PPU College of Engineering and Technology

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College of Engineering & Technology

Electrical and Computer Engineering Department

Graduation Project

Redesign And Operations Of Metal Pressing Multi-axis Robot Arm

Project Team

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Abstract (English)

With the industrial revolution experienced by the vast world and the growing demand for product was an urgent need to replace old machines with modern ones that's depend heavily on the use of modern technologies aiming at increasing the production with high quality and large quantities.

This came of the project (which is a development of robot was employed by Royal Plastic Industries for the transfer of plastic between two machine industrialized and make it a new job and using the systems , new controller) to reflect the capacity of engineer industrial automation to achieve is important is to take advantage of the machines old industrial still maintain on the structure of good mechanical and electrical control systems and the development and leadership to keep pace with the modern industrial machinery.

This command (re-employment of a robot) require the redesign of the chambers of the power and control, and add new parts to do a good job in the form of pressed sheet metal(iron) and formed to meet the needs of the local market of this product.

Abstract (Arabic)

مع الثورة الصناعية الهائلة التي يمر بها العالم ، والطلب المتزايد على المنتجات ، كانت الحاجة ماسة لاستبدال الآلات القديمة بأخرى حديثة تعتمد وبشكل كبير على استخدام التكنولوجيا الحديثة في التحكم لزيادة الإنتاج والحصول على منتج ذو جودة عالية وبكميات كبيرة .

وقد جاء هذا المشروع (وهو عبارة عن تطوير ربوت كان مستخدما لدى شركة رويال للصناعات البلاستيكية لنقل مواد بلاستيكية بين ماكينتين صناعيتين وجعله يقوم بوظيفة جديدة وباستخدام أنظمة تحكم جديدة) ليعكس قدرة مهندس الأتمتة الصناعية في تحقيق أمر مهم وهو الاستفادة من ماكينات صناعية قديمة لا تزال تحافظ على بنية ميكانيكية وكهربائية جيدة وتطوير أنظمة التحكم والقيادة فيها لتواكب الماكينات الصناعية الحديثة .

وهذا الأمر (إعادة توظيف هذا الروبوت) تتطلب إعادة تصميم لدوائر القدرة والتحكم ، وإضافة أجزاء جديدة للقيام بوظيفة جيدة متمثلة في كبس ألواح معدنية (من الحديد) وتشكيلها لتلبية حاجات السوق المحلي من هذا المنتج .

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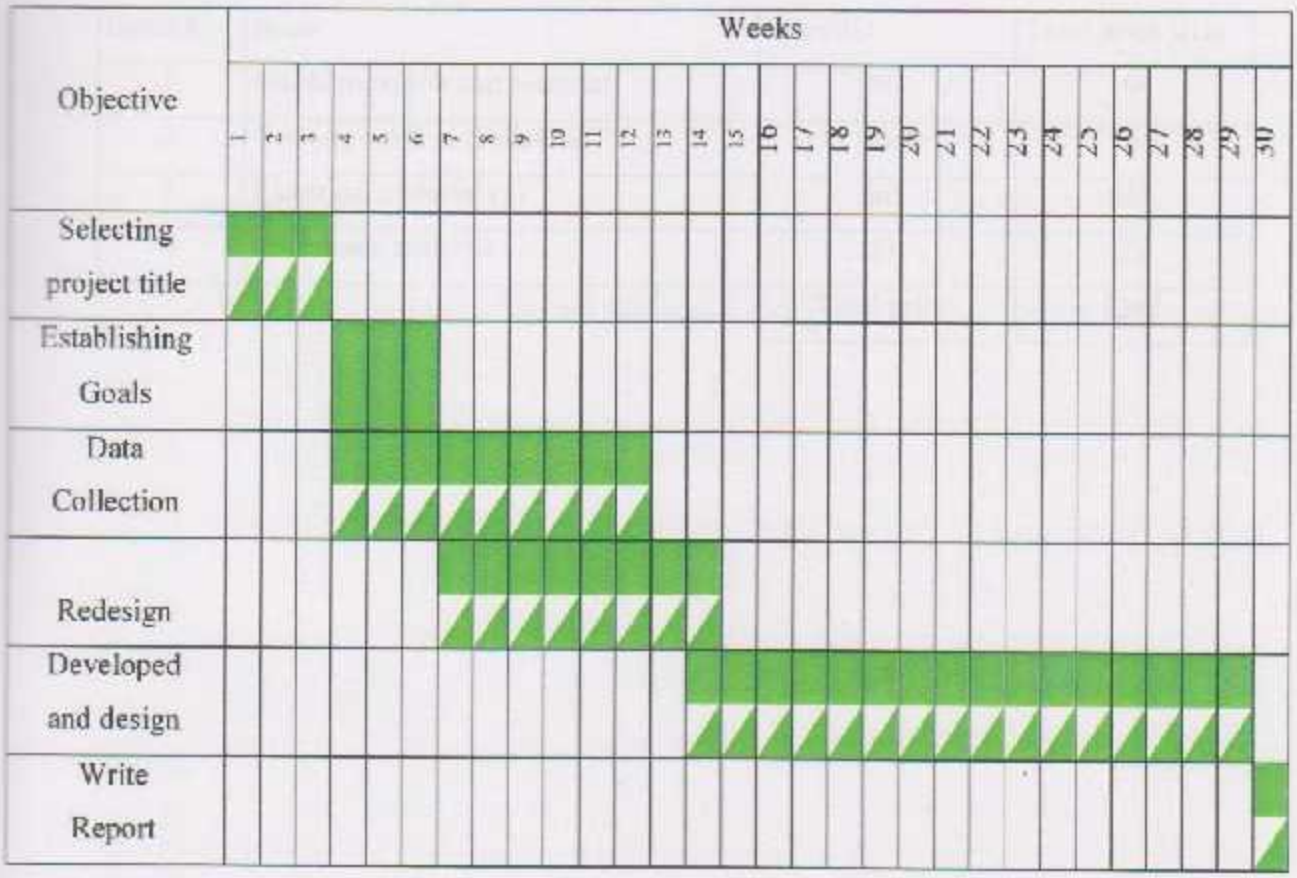
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Selecting project title
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Data Collection
Redesign
Developed and design
Write Report

Estimated Budget

Items #	Items	Price\JD	Total price \JDs
1	Mechanical job and material	194	194
2	Turning work and material	366	366
3	Electrical material (1)	665	665
4	Pneumatic material	23	23
		Total price	1248

CHAPTER ONE:
Introduction

1.1 Introduction :

1.2 Review :

1.2.1 ADVANTAGES AND DISADVANTEGES OF USING ROBOT

Chapter 1
Introduction

1.1 Introduction :

Industry is developing rabidly due to the inventing of new machines so the manufactures replace the old machine with new ones, the old machines are always sold to the iron factories for recycled purposes.

Replacing the old machines with new ones doesn't mean that the old ones faulty or not valid but it means that these machine become unable to keep up with new ways of manufacturing, however we can find other functions for these old machines by improving and developing their power circuit and control and adding other mechanical parts.

Our project focus on robot which was used in Royal Company for moving plastic chips between production lines . using new technology in Royal Company made the owner ships to replace this robot with faster and more accurate one .

Although the old robot has some disadvantage comparing with the new one , we find that this robot can be used effectively in other domain that do not need high speed or high accuracy like metal pressing ,and this will be the new job of our robot.

The idea was initially based on the operation of the robot to carry out machining of parts are expensive and small in size, but that, after research and audit there were problems prevented the continuation of this thinking, including:

1 - difficulties in the implementation of this mechanism for the robot such as this type of business.
2 - Problems in identifying a piece of turnings, and whether this robot will be designed to implement the turning of one type of pieces or more
3 - financial problems in covering the costs of implementing such a project.

For these reasons have been thinking about the another direction ; which that using the robot to process another production ; and this process is Pressing metals (Pressing sheet metal) , And composition in different forms to be used in forging, and the work of the doors and windows ,and it was found that the use of robots in this kind of work will be meaningful and useful, where :

1- That there are many outline the risks to human beings while doing this kind of business, so the use of robots provide a degree of safety and security for workers in this field.
2- The need for this type of product is large and economically viable prices.
3- We can use different kinds and forms of the templates and thus we get the different forms of the product shall not be limited to a particular type.

The development and improvement that we applying it to the old robot include the following :-

1- Replacing the control circuit from oldest one(microprocessor) to new one (programming logic control (PLC)).
2- Built the power circuit and control circuit (for electrical part and pneumatic part).
3- Adding pressing machine .
4- Adding pneumatic system that will drive the pressing machine.
5- Adding other mechanical parts like robot fixation, Arm (to Lift pieces).

after doing the developed the Robot perform Pressing the Metal and access to the amount of specific benefit in the work of forging and forming, shall be as follows:

1- Put the pieces in a specific point .
2- Then the Robot carry it to the Pressing Machine .
3- After the Pressing Machine do the job, the Robot carry the pieces then the Robot go to give the next pieces , put it in the Pressing Machine to pressed it .
4- The Robot Arranged the finished Piece in fixed place.

The main work of the our team at this stage is to :
A- Run the REIS[1] Robot (by built the power and control circuit).
B- Re-design and built the pressing machine (all component : mechanical and pneumatic and electrical).
C- Re-design and built the Arm Robot .
D- Enable the robot carrying Piece and placed in a pressing machine.

---

1) The Name Of company that Built This Robot

1.2 Review :

A robot can be defined as : a programmable, self-controlled device consisting of electronic, electrical, and mechanical units. [1]

From this definition we know that the Robot have some component that functioned together that can be divided into (**Figure 1.1**) :

A- Mechanical components :

- Robots can be classified as those with a fixed base , and those with Animated .and in our case we have a robot with a fixed base.
- It has arm to do work.
- It has parts that help the robot to move good and do it's work like joints.
- The pneumatic part (cylinder , pipes ,valves,..)

B- Electrical and Electronics components :

- motors , sensor , ...
- The power and controller .

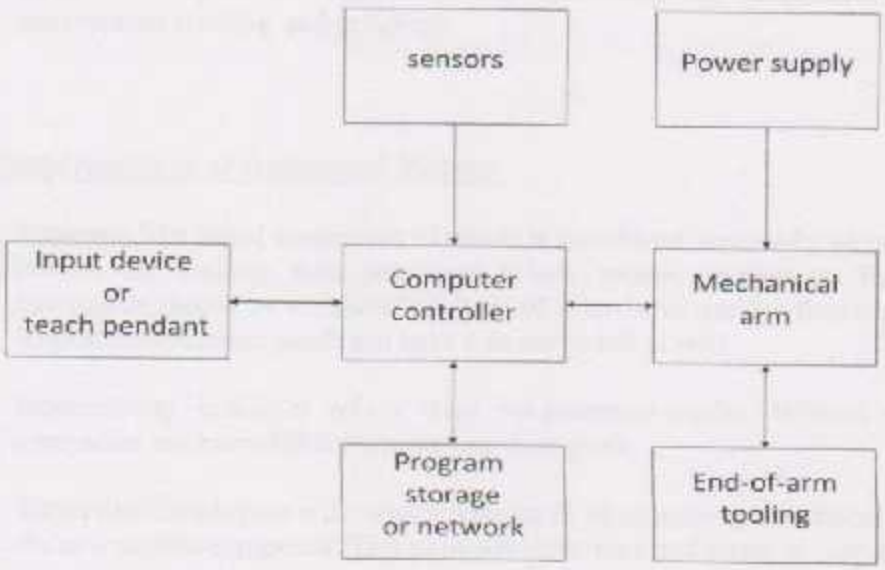


Figure 1.1 : Robotic System

More generally, it is a machine that functions in place of a living agent. Robots are especially desirable for certain work functions because, unlike humans, they never get tired; they can endure physical conditions that are uncomfortable or even dangerous; they can operate in airless conditions; they do not get bored by repetition; and they cannot be distracted from the task at hand.[2]

1.2.1 Advantages And Disadvantages Of Using Robot

A) Advantage of Industrial Robots [3] :

1- Robotics and automations can increase safety, reliability, production amount, profit, quality and quantity of products in a lot of cases.

2- They can do jobs in dangerous situations and save lives of thousands of people.

3- They do not care about the comfort of their environment. Human needs such as hunger or depression have no meanings for them. They do not get tired.

4- Their accuracy is so high and is in the range of millimeters or even micrometers.(turning and grinding)

B) Disadvantages of Industrial Robots:

1. **Expense:** The initial investment of robots is significant, especially when business owners are limiting their purchases to new robotic equipment. The cost of automation should be calculated in light of a business' greater financial budget. Regular maintenance needs can have a financial toll as well.

2. Incorporating industrial robots does not guarantee results. Without planning, companies can have difficulty achieving their goals.

3. **Expertise:** Employees will require training in programming and interacting with the new robotic equipment. This normally takes time and financial output.

4. **Safety:** Robots may protect workers from some hazards, but in the meantime, their very presence can create other safety problems. These new dangers must be taken into consideration

It is true that Robots can cause unemployment by replacing human workers but Robots also create jobs: Robot technicians, salesmen, engineers, programmers and supervisors.

CHAPTER TWO:

The Study of Fundamentals REIS Robot

2.0 Overview

2.1 Part of a REIS Robot:

2.1.1 Robotic Body .

2.1.2 Motors .

2.1.3 Power .

2.1.4 Controller.

Chapter 2
The Study of Fundamentals REIS Robot

2.0 Overview:

Even the most complex robotic system can be broken down into a few basic components, which provide an overview of how a robot works. These components are covered in this chapter, Freedom of motion and the resulting shape of the robot's work area are also addressed in this chapter.

2.1 Part of a REIS Robot [4]:

The industrial *REIR (*The Name Of company that Built This Robot) Robots illustrated in Figure :

Figure 2.1: THE REIS Robot

- Robots consist of a number of components that work together :

  - The body of Robot (That holed the component) .
  - Mechanical Drive system
  - Motors
  - pneumatic part (valves ,pipes , cylinder..)
  - The controller a means for programming
  - the manipulator.
  - a power supply.

- The relationship among these components is illustrated in (**Figure 2.2**):

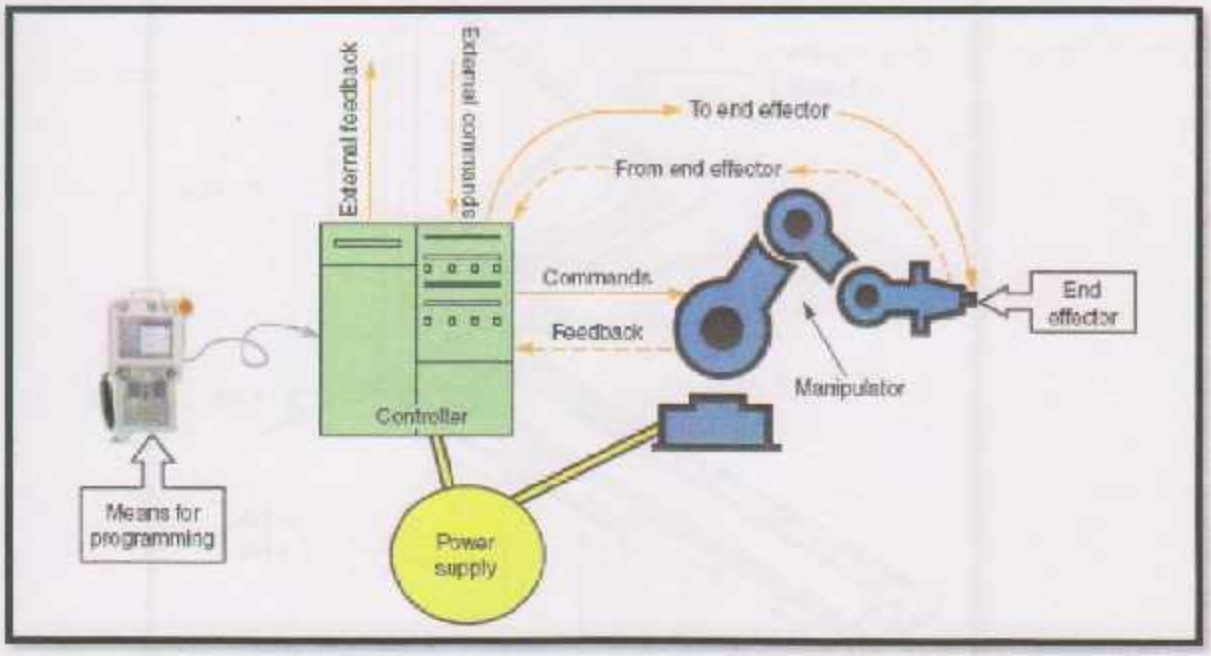


Figure 2.2: The Component Relationship

2.1.1 The body of Robot :

The REIS Robot is equipped with three linear axes which are independent control able The Robot can be installed on floor on it's own support columns but also directly on the processing machine by mean of console.

the compact design and the possibility to mount the robot on only one support column result in low space requirement with a large working area at the same time

The most significant application of this Robot is :

- Handling tasks
- Palletizing tasks

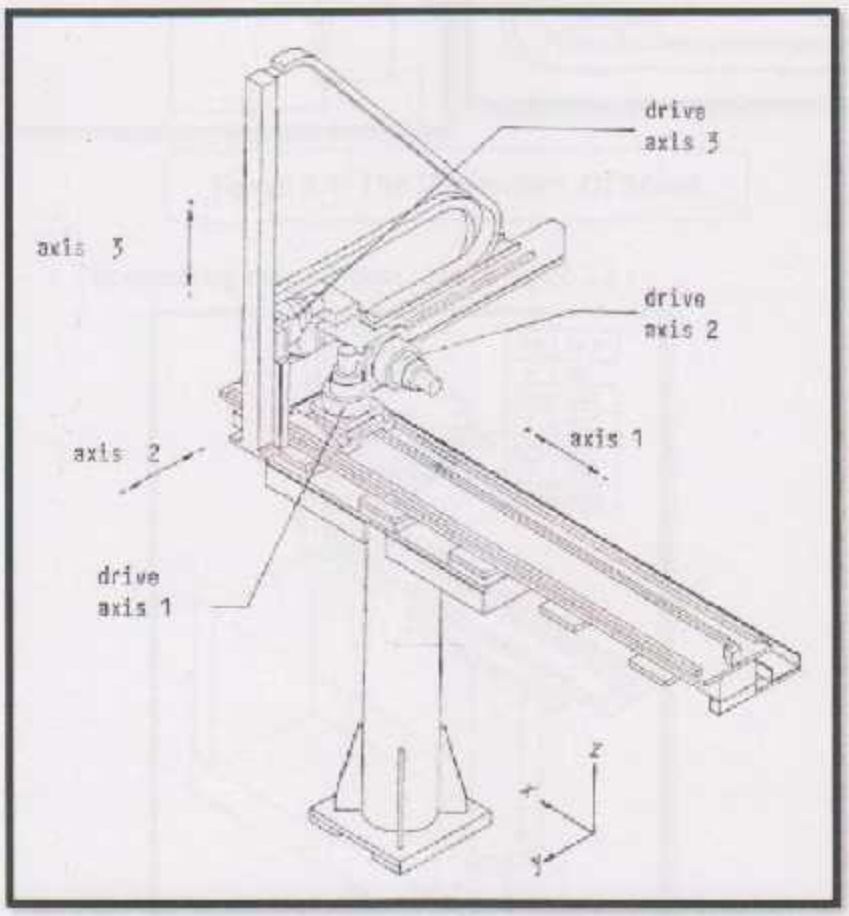


Figure 2.3: The Body of Robot

- The Body Dimension of robot (see in figure 2.4) :

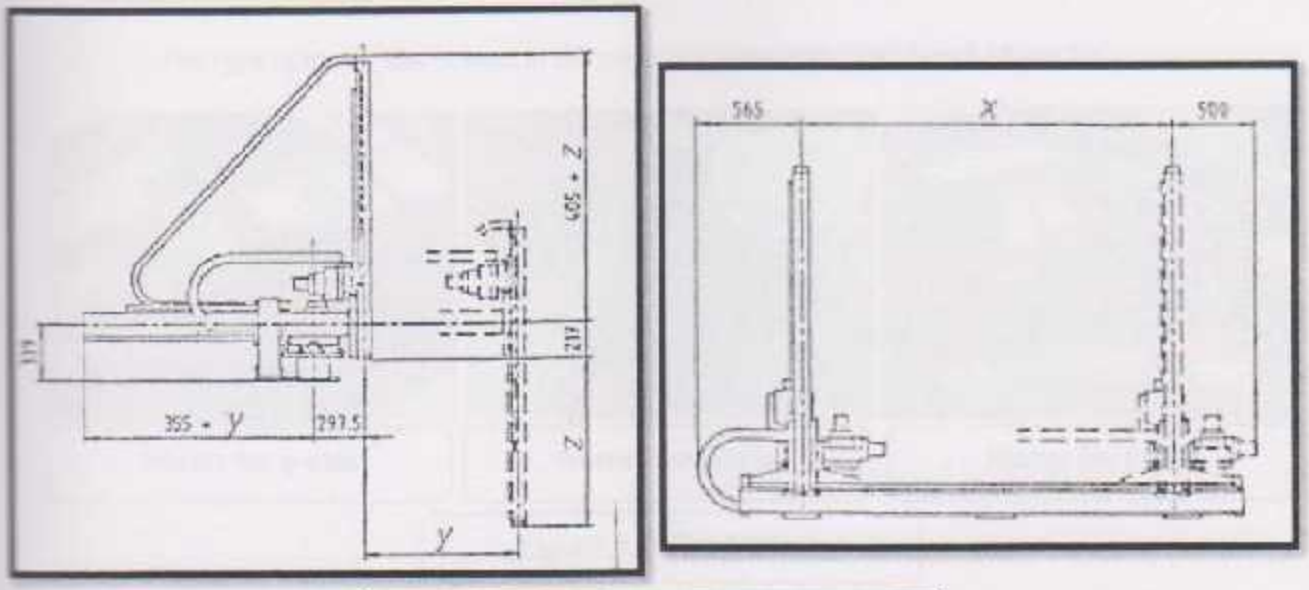
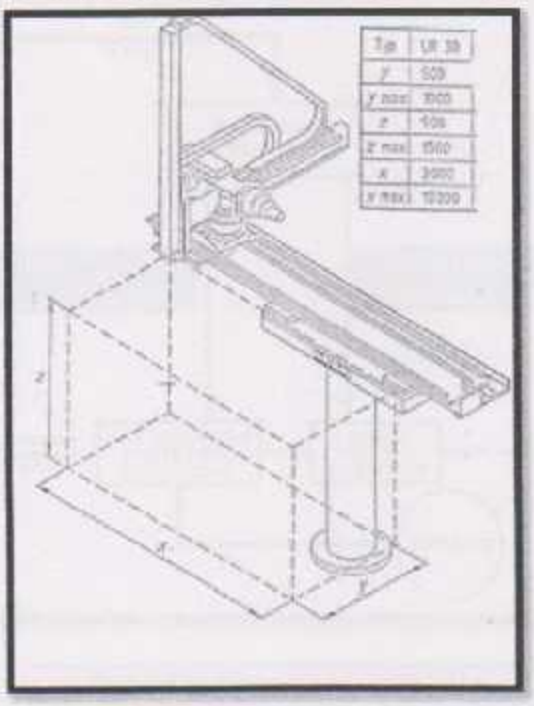


Figure 2.4: The Diminution Of Robot

- The operating rang of robot (see in figure 2.5) :



Fighter 2.5: The Rang Of Robot

2.1.2 The Motors :

The type of motor that is used in the robot is (Rotor Disc \DC Servo Motor) :

Motor for y-axis | Motor for x-axis | Motor for z-axis

Figure 2.6: The Motors

A **servomechanism**, or **servo**, is an automatic device that uses error-sensing negative feedback to correct the performance of a mechanism.[5]

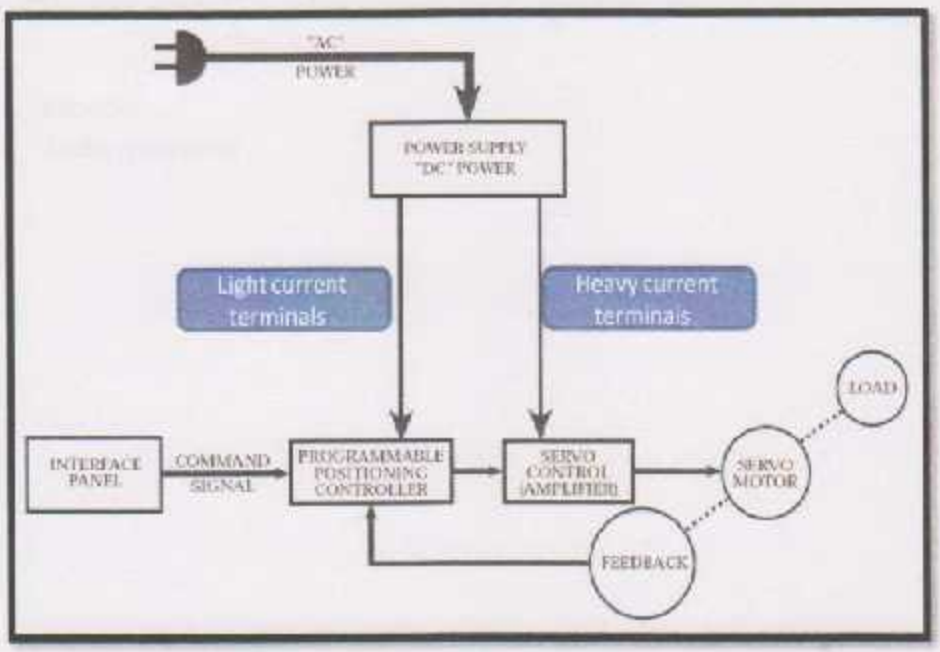


Figure 2.7: A) The Concept of a servo System

This type of motors have the following advantages :

1- High output power relative to motor size and weight.
2- Encoder determines accuracy and resolution.
3- High efficiency, can approach 90% at light loads.
4- High torque to inertia ratio,can rapidly accelerate loads.
5- Has "reserve" power, 2-3 times continuous power for short periods.
6- Has "reserve" torque, 5-10 times rated torque for short periods.
7- Motor stays cool, Current draw proportional to load.
8- Audibly quiet at high speeds. [6]

All axes of the robot are driven by energy saving DC servo motor having a voltage of 150V , maximum current of 20A and total rated capacity of 2600 w.

The drive motor of z-axis (vertical) is equipped with an electro- magnetic blocking break which prevents the axis from moving when motor is de-energized and acts as safety blocking brake in cases of power .

The robot is equipped with a digital incremental encoding system . the optical encoder mounted at each axis , generates electrical pulses that serve the control system for calculation of the axis position .

Elements will help to achieve precision designed into the motor :

1- Encoder .
2- Tacho-generator .

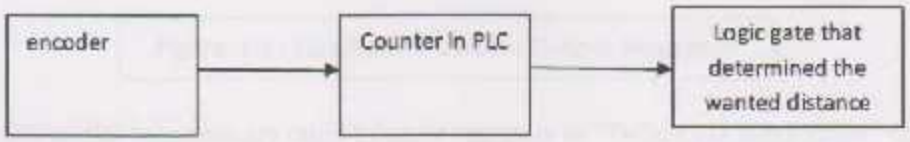
A- The Encoder :

it used to controlled The distance , that's job do as :

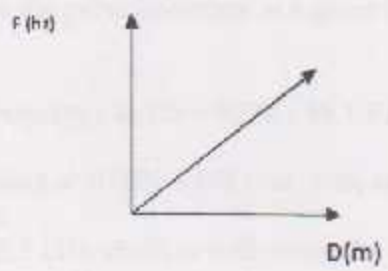
1- The Encoder represent the distance as pulses.

2- then the output of Encoder will connect on the counter in plc that count the pulses and represent it as distance.

3- Counting the pulses tells the application how many revolutions, or fractions of the motor has turned to determined wanted distance.



A)



B)

Figure 2.8 : A) The Block Diagram for Encoder B) The Curve

Since motors can move in forward and backward direction, it is necessary to differentiate the manner that pulses are counted, so that they can increased or decrease a position counter in the application. Quadrature encoders have dual channels, A and B (figure 2.8), which are electrically phased 90° apart. Thus, direction of rotation can be

determined by monitoring the phase relationship between the two channels. In addition, with a dual-channel encoder, a four times multiplication of resolution can be achieved by counting the rising and falling edges of each channel (A and B). For example, an encoder that produces 250 pulses per revolution can generate 1,000 counts after quadrature .

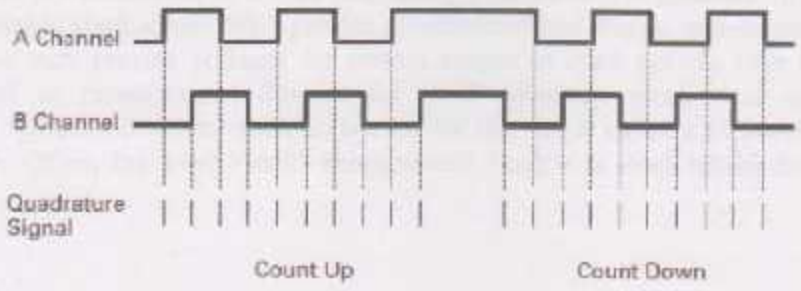


Figure 2.9 : Quadrature Encoder Output Waveform

Commercial encoders are rated by their numbers of "Pulses per Revolution" (also sometimes referred as "Cycles per Revolution). Carefully read the manufacturer's datasheet to understand whether this number represents the number of pulses that are output by each channel during the course of a 360o revolution, rather than the total number of transitions on both channels during a 360o revolution. The second number is 4 times larger than the first one.

The formula below give the pulse frequency at a given RPM and encoder resolution in Pulses per Revolution:

Pulse Frequency in Hz = RPM / 60 * PPR * 4

Example: a motor spinning at 10,000 RPM max, with an encoder with 200 Pulses per Revolution would generate:
10,000 / 60 * 200 * 4 = 133.3 kHz which is well within the 250kHz maximum supported by the encoder module.

An encoder with a 200 Pulses per Revolutions is a good choice for most applications.

A higher resolution will cause the counter to count faster than necessary and possibly reach the encoder module's maximum frequency limit.

An encoder with a much lower resolution, will cause speed to be measured with less precision.[7]

B- *The Tacho-generator :*

An electromechanical generator is a device capable of producing electrical power from mechanical energy, usually the turning of a shaft.

When not connected to a load resistance, generators will generate voltage roughly proportional to shaft speed. With precise construction and design, generators can be built to produce very precise voltages for certain ranges of shaft speeds, thus making them well-suited as measurement devices for shaft speed in mechanical equipment. A generator specially designed and constructed for this use is called a *tachometer* or *tacho-generator*. Often, the word "tach" (pronounced "tack") is used rather than the whole word.

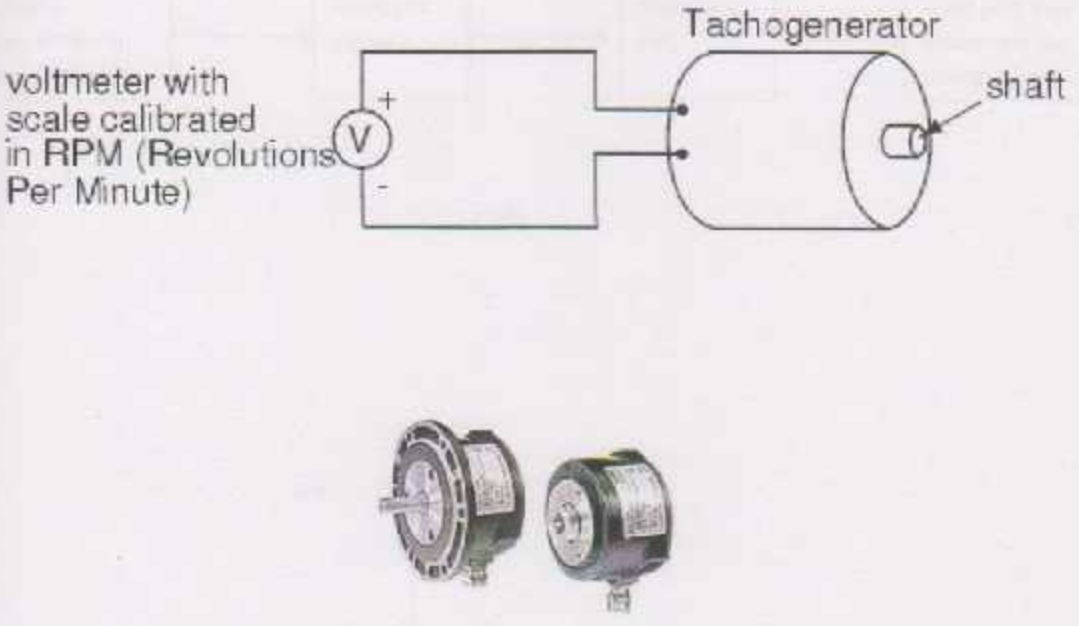


Figure 2.10 : The Tacho-generator

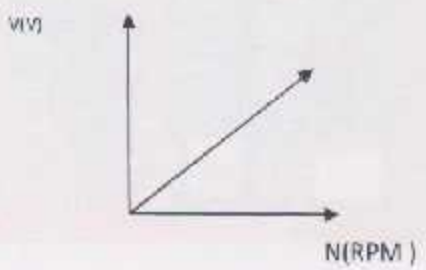
By measuring the voltage produced by a tacho-generator, you can easily determine the rotational speed of whatever it's mechanically attached to. One of the more common voltage signal ranges used with tacho-generators is 0 to 10 volts. Obviously, since a tacho-generator cannot produce voltage when it's not turning, the zero cannot be "live" in this signal standard. Tacho-generators can be purchased with different "full-scale" (10 volt) speeds for different applications. Although a voltage divider could theoretically be

used with a tacho-generator to extend the measurable speed range in the 0-10 volt scale, it is not advisable to significantly over speed a precision instrument like this, or its life will be shortened

The control of speed by using the tacho-generator , it's do by :

A- represent the speed by analog voltage
B- the output of tacho-generator will connect on the input of analog to digital in PLC .
C- after that will connect on counter that will count number of pulses .
D- then will determined the reference speed and control of speed by counter as follow.

A)



B)

Figure 2.11 : A) The Block Diagram for Tacho-generator B) The V-N Curve

2.1.3 The Power Supply :

The power system that was derive all parts containing from 3 ph fully controlled rectifier with input 380 v and output 150 v DC and this rectifier consist from 12 power transistor 8649NBUX98 .

2.1.4 The Controller :

The 6800 CPU microprocessor with capacity 64 Kbyte was used to control the system this controller can be programming by PHG key board and 2*32 LCD display so it have its own programming language cannot be programming on ordinary computer .

The microcontroller work on logic +5v as zero and +15 or -15 v as one ,and we have three card's (figure 2.13) and every card have 6800 CPU to control one of a servo motor .

Figure 2.13: card Of oldest Control

CHAPTER THREE:
Data And Information

3.0 Overview:

3.1 CATIA Program

3.2 Programmable logic Design .

3.3 Festo Fluidsim.

3.4 Autocad .

3.5 The pneumatic element that we use .

Chapter 3
Data And Information:

3.0 Overview:

In this chapter we show data about the programs and equipment that we use to develop and design our project .

3.1 Catia :

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Assaults Systems. Written in the C++ programming language, CATIA is the cornerstone of the Assaults Systems product lifecycle management software suite. CATIA competes in the CAD/CAM/CAE market with Siemens NX, Cero Elements/Pro, Autodesk Inventor.[5]

We use this program to :

- draw the new body of RIES Robot.
- To draw the Pressing Metal Machine .
- To draw the Arm (Hand Robot).

All of this in three dimension.

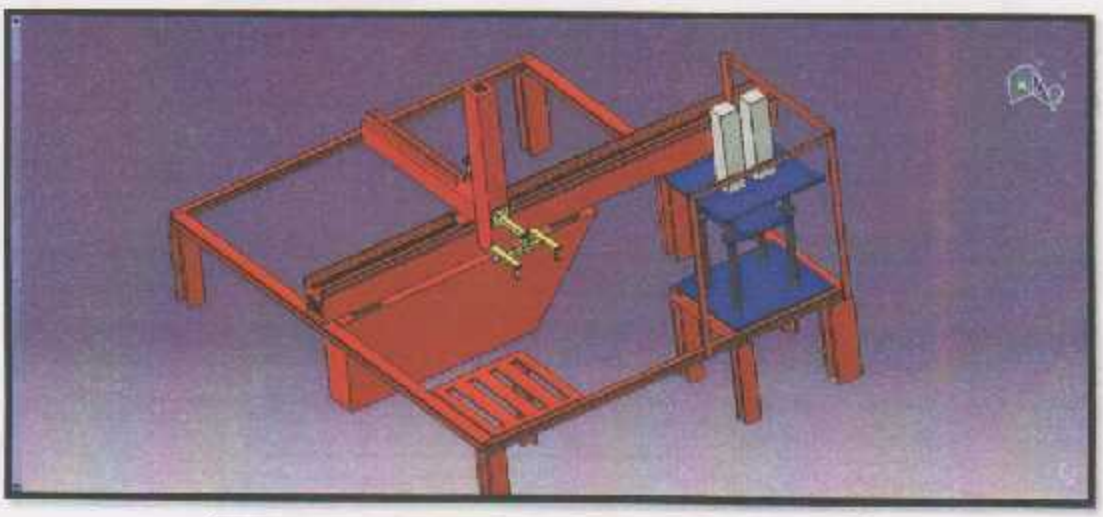


Figure 3.1: Example Of Using CATIA To Draw

3.2 Programmable logic Design (PLC) :

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes , such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures.

Programmable Logic Controllers (PLCs) over a short period of time have shown remarkable presence in process automation industries .Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory.

A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.[5]

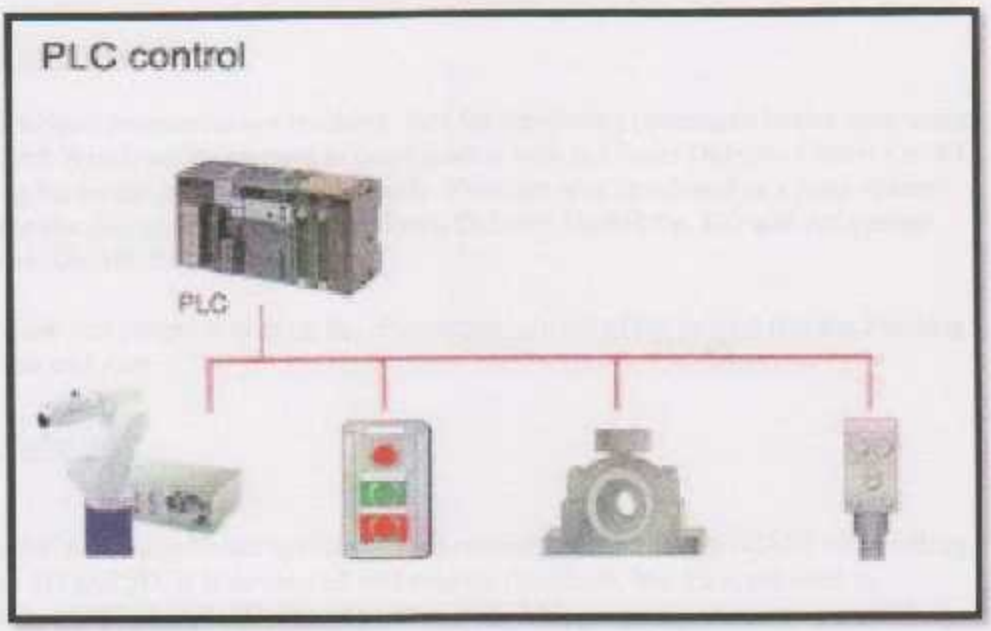


Figure 3.2 : The PLC Control

The use of PLC In this project is very important because :

1- the new controller that used in the new Industrial Machine and it's easy to used .
2- cost effective for controlling complex systems.
3- Same PLC can be used for a wide range of tasks.

- In this project the main job of PLC is :

1- To control the work of DC Servo Motor which Working to move the robot in different directions .

2- To control the Pneumatic Part .

3- To control the Arm (Hand Robot).

3.3 Festo Fluidsim :

Fluidsim pneumatic is a teaching tool for simulating pneumatic basics runs using Microsoft Windows .it can used in combination with the Festo Didactic GmbH Co. KG training hardware ,but also independently. Fluidsim was developed as a joint venture between the university of Paderborn ,Festo Didactic GmbH Co. KG and Art system software GmbH Paderborn.[5]

We use this program to draw the Pneumatic circuit of the project (for the Pressing Machine and Arm).

3.4 Autocad :

AutoCAD is a software application for computer-aided design (CAD) and drafting in both 2D and 3D. It is developed and sold by Autodesk, Inc. First released in December 1982, AutoCAD was one of the first CAD programs to run on personal computers, notably the IBM PC. At that time, most other CAD programs ran on mainframe computers or mini-computers that were connected to a graphics computer terminal for each user.

We use this program to draw the electrical circuit of the project (the connection between the PLC and circuit breaker and the contactor and rely and the load).

3.5 The Pneumatic Element That we use :

For developing this Robot there is pneumatic element used to do some work , these element and work are :

A) Air Compressor :

Air compressor is a mechanical device that increases the pressure of a Air by reducing its volume.[8]

This element used to provide a wide range of pressure and delivery rates To ensure that the full efficiency of air services in the implementation of the business desired.

The selection from the various type of compressor available is dependent upon :

- quantity of air
- pressure
- quality and cleanliness
- how dry the air should be.

There are varying level of these criteria depending on the type of compressor .[12]

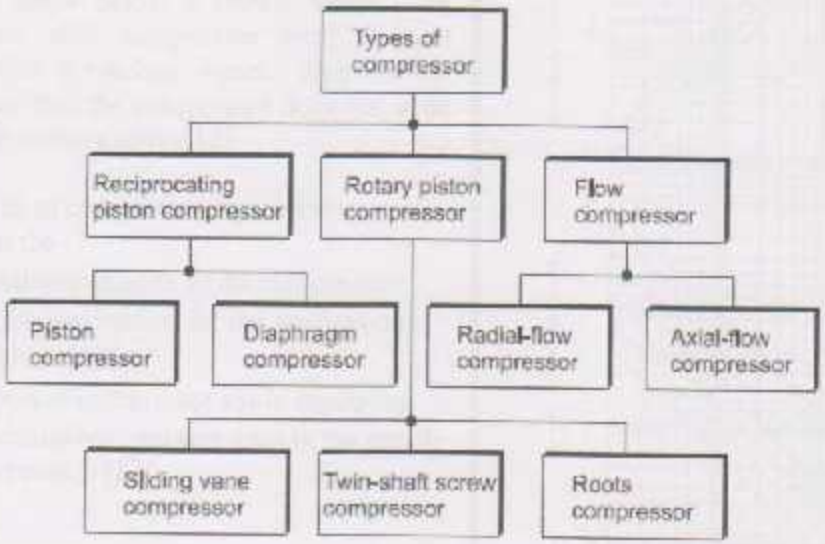


Figure 3.3 : Compressor Type

B) Air Reservoirs :

An air receiver is essential to every compressed air system to act as a buffer and a storage medium between the compressor and the consumption system.

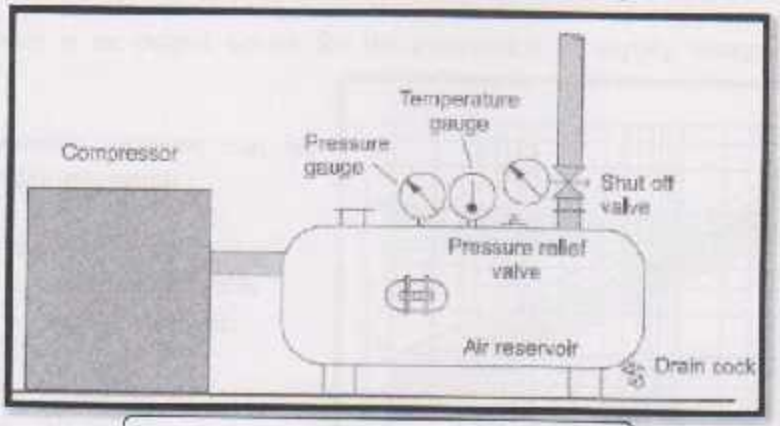


Figure 3.4 : The Reservoir

A reservoir compensates the pressure fluctuation when the compressor air is taken from the system . if the pressure in the reservoir drops below a certain value , the compressor will compensate until the set higher value is reached again . This has the advantages that the compressor does not need to operate continuously .[12]

The size of compressor air reservoir depend on the :

- Delivery volume of the compressor
- Air consumption for the applications
- Network size
- Type of compressor cycle regulation
- Permissible pressure drop in the supply network [12]

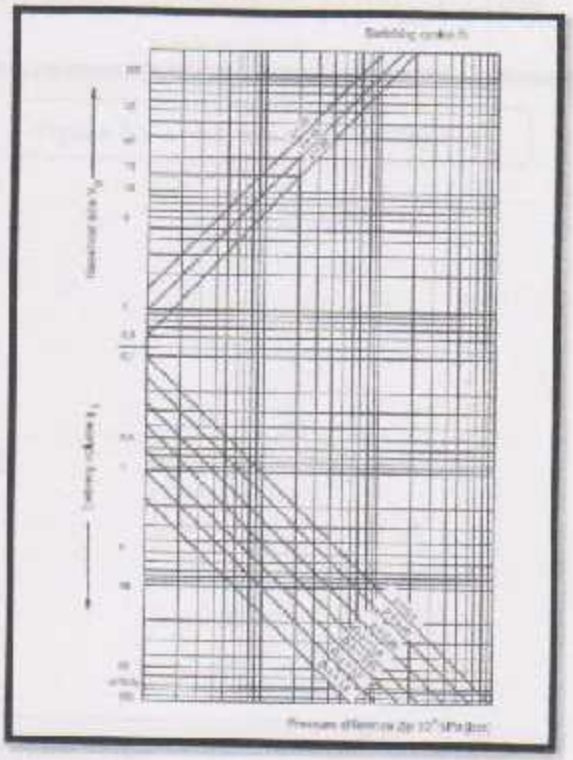


Figure 3.5 : Diagram: Determining the volume of a reservoir

C) Piston Actuator:

To do work which need it (bush the Pieces under the hand Robot , for pressing machine ...) that talked about it in (chapter 4) must add a piece or unit to do this job; And this unit is the Piston Actuator.

An actuator is an output devise for the conversion of supply energy into useful work.[12]

The pneumatic actuator can be described under tow group :

- liner motion :
  - single and double .
  - acting cylinder.
- rotary motion :
  - Air motor
  - Rotary cylinder
  - Rotary Actuator [12]

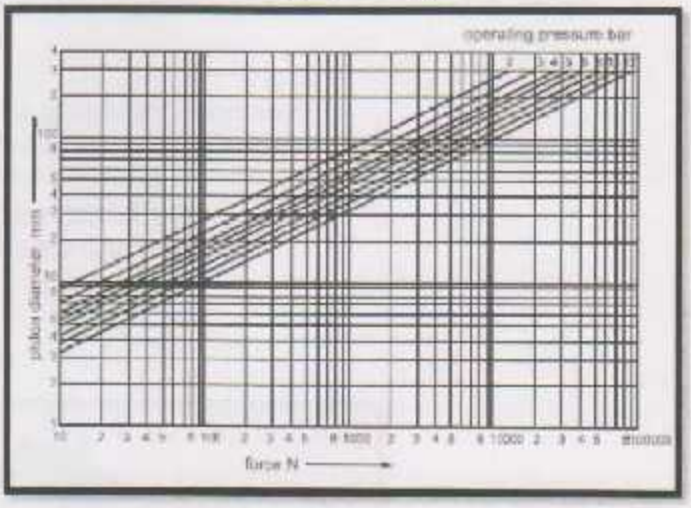


Figure 3.6 : Pressure vs. force diagram

* * In this project there is one type must use it :

* The Double Acting Cylinder .

A) B)

Figure 3.7:The Cylinder Type

A) Double Acting Cylinder B) symbol Of Double Acting Cylinder

D) Directional Control Valve :

Mechanisms that control fluids in a pneumatic or hydraulic system. Control valves direct fluid movement and regulate the amount of pressure exerted in the fluid system. Control valves direct fluid movement and regulate the amount of pressure exerted in the fluid system. [9]

Directional Control Valves can be used to provide a number of different functions. They can:

-Control the direction of cylinder movement.
-Select the path air takes through the system.
-Perform logic control functions.
-Stop and start air flow (on-off valves).
-Sense cylinder positions (limit valves).

Figure 3.8 : Directional Control Valve

E) The Pipes :

The components of a pneumatic circuit are connected through lines. Today they are typically made of plastic tubes from nylon or polyurethane. The material is chosen to meet the required permissible pressure, bending radius, temperature etc. Copper tubes are used for heavy duty applications like actuation of process valves in chemical plants. For plastic tubes push-in fittings can be used which have a low resistance and the additional advantage that no tools are required to install or remove them.[10]

Figure 3.9 : Schematic view of a plastic tube

To know how choosing the pipes see this table :

Working pressure	Inside diameter of piping (mm)			
bar	6	9	13	16
0.20	0.18	0.41	0.91	1.7
0.40	0.28	0.62	1.4	2.6
0.63	0.38	0.85	1.9	3.5
0.80	0.44	1.0	2.2	4.1
1.00	0.52	1.2	2.6	4.9
1.25	0.62	1.4	3.1	5.8
1.60	0.75	1.7	3.8	7.0
2.00	0.91	2.0	4.5	8.4
2.50	1.1	2.5	5.5	10
3.15	1.3	3.0	6.7	12
4.00	1.6	3.7	8.3	15
5.00	2.0	4.6	10	19
6.30	2.5	5.6	13	23
8.00	3.1	7.0	16	29
10.0	3.9	8.7	19	36
12.5	4.8	10	24	45
16.0	6.1	13	31	57

Table 3.1 : Maximum recommended flow rates to be used in pneumatic system piping

F) Arm (PNEUMATIC VACUUM LIFTER) :

The arm is used to carry the metal pieces from cutting machine to the presser and then arranging the piece in wanted place .

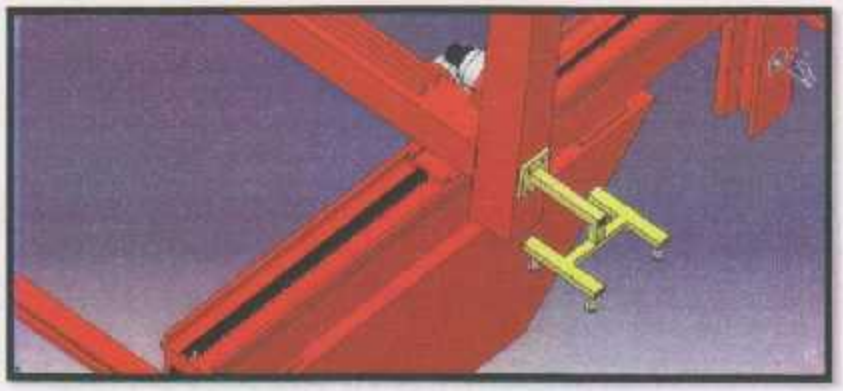


Figure 3.11 : pneumatic Vacuum Lifter

CHAPTER FOUR :
Developing And Design

4.1 Information :

4.2 Developed And Design of Mechanical Part:

4.2.1 Fixation of Robot Body .

4.2.2 Pressing Metal Machine.

4.2.3 Arm (Hand Robot).

4.3 2 Developed and Design of Electrical Part :

4.3.1 Power Supply .

4.3.2 Rectifiers.

4.3.3 PLC .

4.3.4 Limit Switch .

4.4 Developed And Design of Pneumatic Part.

4.5 Protection .

Chapter 4
Developing And Design :

4.1 Introduction :

In this project we do some developed and design which is :

A- developed and design of Mechanical part :

1- Do the fixation for the body of Robot to do the work without any problem like :

- Unbalanced in move the Robot in all direction .
- Problems during the implementation of the application designer to which this robot (inaccuracy ,...)
- Risk of non-work safety .

2- Added the hand to push up the pieces to and from the pressing machine.
3- Design and built the pressing machine .

B- developed and design of Electrical part :

- This Robot it was work by the oldest operating system and control which is the Microcontroller . After reviewing some of the existing components and pieces that show a problem like there is Problems and reduction of the component , and In addition to the belief that the use of new system like using the PLC for control the Robot Will be biggest of the feasibility and usefulness Under scientific development and to achieve the desired results from re-operation of the system .

- Based on this, we used the PLC to re-operating this Robot And a program of precise control to do the work quickly and accurately .

- Design and built the power and control circuit .

C- *Developed and design in Pneumatic part :*

- Pneumatic has long since played an important role as a technology in the performance of mechanical work it is also used in the development of automation solution.[12]

- We used it in the pressing machine to push the plate , and in vacuum control head to hold the pieces from and to the pressing machine .

4.2 Developed And Design of Mechanical Part :

4.2.1 Fixation Of Robot Body :

The first problem existing now is that the body of the robot need to install the road lead the work required, and So we want to make additions that are necessary to implement the new business of carrying the pieces and put in plunger and then arranged to carry it :

Figure 4.1 : REIS ROBOT

- The solve of the problem by adding new part which is show in fighter (with the diminution for all part) :

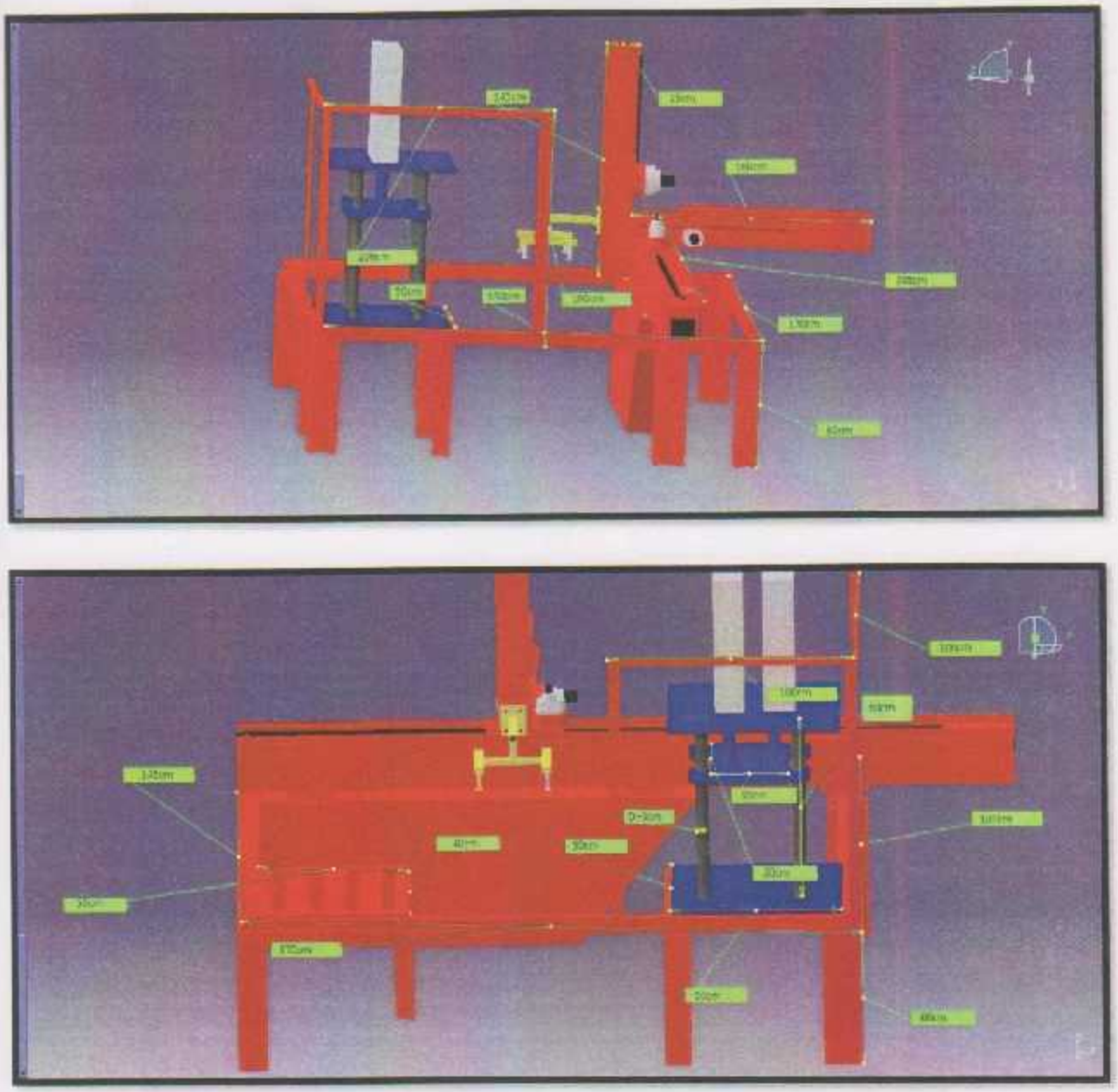


Figure 4.2 :The design of New Body Of REIS ROBOT

Figure 4.3 : New Body Of REIS ROBOT

4.2.2 Pressing Metal Machine :

This Machine do The implementation of the shape you want to get it to the industrial process , and it's consist of :

A- The Body :

Holds the pieces necessary to make the process of pressing.

B- two Double Acting Cylinder :

Working to get the upper template and downloaded strongly to bring about the desired shape the iron piece.

C- Template Iron:

Designed in the form and weight to conform to the location and capacity of Double Acting Cylinder Which carry it.

And the Change of these templates based on the need for industrial process .

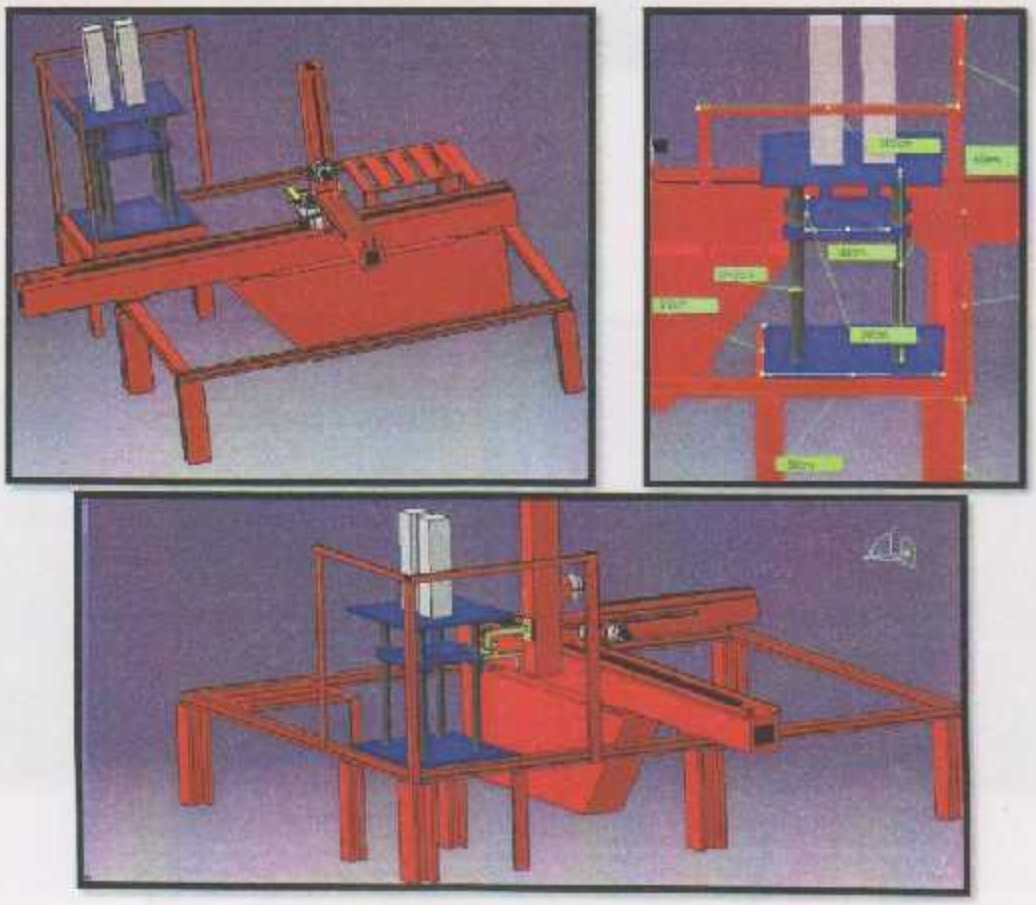


Figure 4.4 :the design of Pneumatic Pressing Machine

Figure 4.5 :the Pneumatic Pressing Machine

4.2.3 Arm (Hand Robot) :

- We design and added the Arm of Robot to hold the pieces to and from pressing machine .

- The hold of pieces to and from pressing machine is by the vacuum control head .

- The Arm consist of :
  - the mechanical part (the body of Arm).
  - vacuum control head.
  - valves .
  - pipes .

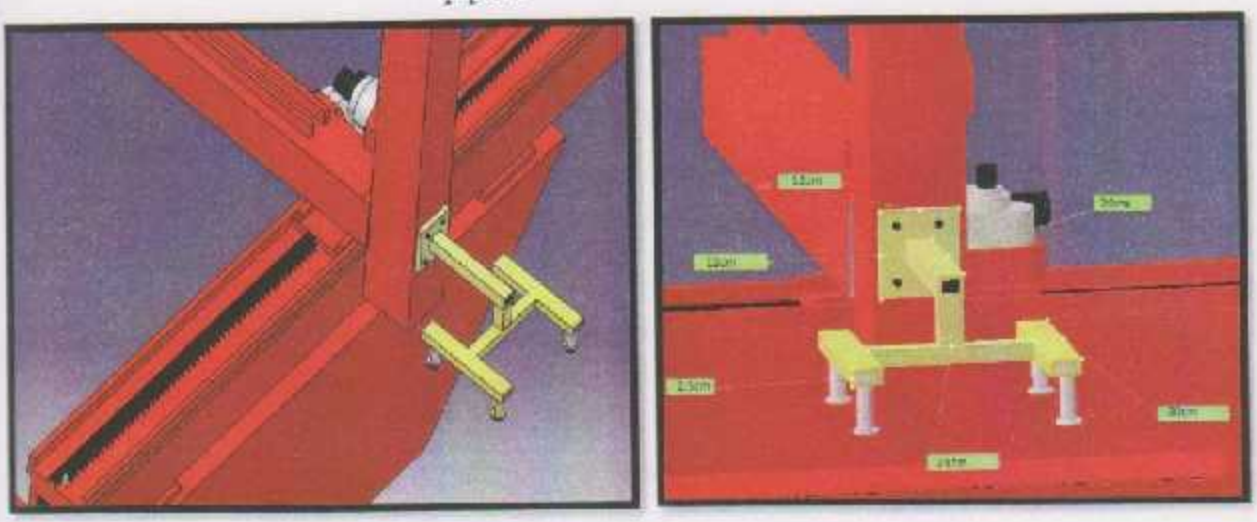


Figure 4.6 :the draw of Pneumatic Arm

Figure 4.7 : Pneumatic Arm

4.3 Developed And Design of Electrical Part :

4.3.1 The Power Supply :

The power supply contain three output :

1) Single phase source with voltage 220 volte that supply the PLC .

2) 3 phase source with voltage 380 volte that supply the compressor

3) DC voltage after rectifier (12v DC (for Motor) , 24v Dc (for brakes)) that energizes the 3 servo motor with :

   A. motor x is servo motor that move in horizontal dimension with max distance 200 cm with driver servo drive X.

   B. motor y is the servo motor that move in vertical dimension with max distance 100 cm with servo drive Y.

   C. motor z is the servo motor that move in horizontal dimension with max distance 90 cm with servo drive Z.

A B C

Figure 4.8 :The Motor Axis A) X-axis motor B) Y-axis motor C) Z-axis motor

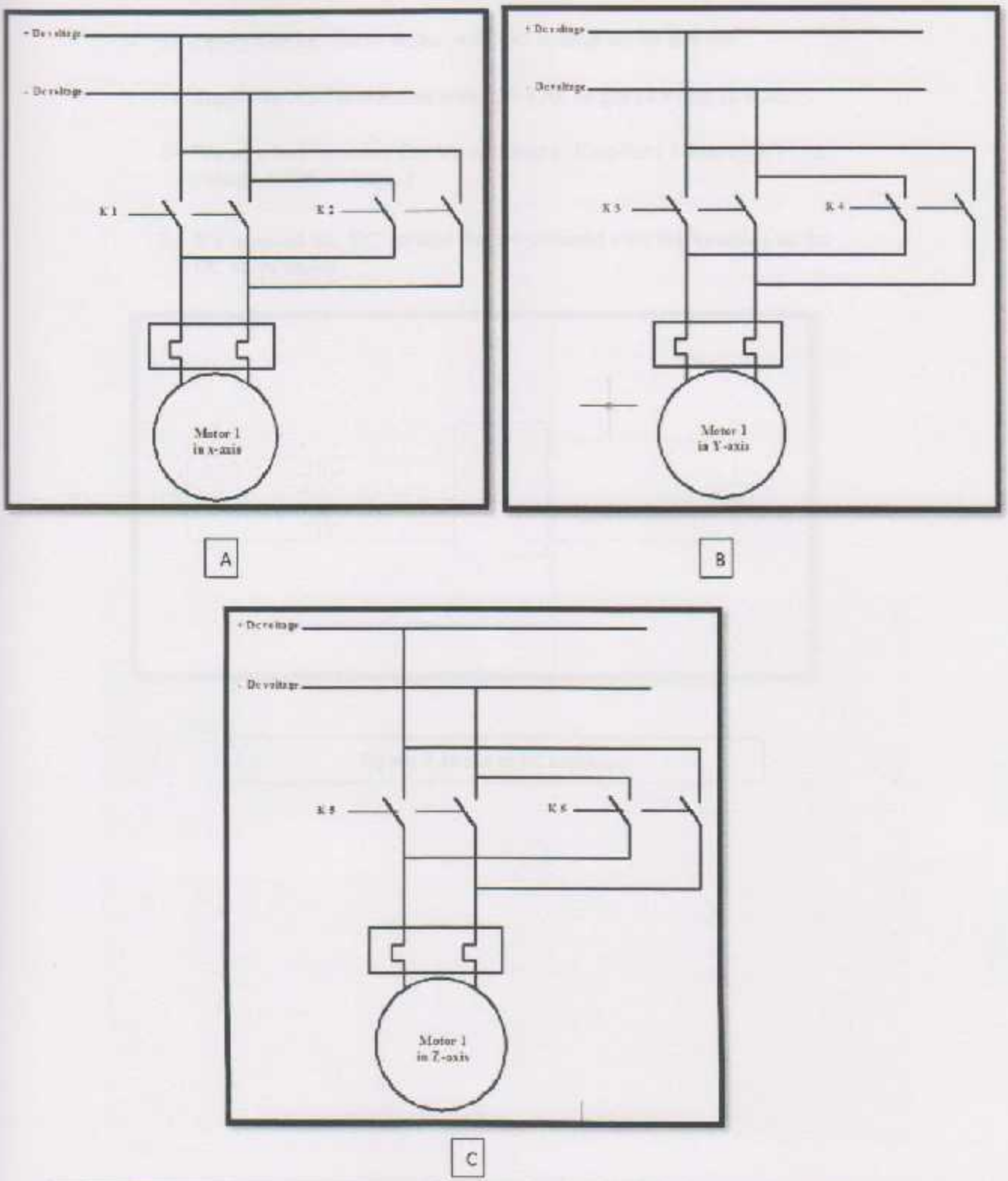


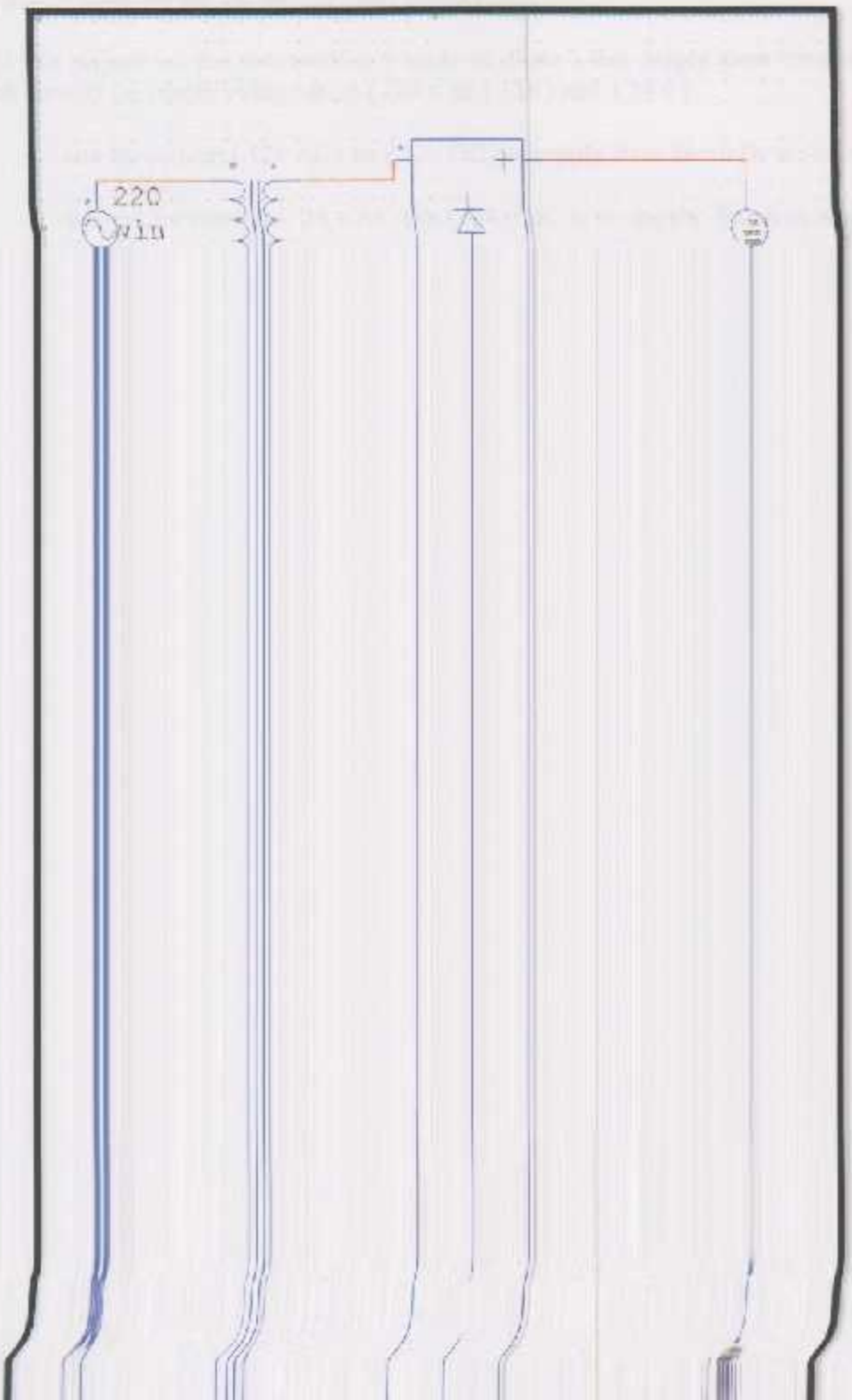
Figure 4.9 :The Power circuit A) of X-axis motor B) of Y-axis motor C) of Z-axis motor

- To supply The DC Servo motor with DC voltage we do this job :

  1- Supply an AS Transformer with 220 v AC to get 24 v and 12 v AC .

  2- We supplied the value that we obtained to Rectifier (Diode type) (AC voltage to DC voltage) .

  3- We supplied the DC voltage that we obtained after the Rectifier to the DC servo motor .



4.3.2 Rectifiers :

A **rectifier** is an electrical device that converts alternating current (AC, to direct current (DC).[5]

The motor which using in this project need a DC power , but the power which is supply by the Network is an Ac power ; because that the use of the Rectifier is very important to convert Ac power to DC power .

Rectifiers may be made of : solid state diodes, silicon-controlled rectifiers, vacuum tube diodes, mercury arc valves, and other components.

In this project we use two rectifier (made of diode) that supply from transformer which convert Ac supply voltage from (220 v)to (12v) and (24 v) :

- one for convert (12v AC) to (12v DC) to supply three Servo Dc motor.
- Second for convert (24 v AC) to (24 v DC) to supply Break in motor of Z-axis .

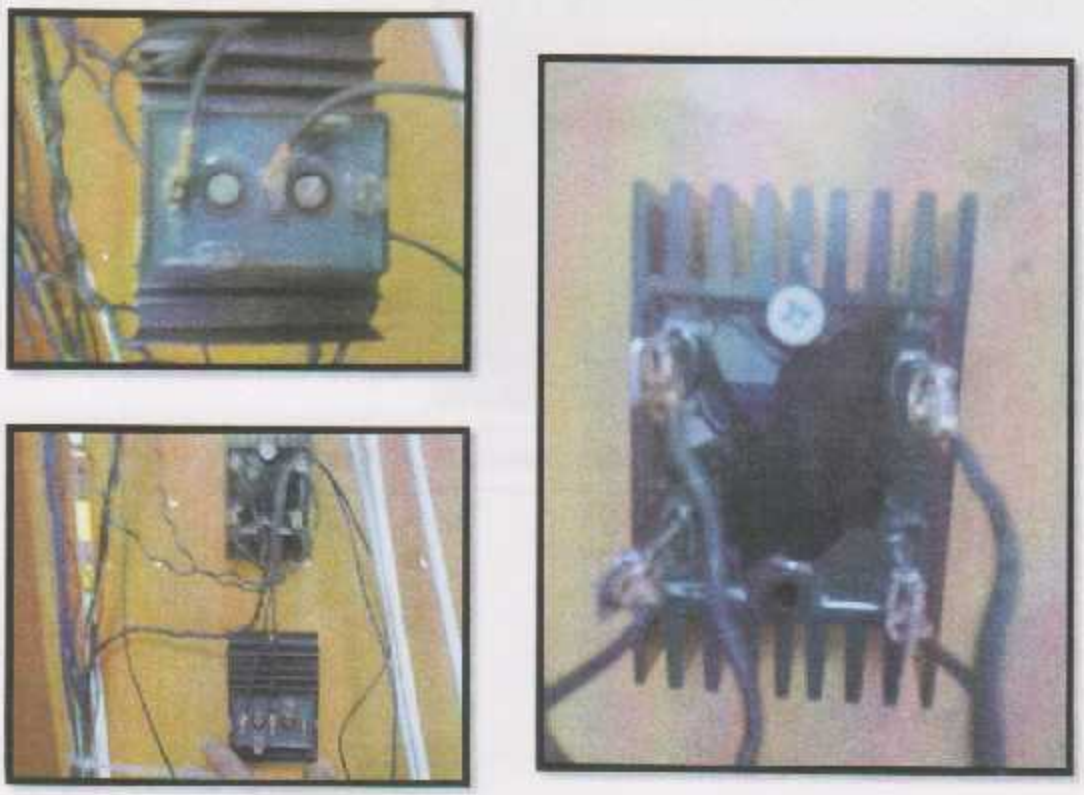


Figure 4.11 :The view of bridge that we use in project

4.3.3 The PLC :

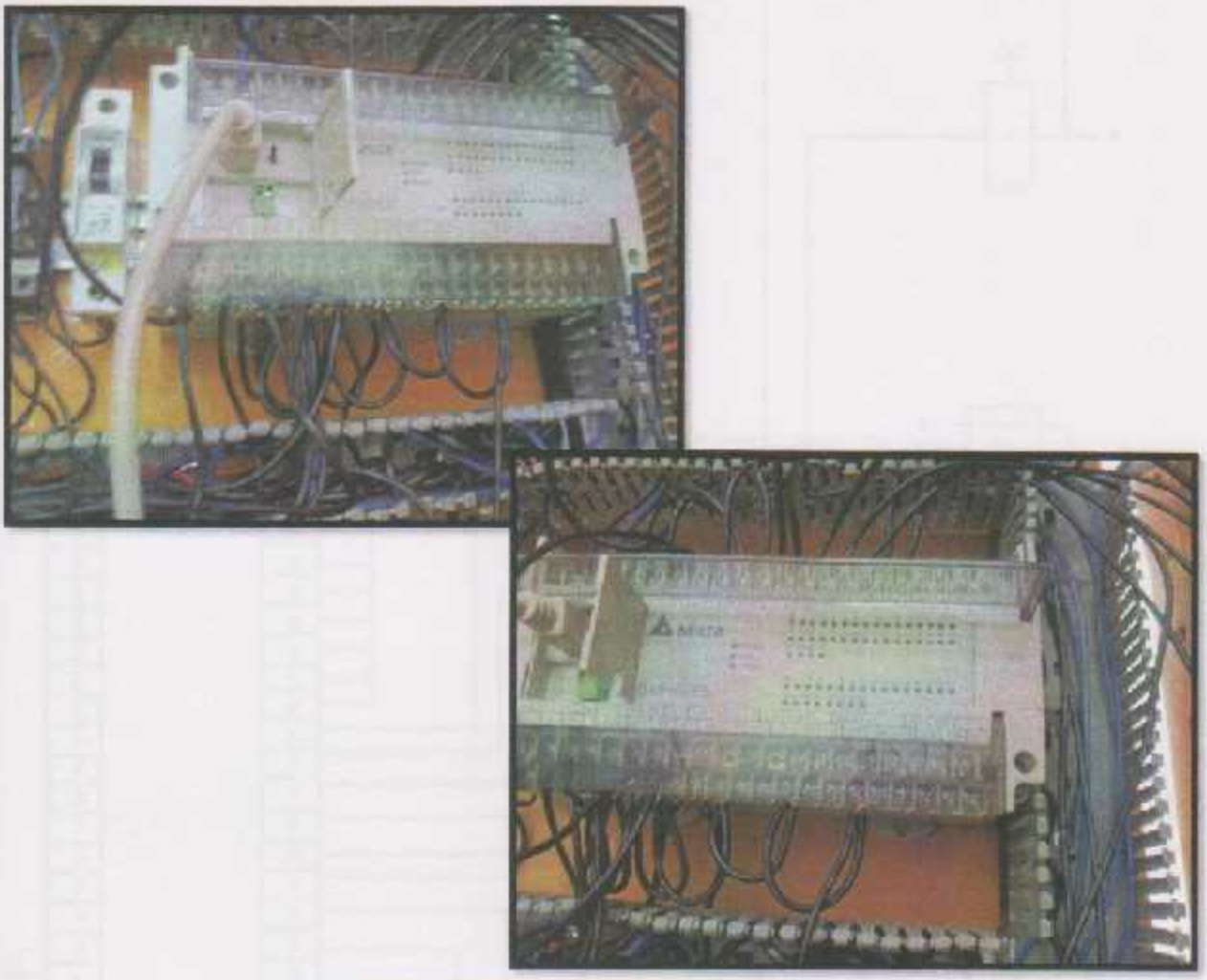


Figure 4.12 : PLC Device (Delta)

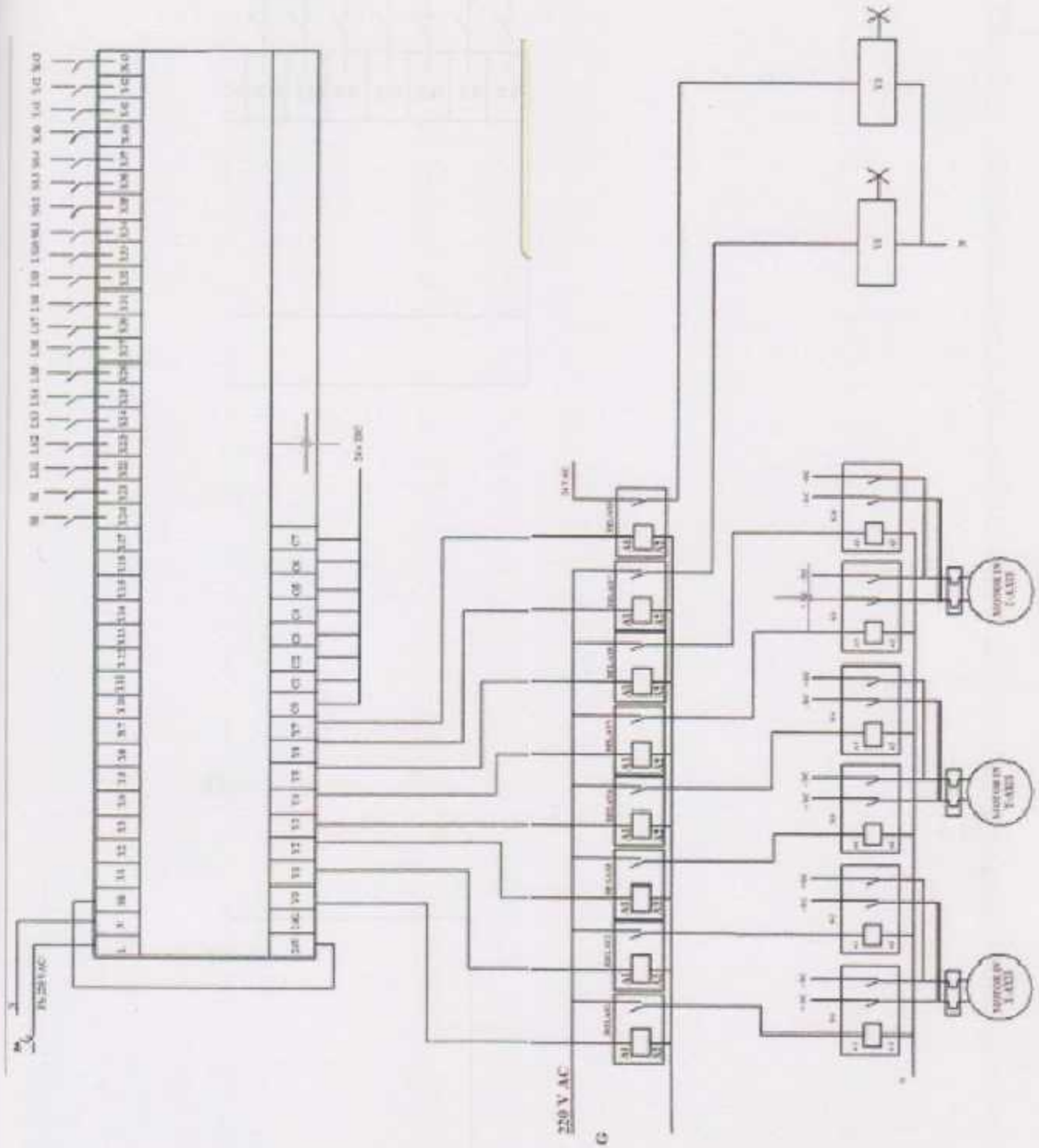
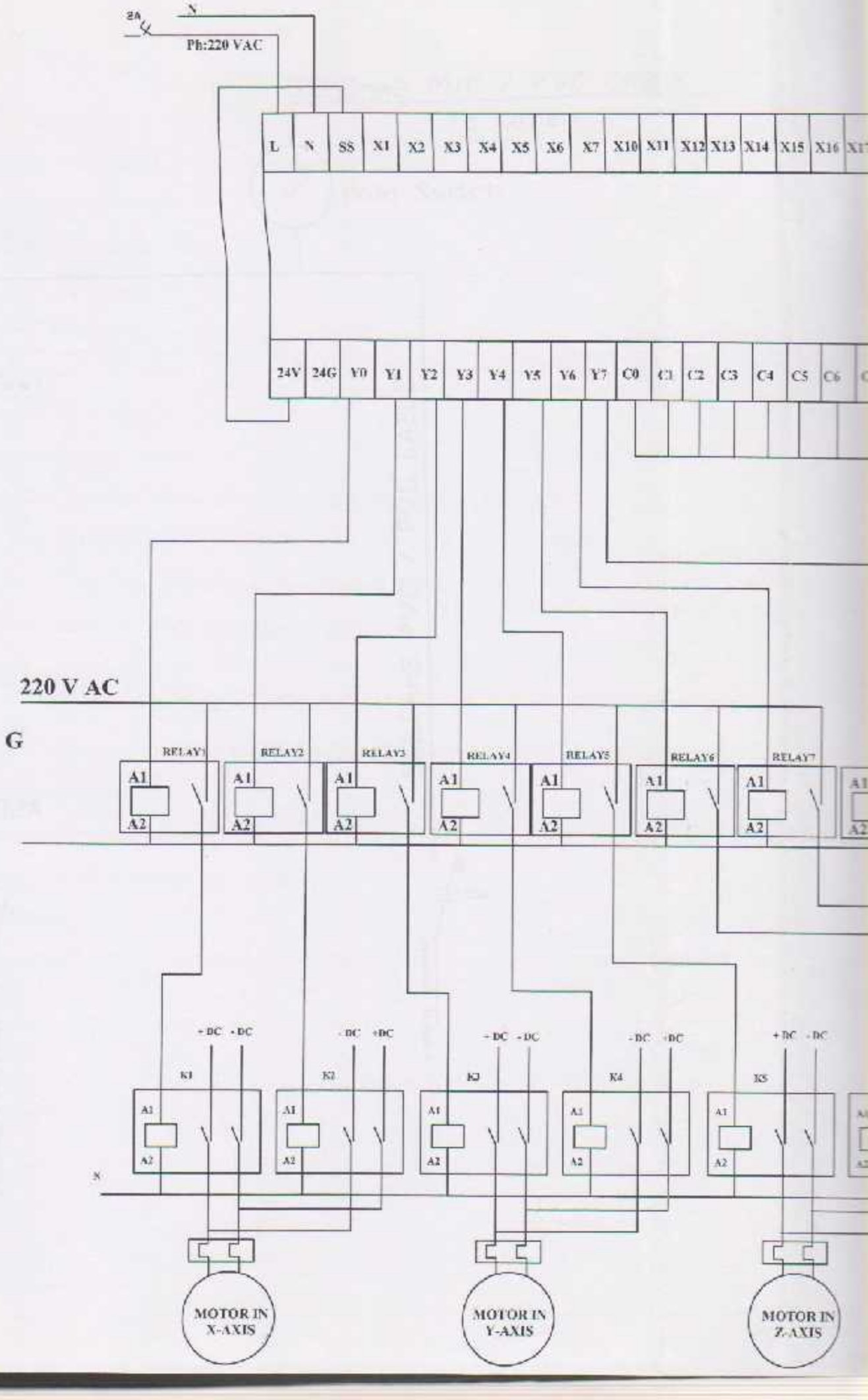
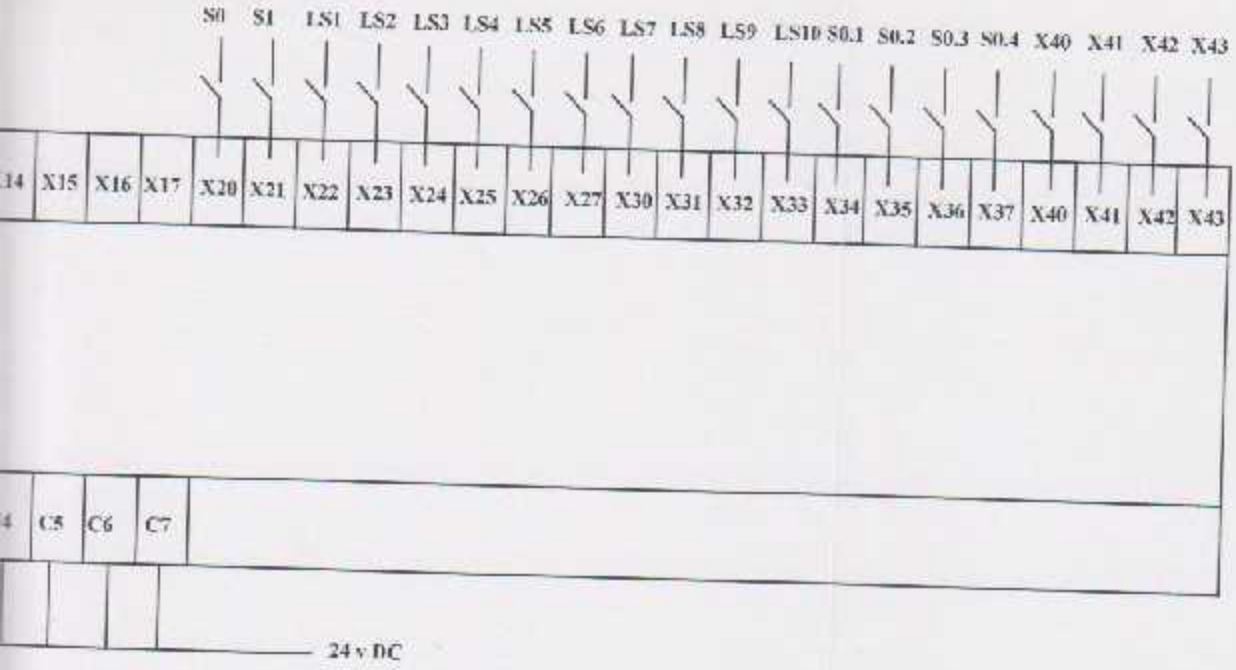
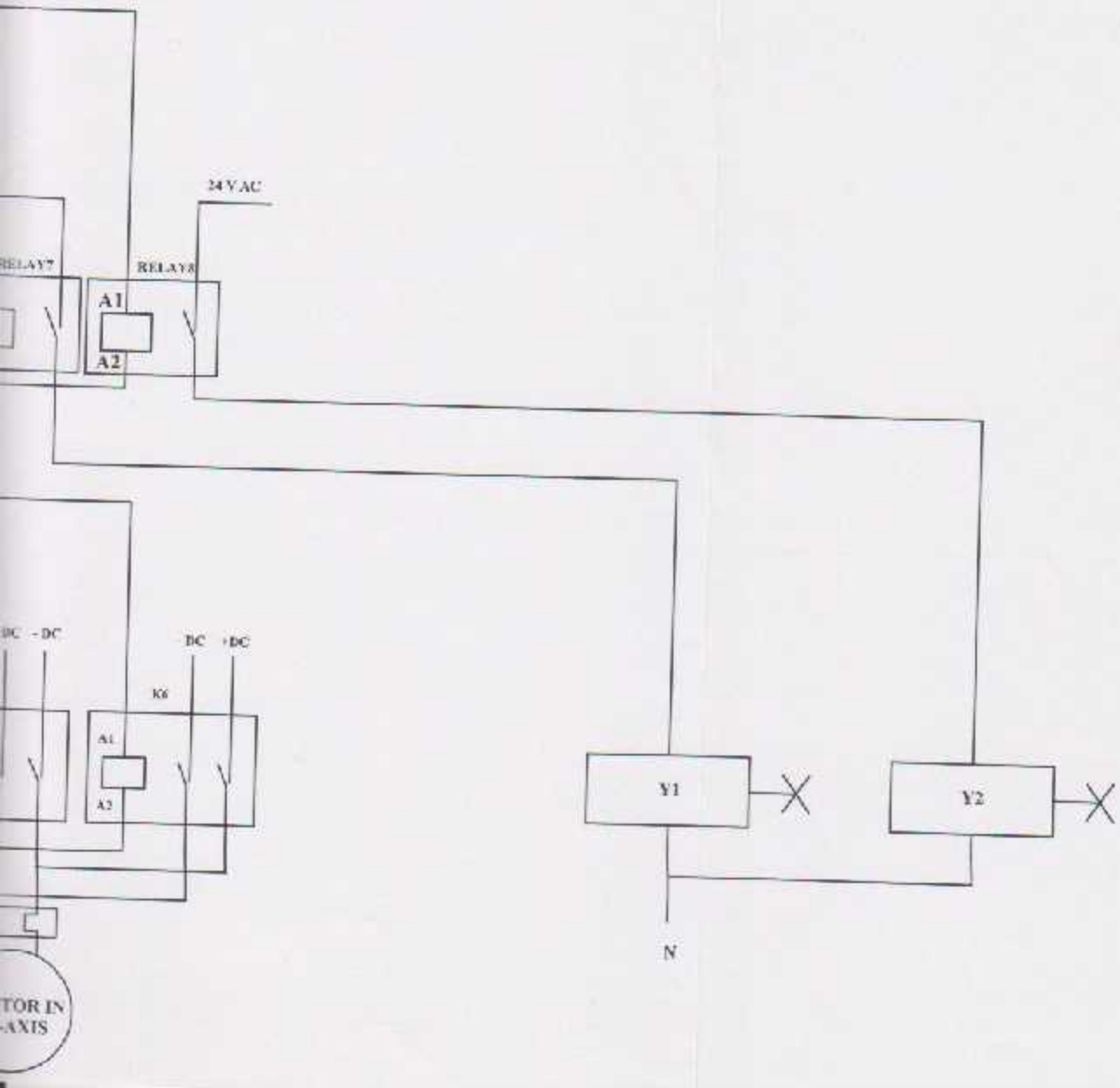
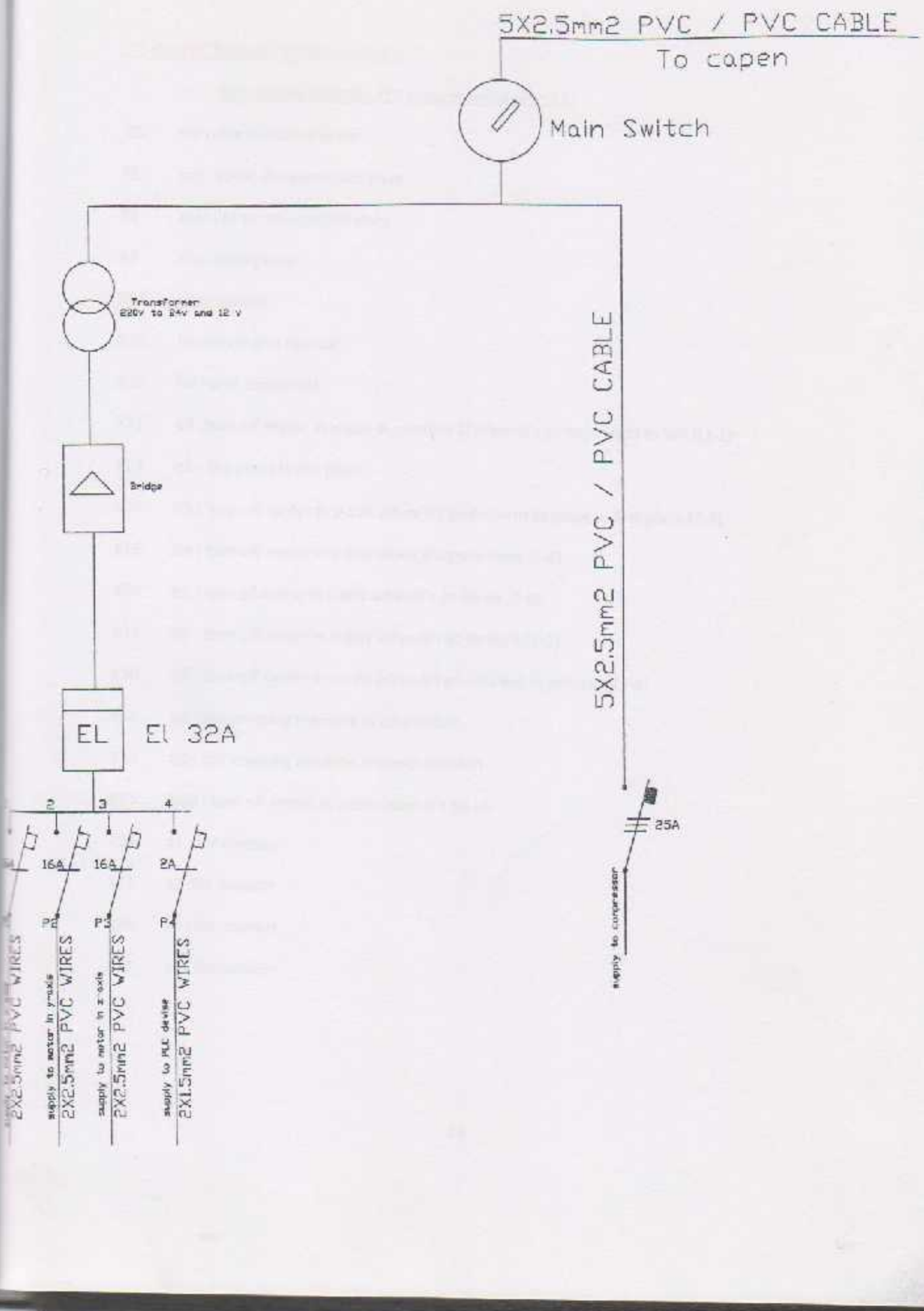


Figure 4.13 : The Electrical circuit (connecting with the PLC)


2A
N
Ph:220 VAC
L
N
SS
X1
X2
X3
X4
X5
X6
X7
X10
X11
X12
X13
X14
X15
X16
24V
24G
Y0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
C0
C1
C2
C3
C4
C5
C6
220 V AC
G
RELAY1
RELAY2
RELAY3
RELAY4
RELAY5
RELAY6
RELAY7
A1
A2
+DC
-DC
K1
K2
K3
K4
K5
MOTOR IN X-AXIS
MOTOR IN Y-AXIS
MOTOR IN Z-AXIS


S0 S1 LS1 LS2 LS3 LS4 LS5 LS6 LS7 LS8 LS9 LS10 S0.1 S0.2 S0.3 S0.4 X40 X41 X42 X43
14 X15 X16 X17 X20 X21 X22 X23 X24 X25 X26 X27 X30 X31 X32 X33 X34 X35 X36 X37 X40 X41 X42 X43
4 C5 C6 C7
24 v DC


24 V AC
RELAY7
RELAY8
A1
A2
DC - DC
DC + DC
K6
A1
A2
Y1
Y2
N
TOR IN
-AXIS


5X2.5mm2 PVC / PVC CABLE
To capen
Main Switch
Transformer
220v to 24v and 12 v
Bridge
5X2.5mm2 PVC / PVC CABLE
EL
EL 32A
2
3
4
16A
16A
2A
25A
supply to compressor
2X2.5mm2 PVC WIRES
supply to motor in y-axis
2X2.5mm2 PVC WIRES
supply to motor in x-axis
2X2.5mm2 PVC WIRES
supply to PLC device
2X1.5mm2 PVC WIRES

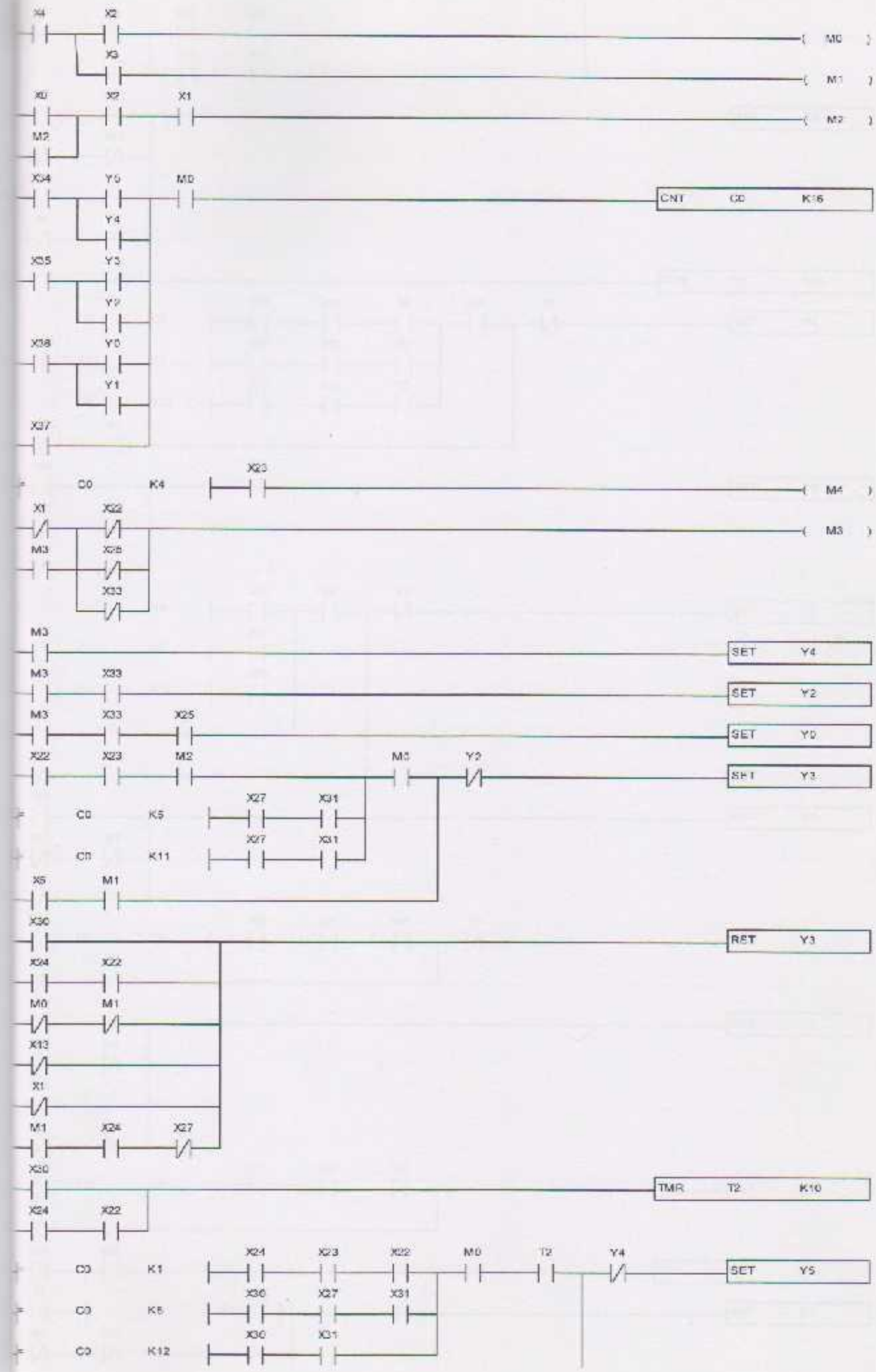
** the PLC Program for the project :

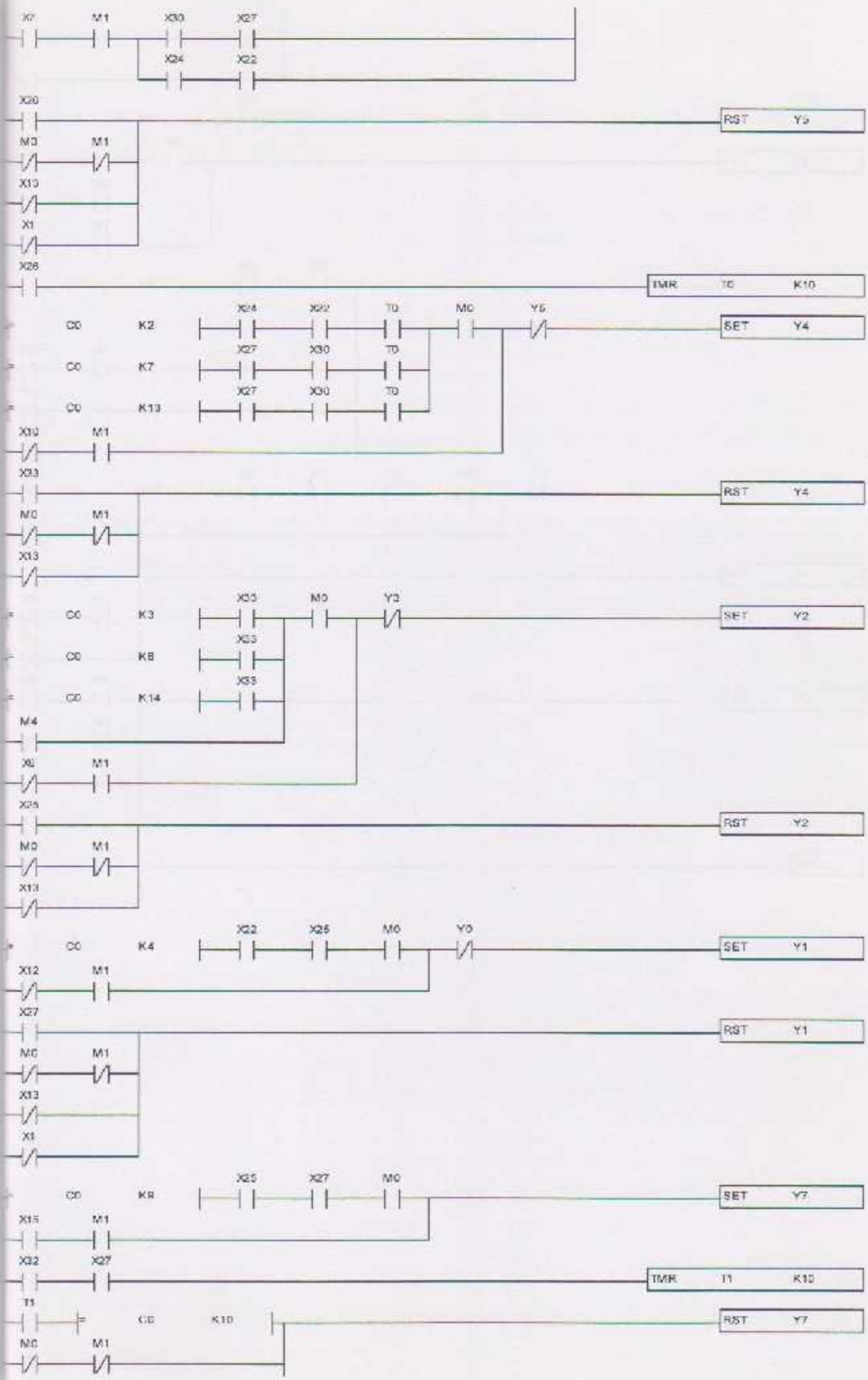
- *The symbol table for PLC programming (input) :*

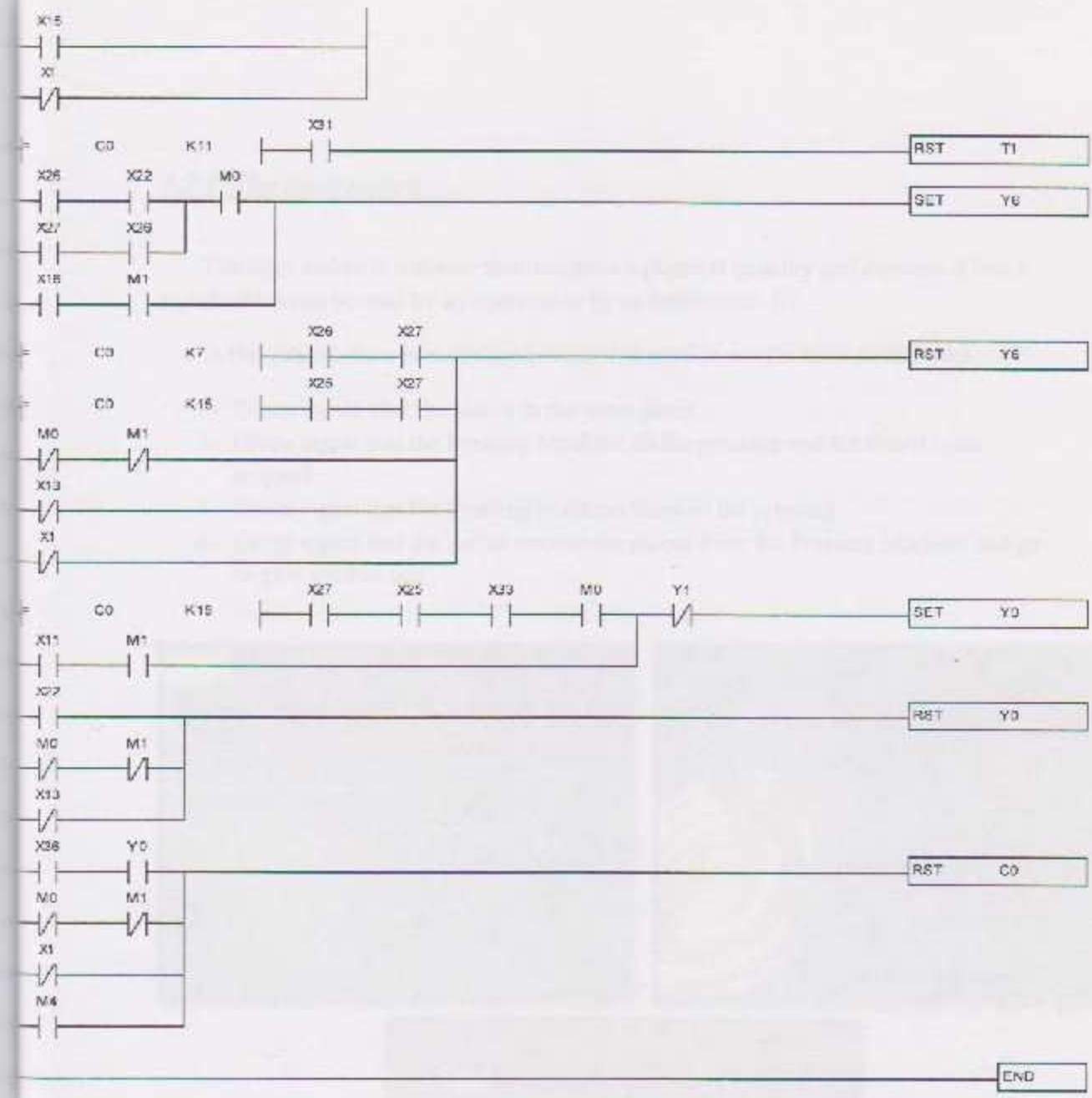
X1	s0: reset in normal state
X2	sot : to set the automatic state
X3	sma : to set the manual state
X4	Em : emergency
X13	stop manual
X15	for pressing in manual
X16	for hand in manual
X22	ls1 :turn off motor in x-axis in position 1(when it's go from right to left)(2-1)
X23	ls2 : the piece in the place
X24	ls3 : turn off motor in y-axis when it's go forward to piece in first place (3-4)
X25	ls4 : turn off motor in y-axis when it's go reveres (4-3)
X26	ls5 : turn of motor in z-axis when it's go down (5-6)
X27	ls6 : turn off motor in x-axis when it's go to right (1-2)
X30	ls7 : turn off motor in y-axis when it's go forward to pressing (3-4)
X31	ls8 : the pressing machine in up position
X32	ls9 : the pressing machine in down position
X33	ls10 : turn off motor in z-axis when it's go up
X34	s1 : for counter
X35	s2 :for counter
X36	s3 : for counter
X37	s4 : for counter

- *The symbol table for PLC programming (output) :*

Y0	Mx0 ; K of motor go left
Y1	Mx1 : K of motor go right
Y2	My0 : K of motor go reverse
Y3	My1 : K of motor go forward
Y4	Mz0 : K of motor go up
Y5	Mz1 : K of motor go down
Y6	y1 : K of vacuum control head
Y7	y2 : K of the cylinder of pressing


X4
X2
M0
X3
M1
X0
X2
X1
M2
M2
X34
Y5
M0
CNT C0 K16
Y4
X35
Y3
Y2
X36
Y0
Y1
X37
C0 K4
X23
M4
X1
X22
M3
M3
X25
X33
M3
SET Y4
M3
X33
SET Y2
M3
X33
X25
SET Y0
X22
X23
M2
M3
Y2
SET Y3
C0 K5
X27
X31
C0 K11
X27
X31
X5
M1
X30
RST Y3
X24
X22
M0
M1
X13
X1
M1
X24
X27
X30
TMR T2 K10
X24
X22
C0 K1
X24
X23
X22
M0
T2
Y4
SET Y5
C0 K5
X30
X27
X31
C0 K12
X30
X31


X7 M1 X30 X27
X24 X22
X20
RST Y5
M0 M1
X10
X1
X26
TMR T0 K10
C0 K2 X24 X22 T0 M0 Y5
SET Y4
C0 K7 X27 X30 T0
C0 K13 X27 X30 T0
X10 M1
X33
RST Y4
M0 M1
X13
C0 K3 X33 M0 Y3
SET Y2
C0 K8 X33
C0 K14 X33
M4
X2 M1
X25
RST Y2
M0 M1
X13
C0 K4 X22 X25 M0 Y0
SET Y1
X12 M1
X27
RST Y1
M0 M1
X13
X1
C0 K8 X25 X27 M0
SET Y7
X15 M1
X32 X27
TMR T1 K10
T1 = C0 K10
RST Y7
M0 M1


X15
X1
C0
K11
X31
RST T1
X26
X22
M0
SET Y6
X27
X29
X18
M1
C0
K7
X26
X27
RST Y6
C0
K16
X25
X27
M0
M1
X13
X1
C0
K15
X27
X25
X33
M0
Y1
SET Y0
X11
M1
X22
RST Y0
M0
M1
X13
X36
Y0
RST C0
M0
M1
X1
M4
END

4.3.4 The limit switch :

The limit switch is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument .[5]

In this project there is many application that need to use the limit switch like :

1- Given signal that the pieces in the exact place .
2- Given signal that the Pressing Machine do the pressing and the Robot must stopped .
3- Given signal that the Pressing Machine finished the pressing .
4- Given signal that the Robot remove the pieces from the Pressing Machine and go to give another one .

Figure 4.14 : The Limit Switch

4.4 Developed And Design of Pneumatic Part :

for using pneumatics system there is some advantages:

1. Simplicity of Design And Control:

   The control machines are easy to design. i.e they can be manufactured using standard cylinders & other components. Controlling mechanism simply contains two **ON-OFF** states, so its easy to implement and understand . [11]

2. Reliability:

   pneumatic control mechanism is well known for its long lasting operation life time. In fact they need very little maintenance but operates continuously with high reliability.

3. Safe to use:

   Pneumatic controls have high safety profile due to many reasons. Air used in these are fire proof, and less vulnerable to explosions and electric hazards. These are adoptable in extreme weather conditions, and we can rely on their continuous operation. This is because compressed air can stay in good condition in high temperature fluctuations .

4. Storage:

   Compressed Gas can be stored easily, and once compressed, above a certain threshold level they can be operate with out further need of compressing. This feature allows the use of machines when electrical power is lost.

5. Clean:

   there is no messy waste produce at the end of the day

6. Easily transported:

   Air is easily obtainable from atmosphere and can be used with little purification. Air can be pumped to long distances in pipelines, so can control pneumatic equipments for long distances. This makes central controlling possible. These also requires no return line, so easy to manage and cost effective.

7. Light in weight:

   Air is very light compared with other fluids, which are very heavy. They don't need high power to transfer

8. Cost Effective:

   The Pneumatics require low maintenance cost, since wear of equipments are very less. These operates at low pressure , so equipments can be produced for low cost using cheap materials. In contrast hydraulic controlling systems require high pressure, so need tough materials, which comes in high prices.[11]

The pneumatic element that we use is :

1- Double acting cylinder :

Length =40 cm
Diameter of rod –2 cm
Weight of load (for tow cylinder) =400 N

2- Compressor :

Motor (name plate) =

3~ MOTOR		Nr. 200 26 971	
Δ/λ	230/400 V		5.7 A
1.5 KW	S1	COS ϕ 0.86	
2850	min^{-1}	50 Hz	
			0.7 A
Synchronies Induction motor			

3- Receivers :

Receiver size = 1.2 m3

4- Piping :

For the double acting cylinder we use pipe with (9mm) to give maximum recommended flow rate = 10 ,with compressor = 12 bar.

For the vacuum control head we use pipe with (6mm) to give maximum recommended flow rate = 4.8, with compressor = 12 bar

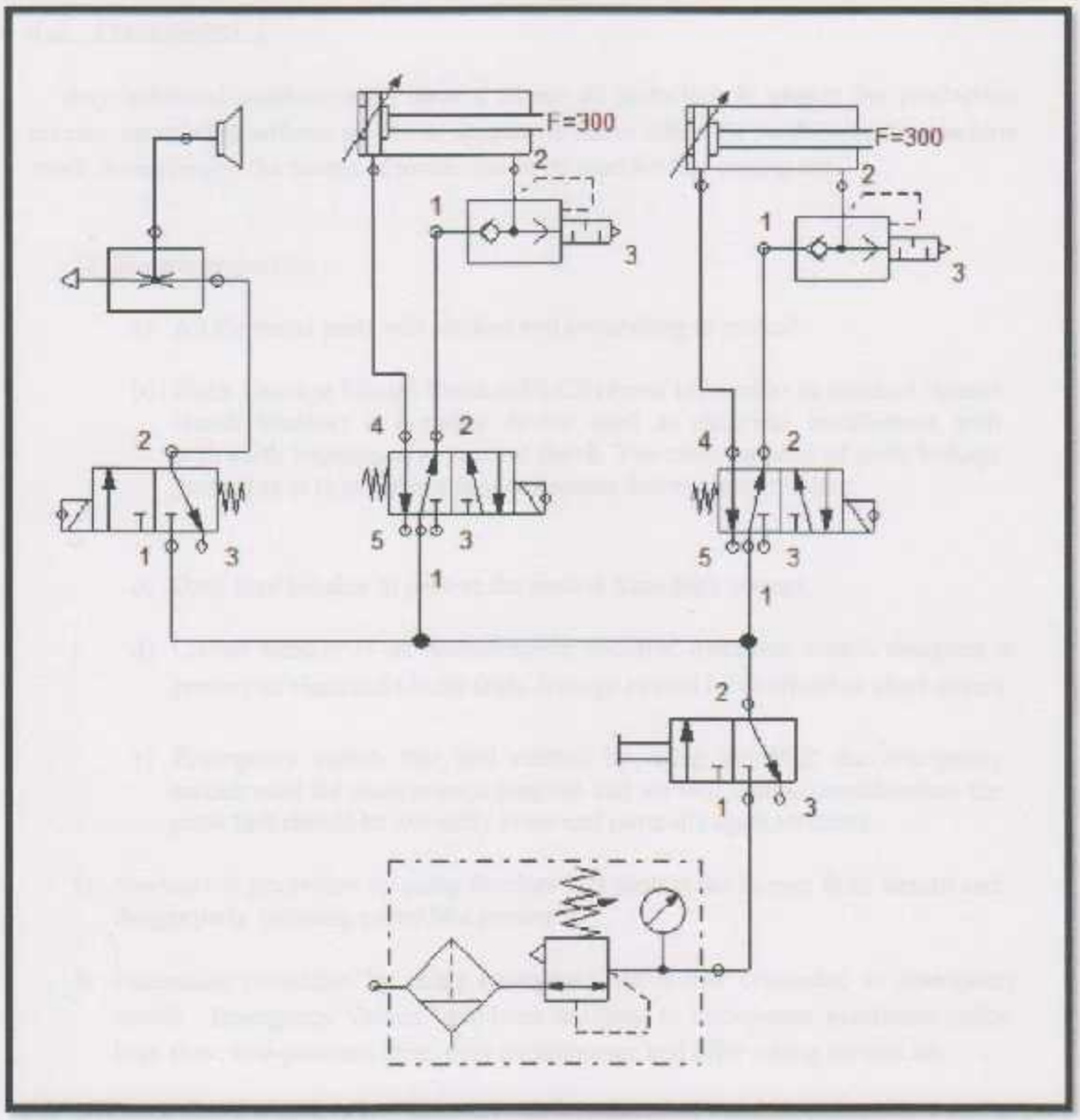


Figure 4.15 : Pneumatic circuit

4.5 Protections :

Any industrial machine must have a means of protection to ensure the production process completely without problems negatively affect either the workers or the machine itself. Accordingly, the means of protection to be used for this project are:

1) Electric protection :

   a) All the metal parts will earthed and connecting to ground .

   b) Earth Leakage Circuit Breaker(ELCB) (now referred to as residual current circuit breaker) is a safety device used in electrical installations with high earth impedance to prevent shock. The main purpose of earth leakage protectors is to prevent injury to humans due to electric shock.

   c) Over load breaker to protect the motors from high current.

   d) Circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit.

   e) Emergency switch that will control by using the PLC the emergency switch used for maintenance purpose and we will take in consideration the parts that should be normally close and normally open switches.

2) Mechanical protection by using Barriers that protect the human from hazard and danger parts (moving parts) like presser .

3) Pneumatic protection by using emergency valve that connected to emergency switch . Emergency Valves have been designed to incorporate maximum safety, high flow, low-pressure drop, easy maintenance and offer a long service life.

CHAPTER FIVE :
Conclusion And Recommendation

5.1 Conclusion :

5.2 Recommendation :

Chapter 5
Conclusion And Recommendation :

5.1 Conclusion :

After finishing the project we have some conclusion which is :

1- This type of project is very important for :

A- the student :
- because it give to us more information and an application for our study.
- Gained the ability to deal with the electrical parts in the life process is well.

B- The Labor market :
- Giving them confidence in the Palestinian engineering competencies and their ability to design and development.

2- There are a lot of the problems that we have overcomed a large part of :
- The cost of some element is very high like the drive of servo motor and we have overcame it by using PLC-device .

5.2 Recommendation :

1- do the next part of develop of this machine which is design the cutting machine to give a complete machine that do all job(cutting metal then pressing it) .
2- Marketing this machine in the local market .

References

1.	http://www.electronicsteacher.com/robotics
2.	www.pc-control.co.uk/robotics.htm
3.	www.robots.com/blog.php?tag=112
4.	Programmable Logic Controllers, 4 edition by Frank Petruzella C.reer Ed.cation
5.	http://en.wikipedia.org/wiki/Servo_motor
6.	www.machinetoolhelp.com/Automation/systemdesign/stepper_dcservo.html
7.	www.active robots .com/ products/ motorcon /roboteq/ ax2550/ encodermodule.pdf
8.	http://en.wikipedia.org/wiki/Gas_compressor
9.	www.ezinearticles.com/?Something-About-Control-Valves&id=5361278
10.	Pneumatic Drives: System Design, Modelling and Control by Peter Beater
11.	wiki.answers.com/Q/What_are_the_Advantages_and_disadvantages_of_electro-pneumatics
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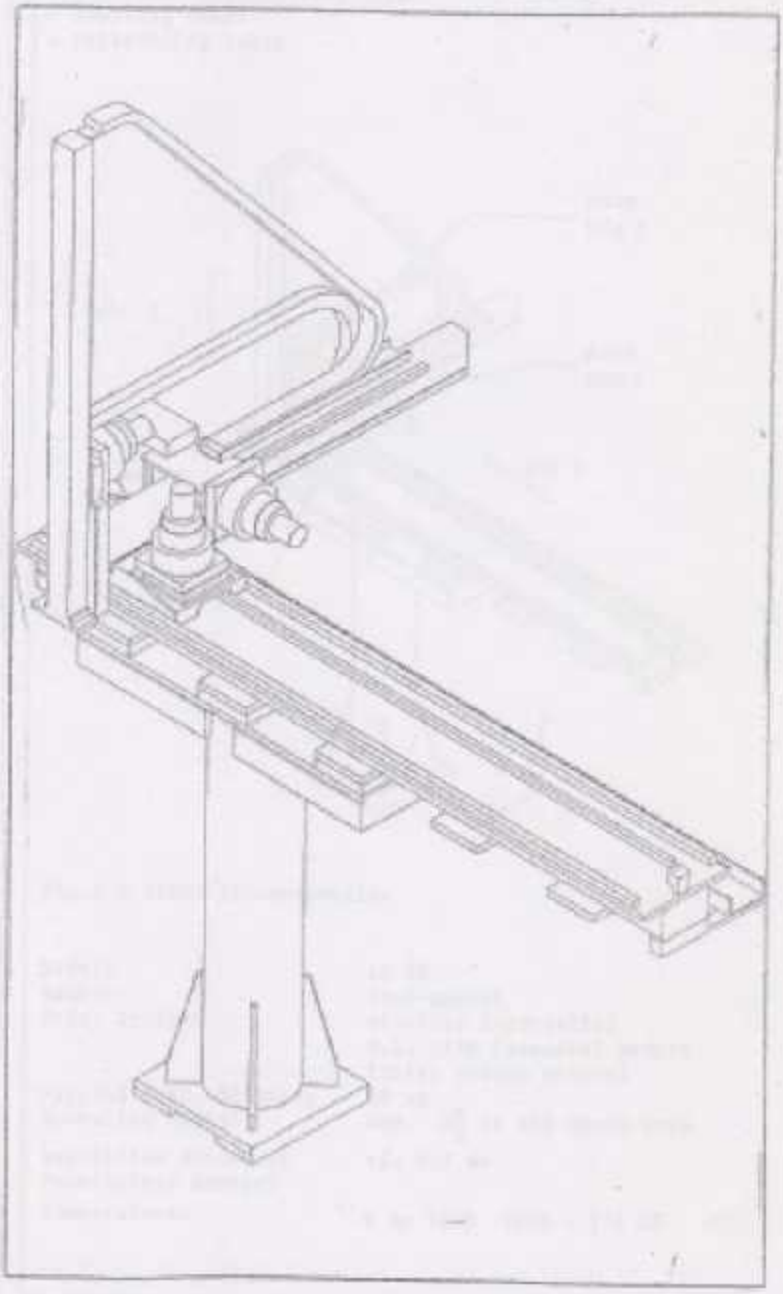
Appendix

PPS

REIS GMBH & CO MASCHINENFABRIK

Technical Manual

INDUSTRIEROBOTER **REIS-ROBOT** LR 30



Issue 1/1986

KINEMATICS and TECHN. DATA

2. Kinematics and techn. Data

The Industrial Robot REIS Linear Robot LR 30 is equipped with three linear axes which are independently controllable. The robot can be installed on the floor on it's own support columns but also directly on the processing machine by means of a console.

Significant applications are:
- Handling Tasks
- Palletizing Tasks

2.1 Design of Kinematics

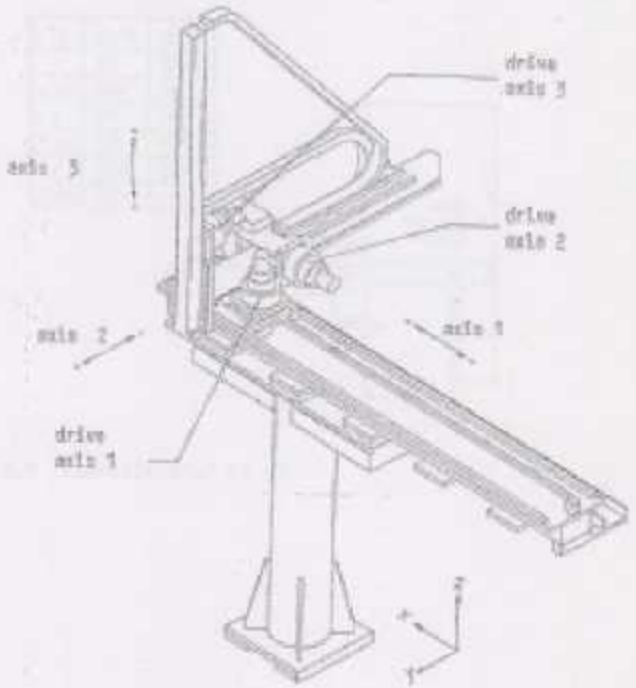


Fig.2.1 Robot Sub-Assemblies

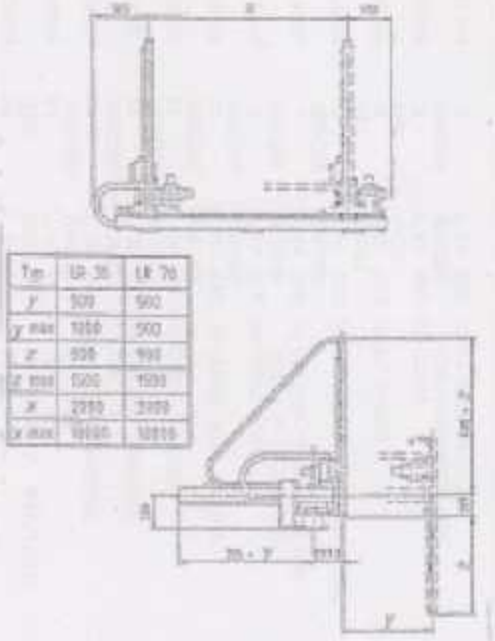
2.2 Techn. Data Robot

Model:	LR 30
Design:	semi-portal
Drive System:	electric (hydraulic) D.C. disk (pancake) motors (axial piston motors)
Payload Incl. Gripper:	30 kg
Operating Speed:	max. $2\frac{m}{s}$ in all three axes
Repetitive Accuracy:	+/- 0.2 mm
Permissible Ambient Temperature:	0 to 45°C (273 - 318 K)

2.2.1 Identification of Movement Axes

2.2.2 Dimensions

see Fig. 2.1



Typ	LR 30	LR 70
y	509	900
y max	1000	900
z	800	900
z max	1500	1500
x	2350	2400
x max	10000	10000

Fig. 2.2 Dimensions of LR 30

A S S E M B L Y - P A R T L I S T 15.03.11 PAGE: 1

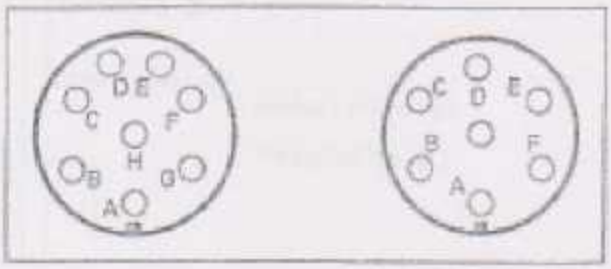
STAGE	ID.NO.	ITEM / STORAGE	QTY / AREA	DU	PT	DESIGNATION / GEOMETRY	DRAWING NO	SUPPLIER / DIN/ - NO.	GROUP VT	R	T	S	I
	792440				10	AXIS 1 (B)	010188-09.303						109 0
1	887364	2 KARDEX	1,00 STK KARDEX		20	SERVOAMPLIFIER 620/150V/MSMN-23A		I R T SA	N	0	0	(	102 0
1	588650	3 KML	1,00 STK G638		20	CHOKE		BerGprenzTal	N	0	0	(	101 1
1	584366	5 161	1,00 STK PR202		20	DC MOTOR	GKR 731D-5	INFRANOR GMBH	N	0	0	(	102 1
1	512343	6 KARDEX	1,00 STK KARDEX		20	INCREMENTAL TRANSDUCER		LTN SERVOTECHNIK GMBH	N	0	0	(	104 0
1	519187	7 KARDEX	1,00 STK KARDEX		20	BELLOW-TYPE COUPLING BK15/30-6HT-9,53H		DEWAL	N	0	0	(	102 0
1	223339	9 KARDEX	1,00 STK KARDEX		20	CABLE PLUG		SIEB ELECTRONIC GMBH	N	0	0	(	13 0
1	223364	10 KARDEX	1,00 STK KARDEX		20	CABLE PULL RELIEF		SIEB ELECTRONIC GMBH	N	0	0	(	13 1
1	223370	11 KARDEX***	1,00 STK KARDEX		20	CABLE HOUSING		SIEB ELECTRONIC GMBH	N	0	0	(	105 0
1	24752	20 KARDEX***	14,00 STK KARDEX		20	SERIES TERMINAL SAK 2,5		KRIWAUELLER GMBH EPLI 3	N	0	0	(	105 0
1	24596	21 KARDEX	2,00 STK KARDEX		20	GROUND TERMINAL EK 2,5N		KRIWAUELLER GMBH EPLI 3	N	0	0	(	105 1
1	339002	23 KML	6,00 M HAI3		20	TRIP LINE LIYY-LITCY 8X0,5/5C	2 ADERN GESCHIRMT	KEYDEMEYER GMBH	N	0	0	(	105 0
1	212893	24 161	6,00 M K05		30	TRIP LINE LIFYCY 8X2X0,2/22	GESAMTSCHIRM	LEONI KIDEL GMBH & CO KG	N	0	0	(	56 0
1	686022	25 KML	1,00 STK W635		20	INSTRUMENT HOUSING		LEMO GMBH	N	0	0	(	105 0
1	793042	26 KML	1,00 STK LEE8		20	PLUG ANGLE		LEMO GMBH	N	0	0	(	105 0
1	793059	27 KML	1,00 STK LEE8		20	CABLE PROTECTING SLEEVE		LEMO GMBH	N	0	0	(	105 0

VT = wear part Y/N V1-process component gets worn; V2-in normal load comp. fails within 12 months with hig probability
R = 1=spare part; 6=spare part package; E1=def necessary; E2=simple ex. by customer supp. by Keis; E3=ex.is only qual. personal
T - parts main status 1-design status 2-release-design 1-release-planning 0-planned
S = parts list status 3-design status 2=release-design 1=release-planning 0=planned

end of list

10.1.7 Plug layout

Plug layout for motors, tacho and brake.



	LR30/LR70
Motor M1	C=Plus D=Minus
Tacho P1	E=Plus F=Minus
Motor M2	C=Plus D=Minus
Tacho P2	E=Plus F=Minus
Motor M3	A/B=Plus C/D=Minus
Tacho P3	E=Plus F=Minus
Brake Y3	G=Plus H=Minus

Channel A ① 90° +/- 45 ° electrical degrees ③

Channel B ②

Zero signal ④

minimal width ⑤

1 revolution ⑥