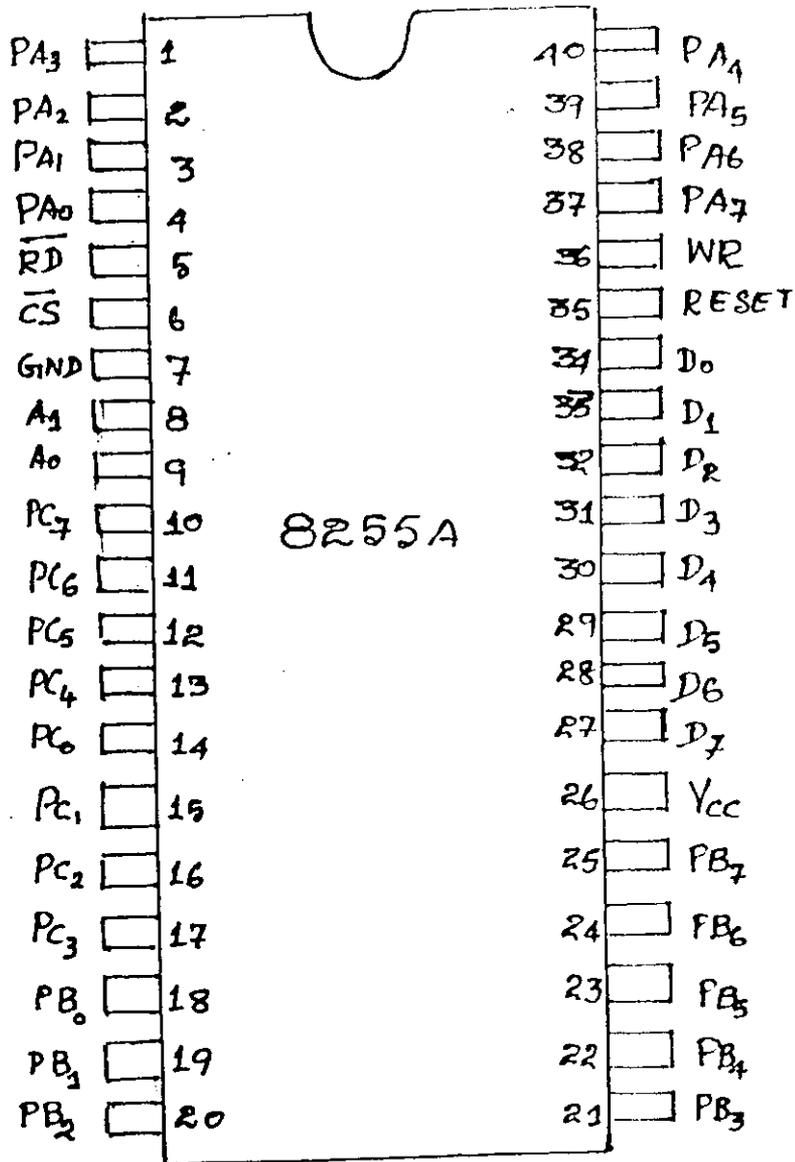
FIG 5.1

PIN NAMES

$D_7 - D_0$	Data Bus (Bidirectional)
RESET	Reset Input
$\overline{CS}$	Chip Select
$\overline{RD}$	Read Input
$\overline{WR}$	Write Input
A_0, A_1	Port Address
$PA_7 - PA_0$	Port A (Bit)
$PB_7 - PB_0$	Port B (Bit)
$PC_7 - PC_0$	Port C (Bit)
Vcc	+5 Volts
GND	0 Volts

Power Supplies { → +5V
→ GND

Group A control

Group A Port A (8)

I/O PA7-PA0

Bidirectional Data Bus

Data Bus Buffer

D7-D0

8-Bit internal Data Bus

Group A Bit C upper (4)

I/O PC7-PC4

Group B Bit C Lower (4)

I/O PC7-PC0

RD

WR

A1

A0

RESET

Read Write control Logic

Group B Control

Group B Port B (8)

I/O PB7-PB0

CS
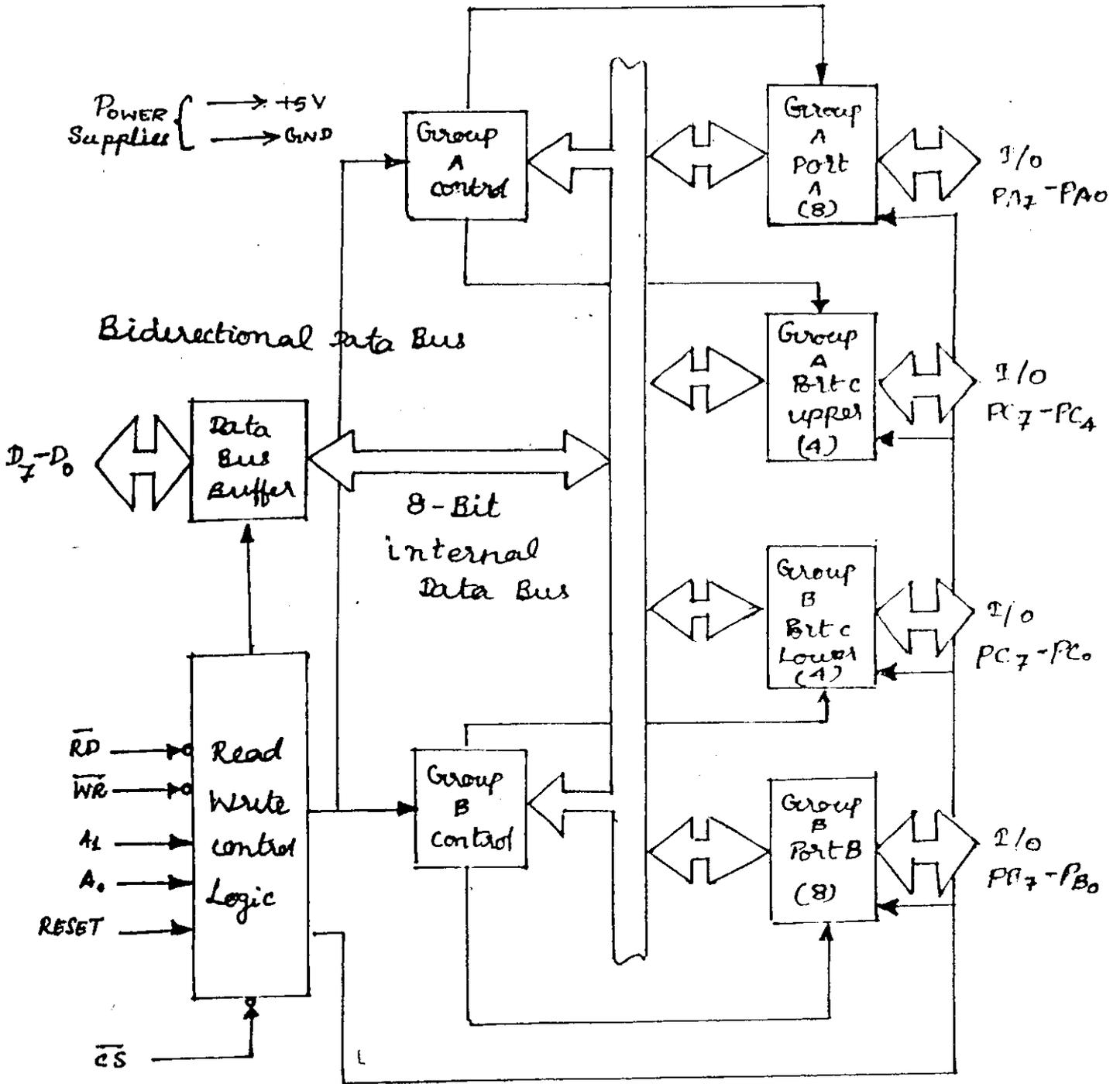
FIG 5.2
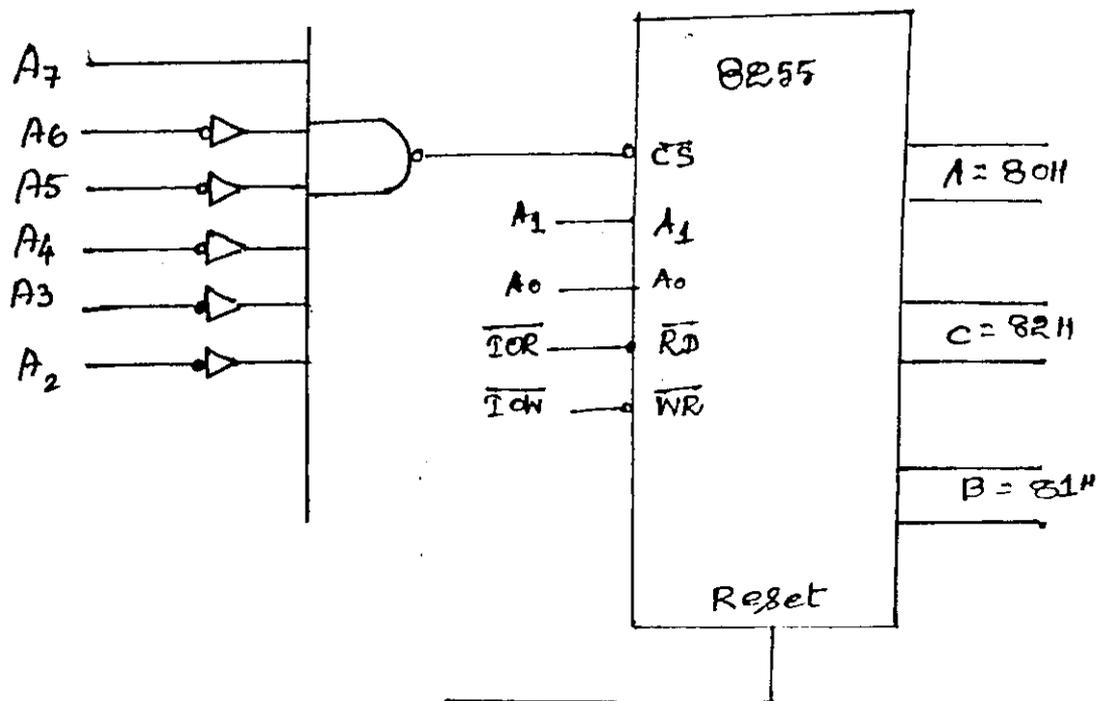
FIG 5.4

$\overline{CS}$				Hex Address	Port
A_7 A_6 A_5 A_4 A_3 A_2		A_1	A_0		
1 0 0 0 0 0		0	0	= 80H	A
		0	1	= 81H	B
		1	0	= 82H	C
		1	1	= 83H	Control Register

FIG 5.3

Control word

| D_7 | D_6 | D_5 | D_4 | D_3 | D_2 | D_1 | D_0 |

Group B

Port C (Lower — PC_3–PC_0)
1 = Input
0 = Output

Port B
1 = Input
0 = output

Mode Selection
0 = Mode 0
1 = Mode 1

Group A

Port C (upper — PC_7–PC_4)
1 = Input
0 = Output

Port A
1 = Input
0 = output

Mode Selection
00 = Mode 0
01 = Mode 1
1x = Mode 2

1 = I/O Mode
0 = BSR Mode
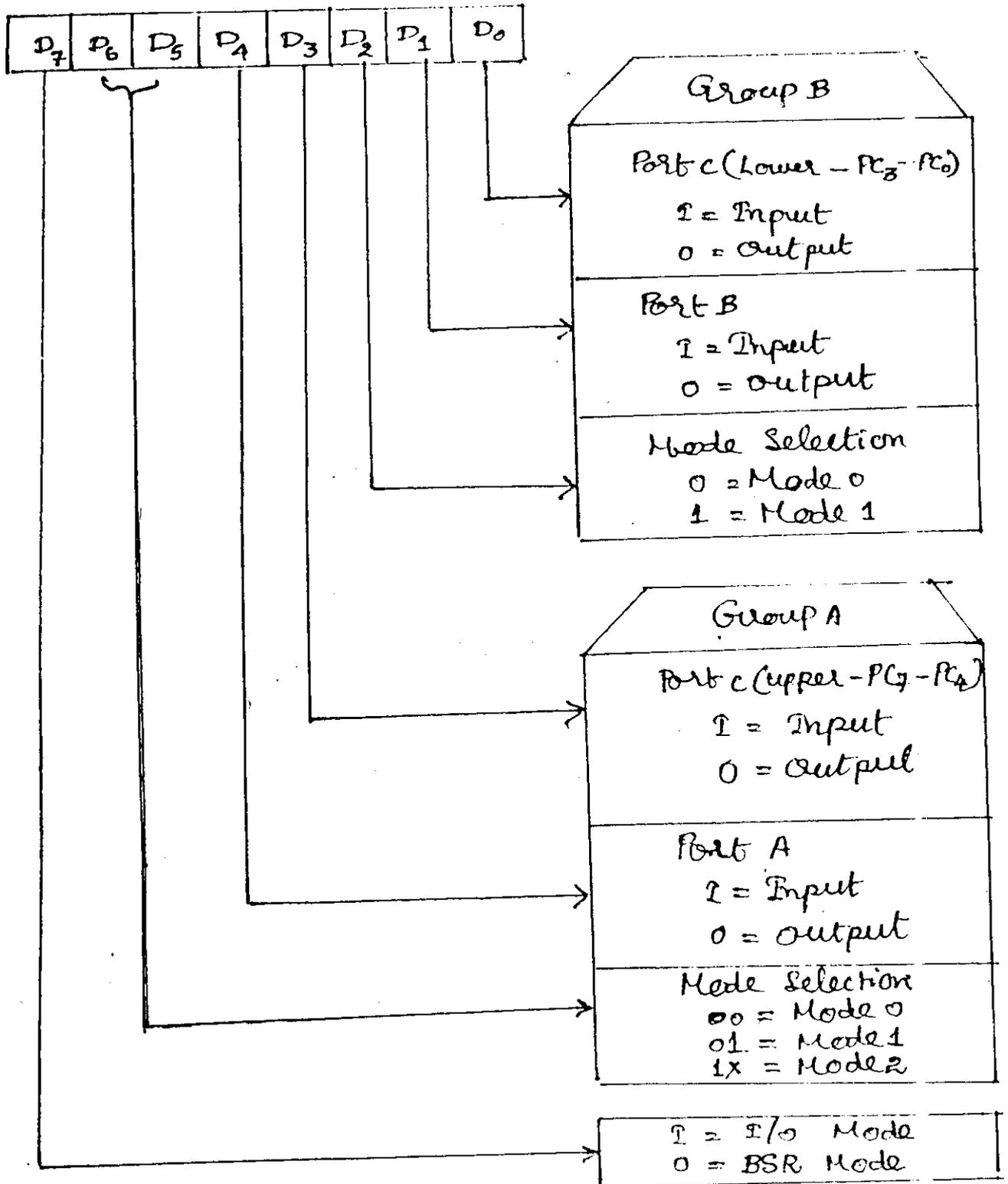
FIG 5.5

Microprocessor Architecture

CHAPTER VI

MICROPROCESSOR ARCHITECTURE

The figure 6.1 shows the internal archi-
tecture of 8085. It includes the ALU, Timing & Control
Unit, Instruction Register and Decoder, Register array,
Interrupt control and serial Input output control.

6.1 Registers

Inside the 8085 there are several registers
which are used during the execution of a program.

Accumulator There is one 8 bit (temporary storage)
register known as the acumulator (ACC). It is used
in various arithmetic & logical operations. For e.g.
during the addition of the two 8 bit integers, one
of the operands must be in the accumulator while the
other may be either in the memory (or) in one of the
other registers.

Temporary Register The temporary register is used
to hold data during an arithmetic & logic operation.
The result is stored in the accumulator and the flags
(flip-flops) are set (or) reset according to the result
of operation.

INTR
INTA   RST 5.5   RST 6.5   RST 7.5   TRAP
RST 5.5   RST 7.5

Interrupt Control

SID   SOD

Serial I/O Control

8-Bit Internal Data Bus

Accumulator (8)

Temp. Reg. (8)

Flag (5)
Flip-Flops

Arithmetic
Logic
Unit
(ALU) (8)

Instruction
Register (8)

Instruction
Decoder
and
Machine
Cycle
Encoding

Multiplexer

Register
Array

W (8) Temp. Reg.	Z (8) Temp. Reg.
B (8) Reg.	C (8) Reg.
D (8) Reg.	E (8) Reg.
H (8) Reg.	L (8) Reg.
Stack Pointer (16)
Program Counter (16)
Incrementer/Decrementer Address Latch (16)

Reg. Select

Data/Address Buffer (8)

AD₇–AD₀
Address/Data Bus

Address Buffer (8)

A₁₅–A₈
Address Bus

Timing and Control

Power Supply   +5 V   GND

X₁
X₂

CLK
GEN

CLK OUT

READY

Control

RD   WR   ALE   S₀   S₁   IO/M   HOLD

Status

DMA

HLDA

RESET IN

Reset

RESET OUT

FIGURE 3.7
The 8085A Microprocessor: Functional Block Diagram

NOTE: The 8085A microprocessor is commonly known as the 8085.
SOURCE: Intel Corporation, MCS – 80/85 Family User's Manual (Santa Clara, Calif.: Author, 1979), p. 6-1.

FIG :- 6·1

Flags (Flip-Flop) The flags are affected by the a arithmetic & logic operations in the ALU. In most of these operations, the result is stored in kthe accumulator. Therefore, the flags generally reflect data conditions in the accumulator with some exceptions. The descriptions & condtions of the flags are as follows:

Sign Flag A logical 1 was left in the most significant bit of the accumultor after the last instruction was executed.

Zero Flag All bits in the accumulator were zero after the last instruction was executed.

Auxillary Carry Flag In an arithmetic operation, when a carry is generated by digit D_3 & passed on to digit D_4, the AC flag is set.

Parity Flag The number of ones in the accumulator is odd after execution of the last instruction.

Carry Flag An accumulator arithmetic overflow occured on execution of the last instruction.

The bit positions reserved for these flags in the flag register are as follows:

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
S	Z		AC		P		CY

Instruction Register The instruction register stores the binary word fetched as an instruction during the decoding & execution portions of the instruction cycle. This is not programmable & the contents of the instruction register may not be changed except by calling a new instruction. Some computers have two instruction registers, & so they can fetch & save one instruction while executing the previous one. This process is called pipelining.

Memory Address Register (MAR) This hold the addresses of data in memory. The addresses may be part of the instructions (or) may be provided separately by the program.

General Purpose Register There are six General purpose 8 bit registers (B,C,D,E,H & L) that can be used by a programmer for a variety of purposes. They can

be used individually (when operation on 8 bit data is desired) or in pairs (when a 16 bit address is to be stored). Such registers may serve as temporary storage for data (or) addresses. The programmer may be able to assign them as accumulators (or) even as program counters.

Stack pointer A stack is to save the program counter so that the program may continue where it left off when it went to compute a subroutine. A stack pointer is a register that is used to maintain a stack in the memory.

Program Counter There is a 16 bit register which is used by the 8085 to keep tract of the address of the instruction (in the memory) that has to be executed next. This register is called the program Counter (PC). The contents of the PC are automatially updated by the 8085 during the execution of an instruction so that at the end of execution of this instruction it points to the address of the next instruction in the memory.

6.2 Arithmetic & Logic Unit (ALU) This performs the arithmetic & logical operations. This accepts two binary inputs & produce the binary sum & a carry

from the most significant bit of the addition. Subtraction can be performed by taking the two's compliment of one input before sending it to the adder. Multiplication & division may be performed by repeated additions & subtractions, respectively. The function inputs determine which function the ALU performs; typical choices are: Addition, subtraction, Logical AND, Logical INCLUSIVE OR, logical EXCLUSIVE OR, logical NOT (Compliment), Increment (add 1), decrement (subtract 1), left shift (add input to itself), clear (result is zero).

6.3 Timing and Control Unit This unit synchronizes all the Microprocessor operations with the clock, & generates the contro signals necessary for communication between the Microprocessor & peripherals. The control signals are similar to a sync. pulse in an oscilloscope. The RD & WR signals are Sync. pulses indicating the availability of data on the data bus.

Address Bus The address bus is a unidirectional bus. This is a 16 bit bus to provide address to full 64k memory. The upper eight lines A_{15}........A_8 form the page no: and the lower eight lines A_7......A_0 form the address within the page and they also carry the data. This process is known as Multiplexing.

Data Bus This is a bidirectional bus. This bus consists of eight lines carrying data into & out of the microprocessor. Since this bus is bi-directional, there is no need for a separate set of 8 pins for the data transmitted out of the Microprocessor. So the data pins is reduced to 8 from 16.

Control Bus This bus consists of as many lines in a Microprocessor as the number of control signals. One such signal is that which distinguishes between whether the Microprocessor is transmitting the data (or) receiving the data on the data bus. The other control signals are (i) The interrupt Line (ii) Reset Line (iii) Hold line (iv) DBIN (v) Tristate Control (vi) tristate acknowledge (Vii) I/O read write control.

Software

CHAPTER VII

SOFTWARE

7.1 Analog to Digital Conversion

Need for software

The output voltage of the op-amp 741, with no pressure applied to the linear potentiometer, which is nothing but a feedback resistor (10 KΩ), at its minimum position (0KΩ), is found to be 1.8V. Similarly due to pressure, when the feedback resistor is at its maximum value (10K Ω), then the corresponding output voltage is found to be 3.6V. So the conversion of analog voltage into digital should be had for every increase in 0.1V from the initial value (1.8V), since the applied pressure may introduce an output voltage in between 1.8V & 3.6 V.

The above technique can be obtained easily using BASIC language. The program of A/D conversion is thus given.

```
PRINT "***********************************"
PRINT "ANALOG TO DIGITAL CONVERSION"
PRINT "***********************************"
DIM B(20)
INPUT A
REF = 5.0
FOR I = 1 TO 7
B(I) = 0
NEXT I
FOR I = 1 TO 8
G = B(1)/2+B(2)/4+B(3)/8+B(4)/16+B(5)/32+B(6)/64+B(7)/128
G1 = (G  + 1/(2^I))*REF
IF(A>G1)GO TO 20
B(I) = 0
GO TO 30
20 B(I) = 1
30 PRINT B(I);
NEXT I
STOP
END
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 1.8
 0  1  0  1  1  1  0  0
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 1.9
 0  1  1  0  0  0  0  1
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 2
 0  1  1  0  0  1  1  0
```

Stop statement executed. Press any key.

Stop statement executed. Press any key.

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.2
  0  1  1  1  0  0  0  0
```

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.3
  0  1  1  1  0  1  0  1
```

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.4
  0  1  1  1  1  0  1  0
```

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.5
  0  1  1  1  1  1  1  1
```

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.6
  1  0  0  0  0  1  0  1
```

```
********************************************
ANALOG TO DIGITAL CONVERSION
********************************************
? 2.7
  1  0  0  0  1  0  1  0
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 2.3
 1  0  0  0  1  1  1  1
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 2.8
 1  0  0  1  0  1  0  0
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 3
 1  0  0  1  1  0  0  1
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 3.1
 1  0  0  1  1  1  1  0
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 3.2
 1  0  1  0  0  0  1  1
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 3.3
 1  0  1  0  1  0  0  0
```

```
****************************************
ANALOG TO DIGITAL CONVERSION
****************************************
? 3.4
 1  0  1  0  1  1  1  0
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 3.5
 1  0  1  1  0  0  1  1
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 3.6
 1  0  1  1  1  0  0  0
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 3.7
 1  0  1  1  1  1  0  1
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 3.8
 1  1  0  0  0  0  1  0
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 3.9
 1  1  0  0  0  1  1  1
```

```
*****************************************
ANALOG TO DIGITAL CONVERSION
*****************************************
? 4
 1  1  0  0  1  1  0  0
```

7.2 FLOW CHART FOR PRESSURE CONTROL UNIT

```
                    ┌──────────────────┐
                    (      START        )
                    └──────────────────┘
                              │
                              ▼
            ┌──────────────────────────────┐
            │   INITIALISE  8255  PORTS      │
            └──────────────────────────────┘
                              │
                              ▼
            ┌──────────────────────────────┐
            │  INPUT THE REQUIRED PRESSURE   │
            │   IN  REGISTER  C (HEX)        │
            └──────────────────────────────┘
                              │
                              ▼
            ┌──────────────────────────────┐
            │   INPUT FROM TRANSDUCER        │
            └──────────────────────────────┘
                              │
                              ▼
            ┌──────────────────────────────┐
            │   CALL  A/D  CONVERSION        │
            └──────────────────────────────┘
                              │
                              ▼
                         ╱╲
              No       ╱  IS  ╲
            ◄─────────╱ EOC HIGH ╲
                      ╲    ?    ╱
                       ╲      ╱
                         ╲╱
                          │ YES
                          ▼
            ┌──────────────────────────────┐
            │   STORE IN ACCUMULATOR         │
            └──────────────────────────────┘
                          │
                          ▼
            ┌──────────────────────────────┐
            │   COMPARE  A & C               │
            └──────────────────────────────┘
                          │
                          ▼
                        ╱╲
                      ╱CHECK╲        YES
                     ╱  FOR  ╲──────────►
                     ╲ ZERO ╱
                       ╲  ╱
                        ╲╱
                          │ NO
                          ▼
            ┌──────────────────────────────┐
            │  SEND +5V TO ACTIVATE SOLENOID │
            │     VALVE   (PORT B0)          │
            └──────────────────────────────┘
```
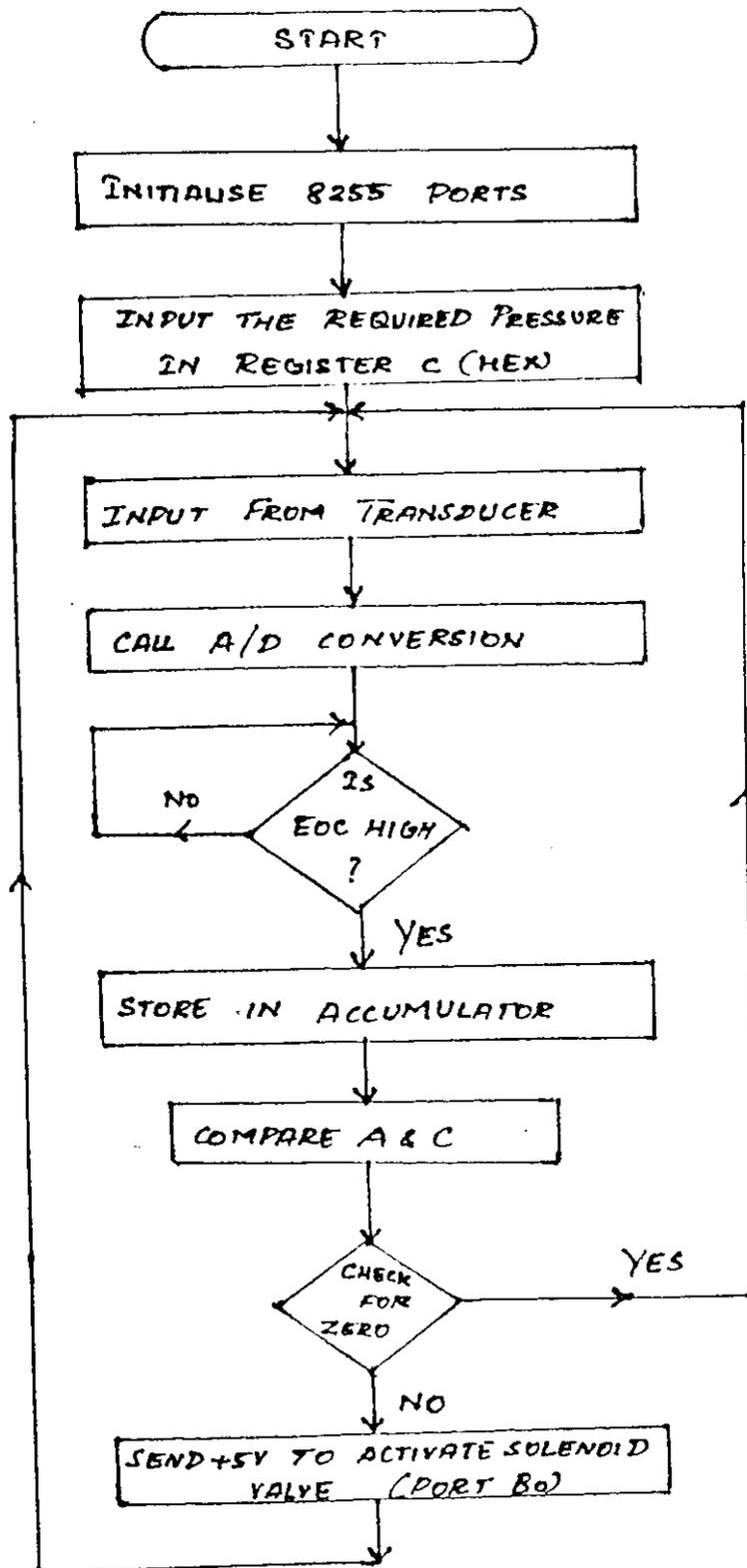
7.3 Program for Pressure Control Unit

ADDRESS	LABEL	MNEMONICS	OPCODE	COMMENTS
4600		MVI A,90	3E,90	Initialisation of 8255 ports
4602		OUT CNTRL REG	D3, 0F	
4604		LXI H,4650	21,50,46	Load the pressure to be maintained in Hexadecimal
4607	START	MOV B,M	46	
4608		MVI A,03	3E,03	Intialise ADC0808 controls
460A		OUT 38	D3,38	
460C		MVI A,02	3E, 02	Selection of IN02 in ADC 0808
460E		OUT 08	D3,08	
4610		IN PORT A	DB, 0C	
4612		CALL ADCONV	CD,05,00	Subroutine call for ADC
4615		STA 4645	32,45,46	
4618		LXI H,4645	21,45,46	
461B		MOV A,M	7E	
461C		CMP B	B8	
461D		JNC LOOP	D2,23,46	Pressure is higher
4620		JMP START	C3,07,46	Pressure is lower
4623	LOOP	MVI A,02	3E,02	
4625		OUT PORT B	D3,0D	Send control to the system
4627		JMP START	C3,07,46	

7.4 FLOW CHART FOR FLAME CONTROL UNIT

START

INITIALISE 8255 PORTS

INPUT FROM FLAME SENSOR TO PORT A

IS $PA_0 = 1$?

YES

NO

SEND CONTROL PULSE TO PORT C

ACTIVATE THE SOLENOID VALVE TO STOP FUEL SUPPLY
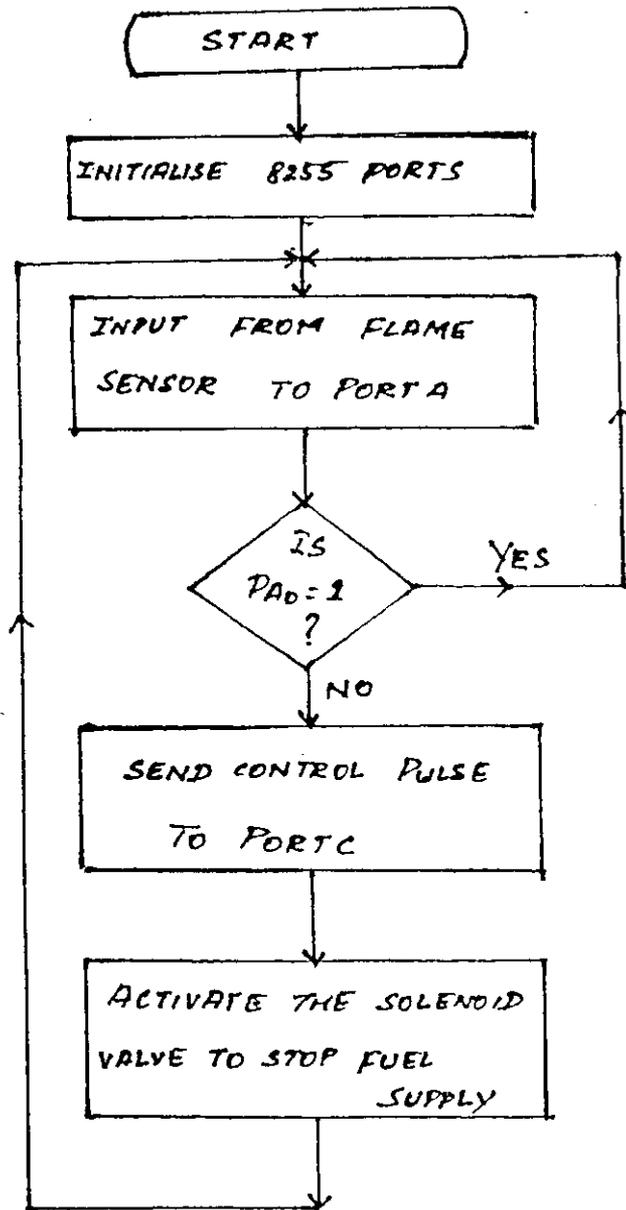
7.5 Program for Flame Control Unit

ADDRESS	LABEL	MNEMONICS	OPCODE	COMMENTS
5000		MVI A,90	3E,90	Initialisation of 8255 ports
5002		OUT CNTRL REG	D3, 0F	
5004	LOOP1	IN PORT A	DB,0C	
5006		JZ LOOP1	C2,04,50	Absence of flame
5009		MVI A,01	3E,01	Presence of flame
500B		OUT PORT B	D3, 0D	
500D		RET	C9	

Conclusion

CHAPTER VIII

CONCLUSION

The microprocessor controlled industrial vigilance system has been fully designed for the accident proof maintenance and control for any industrial environments. The system is said to be versatile because of its expanding applications and developments to various field of industries. The accuracy of the measured value, mainly depends upon the perfect calibrations with eference to standard values. Process informations can be displayed in master control room so that the supervisor can know the details.

Appendix

APPEXDIX

Appendix A : Silicon Planar Epitaxial Transistor

Appendix B : Dual 4-input nand Schmitt-trigger.

Appendix C : Bhopal Tragedy.

Appendix D : Vi Micro system Pvt.Ltd.,.

Component Layout

Peripherals

CPU-Printer-Decoder

Appendix E : Implementation in Petrochemical Industry.

Appendix F : Accidents in Petro Chem Complexes.

SILICON PLANAR EPITAXIAL TRANSISTOR

N–P–N transistor in a TO–39 metal envelope with the collector connected to case. BEL100N is primarily intended for use in audio output class 'B' push pull stage of a mains radio set. It features high collector emitter breakdown voltage and current handling capacity upto one ampere.

Matched pairs of 2 × BEL100N yield upto 3 watts of power output in a typical 24 volts class 'B' push pull stage. When used in complementary circuit with transistor BEL100P (PNP) it yields 7 watts at 30 volts.

QUICK REFERENCE DATA			
Collector base voltage (open emitter)	V_{CBO}	max.	60 V
Collector emitter voltage ($R_{be} = 1K$)	V_{CER}	max.	50 V
Emitter base voltage (open collector)	V_{EBO}	max.	7 V
Collector current (d.c.)	I_C	max.	500 mA
Total power dissipation upto $T_{amb} = 25°C$	P_{tot}	max.	0 8 W
Junction temperature	T_j	max.	230°C
D.C. Current gain at $T_j = 25°C$	h_{FE}	50 to	230
$I_C = 150\,mA,\ V_{CE} = 1V$			

Dimensions in mm

MECHANICAL DATA

Collector connected to case

TO-39

RATINGS (limiting values in accordance with the Absolute maximum system IEC 134)

Voltages

Collector-base voltage (open emitter)	V_{CBO}	max.	60 V
Collector emitter voltage (with 1K resistance between emitter & base)	V_{CER}	max.	50 V
Emitter-base voltage (open collector)	V_{EBO}	max	7 V

Current

Collector current (d.c.)	I_C	max.	500 mA

Power dissipation

Total power dissipation upto $T_{amb} = 25°C$	P_{tot}	max	0.8 W
upto $T_{case} = 25°C$	P_{tot}	max.	5 W
upto $T_{case} = 100°C$	P_{tot}	max	2.8 W

Temperatures

Storage temperature	T_{stg}		$-65°$ to $+200°C$
Junction temperature	T_j	max.	200°C

THERMAL RESISTANCE

from junction to ambient in free air	$R_{th\ j-a}$	220°C/W
from junction to case	$R_{th\ j-c}$	35°C/W

CHARACTERISTICS

$T_j = 25°C$ unless otherwise specified

Collector cut-off current

$I_E = 0, \quad V_{CB} = 40V$ $\qquad I_{CBO} \qquad < 50\ nA$

Emitter cut-off current

$I_C = 0, \quad V_{EB} = 5V$ $\qquad I_{EBO} \qquad < 25\ nA$

Breakdown voltages

$I_E = 0$, $I_C = 10 \ \mu A$ $V_{(BR)CBO}$ $>$ 60 V

$R_{be} = 1K$, $I_C = 10 \ mA$ $V_{(BR)CER}$ $>$ 50 V

$I_C = 0$, $I_E = 10 \ \mu A$ $V_{(BR)EBO}$ $>$ 7 V

D.C. Current gain

$I_C = 150 \ mA$, $V_{CE} = 1V$ [1] h_{FE} 50 to 280

D.C. Current gain hold up

$$\frac{h_{FE1}}{h_{FE2}} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad > \ 60\%$$

          h_{FE1} is that h_{FE} at $I_C = 50 \ mA$ $V_{CE} = 1V$

          h_{FE2} is that h_{FE} at $I_C = 200 \ mA$ $V_{CE} = 1V$ [1]

Saturation voltage

$I_C = 150 \ mA$, $I_B = 15 \ mA$ [1] $V_{CE \ sat}$ $<$ 0.6 V

Base-emitter voltage

$I_C = 150 \ mA$, $V_{CE} = 1V$ V_{BE} $<$ 0.9 V

When matched pairs are required h_{FE} matching is done
within ± 20%

---

1) Measured under pulsed conditions.
   Pulse duration $<$ 300 µs Duty cycle $<$ 2%

APPENDIX·B

dual 4-input nand schmitt-trigger

1 – SN 7413 N	2 – F 7413 PC	3 – F9 N 13 PC
4 –	5 – DM 7413 N	6 –
7 – ZN 7413 E	8 – N 7413 A	9 –
10 – FJL 131	11 – FLH 351	12 – MIC 7413 N
13 – TL 7413 N	14 – SF.C 413	15 –

Positive logic $Y = \overline{A.B.C.D}$

Negative logic $Y = \overline{A+B+C+D}$

schematic diagram
(each Schmitt-trigger)

DESCRIPTION - The dual Schmitt triggers functions are compatible with standard TTL output logic levels. Each function is essentially a 4-input NAND gate with different input threshold levels for positive and negative going signals. Typically, the hysteresis, the difference between the two threshold levels, is 800 mV.

On-chip temperature compensation ensures excellent stability of the hysteresis over a wide temperature range. Typically the hysteresis changes by 3% over the range of -55°C to +125°C, the upper threshold changes by 1% over the same range. The Schmitt trigger can be triggered from slow input ramps and straight dc levels.

RECOMMENDED OPERATING CONDITIONS

PARAMETER		MIN.	TYP.	MAX.	UNITS
Supply Voltage VCC		4.75	5.0	5.25	Volts
Operating Free Air Temperature Range		0	25	70	°C
Normalized Fan Out from Each Output, N	HIGH Logic			20	U.L.
	LOW Logic			10	U.L.
Maximum Input Rise and Fall Time		No Restriction			

ELECTRICAL CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (Unless Otherwise Noted)

SYMBOL	PARAMETER	MIN.	TYP. (2)	MAX.	UNITS	TEST CONDITIONS (1)
V_{T+}	Positive-Going Threshold Voltage	1.5	1.7	2.0	Volts	$V_{CC} = 5.0$ V
V_{T-}	Negative-Going Threshold Voltage	0.6	0.9	1.1	Volts	$V_{CC} = 5.0$ V
$V_{T+} - V_{T-}$	Hysteresis	0.4	0.8		Volts	$V_{CC} = 5.0$ V
V_{CC}	Input Clamp Diode Voltage			-1.5	Volts	$V_{CC} = $ MIN., $I_I = -12$ mA
V_{OH}	Output HIGH Voltage	2.4	3.3		Volts	$V_{CC} = $ MIN., $V_{IN} = 0.6$ V, $I_{OH} = -0.9$ mA
V_{OL}	Output LOW Voltage		0.22	0.4	Volts	$V_{CC} = $ MIN., $V_{IN} = 2.0$ V, $I_{OL} = 16$ mA
I_{T+}	Input Current at Positive-Going Threshold		-0.55		mA	$V_{CC} = 5.0$ V, $V_{IN} = V_{T+}$
I_{T-}	Input Current at Negative-Going Threshold		-0.85		mA	$V_{CC} = 5.0$ V, $V_{IN} = V_{T-}$
I_T	Input Current at Maximum Input Voltage			1.0	mA	$V_{CC} = $ MAX., $V_{IN} = 5.5$ V
I_{IH}	Input HIGH Current			40	μA	$V_{CC} = $ MAX., $V_{IN} = 2.4$ V
I_{IL}	Input LOW Current		-1.0	-1.6	mA	$V_{CC} = $ MAX., $V_{IN} = 0.4$ V
I_{OS}	Output Short Circuit Current (3)	-18		-55	mA	$V_{CC} = $ MAX.
I_{CCH}	Supply Current HIGH		14	23	mA	$V_{CC} = $ MAX., $V_{IN} = 0$ V
I_{CCL}	Supply Current LOW		20	32	mA	$V_{CC} = $ MAX., $V_{IN} = 4.5$ V

Cause
Union Carbide version:
disgruntled employee
removed pressure gauge
and hosed in water,
causing violent
chemical reaction
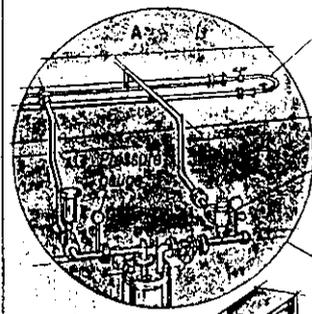
Jumper, may have
provided pathway
to MIC tank 610

Vent pipe, where
gases escaped when
scrubber was
not working

Safety valve: popped
open to let gases
escape

MIC manufacturing facility

Vent gas scrubber:
was not refilled
with caustic soda to
neutralize escaping
gases or was
incapable of handling
the volume of gases
that did escape

Tank 610, where
reaction occurred;
tank was overfull

Refrigeration system:
turned off for months

Water curtain:
a water spray
may not have
reached high
enough

Tank 611

Process vent header:
may have completed
pathway to tank 610

Leaky valve?

Water plug

Water entry

Tank 619, partially full,
so could not be used
to transfer MIC
from tank 610

*Relief-valve vent
header:* where water
may have backed
up to tank 610;
also where gases
escaped to vent-
gas scrubber
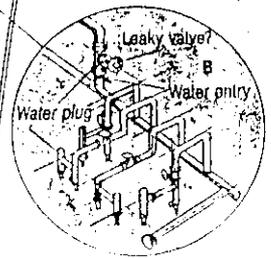
Cause
Indian Government
version: water backed
up through leaky
valve and entered
relief valve vent
header after a
worker hosed
clogged pipes;
eventually the
water reached
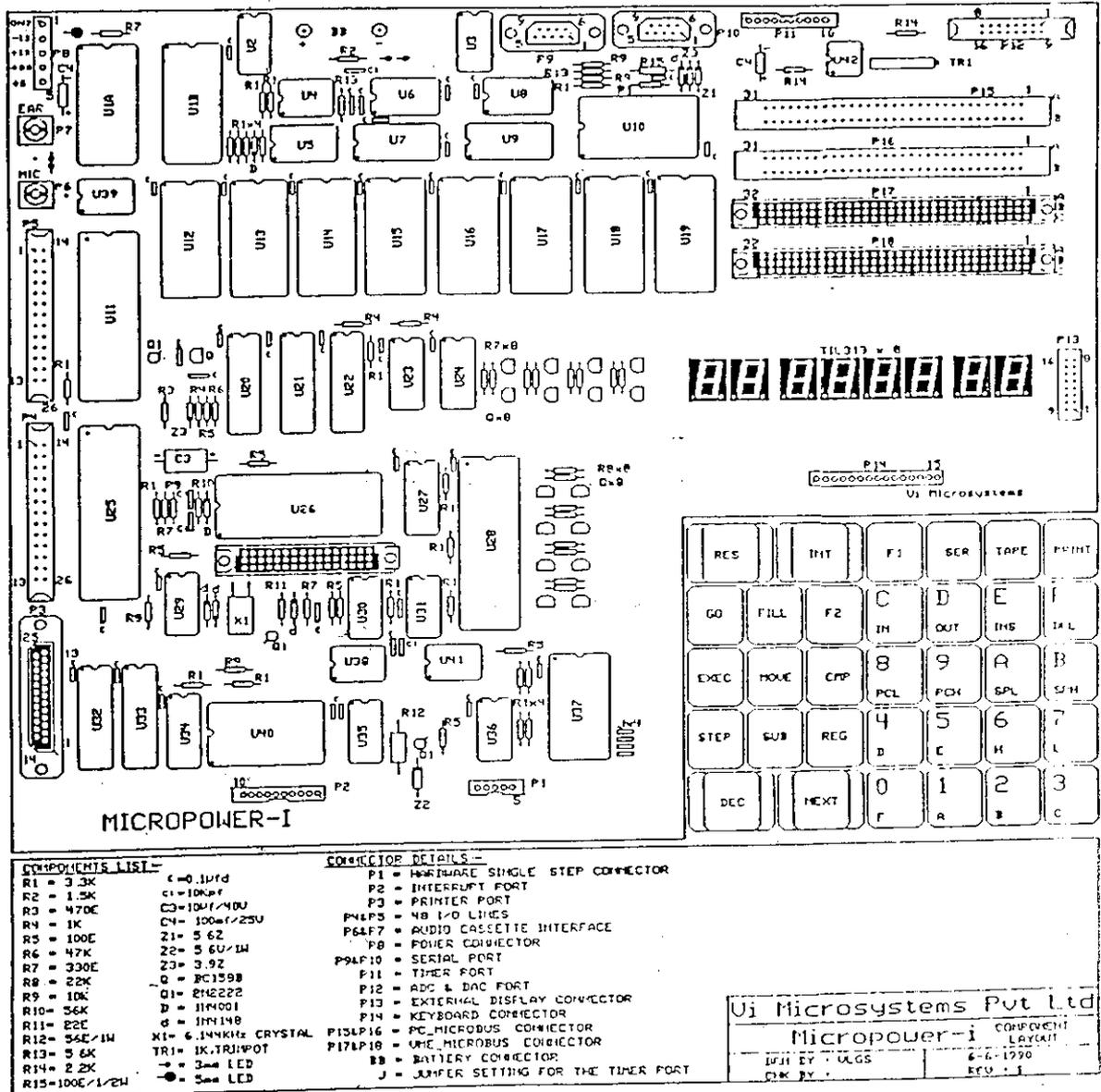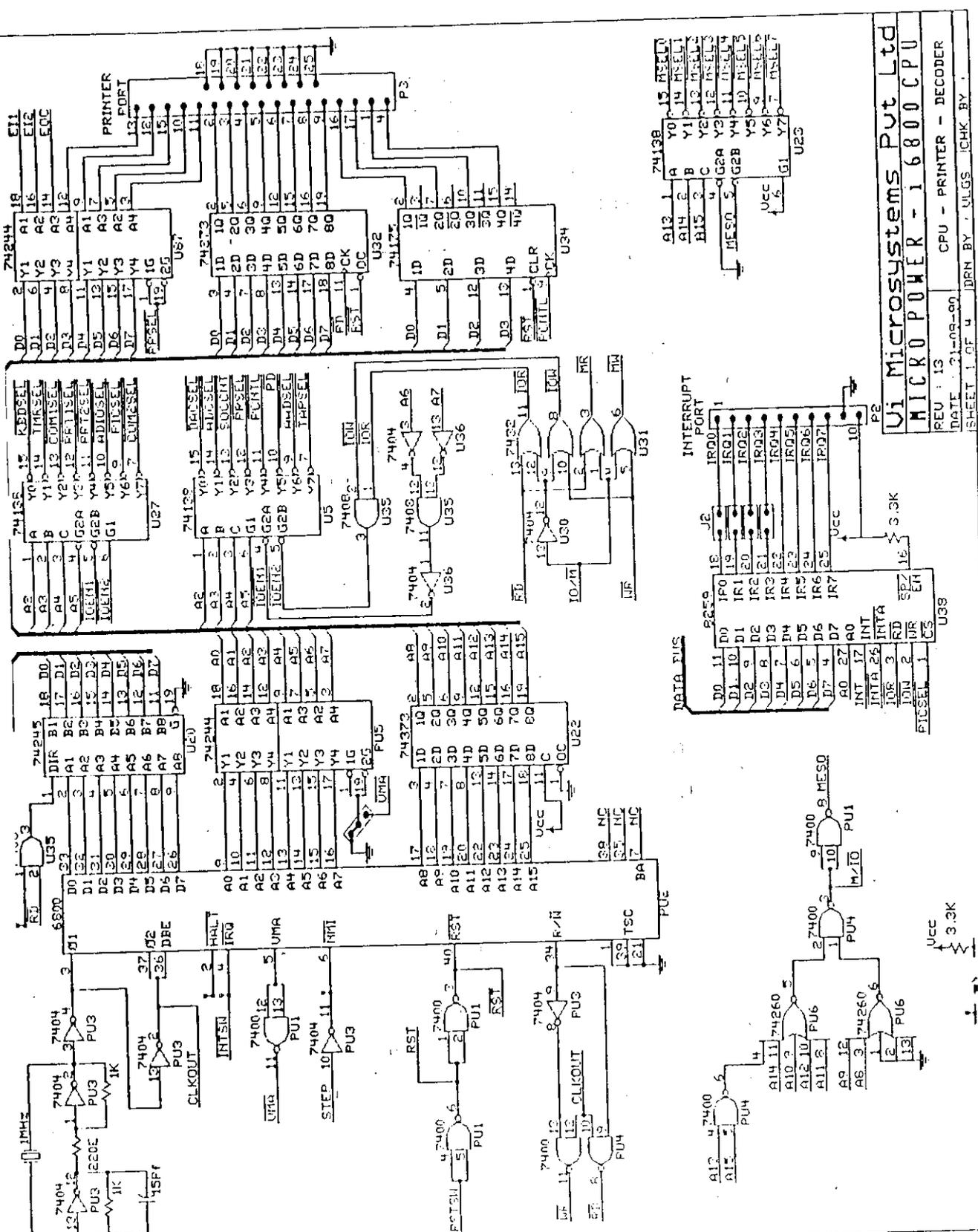tank 610, causing
the reaction

Flare tower: some of the gases
not neutralized by the vent gas
scrubber could have been burned
off by flare tower; the tower,
however, was not working
or was turned off
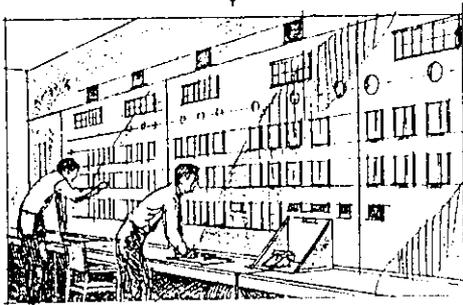
Control room, gauges may
not have worked; alarms
were not properly set

(*Out of the many versions of what happened around midnight
on Dec. 2–3, 1984, when the Bhopal tragedy occurred, two have
gained the most credence. Union Carbide Corp., which has a
majority interest in the company that owns the Bhopal plant, says
that a disgruntled employee unscrewed a pressure gauge on a tank
storing methyl isocyanate and hosed in water [inset A]. (MIC is
an intermediate chemical for making Sevin and other carbaryl-
based pesticides.) Warm MIC reacts violently with water and can
cause an out-of-control buildup of heat and pressure as MIC reacts
with itself, water, and byproducts of the reaction. When pressure
built past 275 800 pascals above atmospheric pressure (40 pounds
per square inch) on tank 610, the MIC vapor opened a safety valve
and flowed down a pipe, the relief-valve vent header, through a
vent-gas scrubber (which had not been replenished with caustic
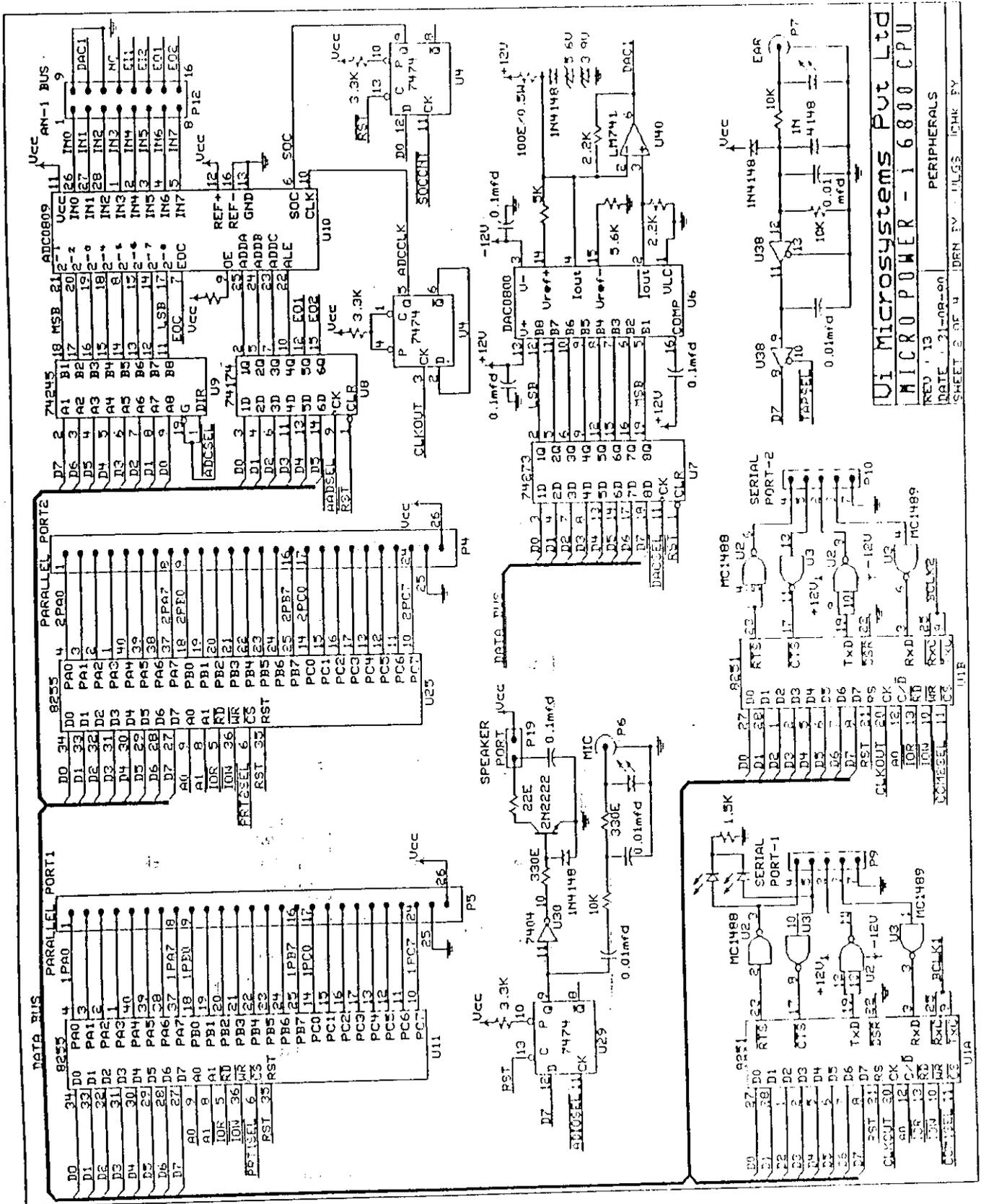soda to neutralize the gas), and out to the surrounding commu-
nity through a vent pipe.*)

Stix—Bhopal: a tragedy in waiting

COMPONENT LAYOUT

MICROPOWER-I

COMPONENTS LIST:-

R1 = 3.3K	c =0.1µfd
R2 = 1.5K	c1=10Kpf
R3 = 470E	C3=10µf/40v
R4 = 1K	C4= 100mf/25v
R5 = 100E	Z1= 5.6Z
R6 = 47K	Z2= 5.6v/1W
R7 = 330E	Z3= 3.9Z
R8 = 22K	Q = BC159B
R9 = 10K	Q1= 2N2222
R10= 56K	D = 1N4001
R11= 22E	d = 1N148
R12= 56E/1W	X1= 6.144KHz CRYSTAL
R13= 5.6K	TR1= 1K TRIMPOT
R14= 2.2K	–● = 3mm LED
R15=100E/1/2W	–●= 5mm LED

CONNECTOR DETAILS:-
P1 = HARDWARE SINGLE STEP CONNECTOR
P2 = INTERRUPT PORT
P3 = PRINTER PORT
P4&P5 = 48 I/O LINES
P6&P7 = AUDIO CASSETTE INTERFACE
P8 = POWER CONNECTOR
P9&P10 = SERIAL PORT
P11 = TIMER PORT
P12 = ADC & DAC PORT
P13 = EXTERNAL DISPLAY CONNECTOR
P14 = KEYBOARD CONNECTOR
P15&P16 = PC_MICROBUS CONNECTOR
P17&P18 = VME_MICROBUS CONNECTOR
B = BATTERY CONNECTOR
J = JUMPER SETTING FOR THE TIMER PORT

Vi Microsystems Pvt Ltd
Micropower-i   COMPONENT LAYOUT
DRN BY : ULGS   6-6-1990
CHK BY :   REV : 1

APPENDIX-E₁ IMPLEMENTATION IN

PETROCHEMICAL INDUSTRY

Block diagram labels:

- MICRO COMPUTER
- ADC
- PRESSURE TRANSDUCER
- COMPRESSOR 2.5 ATM
- PRESSURE CONTROL UNIT (VALVE)
- CATALYTIC REACTOR BED
- HEATER 500°C
- HEATER 500°C
- REACTOR BED (CATALYTIC)
- CONDENSOR
- TO FRACTIONATOR
- FRACTIONATOR
- SOLENOID VALVE
- RESIDUE GASOLINE FEEDSTOCK
- Low Boiling 10 A... Explosive Reaction with H₂
- 230 V A.C.
- P N 230 V A.C.
- +12V
- RLC
- CONTROL SIGNAL FROM FLAME CONTROL UNIT

Control from Pressure Monitor

Steam Outlet

BOILER UNIT

Flame Burners

Solenoid valves

Steam Chamber

Water Inlet

FURNACE OIL

AC 230V

RL# 3 300E/12V

SL100

+12V

RL2,300E 12V

SL100

+12V

RL1 300E/12V

SL100

+12V

RELAY F 300E/12V

SL100

Control Signal from (FLAME CONTROL)

Peripheral Circuits

APPENDIX · E2

Accidents in petrochem complexes

Company	Plant location	Product capacity (in thousand tonnes a year)	Month and year	Nature of accident	Shutdown period and casualties
B.P. Chemicals, Antwerp Compania Quimica.	Antwerp, Belgium Bahia State, Brazil	Ethylene oxide 115 Ethyl glycol 115	July '87 Dec. '87	Explosion in EO plant	15 months 12 months
Metacril Texaco	Port Arthur, Texas	Ethylene 544	June '88	Lube oil failure in refrigeration unit	one month
Praecizter industries inc. (Pil)	Dallas, Oregon, US	PVC methylene chloride	August '87	Fire suspected to have been caused by an immersion heater	One year
DSM	Geleen, the Netherlands	LDPE 194	April '88	Fire	Four weeks
Norsk Hydro Akzo Chemie	Norway The Netherlands	VCM 420 Chlore	Sept. '88 Jan. '89	Gas leak Fire in high voltage electrical installation	One month Three weeks
Bast	Antwerp	EO 150 EG 160	Jan '89	Explosion	Two to three years, five injured
Osaka Petro Quantum Chemicals	Osaka, Japan Morris, Illinois	Ethylene 230 Ethylene 454	May '89 June '89	Fire near furnace	Seven months $50 million damage
Mobil Lucky Ltd Phillips Petroleum	Beaumont, Texas Yeocnon, S Korea Pasadena, Texas, US	LDPE 230 ABS 135 HDPE and PP 675 and 230	Oct. '89 Oct. '89 Oct. '89	Fire at high pressure Fire Explosion in polymerisation reactor	15 days One year two killed, 124 injured Six months
Taiwan Styrene Corporation	Taiwan	EB/Styrene 140	Jan. '90	Fire in boiler	One injured
Phillips Petroleum	Sweeny, Texas	Olefins and isopentane 270	Jan. '90	Explosion	One injured
East German Pet. complex	Schkopu	Polyproducts	Feb. '90	Two years	Five killed, 20 injured

APPENDIX · F

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