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Electrical Engineering Department

Mechanical Engineering Department

Mechatronics Engineering Program
Automation Engineering Program

Graduation Introduction Project

Design and Building Grape Squeeze Machine

Project Team

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Hebron – Palestine

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جامعة بوليتكنكفلسطين

الخليل – فلسطين

كلية الهندسة والتكنولوجيا

دائرة الهندسة الكهربائية

اسم المشروع

Design and Building Grape Squeeze Machine

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محمود حمامرة

بناءً على نظام كلية الهندسة والتكنولوجيا و**إشراف ومتابعة المشرف المباشرة على المشروع و موافقة أعضاء اللجنة** الممتحنة ثم تقديم **هذا المشروع إلى** دائرة الهندسة الكهربائية و**ذلك للوفاء بمتطلبات** درجة البكالوريوس في الهندسة تخصص هندسة الميكاترونيك **و**الاتمتة الصناعية

توقيع المشرف

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توقيع اللجنة الممتحنة

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توقيع رئيس الدائرة

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إهـــــــــــــــداء:

الحمد لله حتى يبلغ الحمد منتهاه والشكر لرسوله سيد الخلق وأشرفهم أجميعين
إلى من خُلقت الجنة تحت أقدامهن أمهاتنا ,إلى الحصن المنيع الذي حمانا حتى
بلغنا لشدنا أبائنا، إلى سندنا فيه هذه الدنيا أخوتنا ، إلى قوارير الرحمن أخواتنا ، إلى
هبة السماء أصدقائنا , إلى الهيئة الادراية والتعليمية في هذا الصرح العلمي الاصيل
جامعة بوليتكنك فلسطين ، إلى أسرانا البواسل الذين يخوضون معركة الامعاء
الخاوية ، إلى شهداء المسلمين والحرية في العالم أجمع
إلى كل الذين نحترمهم ونحبهم
نهدي هذا العمل المتواضع

عصام جهاد أبوزينه
أحمد عطوان
محمود محمدحمامرة

Dedication

To Palestine Polytechnic University

To our supervisor who always

Encouraged and supported us

Teacher Eng. Abd-Al-Qader Al-Zaro

To the coordinator of

MechanicalAndElectrical Engineering

To all of you

Esam –Jihad- Abuzeineh
Ahmad Atwan
MahmoudMuhamamdHamamreh

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Finally We can't forget to acknowledge our great parents who scarified themselves for educating us and facilitate our life.

Esam –Jihad- Abuzeineh
Ahmad Atwan
Mahmoud Hamamreh

Abstract:

Farming sector is one of the most important sectors of Palestinian industries. Many of Palestinian people depend on farming in their life. Our target from the farming is the grape part society that suffers from Israel occupation.

We aim from this project to not let the Palestinians deal with any kind with Israel in our farming; one of it is the grape juice.

It is seemed that the farmers around Palestine don't know exactly how to convert the grape on to a juice with 100% clean and good, we made this design for a machine that allow all farmers to be in their hand, in order to broke the wall between us and dealing with Israel.

The machine is set to squeeze one ton of grape per hour. It consist from three stages, the first one is smashing the grapes and moving it, squeeze it and finally filling the juice in a tank.

ملخص

القطاع الزراعي في فلسطين يعد من اهم المقومات للاقتصاد الفلسطيني، ولكن بسبب تعنت الاحتلال فان الكثير من المزارعين الفلسطينيين يعانون من عدم مقدرتهم على الاستفادة كما يجب من محصولهم.

يشكل قطاع العنب من اهم المقومات للقطاع الزراعي بشكل عام في فلسطين. لذا تم تصميم عمل هذا المشروع لتمكين المزارعبن من الاستفادة المثلى بعصر العنب من خلال ماكنة متقدمة ذو كفاءة عالية.

صممت هذه المكنة على اساس ان تقوم بعصر ١ طن من العنب خلال ساعة واحدة وتتكون الماكنة من ثلاث مراحل اساسية.

في المرحلة الاولى تتمثل في تحطيم العنب بشكل يسمح لعناقيد العنب بالانفصال قليلا عن حبات العنب ، ومن ثم نقل العنب عن طريق سير ناقل الى صندوق ليتم عصره ، ومن ثم افراغ المتبقي من العنب في وعاء يكون جاهزا لاستيعاب الكمية المطلوبة.

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Chapter One

Introduction

1.1 Overview

This chapter illustrates an introduction to the project, the objectives and motivations of the project

This chapter also shows the methodology used to build and complete this system, the parts of the system is mentioned. Some of risk management, results and problems are mentioned. The estimated cost is modified, after that the content of the report is shown.

1.2 Introduction

Now a day, industrial machine is very important in the daily life, get the gob to be done very fast than before. Thus, the production line for the product is given more and bigger. Now the intelligent computers and intelligent control system is introduced to a machine to increase its accuracy and safety when doing work, it is also important to for the production process that is complicated to deal with.

Squeeze grape machine, with its new design; help the industrial companies to produce a clean juice with small time compared with a human work time. This new design decreases the number of workers to do the job, thus safe money for other important things.

1.3 Project Objectives

This project aims to achieve the following:

1) Produce a clean juice from the grapes rather than using the human work process.
2) Safe time and money from the workers and the lost production due to major errors happens.
3) Implement a new technology to the machine in order to increase its accuracy, safety, and reduce the losses.
4) Prevent depending on the outside companies to squeeze the grape for a large quantity.

1.4 Project Procedure:

The requirement needed to be successfully done is as follows:

1_smashing the grape by two rolls.

2_transfering smashed grape through conveyer belt.

3_squeezing the grape in special tank by pressing system.

4_emptying rest of the grape in rubbish tank.

1.5 Approach

The system is divided into five subsystems:

1- Two Rotating Shaft.
2- Shafts tank.
3- Conveyor belt
4- Tank.“That the piston going to squeeze the grape”.
5- Pneumatic compressor.
6- Container tank.

At the first stage the two rotating shaft is smashed the grape but not letting the juice of the grape to be appear , the two rotating shaft is rotating at reverse direction of each other and a distance of 2cm between them, because the grape piece is nearly 2cm in diameter. The calculation of this two rolling cylinders is discussed in details in chapter 4.

Chapter four gives a detailed mechanical design about designing the machine. At the final stage the juice is collected to a reservoir that is taken for other production line and for several uses.

1.6 Project Schedule and Time Plan

- **Stag1: Select the idea**

  Determine the idea of the project, the motivation, and the main objective that intend to be achieved.

- **Stage2: Preparing for the project and collecting data**

  In this stage, more and deeper determination of the tasks and steps is done, and more information about the project is prepared.

- **Stage3: Project Analysis**

  In this step, a study of the all possible design options to determine the design process.

- **Stage4: Determine the project requirement**

  After determine the project design scheme, the entire needed requirement detailed mathematical model for the system is specified, software and hardware. And try to bring them to be ready for the implementation stage.

- **Stage5: Documentation Writing**

  Documenting the project isbeginning from the first stage to the last stage.

- **Stage6: make the hardware available**

  In this stage, the needed hardware devices is brought for the next steps, arduino device, motors, switches, sensors, belt, shaft rolls, gears, and speed reducers.

- **Stage 7: build up the machine and finishing**

  All The machine equipment and devices bought it there is an available source in the market or if not, going to the lath to introduce the mechanical parts.

- **Stage8: testing the machine**

  Detect if there is an error occurred and making a report about that.

- **Stage 9: finishing the graduation final report**

  All documentation has made is to be checked and done in this stage. Every change in it is to be added and to be noticed that something is changed.

- **Stage 10: Preparing for the final presentation**

  The presentation is prepared to show the project and its parts.

Table1.1: Timing plan for the first semester

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S1	■	■	■												
S2			■	■	■	■	■	■	■	■	■	■	■		
S3				■	■	■									
S4							■	■	■	■					
S5				■	■	■	■	■	■	■	■	■	■	■	■

Table1.2: Timing plan for the second semester

Week / Task	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
S6	■	■	■	■													
S7	■	■	■	■	■	■	■	■	■	■	■	■	■				
S8					■	■	■	■	■	■	■	■	■				
S9												■	■	■	■		
S10														■	■	■	■

1.7 Project contents

The report is divided up to five chapters, these chapters explain the project, its contents and requirements and present an interview about it:

- **Chapter 1: Introduction**

  Discuss the project from many sides, represents and overview about the project, the objectives and important for it, and the work plan and estimated cost. Also, the project risk management is shown in this chapter.

- **Chapter 2: Literature review**

  Talks about the theoretical background of the project, review of previous machine about the same purpose or similar to it.

- **Chapter 3: Description and analysis of system Requirements**

  This chapter illustrates the design concepts, the general block diagram, and the functional block diagram that mention all the implemented functions in the system.

- **Chapter 4: grape squeeze machine mechanical design**

  This chapter is talking about the detailed software engineering design, detailed mathematical modeling of each component and part of the machine is illustrated in this chapter

- **Chapter 5: System control**

  This chapter is talking about the used electrical devices and control circuits

- **Chapter 6: implementation**

  This chapter illustrates the implemented prototype of the grape machine system.

1.8 Estimated Cost

NO.	Description	Cost “NIS”
1	Motors(4 motors)	2000
2	ARDUINO	300
3	Electrical Panel & protection	200
4	Level and electrical Sensor	200
5	Pipeline + Pipe connectors	150
6	Wires , Cables and Switches	250
7	Labor Work (in hour)	50hr*10NIS=500
8	Reservoir (3)	600
9	Shaft tank	500
10	Conveyer belt (including the rubber)	1500
11	Pump	600
12	Piston (2)	400
13	Filters	150
Total		7350NIS

2

Chapter Two

Literature Review

2.1: Overview

Squeezing grape is one of the most used ways to take advantage from the grape since it is including many benefits like the high of the sugar's percent in the grape.

Many ways have been used to squeeze the grape beginning from primitive way until the modern industrial machines.

2.2: Primitive way

In the old days the famers used very traditional and unsafe way to squeeze the grape, their way was collecting the grape in canvas bags and putting them in stony hole.

After that they were standing over those bags and making pressure over bags but using their legs. This way is still used until these days.[1]

Figure 2.1 old grape mills in Karma Mountain.

2.3: Industrial machines:

International machines

1- Grape Squeezing Machine (GG-A)

It is applicable to squeeze the skin slag of broken grape. This machine is with double helix, and their Rotation direction is contrary. The squeezing force is both big and evenly. It can change the juice rate by adjusting dregs mouth clearance. Contacting materials parts, frame and appearance were made by stainless. The machine can also be used to other materials solid-liquid separation, its effects for different material quality has certain differences**.**[2]

Machine details:

Place of Origin: Henan China (Mainland).

Brand Name: GELGOOG.

Type: Grape Squeezing Machine.

Voltage: 220/380v.

Power (W): 7.87 KW.

Dimension (L*W*H): 3500X1000X1300mm.

Certification:ISO9001CE.
Capacity: 5t/h

Figure 2.2: grape squeezing machine.

Description

1. The machine is used for peeling and squeezing of fruit and vegetables.
2. Simple structure, low noise, beautiful appearance, easy to operate and maintain low cost. Stable performance.
3. The machine is suitable for crushing the fresh grapes after removing infraction and the hide trimmings of separated fruit juice, or sugar juice extractor of hide trimming after fermentation.

Manual information:

Pressure: 100 kg, Weight: 40kg

Dynamic: manual operation

Material: 304 stainless steel

Charging barrel: 30*35cm

Capacity: 20-40 kg/h

Dimension: 1200*350*350mm

Figure 2.3: grape squeezing with pneumatic cylinder

2.4: Local machines:

1- Grape squeeze machine

It consists from two separated stages:

The first stage consists from two parts, first part is roll which separates the grapes from there clusters, then the second part the grain of the grape goes down the roll which there another roll which mince those grains which goes in external tank.

After that the worker hold the minced grape and put it in the second stage which consist from hydraulic compressor which press the minced grape and the juice of the grape goes in another tank .

2.5: Relative local machine:

Automated olive press for households use

This machine consists from two main stages, first stage is pressing and second liquid sorting and have an assistant system to transport the pressing cylinder from malefaction stage to pressing stage, so the machine is divided into five parts and components in which they are connected to each other to cover all stages needed.

These parts different types and shapes with different prosperities. The design should compromise between these properties to achieve the required shape and performance without affecting safety. [3]

2.6: Ceramic membrane filtration

Filtration of juices

A filtration step is required to produce clear juices. Colloidal tub material as well as particles has to be removed to prevent the juice or concentrate from subsequently becoming turbid. Diatomaceous earth filtration (DE filtration) was used in the past, but cross-flow ultra-filtration has now become the established standard for polishing apple juice.

The DE technique is still often used for filtering colored juices. As more stringent requirements are placed on the type of membrane in these applications, the ceramic membrane is well tried and tested in the field.

Structure of Cross-Flow Filtration

With this method, the juice is guided along the surface of the membrane at a tangent. The Permeate comes through the membrane and is collected in a clear juice tank. A loop pump ensures that the cloudy juice, the retentive, circulates in the filtration circuit.

The volume of filtrate which flows off is replaced by cloudy juice. The feed pump puts cloudy juice into the filtration circuit. Part of the flow of retentive is passed back into the process tank. In the course of filtration, the solids become concentrated in the retentive circuit.

Ceramic membrane

The core element of these units is ceramic membranes with a pore size of 20 to 200 nm. They are extremely resistant to temperature, pressure and chemicals, easy to clean and, compared to polymer membranes, have a very long service life.

Over 1000 lines supplied all over the world, many of them in the fruit juice industry, have already been working at a constantly high output for twenty years. Only a ceramic membrane makes it possible to concentrate retentive until there is no free juice left.

2.7: Filtration of colored juices

The fundamentally complex filtration properties of colored juices such as elderberry juice mean that output is reduced. The ceramic membrane has key advantages – from the choice of material to start with. It is unable to adsorb coloring constituents, as the material is completely inert. On the other hand, its pore size is much smaller than that of a polymer membrane, so that particles can only penetrate the pore opening to a very limited extent.

This means that formation of a coating on the surface is reduced, achieving a much higher specific flux per unit surface area.

3

Chapter Three

Description and Analysis of System Requirements

3.1 Overview

This chapter is showing the selection of the component of the system. Notice that this is a first principle model of the machine that is designed in the next chapter.

This chapter is divided in two parts, the mechanical part and the electrical part.

3.2 Part I: Mechanical Component Selection.

3.2.1First principle model of the system:

Figure 3.1 shows the general Description of the System:

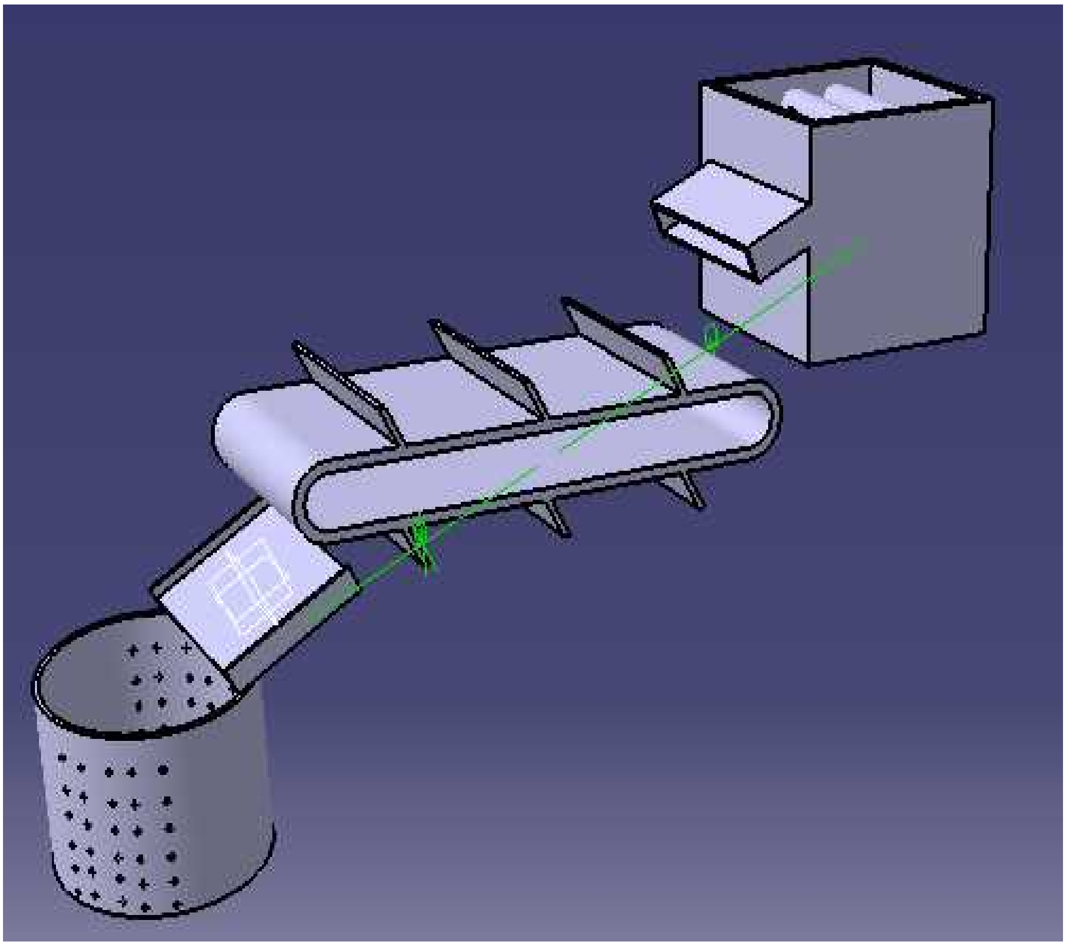


Figure3.1: Thefirst imaginepicture of the System using CATIA program.

The figure above shows the general Description of System Requirements, and its parts and how they are integrated with each other. Also, the figure shows all the components of each part in the system.
The system is divided into five subsystems:

- Rotating Shafts.
- Shafts tank.
- Tank that the piston squeezes the grapes.
- Hydraulic compressor.
- And the tank that contains the juice.

The systems based on squeeze the grape and connect each step via a PLC program and microcontrollers. The hydraulic part of the system is designed to accomplish the need of the produced product.

3.2.2 Stages of the System

In this section, the block diagrams of each stage are shown, the first for smashing the grape and sending it to the container tank. While the second for containing the grape. The third is for the tank that the compressor is squeezing the grape on it to be a juice. Though, the forth is for the hydraulic compressor that squeezes the grape to be a juice.Thefifth is for containing the juice in a tank.

The main components of the system are the Roll mechanism, Conveyor Belt, Piston, Tank for the piston to squeeze the grape, and the tank that the juice is going to it. All the components is explained in this Chapter in more details.

3.2.3Shafts Selection and GearMechanism:

This is the first component of the system. The Shafts is placed on a specified tank that holds two or three rolls, if three rolls are selected. All rolls are driven in one motor using gear. These gears are havingan **IDLER GEAR**. The gear mechanism is coupled together. This mechanism allows the rolls to rotate in a reverse direction to the each other. Rolls are connected to the gears, so the rolls rotate due gear rotating that gets the rotation from the motor.

Another design that takes in consideration that if the gears is hard to get, every roll is rotating with its own motor. The design technique of the roll mechanism is different and depends on the applications. The system purpose is to put the grape in the rotating rolls, that smashes the grape and explode the clusters for better squeezing process.

The size of the box that contains the rolls, motor, and the gears, is to be 60X60X60 cm.

Shaftsdiameterselected to be about 15 cm, and 60 cm long. The gears are designed to meet the requirement.

So far, the gear size is bigger the diameter of the roll, that have a pitch diameter of 12 cm. figure 3.2 shows the roll and the rolls container also the gear.

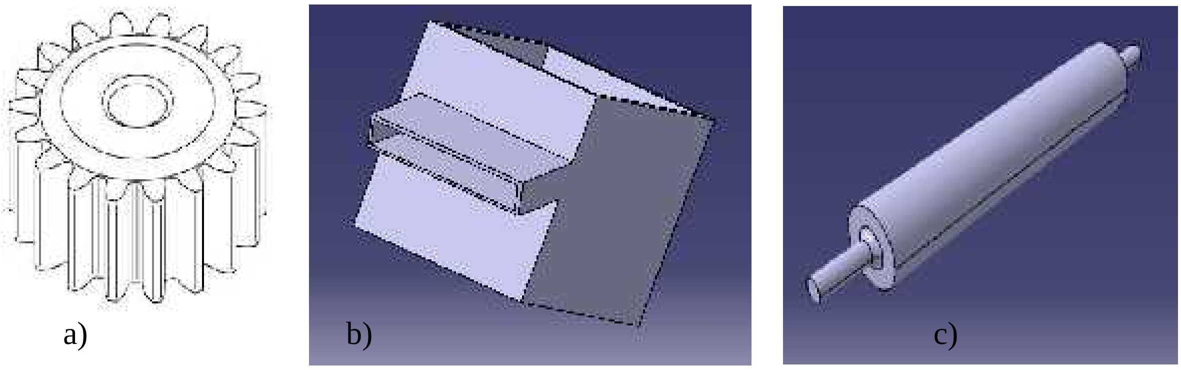


Figure3.2 :a)gear, b)box, and c)the roll.

3.2.4Conveyor Belt

The second and main part of the system is the Conveyor Belt. This is responsible for containing the grape smashed from the Rolls action, and transport the grape to the next stage, which is the secondary tank that the compressor squeezes the transported grape.

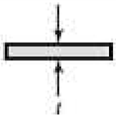
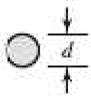
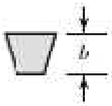
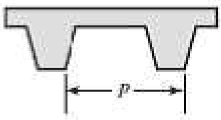
The four principal types of belts are shown, with some of their characteristics, in Table 3–1. Crowned pulleys are used for flat belts, and grooved pulleys, or sheaves, for round and V belts. Timing belts require toothed wheels, or sprockets.

In all cases, the pulley axes should be separated by a certain minimum distance, depending upon the belt type and size, to operate properly. Other characteristics of belts are:

•They are used for long center distances.
•Except for timing belts, there is some slip and creep, and so the angular-velocity ratio between the driving and driven shafts is neither constant nor exactly equal to the ratio of the pulley diameters.

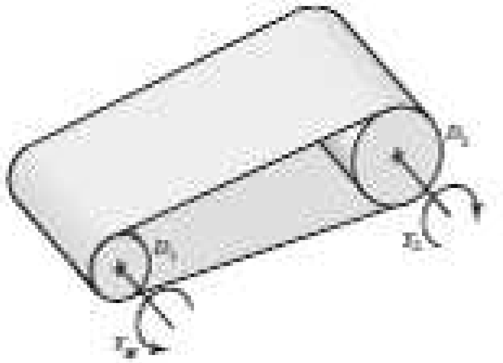
• In some cases an idler or tension pulley can be used to avoid adjustments in center distance that are ordinarily necessitated by age or the installation of new belts [1]. Table 3.1 shows the Characteristics of Some Common Belt Types.

Table 3.1 Characteristics of Some Common Belt Types

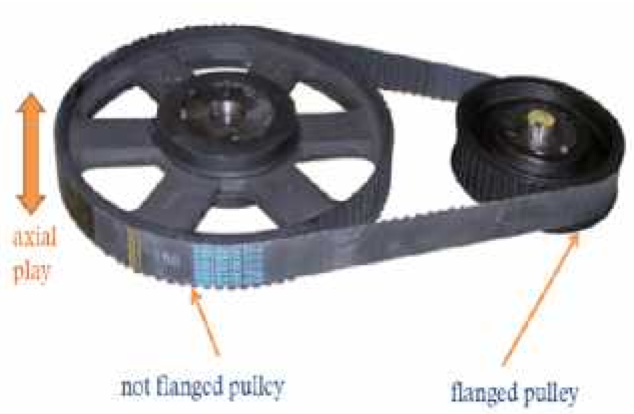
Belt Type	Figure	Joint	Size Range	Center Distance
Flat		Yes	$t = \begin{cases} 0.03 \text{ to } 0.20 \text{ in} \\ 0.75 \text{ to } 5 \text{ mm} \end{cases}$	No upper limit
Round		Yes	$d = \frac{1}{8}$ to $\frac{3}{4}$ in	No upper limit
V		None	$b = \begin{cases} 0.31 \text{ to } 0.91 \text{ in} \\ 8 \text{ to } 19 \text{ mm} \end{cases}$	Limited
Timing		None	$p = 2$ mm and up	Limited

According to the last paragraph the tank land is movable and connected to a driving motor, so making in the account for these elements to take the size and the length of this container and finding that it is a 150x60x20 cm.

The conveyor belt is made of steel. The conveyor belt is connected to a diagonal plate at 60degrees, 10cm height. Figure 3.3 shows Some Common Belt Types



a) Flat belt



b) Timing belt

c) V belt

Figure 3.3: Some Common Belt Types

Figure 3.4 shows conveyor belt using CATIA program that is to be used.

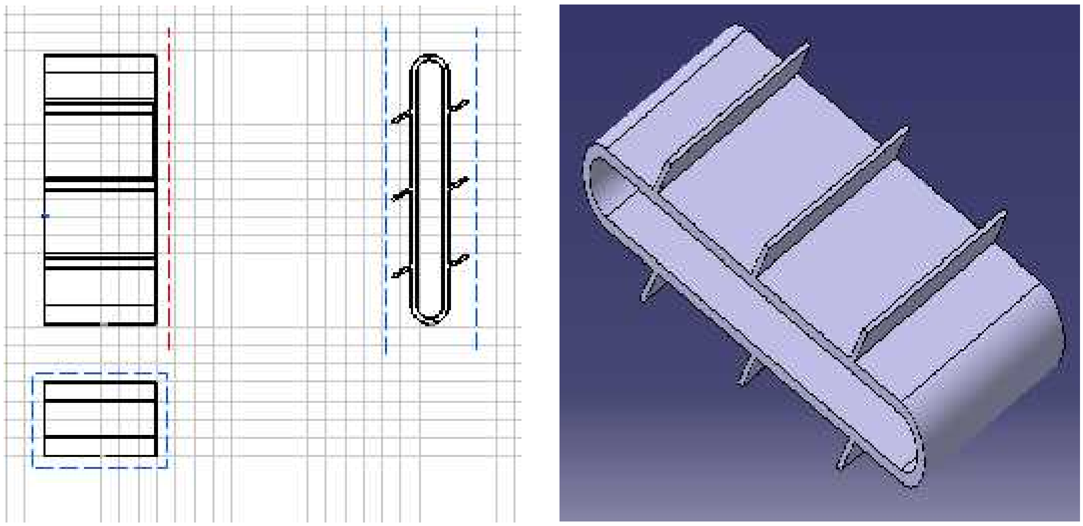


Figure3.4: conveyor belt using CATIA program.

3.2.5Tank.

In this stage the conveyor belt transform the smashed grape to this tank. The construction of this tank is such that to just allow the juice of the grape to go out the tank and the rest remain in the bottom of it.

The tank should be designed in order to handle the pressure and the force of the hydraulic compressor so the tank should be made of steel that have such properties.
According to the assumption made. The tank diameter is 40cm and at a height of 60cm.tank thickness is 30mm.
In order to keep this tank at steady state while the hydraulic piston gets inside of it, two pistons is placed at each side of the tank. This tank need to be drilled in a very small hole to allow just the juice to pass on, and these small holes selected to be at a diameter of 20mm each.

3.2.6Pressing System:

In the pressing system there are three different types for pressing. There is the power screw, the pneumatic compressor and the hydraulic compressor.

A power screw is a device used in machinery to change angular motion into linear motion, and to transmit power. Familiar applications include the lead screws of lathes, and the screws for vises, presses, and jacks.

Compressors Pneumatics "as shown in figure3.5" is all about using compressed air to make a process happens. Compressed air is squeezed into a small space under pressure. You might remember that air under pressure possesses potential energy which can be released to do useful work.

Figure 3.5 pneumatic compressor

Tables 3.2 and 3.3 show the advantages and the disadvantages for pneumatic systems:

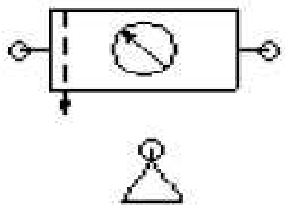
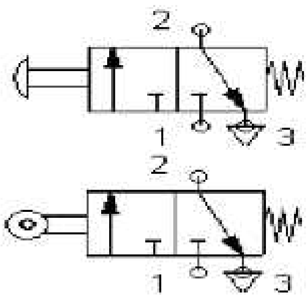
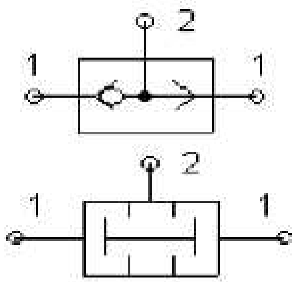
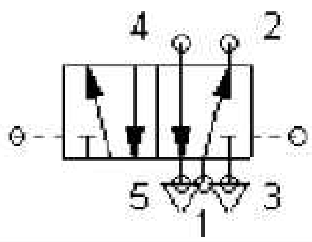
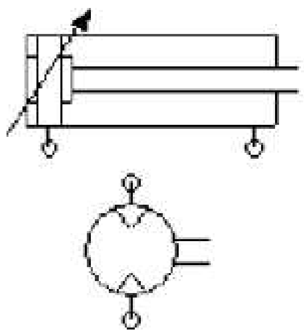
Table 3.2 advantages of pneumatic system

Advantages of Pneumatic Systems	
Availability	Air is available practically everywhere in unlimited quantities.
Transport	Air can be easily transported in pipelines, even over large distances.
Storage	Compressed air can be stored in reservoirs and removed as required. In addition, the reservoir is transportable.
Temperature	Compressed air is relatively insensitive temperature fluctuations. This ensures reliable operation, even under extreme conditions.
Explosion Proof	Compressed air offers no risk of explosion or fire.
Cleanliness	Un-lubricated exhaust air is clean. Any un-lubricated air that escapes through leaking pipes or components does not cause contamination.
Components	The operating components are of simple construction and therefore relatively inexpensive.
Speed	Compressed air is a very fast working medium. This enables high working speeds to be attained.
Overloads Safe	Pneumatic tools and operating components can be loaded to the point of stopping and are therefore overload safe.

Table 3.3 disadvantages of pneumatic systems

Disadvantages of Pneumatic Systems	
Preparation	Compressed air requires good preparation and constant piston speeds.
Compression	It is not always possible to achieve uniform and constant piston speeds with compressed air.
Force Requirement	Compressed air is economical only up to a certain force requirement. Under normal working pressure of 600 to 700 KPa (6 to 7 bar) and dependent on the travel and speed, the output is limited between 40 000 to 50 000 Newton.
Noise Level	The exhaust air is loud. This problem can be solved by the use of sound absorption material and silencers.

Table 3.4 shows the main five categories for elements of pneumatic systems.

Pneumatic System Elements	
Supply elements Compressor Reservoir Pressure regulating valve Air service unit	
Input elements Push button valves Limit switches Proximity switches	
Processing elements Directional control valves Nonreturnable valves Pressure control valves Timers, counters	
Final control elements Directional control valves	
Power elements (actuators) Pneumatic cylinders Pneumatic motors	

Hydraulic pressing

Pumps perform the function of adding energy to the fluid of a hydraulic system for transmission to some output location. Hydraulic actuators and motors do just the opposite. They extract energy from a fluid and convert it to mechanical energy to perform useful work.

Fluid power can be transmitted through either linear or rotary motion by using linear actuators called “hydraulic cylinders” or rotary actuators called “hydraulic motors”. Hydraulic cylinders extend and retract to perform a complete cycle of operation. They sometimes include cushions in their end plated=s to prevent shock loading, which can damage the moving piston or the stationary cylinder and plates. Rotary actuators can be of the limited rotation or the continuous rotation type.

Limited rotation motors are frequently called “oscillation fluid motors”because they produce a reciprocating motion. Continuous rotary hydraulic motors (or simply hydraulic motors). In reality, are umps that have been redesigned to withstand the different forces that are involved in motor applications. As a result, hydraulic motors are of the gear, van, or piston configuration. Also, as in the case of pumps, piston motors can be either fixed or variable displacement unit.

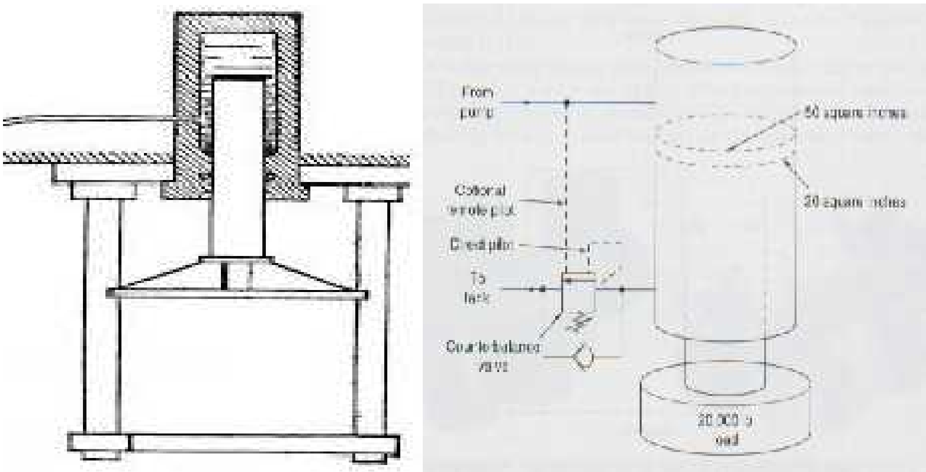


Figure 3.6 hydraulic pressing piston.

The output force (F) and piston velocity (υ) of double-acting cylinders are not the same for extension and retraction. This is explained as follows: During the extension stroke, fluid enters the blank end of the cylinder through the entire circular area of piston (A_p).

The retraction velocity is greater than the extension velocity for the same input flow rate.

3.3 Part II: Electrical Devices Selection for the Machine

3.3.1 Electrical motors:

Electrical motors are used to efficiently convert electrical energy into mechanical energy. Magnetism is the best of their principles of the operation. They use permanent electromagnets, and exploit the magnetic properties of material in order to create these machines.

There are several types of electric motors available today. The following outline give an over view of several popular ones. There is two main classes of motors: AC and DC.

Ac motors require an alternating current or voltage source to make them work. Dc motors require a direct current or voltage source to make them work.

Figure3.7: common type of motors.

3.3.2DC motor construction

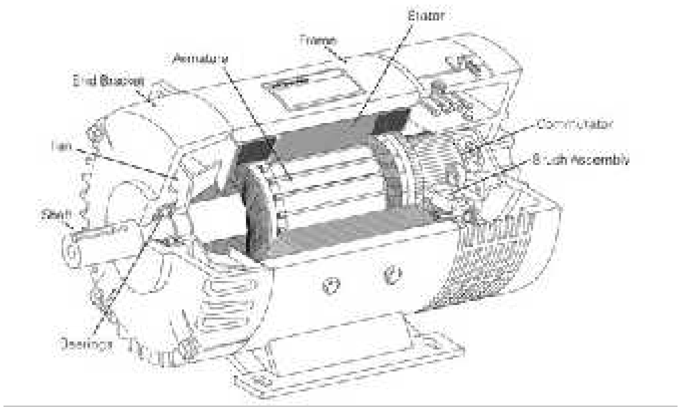


Figure 3.8: general arrangement of dc motors

The stator of the DC motor has poles , which are excited by dc current to produce magnetic fields.

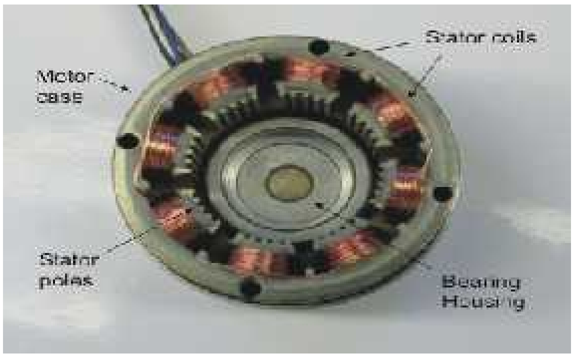


Figure 3.9 the stator of the dc motor

-In the neutral zone, in the middle between the poles, commutating poles are placed to reduce sparking of the commentator.

-the commutating poles are supplied by dc current.

-Compensating windings are mounted on the main poles. These short-circuited windings damp rotor oscillations.

- The poles are mounted on an iron core that provides a closed magnetic circuit.

-The motor housing supports the iron core, the brushes and the bearings.

-The rotor has a ring-shaped laminated iron with slots.

-Coils with several turns are placed in the slots. The distance between the two legs of the coil is about 180 electric degrees.

- The coils are connected in series through the commentator segment

-The ends of each coil are connected to a commentator segments.

- The commentator consists of insulated copper segments mounted on an insulated tube.

-Two brushes are placed in the neutral zone, where the magnetic fields is close to zero

- The commentator switches the current from one rotor coil to the adjacent coil.

-The sudden interruption of an inductive current generates high voltages.

-The high voltage produces flashover and arcing between the commentator segment and the brush.

3.3.3 DC Motor Operation

There are five different methods for supplying the dc current to the motor:

1- Separate excitation.
2- Shunt connection.
3- Series connection.
4- Compound.
5- Permanent magnet (Wiper Motor).

3.3.4 AC Motors:

AC Motors can be divided into two major categories:

Asynchronous and synchronous:

The induction motor is the most common form of asynchronous motor and is basically an AC transformer with a rotating secondary. The primary winding (stator) is connected to the power source, and the shorted secondary (rotor) carries the induced secondary current.

Torque is produced by the action of the rotor (secondary) current on the air gap flux.

The synchronous motor resembles a dc motor turned inside out, with the permanent magnets mounted on the rotor. As an alternative, some are constructed using a wound rotor excited by a dc voltage through slip rings. The flux created by the current carrying conductors in the stator rotates around the inside of the stator in order to achieve motor action.[4]

3.3.5 Advantages and Disadvantages of AC Motors:

*Advantages of AC Motors:

-Variety of Mounting Styles.

-Low Cost.

-Reliable Operation.

*Disadvantages of AC Motors

-Expensive speed control.

-Inability to operate at low speeds.

-Poor position control.

3.3.6Relays

Relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits should be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit.[6]

Figure 3.10 relay

3.3.8 Overload

It is of three thermal related to the motor in series. It has graduation which is adjust to the same value of the current intensity draw by the contactor function the main function of the over load is to protect the motor from any increase in current intensity.

Figure3.11: overload contactor

3.3.9 Switches

Switch is an electrical component that can break an electrical circuit , interrupting the current or diverting it from one conductor to another .

There are many types of switches like , on/off switches , push button switch and limit switch .

3.3.10 Microcontroller family

Microcontroller is one of the most important kind of controllers these days and specially in industrial machines .

There are many kind of microcontroller like arduino and pic.

Microcontrolleris also a single integrated circuit that accepts and executes coded instructions for the purpose of manipulating data and controlling a digital system similar to a microprocessor.

The difference between a microcontroller and a microprocessor is that the microcontroller also contains RAM, ROM, and I/O circuitry in that single IC package.

This allows miniaturization of single application, microprocessor controlled, digital systems because the required associated circuitry is contained within the integrated circuit of a microcontroller.

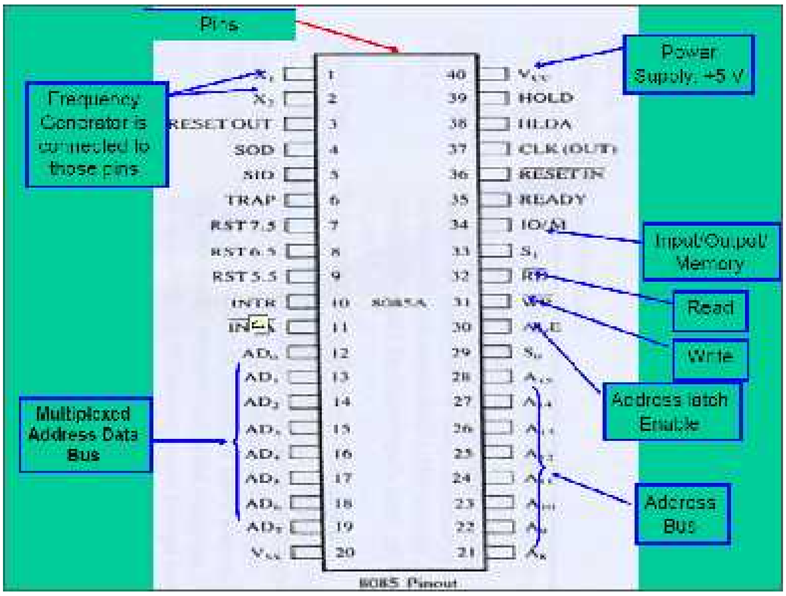


Figure 3.12 PIC Microcontroller

4

Chapter Four

Squeeze Grape Machine Mechanical Design

4.1 Overview

This chapter is showing the design of the system and discussed all parts of the project. Also, it introduces an overall explanation for every unit used in the machine. Additionally, features and detailed schematic diagrams for each component are shown.

Sometimes the strength required of an element in a system is an important factor in the determination of the geometry and the dimensions of the element. In such a situation the strength is an important design consideration. When we use the expression design consideration, some characteristic that referred to, influences the design of the element or, perhaps, the entire system. Usually quite a number of such characteristics should be considered and prioritized in a given design situation. Many of the important ones are as follows (not necessarily in order of importance):

1. Functionality
2. Strength/stress
3. Wear
4. Safety
5. Reliability
6. Cost
7. Friction
8. Weight
9. Life
10. Size
11. Volume

Some of these characteristics have to do directly with the dimensions, the material, the processing, and the joining of the elements of the system. Several characteristics is interrelated, which affects the configuration of the total system.

Some of the standards and codes, as well as addresses, can be obtained in most technical libraries or on the Internet. The organizations of interest to mechanical engineers are:

-Aluminum Association (AA)
-American Bearing Manufacturers Association (ABMA)
-American Gear Manufacturers Association (AGMA)
-American Institute of Steel Construction (AISC)
-American Iron and Steel Institute (AISI)
-American National Standards Institute (ANSI)
-American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
-American Society of Mechanical Engineers (ASME)
-American Society of Testing and Materials (ASTM)
-American Welding Society (AWS)
-ASM International
-British Standards Institution (BSI)
-Industrial Fasteners Institute (IFI)
-Institute of Transportation Engineers (ITE)
-Institution of Mechanical Engineers (IMechE)
-International Bureau of Weights and Measures (BIPM)
-International Federation of Robotics (IFR)
-International Standards Organization (ISO)
-National Association of Power Engineers (NAPE)
-National Institute for Standards and Technology (NIST)
-Society of Automotive Engineers (SAE)

These standardsarehelpingthe project to accomplish the need of the calculations.

4.2 Shaft Design

This section is to design the Shaft selected in chapter 3.

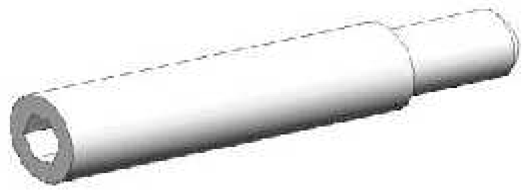


Figure 4.1 rotating shaft

The company wants a mass production of 25 kg/min of grapes in the tank before squeezing it to juice. And so the first stage is to produce an amount equal to 416.7g/s. upon this the tank size should be considered to meet the specification.

The shaft is made to roll 416.7 g/sec, by experiment the shaft speed is to be 400 rpm= 41.9rad/sec to get the specified weight. The force exerted by the grape equal to 5N.

Necessary strength to resist loading stresses affects the choice of materials and their treatments. Many shafts are made from low carbon, cold-drawn or hot-rolled steel, such as ANSI 1020-1050 steels.

The shaft size need to be bigger than the grape size in order to pull it very easy and all of it at once.

An annealed AISI 1018 steel with a cold work factor ‘W’ of 15% is used for the shaft. The nominal diameter of the bar can be left un-machined in areas that do not require fitting of components. For large shafts requiring much material removal, the residual stresses are tended to cause warping [7].

The Hollow shaft is to be 15 cm in outer diameter, and 10 cm inner diameter.

When designing the shaft. Stresses due to bending and torsion are given by:

$$P = T\omega \qquad (4-1)$$

$$\tau_{max} = \frac{S_y}{2n} (4-2)$$

Where

P: pressure (kpa).

T : torque(N.m).

w : speed (rad/sec).

τ: shear stress (kpa).

Sy: tensile strength (kpa) .

n: factor of safety.

Table 4.1 Results of Tensile Tests of Some Metals

			Strength (Tensile)				
Number	Material	Condition	Yield S_{y}, MPa (kpsi)	Ultimate S_{u}, MPa (kpsi)	Fracture, σ_f, MPa (kpsi)	Coefficient σ_0, MPa (kpsi)	Strain Strength, Exponent m
1018	Steel	Annealed	220 (32.0)	341 (49.5)	628 (91.1)†	620 (90.0)	0.25
1144	Steel	Annealed	358 (52.0)	646 (93.7)	898 (130)†	992 (144)	0.14
1212	Steel	HR	193 (28.0)	424 (61.5)	729 (106)†	758 (110)	0.24
1045	Steel	Q&T 600°F	1520 (220)	1580 (230)	2380 (345)	1880 (273)†	0.041
4142	Steel	Q&T 600°F	1720 (250)	1930 (210)	2340 (340)	1760 (255)†	0.048
303	Stainless steel	Annealed	241 (35.0)	601 (87.3)	1520 (221)†	1410 (205)	0.51
304	Stainless steel	Annealed	276 (40.0)	568 (82.4)	1600 (233)†	1270 (185)	0.45

From the catalog Sy=220, MPa. at a factor of safety to be 3.

$$maximum\, shear\, stress = \tau_{max} = \frac{220 * 10^6}{6} = 36.7 MPa$$

$$maximum\, stress = \sigma_{max} = \frac{220 * 10^6}{3} = 73.3\, MPa$$

In the machine there is a need for a two rotating shafts. The upper diameter is 10cm (100mm), and the inner diameter is 9.7cm (97mm). A length of 40 cm (300mm) long.

Table 4.2: American standard pipe.

Nominal Size, in	Outside Diameter, in	Threads per inch	Wall Thickness, in: Standard No. 40	Extra Strong No. 80	Double Extra Strong
$\frac{1}{8}$	0.405	27	0.070	0.098	
$\frac{1}{4}$	0.540	18	0.090	0.122	
$\frac{3}{8}$	0.675	18	0.093	0.129	
$\frac{1}{2}$	0.840	14	0.111	0.151	0.307
$\frac{3}{4}$	1.050	14	0.115	0.157	0.318
1	1.315	$11\frac{1}{2}$	0.136	0.183	0.369
$1\frac{1}{4}$	1.660	$11\frac{1}{2}$	0.143	0.195	0.393
$1\frac{1}{2}$	1.900	$11\frac{1}{2}$	0.148	0.204	0.411
2	2.375	$11\frac{1}{2}$	0.158	0.223	0.447
$2\frac{1}{2}$	2.875	8	0.208	0.282	0.565
3	3.500	8	0.221	0.306	0.615
$3\frac{1}{2}$	4.000	8	0.231	0.325	
4	4.500	8	0.242	0.344	0.690
5	5.563	8	0.263	0.383	0.768
6	6.625	8	0.286	0.441	0.884

From the standard shaft inner and outer diameter is to be 4inch and 3.5 respectively (10cm, 9.7cm)

The volume of the shaft is to be

$$volum = V = \pi * (D - d)^2 * l \quad (4-3)$$

$$V = \pi * (0.1 - 0.097)^2 * 0.6 = 0.016 * 10^{-3} m^3$$

The density of the cast iron is to be 7840 kg/m3.

The mass is to be the density multiplying by the volume =0.13 kg.

So the force exerted by the shaft is to be 1.3N

Table 4.3 physical constants of materials

Material	Modulus of Elasticity E		Modulus of Rigidity G		Poisson's Ratio ν	Unit Weight w		
	Mpsi	GPa	Mpsi	GPa				
Aluminum (all alloys)	10.4	71.7	3.9	26.9	0.333	0.098	169	26.6
Beryllium copper	18.0	124.0	7.0	48.3	0.285	0.297	513	80.6
Brass	15.4	106.0	5.82	40.1	0.324	0.309	534	83.8
Carbon steel	30.0	207.0	11.5	79.3	0.292	0.282	487	76.5
Cast iron (gray)	14.5	100.0	6.0	41.4	0.211	0.260	450	70.6
Copper	17.2	119.0	6.49	44.7	0.326	0.322	556	87.3
Douglas fir	1.6	11.0	0.6	4.1	0.33	0.016	28	4.3
Glass	6.7	46.2	2.7	18.6	0.245	0.094	162	25.4

By experiment the required force to crash the grape is to be 2N, including the shaft and the grape force

So

$$\text{The total force} = \text{weight of grape} + 2 * \text{weight of roll} + \text{crashing force}$$

F_T=2 + 2*1.3+2 = 6.6 N

$$T = F * R = 6.6 * 0.025 = 0.16\ N.m$$

The two shafts is not in contact to each other and the space between them is to be less than the diameter of the grape,so by experiment the space between two shaft is to be 2cm.

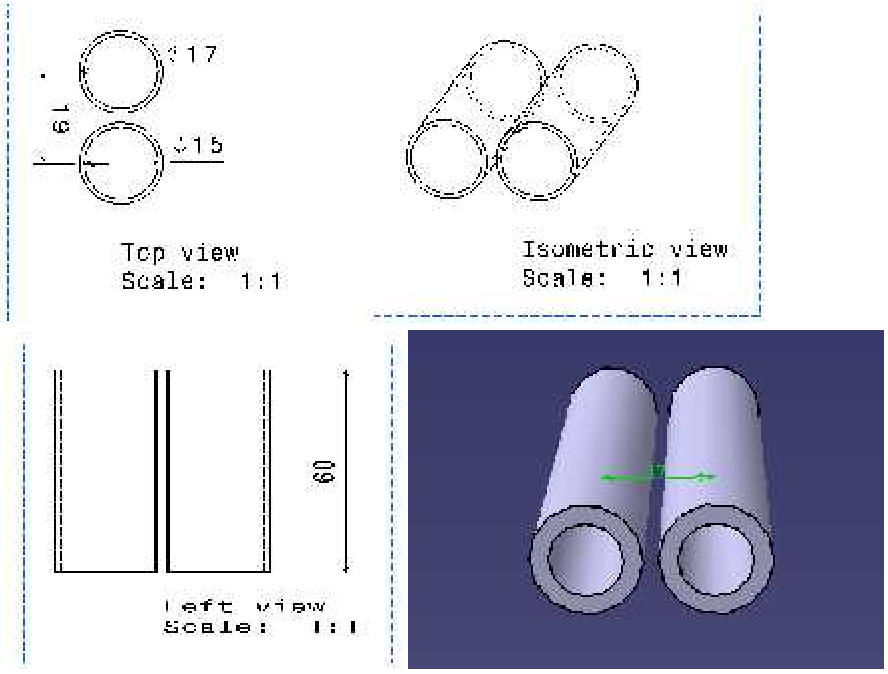


Figure 4.2 Two shafts with a distance of 19cm between the two centers

4.3 Shafts Container Design

In chapter 3 the selection of the container of the roll position and its component is presented. This section is to design the size of the container and the gears that drive the rolls.

In order to design the container, its components need to be shown in order to contain them; here is the element that is inserted to the container:

- Rolls, two rolls.
- Gears, each roll are connected to a gear.
- Motor and gear box

According to the calculation made for the two shafts, the gear the tank contain them is to be 450mm width, 650mm long, 600mm height. This container has an open side with an angle to allow the grape to exit to the conveyor belt.

The volume of the container is

$V = 0.45 - .41 * (0.65 - 0.61) * .6 = 0.00096\ m^3$

$m = \rho * V = 7840 * 0.00096 = 8\ Kg$

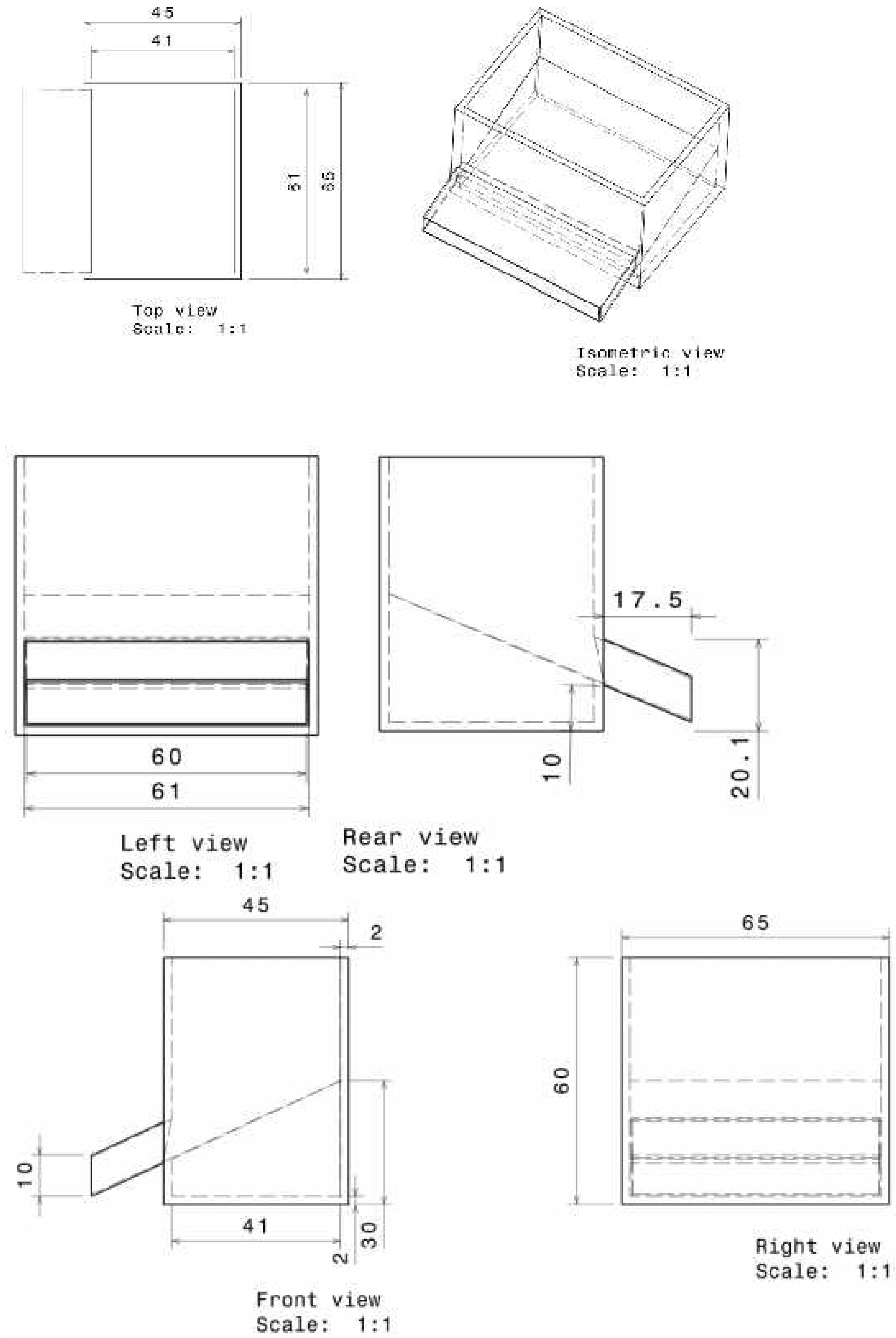


Figure 4.3 shafts container design drawing by 3rd angle projection

4.5 Conveyor Belt Design

In case of producing a juice from the action of rotating shafts, conveyor belt should be designed to keep this juice in it and not sliding outside the conveyor belt.

According to this assumption the conveyor belt sides is to be closed at a certain height. Another problem is found that the last one does need an initial tension. So the new design is to select another type of belts to do the perfect job and is the flat belt.

the conveyer belt consist of two cylinders of the same diameters having D=15cm in diameter. Flat-belt drives produce very little noise and absorb more torsional vibration [9].

The values given in Table 4–5 for the allowable belt tension are based on a belt speed of 600 ft/min. For higher speeds

Table 4-5 Properties of Some Flat- and Round-Belt Materials.

Material	Specification	Size, in	Minimum Pulley Diameter, in	Allowable Tension per Unit Width at 600 ft/min, lbf/in	Specific Weight, lbf/in³	Coeffici of Frict
Leather	1 ply	$t = \frac{11}{64}$	3	30	0.035–0.045	0.4
		$t = \frac{13}{64}$	$3\frac{1}{2}$	33	0.035–0.045	0.4
	2 ply	$t = \frac{18}{64}$	$4\frac{1}{2}$	41	0.035–0.045	0.4
		$t = \frac{20}{64}$	6^a	50	0.035–0.045	0.4
		$t = \frac{23}{64}$	9^a	60	0.035–0.045	0.4
Polyamide[b]	F–0[c]	$t = 0.03$	0.60	10	0.035	0.5
	F–1[c]	$t = 0.05$	1.0	35	0.035	0.5
	F–2[c]	$t = 0.07$	2.4	60	0.051	0.5
	A–2[c]	$t = 0.11$	2.4	60	0.037	0.8
	A–3[c]	$t = 0.13$	4.3	100	0.042	0.8
	A–4[c]	$t = 0.20$	9.5	175	0.039	0.8
	A–5[c]	$t = 0.25$	13.5	275	0.039	0.8
Urethane[d]	$w = 0.50$	$t = 0.062$	See	5.2^e	0.038–0.045	0.7
	$w = 0.75$	$t = 0.078$	Table	9.8^e	0.038–0.045	0.7
	$w = 1.25$	$t = 0.090$	17–3	18.9^e	0.038–0.045	0.7
	Round	$d = \frac{1}{4}$	See	8.3^e	0.038–0.045	0.7
		$d = \frac{3}{8}$	Table	18.6^e	0.038–0.045	0.7
		$d = \frac{1}{2}$	17–3	33.0^e	0.038–0.045	0.7
		$d = \frac{3}{4}$		74.3^e	0.038–0.045	0.7

The belt is to be made of polyamide A-3

$$\theta_d = \pi - 2\ \sin^{-1}\frac{D-d}{2C} \qquad (4-15)$$

Where

D= diameter of large pulley

d= diameter of small pulley

C= center distance

θ= angle of contact

L=the length of the belt

$$\theta_D = \pi + 2\ \sin^{-1}\frac{D-d}{2C} \quad 4-16$$

$$L = \sqrt{4C^2 - (D-d)^2} + \frac{1}{2}(D\theta_D + d\theta_d)\ [5] \qquad (4-17)$$

Where the center distance C=80cm, D=15cm, d=15cm, b =60cm.

$\theta_d = \pi - 2\ \sin^{-1} 0 = 180^{\circ}$

$\theta_D = \pi + 2\sin^{-1} 0 = 180.0^{\circ}$

$$L = \sqrt{4*80^2 - (20-20)^2} + \frac{1}{2}(15*180 + 15*180) = 2860mm = 290cm$$

$$V = \pi dn \qquad (4-18)$$

V==282.6 m/min=4.71 m/sec

$$w = 12\gamma bt \ \left(\frac{Ibf}{ft}\right) \qquad (4-19)$$

Where

w: The weight *w* of a foot of belt

γ:the weight density *γ* in lbf/in^3

b: belt width , in

t: thickness , in

$$w = 12*0.042*23.62*0.13 = 15.47\ \left(\frac{Ibf}{ft}\right) = 22.6\frac{N}{m}$$

$$F_c = \frac{w}{g}\left(\frac{V}{60}\right)^2 \qquad (4-20)$$

Fc = hoop tension due to centrifugal force

$$F_c = \frac{226}{9.81}\left(\frac{4.71}{60}\right)^2 = 0.014\ N$$

The belt cylinder is to be hollow of outer diameter of 17cm and inner diameter of 15cm; such that in the shaft size, so the volume is to be $0.18 * 10^{-3} m^3$

At force of 15 N,Thebelt rotates at low speed at 600rpm=21 rad/sec. The required force to rotate the belt and the grape, and weight at it respectively is to be

Weight of grape + 2* weight of roll + weight of conveyer

Total force=0.5kg*10 + 2*0.15+3=11 N

$$T = F * R = 11 * 0.1 = 1.1 N.m$$

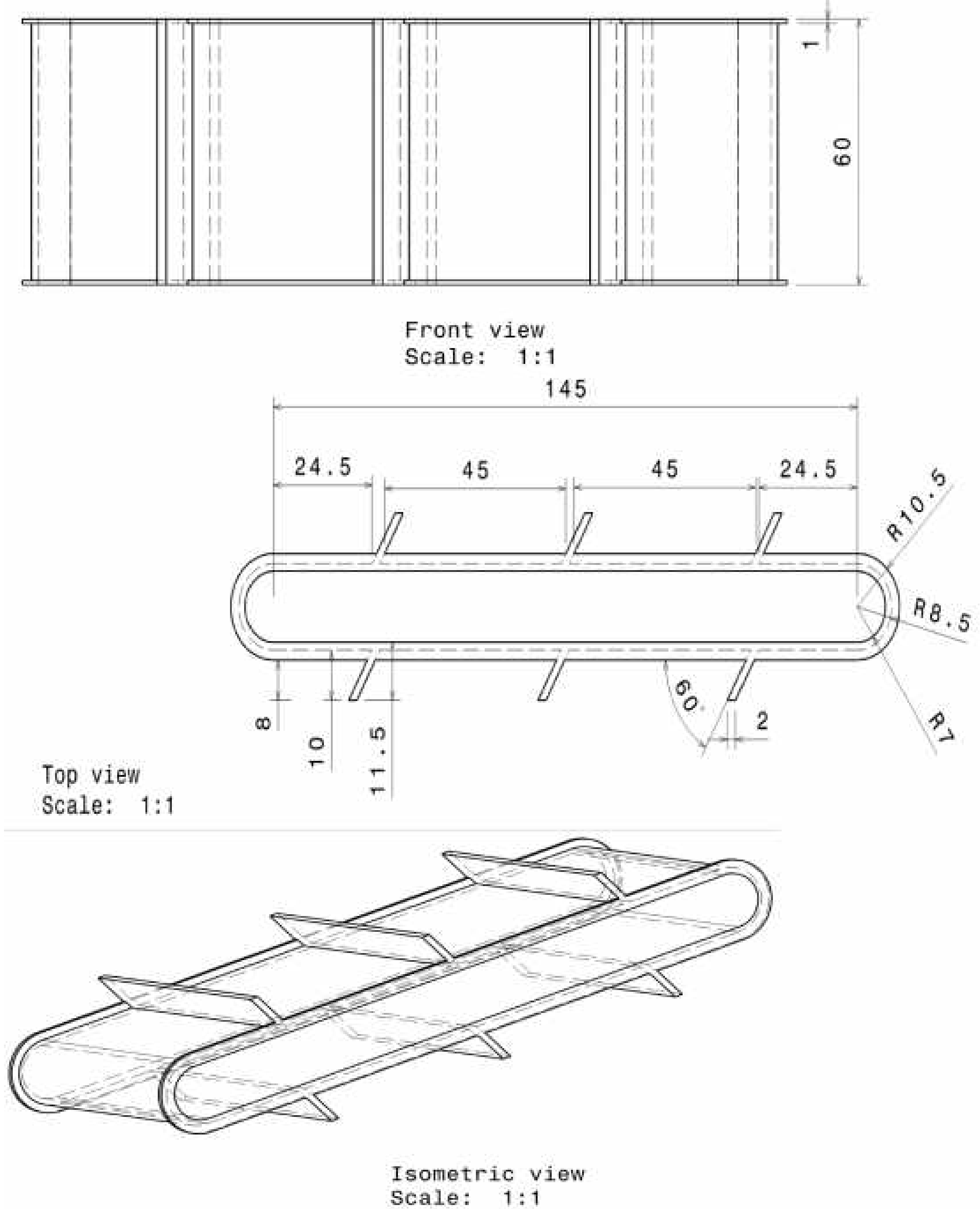


Figure 4-4 conveyer belt

4.6 Pressing system

A pneumatic system "as shown in fig.4.9" is to be used in this machine since the power screw mechanism is too expensive for us to use and the hydraulic system can't be used in this machine because it cause dirt for the juice.

Figure 4.5pneumatic pressing systempiston.

After the pressing system is done.The next step is to push the squeezed tank to the rubbish tank by the mean of another pneumatic piston as shown in fig 4.9.

the force to be pressed is 25 kg plus 1kg of the steel piece that attach to the piston, and the area is to be $60\ cm\ length * 60\ cm\ width = 0.36\ m^2$

then the pressure needed is to be

$$pressure = \frac{Force}{area} = \frac{26}{0.36} = 722.2\ Pascal = 722.2 * 10^{-5} bar$$

The used piston can work on 5 bar and can handle the used pressure

4.7 Tank "for Squeezing" Design

This tank is supposed to handle 25 kg of the smashed grape and by experiment these amount of weight have a volume to be the mass divided by the density of the grape (1.54g/cm3)

$$V = \frac{m}{\rho} = \frac{25000}{1.45} = 17242 cm^3$$

is the volume of the tank

And the volume is to be the base area multiplying by the height, assuming the radius of the tank is to be 15cm, and then the height is

$$17242 = \pi * 15^2 * H$$

$$H = \frac{17272}{\pi * 15^2} = 25cm$$

Allow a clearance of 5 cm for the tank diameter, 10cm for the height. Then the final size of the tank is to have:

D=40cm in diameter

H=40 cm long

The tank is designed to be open from the bottom and from the top of the tank. The tank design is allowing just the juice to get out from the tank. This is done by drilling the tank with a small hole to be 0.5 cm in diameter.

The tank is landing at a blat that is also filter the incoming juice to get a pure juice. Cleaning the tank is done by connecting a slide crank mechanism to move the tank with its rubbish in to a rubbish reservoir the slider crank mechanism is moving by the action of the motor rotation.

The tank is to be made of cast iron, with inner diameter of 40cm, outer diameter of 44cm for the thickness of the tank.

Tank weight is to be the density by the volume

$$V = \pi * (0.22 - .2)^2 * 0.4 = 0.0005024\ m^3$$

$$m = \rho * V = 7840 * 0.0005024 = 4Kg$$

And 2.5N from the grape, the net force is to be 2.5+4=2.9N

This is the force required for the motor to move the tank. Thus the torque required is to be the force by the force arm of the crank slider rod, and it is 60cm.

$$T = F * R = 2.9 * 0.6 = 1.74N.m$$

The reservoir that is containing the juice and the rubbish is drowned in figure 4-15 and its size to be 40X40X20cm

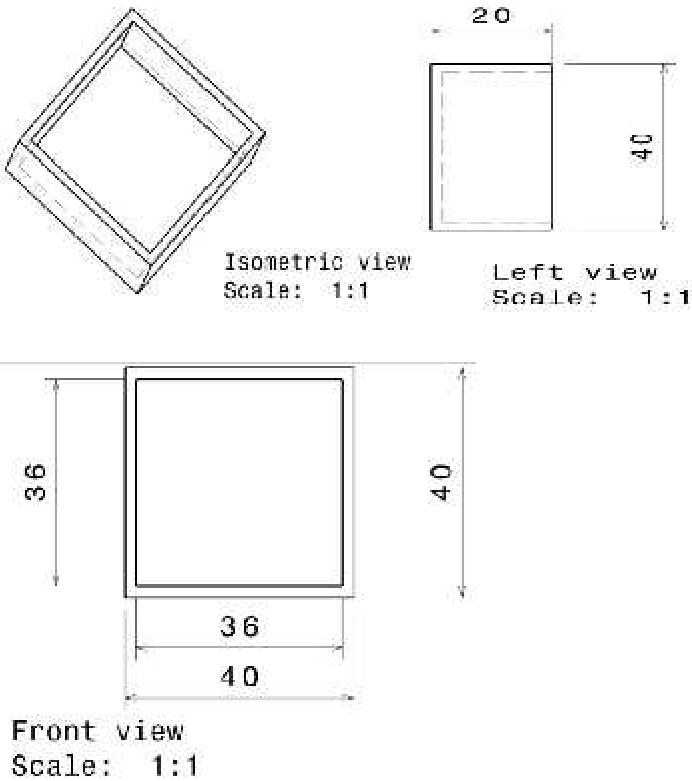


Figure 4.6reservoirs for the juice and the rubbish.

Pushing process:

There is a need for getting out the rest that is no need for it to the rubbish tank and this happens with the pneumatic piston that push the squeezing tank toward the rubbish tank.

The pressure that the squeezing tank applied is the force divided by the area

The tank force is 40N and the area for the square tank is

$$(0.4 + 0.4) * 0.4 = 0.32\text{m}^2$$

$$pressure = \frac{force}{area} = \frac{40}{0.32} = 0.125\ kpa = 125 * 10^{-5} bar$$

So 5 bar of piston pressure can easily push the tank.

5

Chapter Five

Electrical and Control System Design

5.1 Overview

This chapter is illustrating the exact instrument that is used in the squeeze grape machine and the electrical control system of the machine

5.2 Selection of the Motors

The third chapter illustrated the kind of motors that is used in this project and the advantages or disadvantages of each type.

Now the exact motors depending on the calculations of the torque and the speed of each load are to be discovered, there is three AC motors in this machine.

AC motors

As mentioned in 5.2 there are three motors in this machine which is illustrated each one use and calculations.

A- Rolls motor :

The first motor is used in the machine is the one which is responsible of moving the first roll , the torque of the load is (10.7 N.m) and the speed of the rolls 100 rpm . So there is gears ratio in order to combine between the motor and the load from the speed and the torque.

$$T1 * N1 = T2 * N2 \qquad (5-1)$$

$400 * 10.7 = \text{T2} * 3000$

$\text{T2} = 1.426 \text{ N.m}$

Where

T1: the load torque.

N1: The load speed.

T2: The motor torque.

N2: The motor speed.

The output power of the motor

$$P_{out} = T * \omega \qquad 5-2$$

Where

T: Torque.

w: Angular velocity

P_{out}: output power of the motor

$$\omega = \frac{2\pi * N}{60} \qquad (5-3)$$

N: the rated speed of the motor

So the angular velocity

$$\omega = \frac{2 * \pi * 3000}{60} = 314\ rad/s$$

The resultant output power $= 1.426 * 314 = 448$ watt

In horsepower

$$\frac{448}{746} = 0.6\ hp$$

The input power is needed, to get the rated current for the selection of the motor, the needed efficiency is to be 70%.

$$efficincy = \frac{P_{out}}{P_{in}} \qquad (5-4)$$

$$P_{in} = \frac{448}{0.7} = 640\ watt$$

$$P_{in} = V * I * PF \qquad (5-5)$$

Pin: Input Power.

V: Rated Voltage.

I: Rated Current.

PF: Power Factor.

The power factor = 0.74, so by using equation 5.4

$$I = \frac{640}{220 * 0.74} = 4.1A$$

- The second motor is for the second roll with the same calculations

B- Conveyer motor

The torque of the conveyer motor is 10.35 N.m as found in chapter four and the speed is 600 rpm, depending on equation 5.3 the resultant angular velocity for this motor 62.8 rad/second , by using equation 5.2 the output power

$$P_{out} = 62.8 * 10.35 = 650\ watt$$

$$P_{out} in\ hp = \frac{650}{746} = 0.8\ hp$$

The needed efficiency is 70%, from using equation 5.4 the Input power is

$$P_{in} = \frac{650}{0.7} = 928\ watt$$

Assuming the power factor is 0.8 so by using equation 5.5 the rated current is

$$I = \frac{928}{220 * 0.74} = 5.7\ A$$

5.3 Electrical Instrument

The electrical instrument which will be used for the system consists from electronic components and electro pneumatic components.

5.3.1 Electronic component

A-Voltage Regulators

is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

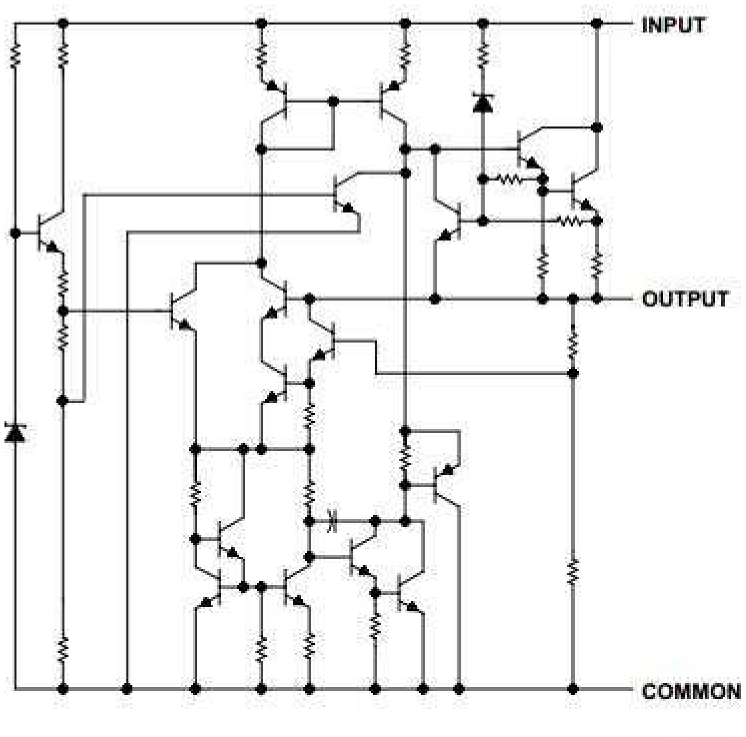


Figure 5.1 internal circuit of voltage regulator

The used regulator in the system is Lm7805 which give pure 5 dc volt we need .

B_ NPN Transistors

is a type of transistor that relies on the contact of two types of semiconductor for its operation. BJTs can be used as amplifiers, switches, or in oscillators. BJTs can be found either as individual discrete components, or in large numbers as parts of integrated circuits.

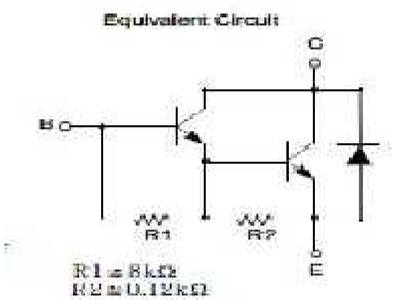


Figure 5.2 internal circuit of NPN transistor

The used transistor in the system is tip122 which has high biasing.

C_ relays

The relay function had been illustrated in section 3.3.7

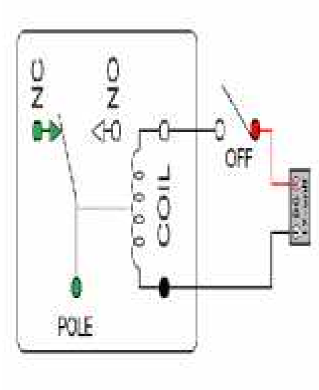


Figure 5.3 internal circuit of the relay

D_ diodes

A diode is a specialized electronic component with two electrodes called the anode and thecathode. Most diodes are made with semiconductor materials such as silicon, germanium, or selenium.

The used diodes in the system is for protecting from reversing current and used as freewheelingdiode .

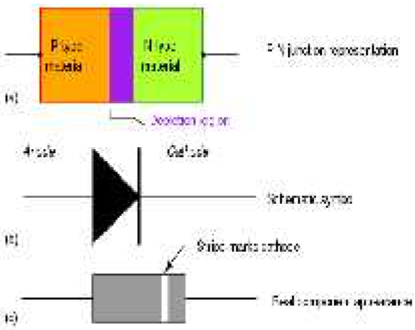


Figure 5.4 symbol and internal circuit of diode

5.3.2 Electro pneumatic system

The electro-pneumatic action is a control system for pipe organs, whereby air pressure, controlled by an electric current and operated by the keys of an organ console, opens and closes valves within wind chests, allowing the pipes to speak. This system also allows the console to be physically detached from the organ itself. The only connection was via an electrical cable from the console to the relay, with some early organ consoles utilizing a separate wind supply to operate combination pistons.

Figure 5.5 electro pneumatic valve.

5.4 Switches and Sensors

Switches are the main keys that are used to turn the machine on/off or as sensors in some cases, in the machine there are three types of switches that are used .

Sensorsare electrical device convert the physical quantity to electrical quantity.

5.4.1 Switches

1_on/off switch

There are two on/off switches in the machine the first one will be used to turn on or off the whole machine which will be connected from the power supply to the power circuit directly, and the second will be for turning on the motors which will be connected from the power supply to the arduinocontroller.

Figure 5.6 the electrical symbol of on/off switch

Figure 5.7 on/off switch

2_ Limit switches

There is one limit switch in the system and its function is to define the position if the first tank reaches the last limit of its distance while emptying it. The limit switch will be connected from the power supply to the arduino controller.

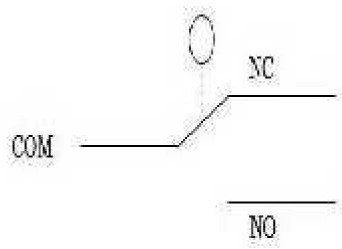


Figure 5.8 the electrical symbol of limit switch

Figure 5.9 limit switch

3_Emergency switch

The switch is used to stop equipment and facilities in emergencies. And it will be connected from the power supply to the arduino controller.

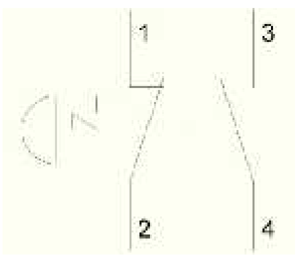


Figure 5.10 the electrical symbol of emergency switch

Figure 5.11 Emergency switch

5.4.2 Sensors

Sensorsare electrical device convert the physical quantity to electrical quantity thismachinecontain three sensors.

There are two sensors which are Adjustable IR Reflection Sensors and is used to identify the level in the first and the third tank.

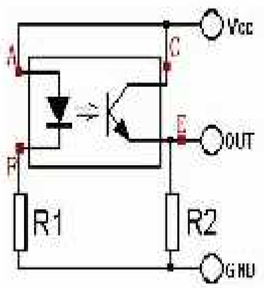


Figure 5.12 the electrical circuit of the sensor

Figure 5.13 Adjustable IR Reflection Sensors

5.5 Arduino Microcontroller

The main controller of the system is the arduinoUno which is the brain of the all system which will be programmed in the sequence of the machine which will be illustrated in section 5.6 .

The Arduino Uno is a microcontroller board based on the ATmega328 .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

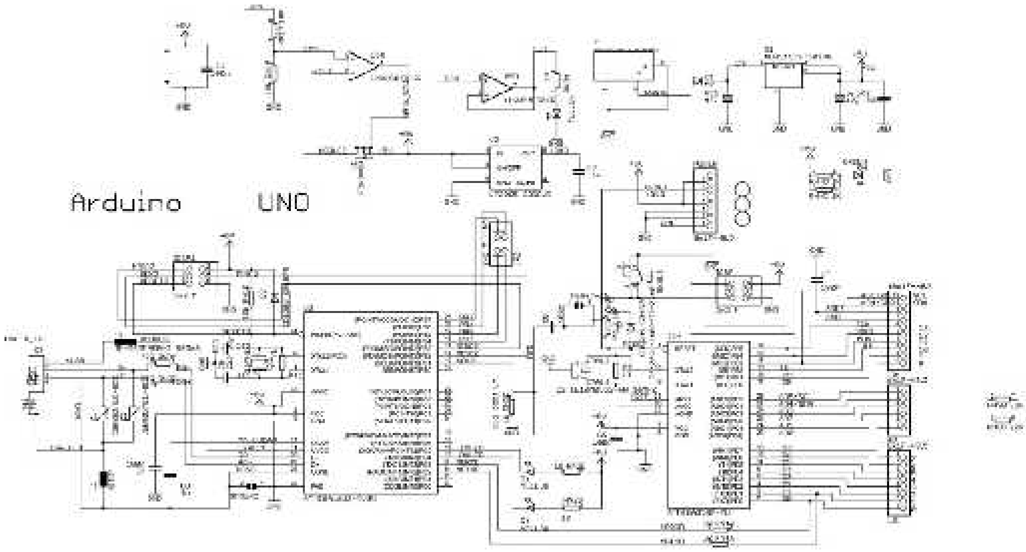


Figure 5.14 arduinoUno internal circuit

Figure 5.15 arduinoUno kit

5.5Control sequence

The sequence of the squeezing operation will go on through multi stage and they are as follows

1_ Turn the machine on.

2_Turn the motors' switch on , when the motors switch is turning on the signal will go through the arduino which will give the conveyer's motor and the rolls motors to begin until the first tank being filled with smashed grape .

3_When the first tank become full which will be examined by first sensor, the sensor will give signal to arduino.

4_After that the arduino will turn off the motors and give the first electro-pneumatic valve to work .

5_The cylinder will go down beginning squeezing the smashed grape in order to squeeze it ,and this operation will be repeated three times in order to be sure that all smashed grape has been squeezed.

6_After that the arduino will turn-off the first electro-pneumatic valveand turn on the second electro-pneumatic valve to move the tank in order to empty it in the third tank.

7_When the moved tank hit the limit switch , the limit switch will give signal to arduino and the arduino will turn of the second electro-pneumatic valve which will move the first tank back.

8_The all operation will be repeated until getting signal from the second sensor which illustrate the level in the tank of the rest of the grape if it got filled full and that will turn off the all system until emptying the last tank.

9_In case of emergency or danger there is emergency switch which will turn of the total system.

5.6Control circuits

There are two main interface circuits in the electrical system between the controller (arduino) and the electrical laod .the first one for the motor and the second one for electro-pneumatic valve.

5.7.1 Motor control circuit

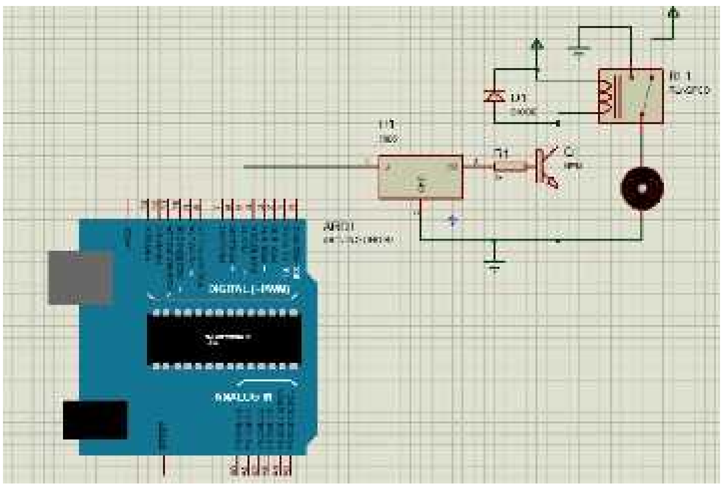


Figure 5.16 motor control circuit

The circuit consists from 5 volt regulator, 1kilo ohm resistance,NPN tip122 transistor, relay and freewheelingdiode.

Each component in the circuit and its function has been illustrated previous in this chapter.

This circuit is responsible for driving the motor and protecting the arduino from the load , when the arduino give out signal the regulator make the signal pure and this signal which will activate the bias of the transistor then the transistor activate the coil if the relay after that the relay will turn on from N.C to N.O will pass the current to the motor and finally the diode is for protecting from the freewheeling diode.

5.7.2 electro-pneumatic valve

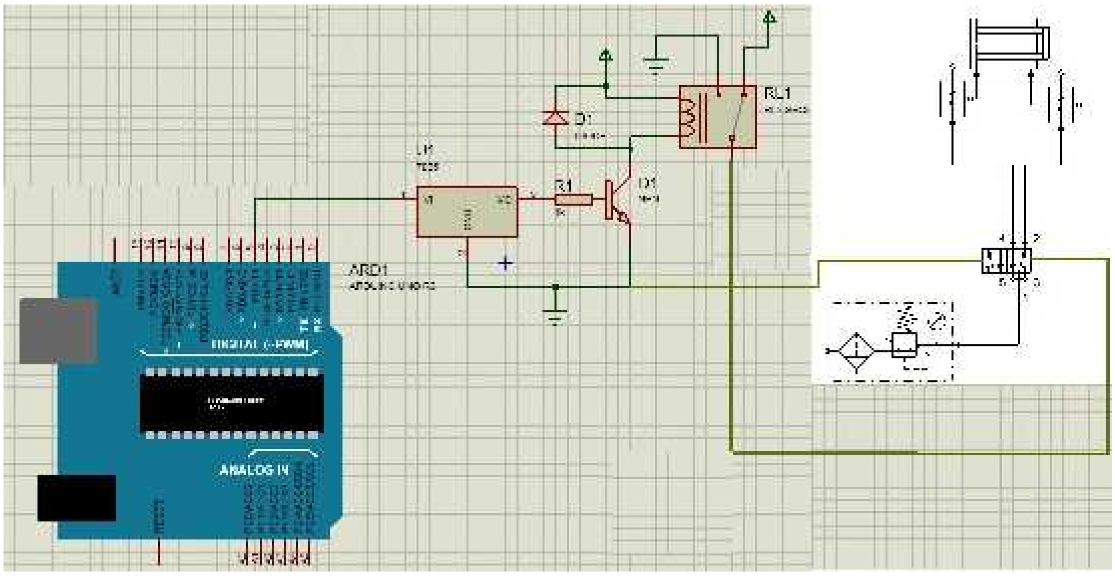


Figure 5.17 elect pneumatic control circuit

This circuit has the same component as previous one and with the same operation butits different in the load.

The load here has tow throttling in order to control the pressure of the air in the cylinder, when the current pass in the solenoid of the selector will let the air pass to move the cylinder go on and when the current is off the cylinder will let the air pass from the another chamber to get the cylinder back.

5.7.3 Thetotal control circuit

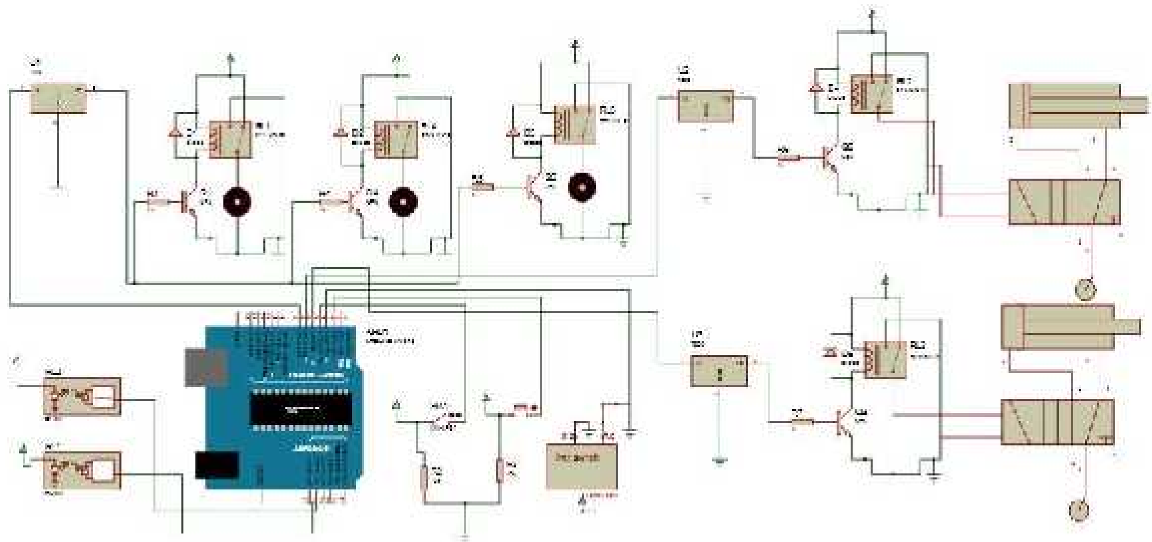


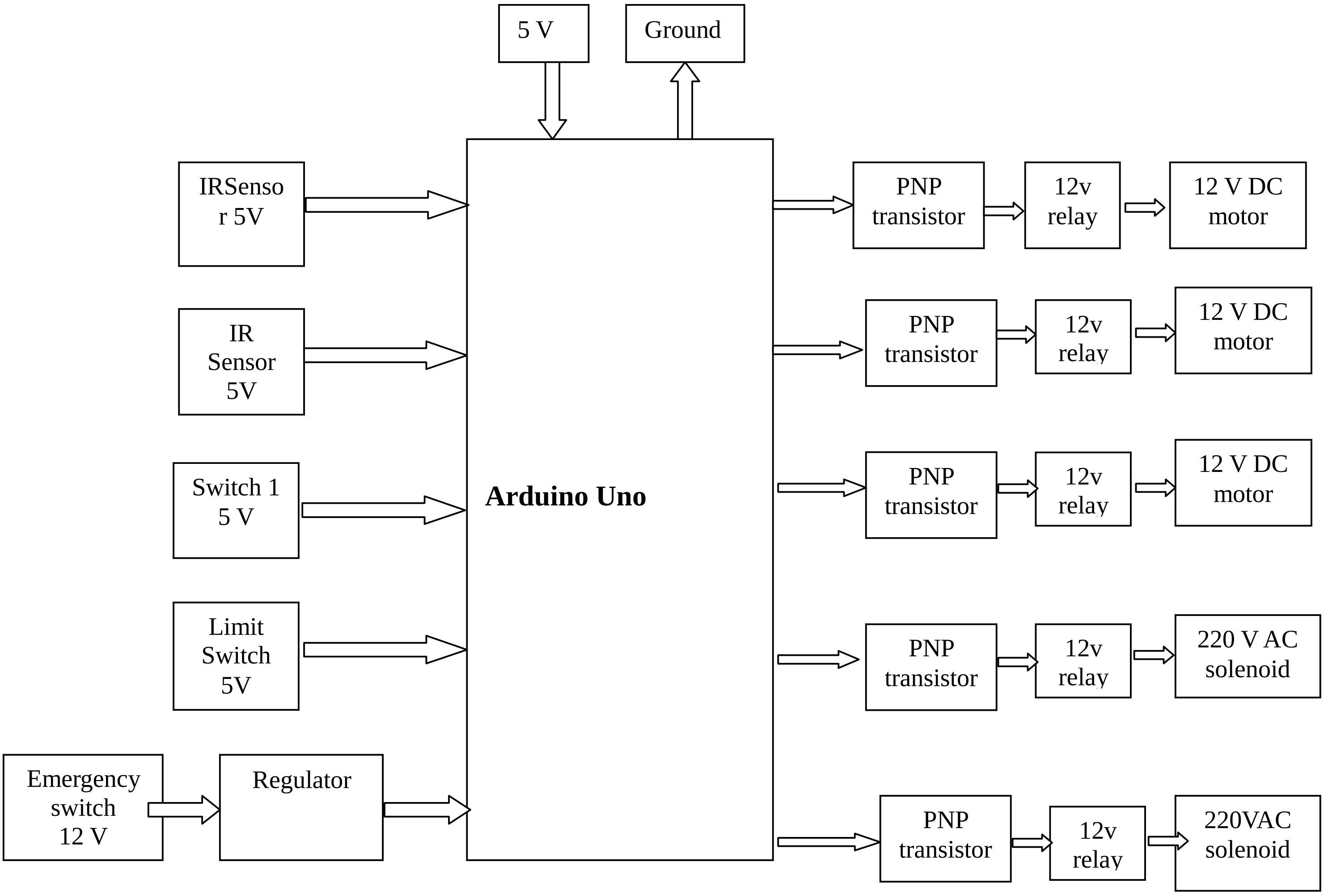
Figure 5.18the total control circuit

The previous circuit shows the total electrical and electro_pneumatic systems And each component has been illustrated and each circuit has been explained previously.

Note: the second motor will work counter clock wise but the other will work clock wise.

5.8 System Block Diagram and Flow Chart

5.8.1 System Block Diagram



5.8.2 Flow chart of the machine system

6

Chapter six

Implementation and Recommendation

6.1 Overview

This chapter illustrates the mechanical and electrical implemented systems. and shows the implemented body.

6.2 Implemented Mechanical System

In this section all mechanical parts are shown. Thus the implemented machine parts are as follows:

- ✓ Rotating rolls
- ✓ Conveyor belt
- ✓ Pneumatic pistons
- ✓ Container tanks
- ✓ Structural case for the overall machine.

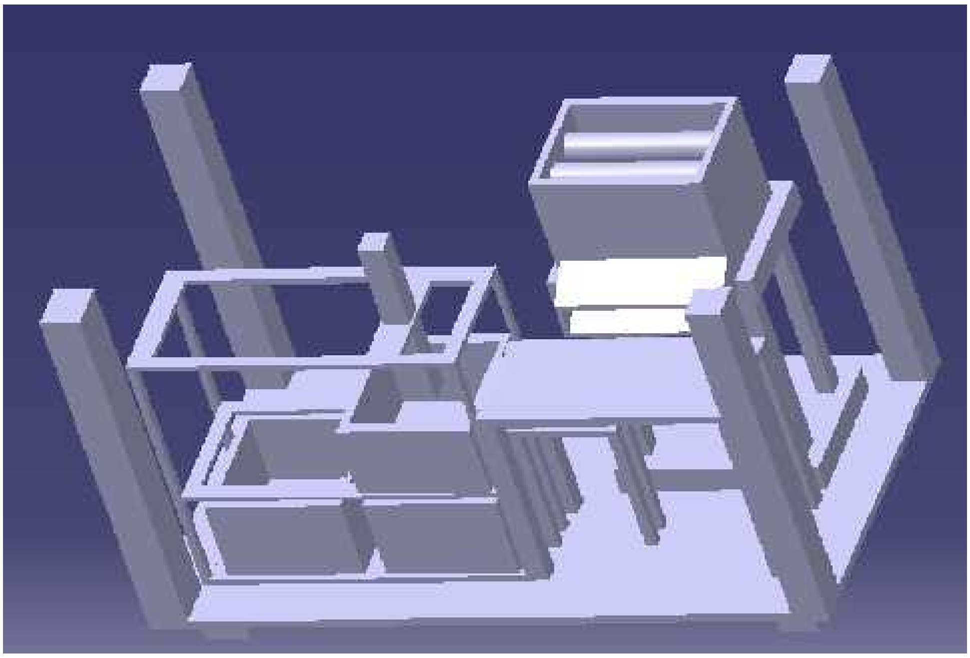


Figure 6.1:implemented grape squeeze machine using Catia program

6.2.1 Implemented rotating rolls and its container

The used rolls dimensions is 5cm outer diameter for each roll, a thickness of 4 mm and 30 cm long

The volume of this roll is

$$volum = V = \pi * (D - d)^2 * l = \pi * (5 - 4.6)^2 * 0.3 = 0.015 * 10^{-3}\, m^3$$

The density of the cast iron is to be 7840 kg/m3.

So the mass of it is $mass = M = 7840 * 0.015 * 10^{-3} = 0.120\, kg$

The container that the rolls is inside it has the following dimensions

The container length is 20 cm, 20 cm width and 15 cm height.

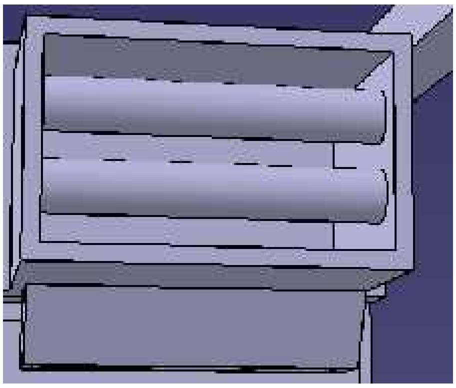


Figure 6.2: implemented rolls for the smashing process of the grape.

6.2.2 Implemented conveyor belt

The used conveyor belt is 50 cm length and 20 cm width.

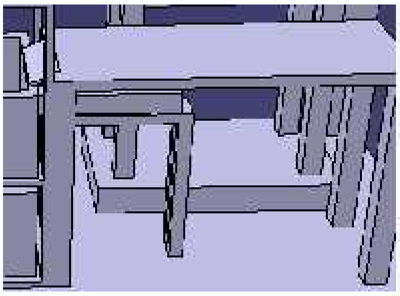


Figure 6.3 : implemented conveyor belt

6.2.3 Implemented pressing system

Two pneumatic pistons are used in this machine working at 4 bar, one for the pressing part and another for pushing the squeezing tank to the rubbish tank.

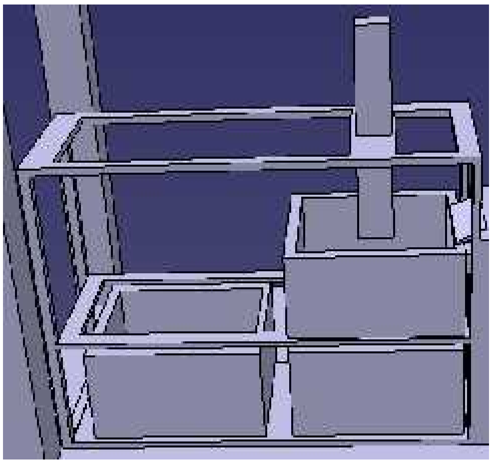


Figure 6.4 : implemented pneumatic pressing system.

6.2.3 Implemented squeezing container tanks

There is three container tanks. One is used for the pressing system from the pneumatic piston, this tank has no base, so under it there is small piece of steel that is Pierced with small holes of around 5mm in diameter.

The dimensions of this tank are 20cm length, 20 cm width and 15 cm height.

The second tank is used for the cleared juice that is placed under the squeezing container tank.

The last tank is used for the rubbish that the pushing pneumatic piston is push the squeezing tank towards it

6.2.3 Implemented structural case for the overall machine

The machine is welded well in the structure with its specific dimensions, and with tolerances of $\pm$ 4 mm.

Structural case for the rolls container dimensions is 22cm length as shown in figure 6.1.

6.3 Implemented Electrical System

6.3.1 Used motors

The used motors are universal series motors which can be used as an ac/dc motor has a rated power 50 watt and implemented voltage 12 volt .

6.3.1.1 Rolls' motors

Figure 6.5 :ZD2531D motor.

The scale between theoretical and implemented values of the motor.
1:10.

Rated values of the used motors:

Rated voltage : 12 volt.
Rated power : 50 watt.
No_loadcurrent :2.5 ampere.
No_loadspeed : 65 rpm.
Load current : 5 ampere.
Load speed : 40 rpm .
6.3.1.2 Conveyor belt motor

The scale between theoretical and implemented values of the motor.
1: 5.

Rated values of the used motors:

Rated voltage : 12 volt.
Rated power : 150 watt.
No_loadcurrent : 2.5 ampere.
No_loadspeed : 65 rpm.
Load current : 5 ampere.
Load speed : 40 rpm .

6.3.2 Implemented Control circuit

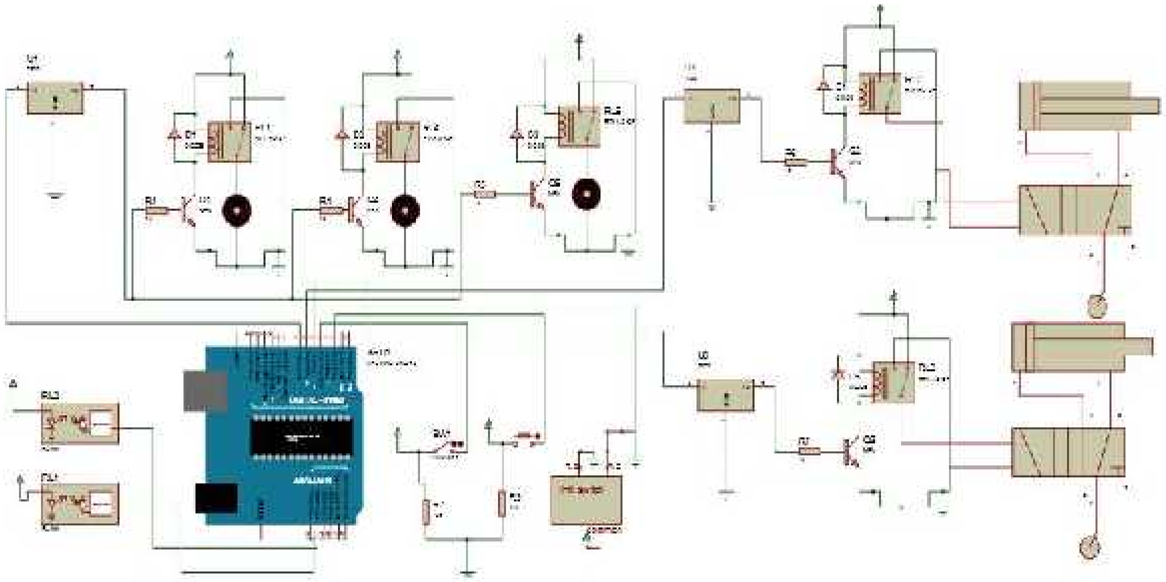


Figure 6.5: implemented control circuit using arduino Uno programming device

Components:

1_12dc/230ac relay.

2_ transistor npn tip122

3_5volt regulator.

4_resistors 1k ohm.

5_ 5 v infrared sensor (3-80)cm.

6_silicon diode.

7_electro pneumatic solenoid .

8_arduinoUno.

9_on/off switches.

10_emergency switch.

11_limit switch.

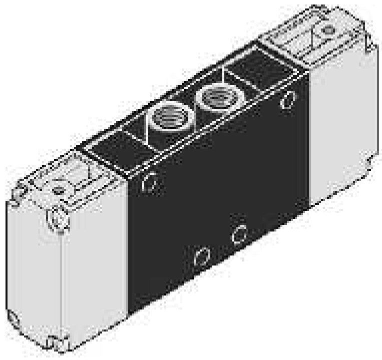
12_ac source.
13_dc power supply

6.4 Recommendation

1_use the same model that has been illustrated in chapters 4 and 5 .

2_use stainless steel for the machine to have high accuracy.

5/2 & 5/3 Way G1/4 Double Pilot

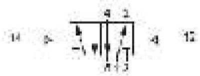
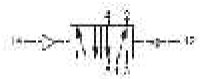
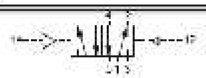


Technical information

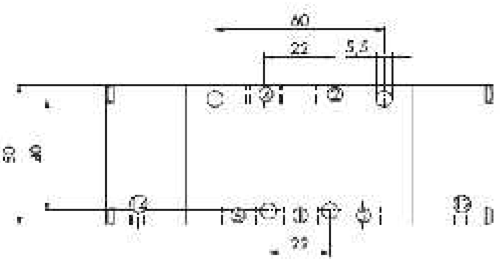
Pressure range:	2.5-10 bar
Control pressure:	2.5-10 bar
Temperature range:	-15°C...+50°C
Housing:	Die-cast and lacquered zinc alloy
Seals:	NBR
Lubricant:	Not required
Operating medium:	5 micron filtered, lubricated or non-lubricated compressed air

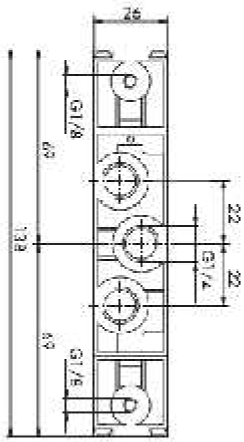
Other information

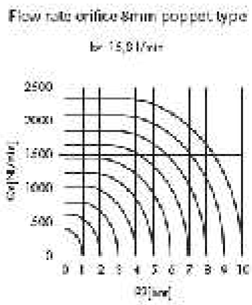
For ATEX certification use suffix code "EX" for example 76.XXX.XX.XX.EX
For NPT ports use prefix code "75" for example 75.XXX.XX.XX

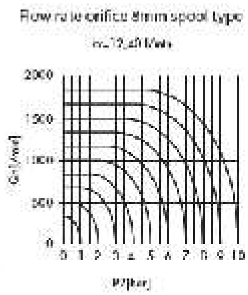
Symbol	Description	Type	Orifice	Ports	Order code
	5/2 way double pilot	Poppet	8mm	G1/4	**76.047.81.42**
	5/2 way double pilot	Spool	8mm	G1/4	**76.043.81.42**
	5/2 way double pilot with priority	Poppet	8mm	G1/4	**76.047.81.47**
	5/2 way double pilot with priority	Spool	8mm	G1/4	**76.043.81.47**
	5/2 way double pilot with priority	Spool	8mm	G1/4	**76.043.81.47**
	5/3 way spring return to centre all ports closed	Spool	8mm	G1/4	**76.044.81.38**
	5/3 way spring return to centre all ports open	Spool	8mm	G1/4	**76.044.81.28**

Dimensional drawings









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[11] Standardized by the American Gear Manufacturers Association (AGMA). Write AGMA for a complete list of standards, because changes are made from time to time. The address is: 1500 King Street, Suite 201, Alexandria, VA 22314; or, www.agma.org.

[12] Electrical Equipment and Componenhttp://electricalequipment.pacontrol.com

1

Chapter One
Introduction

1.1 Overview

This chapter illustrates an introduction to the project, the objectives and motivations of the project

This chapter also shows the methodology used to build and complete this system, the parts of the system is mentioned. Some of risk management, results and problems are mentioned. The estimated cost is modified, after that the content of the report is shown.

1.2 Introduction

Now a day, industrial machine is very important in the daily life, get the gob to be done very fast than before. Thus, the production line for the product is given more and bigger. Now the intelligent computers and intelligent control system is introduced to a machine to increase its accuracy and safety when doing work, it is also important to for the production process that is complicated to deal with.

Squeeze grape machine, with its new design; help the industrial companies to produce a clean juice with small time compared with a human work time. This new design decreases the number of workers to do the job, thus safe money for other important things.

1.3 Project Objectives

This project aims to achieve the following:

1) Produce a clean juice from the grapes rather than using the human work process.
2) Safe time and money from the workers and the lost production due to major errors happens.
3) Implement a new technology to the machine in order to increase its accuracy, safety, and reduce the losses.
4) Prevent depending on the outside companies to squeeze the grape for a large quantity.

1.4 Project Procedure:

The requirement needed to be successfully done is as follows:

1_smashing the grape by two rolls.

2_transfering smashed grape through conveyer belt.

3_squeezing the grape in special tank by pressing system.

4_emptying rest of the grape in rubbish tank.

1.5 Approach

The system is divided into five subsystems:

1- Two Rotating Shaft.
2- Shafts tank.
3- Conveyor belt
4- Tank."That the piston going to squeeze the grape".
5- Pneumatic compressor.
6- Container tank.

At the first stage the two rotating shaft is smashed the grape but not letting the juice of the grape to be appear , the two rotating shaft is rotating at reverse direction of each other and a distance of 2cm between them, because the grape piece is nearly 2cm in diameter. The calculation of this two rolling cylinders is discussed in details in chapter 4.

Chapter four gives a detailed mechanical design about designing the machine. At the final stage the juice is collected to a reservoir that is taken for other production line and for several uses.

1.6 Project Schedule and Time Plan

- **Stag1: Select the idea**

Determine the idea of the project, the motivation, and the main objective that intend to be achieved.

- **Stage2: Preparing for the project and collecting data**

  In this stage, more and deeper determination of the tasks and steps is done, and more information about the project is prepared.

- **Stage3: Project Analysis**

  In this step, a study of the all possible design options to determine the design process.

- **Stage4: Determine the project requirement**

  After determine the project design scheme, the entire needed requirement detailed mathematical model for the system is specified, software and hardware. And try to bring them to be ready for the implementation stage.

- **Stage5: Documentation Writing**

  Documenting the project isbeginning from the first stage to the last stage.

- **Stage6: make the hardware available**

  In this stage, the needed hardware devices is brought for the next steps, arduino device, motors, switches, sensors, belt, shaft rolls, gears, and speed reducers.

- **Stage 7: build up the machine and finishing**

  All The machine equipment and devices bought it there is an available source in the market or if not, going to the lath to introduce the mechanical parts.

- **Stage8: testing the machine**

  Detect if there is an error occurred and making a report about that.

- **Stage 9: finishing the graduation final report**

  All documentation has made is to be checked and done in this stage. Every change in it is to be added and to be noticed that something is changed.

- **Stage 10: Preparing for the final presentation**

  The presentation is prepared to show the project and its parts.

Table1.1: Timing plan for the first semester

Week / Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S1	■	■	■												
S2			■	■	■	■	■	■	■	■	■	■	■		
S3				■	■	■									
S4							■	■	■	■					
S5				■	■	■	■	■	■	■	■	■	■	■	■

Table1.2: Timing plan for the second semester

Week / Task	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
S6	■	■	■	■													
S7	■	■	■	■	■	■	■	■	■	■	■	■	■				
S8					■	■	■	■	■	■	■	■	■				
S9												■	■	■	■		
S10														■	■	■	■

1.7 Project contents

The report is divided up to five chapters, these chapters explain the project, its contents and requirements and present an interview about it:

- **Chapter 1: Introduction**

  Discuss the project from many sides, represents and overview about the project, the objectives and important for it, and the work plan and estimated cost. Also, the project risk management is shown in this chapter.

- **Chapter 2: Literature review**

  Talks about the theoretical background of the project, review of previous machine about the same purpose or similar to it.

- **Chapter 3: Description and analysis of system Requirements**

  This chapter illustrates the design concepts, the general block diagram, and the functional block diagram that mention all the implemented functions in the system.

- **Chapter 4: grape squeeze machine mechanical design**

  This chapter is talking about the detailed software engineering design, detailed mathematical modeling of each component and part of the machine is illustrated in this chapter

- **Chapter 5: System control**

  This chapter is talking about the used electrical devices and control circuits

- **Chapter 6: implementation**

  This chapter illustrates the implemented prototype of the grape machine system.

1.8 Estimated Cost

NO.	Description	Cost “$”
1	Motors(4 motors)	1500
2	ARDUINO	100
3	Electrical Panel & protection	200
4	Level and electrical Sensor	50
5	Pipeline + Pipe connectors	150
6	Wires , Cables and Switches	50
7	Labor Work (in hour)	100hr*10=1000
8	Reservoir (3)	300
9	Shaft tank	200
10	Conveyer belt (including the rubber)	500
11	Pump	400
12	Piston (2)	500
13	Filters	150
Total		5000

2

Chapter Two

Literature Review

2.1: Overview

Squeezing grape is one of the most used ways to take advantage from the grape since it is including many benefits like the high of the sugar's percent in the grape.

Many ways have been used to squeeze the grape beginning from primitive way until the modern industrial machines.

2.2: Primitive way

In the old days the famers used very traditional and unsafe way to squeeze the grape, their way was collecting the grape in canvas bags and putting them in stony hole.

After that they were standing over those bags and making pressure over bags but using their legs. This way is still used until these days.[1]

Figure 2.1 old grape mills in Karma Mountain.

2.3: Industrial machines:

International machines

1- Grape Squeezing Machine (GG-A)

It is applicable to squeeze the skin slag of broken grape. This machine is with double helix, and their Rotation direction is contrary. The squeezing force is both big and evenly. It can change the juice rate by adjusting dregs mouth clearance. Contacting materials parts, frame and appearance were made by stainless. The machine can also be used to other materials solid-liquid separation, its effects for different material quality has certain differences.[2]

Machine details:

Place of Origin: Henan China (Mainland).

Brand Name: GELGOOG.

Type: Grape Squeezing Machine.

Voltage: 220/380V.

Power (W): 7.87 kW.

Dimension (L*W*H): 3500X1000X1300mm.

Certification:ISO9001CE.
Capacity: 5t/h

Figure 2.2: grape squeezing machine.

Description

1. The machine is used for peeling and squeezing of fruit and vegetables.
2. Simple structure, low noise, beautiful appearance, easy to operate and maintain low cost. Stable performance.
3. The machine is suitable for crushing the fresh grapes after removing infraction and the hide trimmings of separated fruit juice, or sugar juice extractor of hide trimming after fermentation.

Manual information:

Pressure: 100 kg, Weight: 40kg

Dynamic: manual operation

Material: 304 stainless steel

Charging barrel: 30*35cm

Capacity: 20-40 kg/h

Dimension: 1200*350*350mm

Figure 2.3: grape squeezing with pneumatic cylinder

2.4: Local machines:

1- Grape squeeze machine

It consists from two separated stages:

The first stage consists from two parts, first part is roll which separates the grapes from there clusters, then the second part the grain of the grape goes down the roll which there another roll which mince those grains which goes in external tank.

After that the worker hold the minced grape and put it in the second stage which consist from hydraulic compressor which press the minced grape and the juice of the grape goes in another tank .

2.5: Relative local machine:

Automated olive press for households use

This machine consists from two main stages, first stage is pressing and second liquid sorting and have an assistant system to transport the pressing cylinder from malefaction stage to pressing stage, so the machine is divided into five parts and components in which they are connected to each other to cover all stages needed.

These parts different types and shapes with different prosperities. The design should compromise between these properties to achieve the required shape and performance without affecting safety. [3]

2.6: Ceramic membrane filtration

Filtration of juices

A filtration step is required to produce clear juices. Colloidal tub material as well as particles has to be removed to prevent the juice or concentrate from subsequently becoming turbid. Diatomaceous earth filtration (DE filtration) was used in the past, but cross-flow ultra-filtration has now become the established standard for polishing apple juice.

The DE technique is still often used for filtering colored juices. As more stringent requirements are placed on the type of membrane in these applications, the ceramic membrane is well tried and tested in the field.

Structure of Cross-Flow Filtration

With this method, the juice is guided along the surface of the membrane at a tangent. The Permeate comes through the membrane and is collected in a clear juice tank. A loop pump ensures that the cloudy juice, the retentive, circulates in the filtration circuit.

The volume of filtrate which flows off is replaced by cloudy juice. The feed pump puts cloudy juice into the filtration circuit. Part of the flow of retentive is passed back into the process tank. In the course of filtration, the solids become concentrated in the retentive circuit.

Ceramic membrane

The core element of these units is ceramic membranes with a pore size of 20 to 200 nm. They are extremely resistant to temperature, pressure and chemicals, easy to clean and, compared to polymer membranes, have a very long service life.

Over 1000 lines supplied all over the world, many of them in the fruit juice industry, have already been working at a constantly high output for twenty years. Only a ceramic membrane makes it possible to concentrate retentive until there is no free juice left.

2.7: Filtration of colored juices

The fundamentally complex filtration properties of colored juices such as elderberry juice mean that output is reduced. The ceramic membrane has key advantages – from the choice of material to start with. It is unable to adsorb coloring constituents, as the material is completely inert. On the other hand, its pore size is much smaller than that of a polymer membrane, so that particles can only penetrate the pore opening to a very limited extent.

This means that formation of a coating on the surface is reduced, achieving a much higher specific flux per unit surface area.

3

Chapter Three

Description and Analysis of System Requirements

3.1 Overview

This chapter is showing the selection of the component of the system. Notice that this is a first principle model of the machine that is designed in the next chapter.
This chapter is divided in two parts, the mechanical part and the electrical part.

3.2 Part I: Mechanical Component Selection.

3.2.1First principle model of the system:

Figure 3.1 shows the general Description of the System:

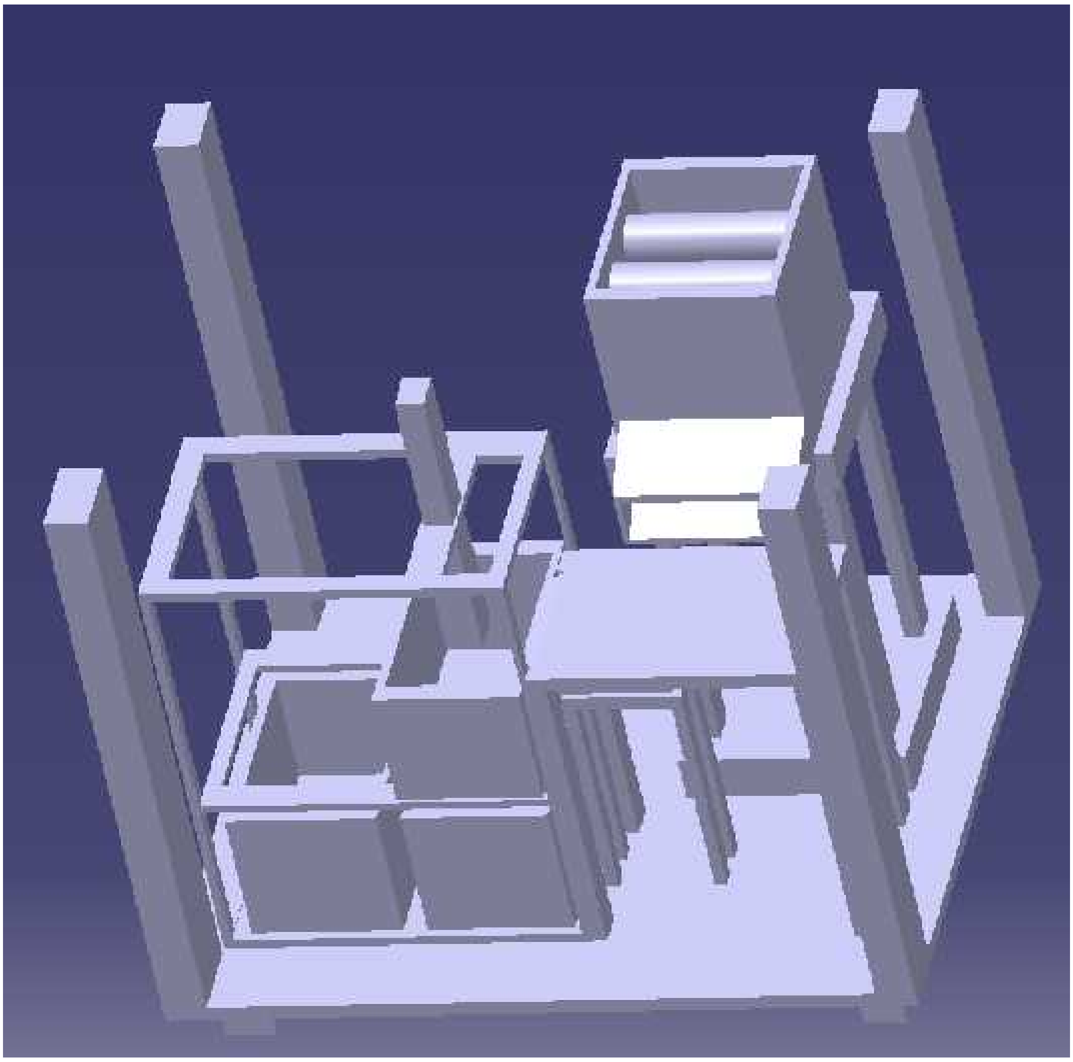


Figure3.1: Thefirstimagine picture of the System using CATIA program.

Figure 3.1 shows the general Description of System Requirements, and its parts and how they are integrated with each other. Also, the figure shows all the components of each part in the system.

The system is divided into five subsystems:

- Rotating Shafts.
- Shafts tank.
- Tank that the piston squeezes the grapes.
- Hydraulic compressor.
- The tank that contains the juice.

The systems based on squeeze the grape and connect each step via a PLC program and microcontrollers. The hydraulic part of the system is designed to accomplish the need of the produced product.

3.2.2 Stages of the System

In this section, the block diagrams of each stage are shown, the first for smashing the grape and sending it to the container tank. While the second for containing the grape. The third is for the tank that the compressor is squeezing the grape on it to be a juice. Though, the forth is for the hydraulic compressor that squeezes the grape to be a juice.Thefifth is for containing the juice in a tank.

The main components of the system are the Roll mechanism, Conveyor Belt, Piston, Tank for the piston to squeeze the grape, and the tank that the juice is going to it. All the components is explained in this Chapter in more details.

3.2.3Shaft Selection and GearMechanism:

This is the first component of the system. The Shaftis placed on a specified tank that holds two or three rolls, if three rolls are selected. All rolls are driven in one motor using gear. These gears are havingan **IDLER GEAR**. The gear mechanism is coupled together. This mechanism allows the rolls to rotate in a reverse direction to the each other. Rolls are connected to the gears, so the rolls rotate due gear rotating that gets the rotation from the motor.

Another design that takes in consideration that if the gears is hard to get, every roll is rotating with its own motor. The design technique of the roll mechanism is different and depends on the applications. The system purpose is to put the grape in the rotating rolls, that smashes the grape and explode the clusters for better squeezing process.

The size of the box that contains the rolls, motor, and the gears, is to be 60X60X60 cm.

Shaftsdiameterselected to be about 15 cm, and 60 cm long. The gears are designed to meet the requirement.

So far, the gear size is bigger than the diameter of the roll, that have a pitch diameter of 12 cm. figure 3.2 shows the roll and the rolls container also the gear.

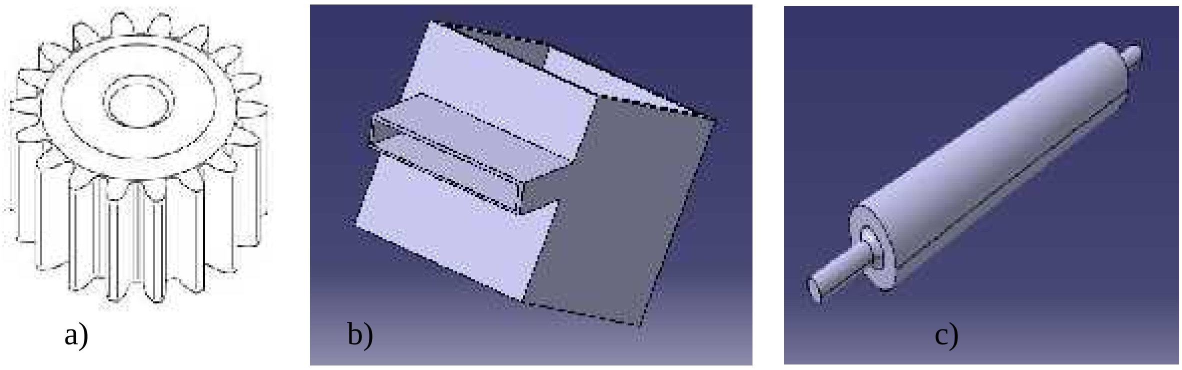


Figure3.2:a)gear, b)box that contains the two rolls, c)the roll for the smashing process.

3.2.4Conveyor Belt

The second and main part of the system is the Conveyor Belt. This is responsible for containing the grape smashed from the Rolls action, and transport the grape to the next stage, which is the secondary tank that the compressor squeezes the transported grape.

The four principal types of belts are shown, with some of their characteristics, in Table 3–1. Crowned pulleys are used for flat belts, and grooved pulleys, or sheaves, for round and V belts. Timing belts require toothed wheels, or sprockets.

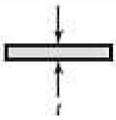
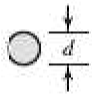
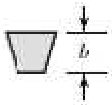
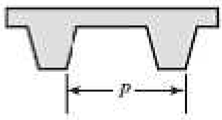
In all cases, the pulley axes should be separated by a certain minimum distance, depending upon the belt type and size, to operate properly. Other characteristics of belts are:

•They are used for long center distances.

•Except for timing belts, there is some slip and creep, and so the angular-velocity ratio between the driving and driven shafts is neither constant nor exactly equal to the ratio of the pulley diameters.

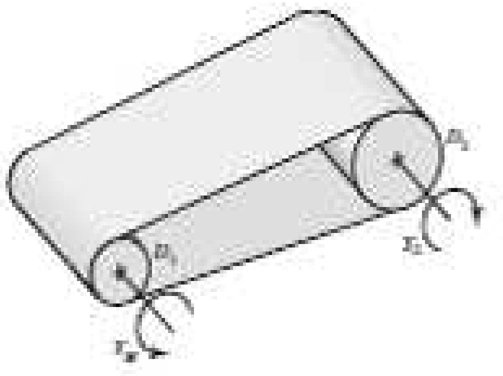
• In some cases an idler or tension pulley can be used to avoid adjustments in center distance that are ordinarily necessitated by age or the installation of new belts [1]. Table 3.1 shows the Characteristics of Some Common Belt Types.

Table 3.1 Characteristics of Some Common Belt Types

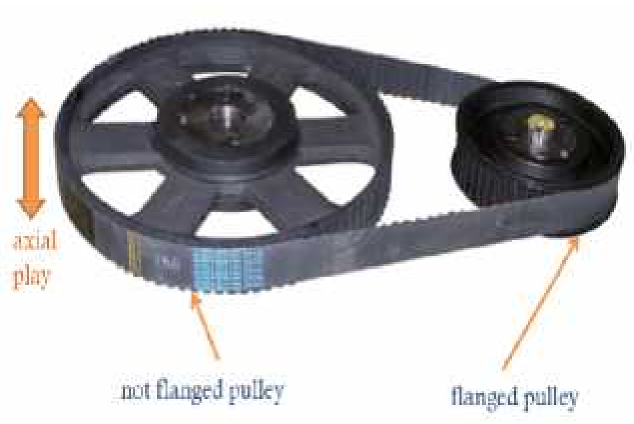
Belt Type	Figure	Joint	Size Range	Center Distance
Flat		Yes	$t = \begin{cases} 0.03 \text{ to } 0.20 \text{ in} \\ 0.75 \text{ to } 5 \text{ mm} \end{cases}$	No upper limit
Round		Yes	$d = \frac{1}{8}$ to $\frac{3}{4}$ in	No upper limit
V		None	$b = \begin{cases} 0.31 \text{ to } 0.91 \text{ in} \\ 8 \text{ to } 19 \text{ mm} \end{cases}$	Limited
Timing		None	$p = 2$ mm and up	Limited

According to the last paragraph the tank land is movable and connected to a driving motor, so making in the account for these elements to take the size and the length of this container and finding that it is a 150x60x20 cm.

The conveyor belt is made of steel. The conveyor belt is connected to a diagonal plate at 60degrees, 10cm height. Figure 3.3 shows Some Common Belt Types



a) Flat belt



b) Timing belt

c) V belt

Figure 3.3: Some Common Belt Types

Figure 3.4 shows conveyor belt using CATIA program that is to be used.

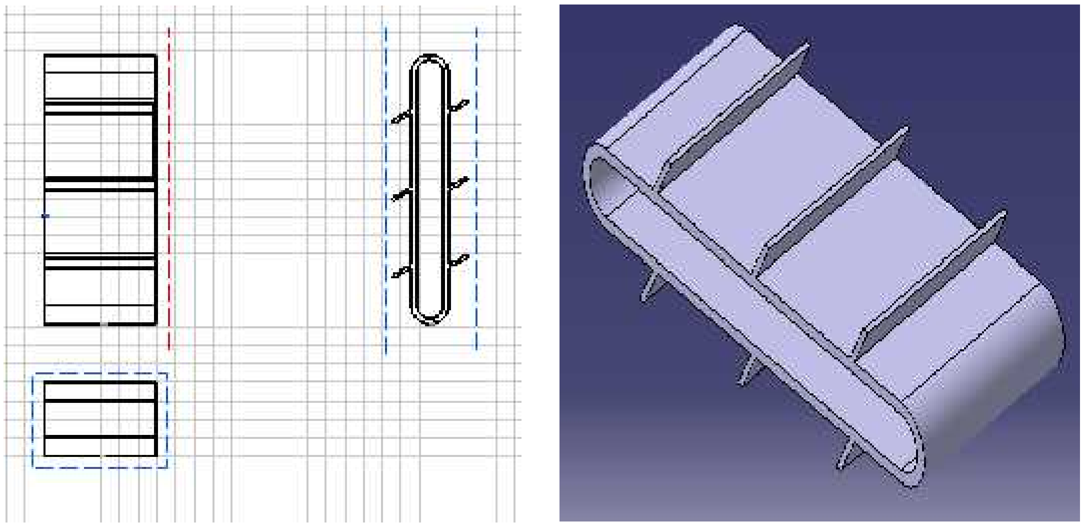


Figure3.4: conveyor belt using CATIA program.

3.2.5Tank.

In this stage the conveyor belt transform the smashed grape to this tank. The construction of this tank is such that to just allow the juice of the grape to go out the tank and the rest remain in the bottom of it.

The tank should be designed in order to handle the pressure and the force of the hydraulic compressor so the tank should be made of steel that have such properties.

According to the assumption made. The tank diameter is 40cm and at a height of 60cm.tank thickness is 30mm.

In order to keep this tank at steady state while the hydraulic piston gets inside of it, two pistons is placed at each side of the tank. This tank need to be drilled in a very small hole to allow just the juice to pass on, and these small holes selected to be at a diameter of 20mm each.

3.2.6Pressing System:

In the pressing system there are three different types for pressing. Theyare the power screw, the pneumatic compressor and the hydraulic compressor.

A power screw is a device used in machinery to change angular motion into linear motion, and to transmit power. Familiar applications include the lead screws of lathes, and the screws for vises, presses, and jacks.

Compressors Pneumatics "as shown in figure3.5" is all about using compressed air to make a process happens. Compressed air is squeezed into a small space under pressure. You might remember that air under pressure possesses potential energy which can be released to do useful work.

Figure 3.5 pneumatic compressor

Tables 3.2 and 3.3 show the advantages and the disadvantages for pneumatic systems:

Table 3.2 Advantages of pneumatic system

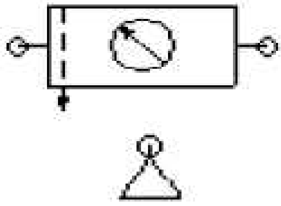
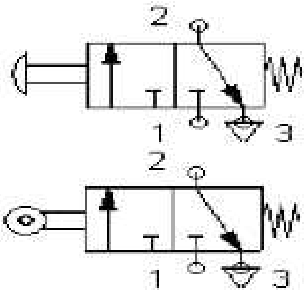
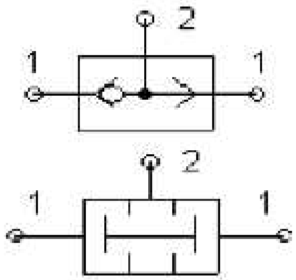
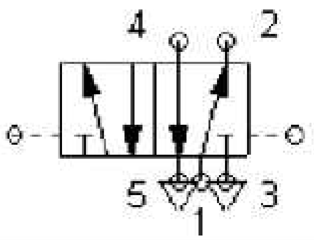
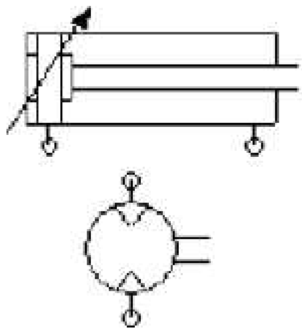
Advantages of Pneumatic Systems	
Air is available practically everywhere in unlimited quantities.	**Availability**
Air can be easily transported in pipelines, even over large distances.	**Transport**
Compressed air can be stored in reservoirs and removed as required. In addition, the reservoir is transportable.	**Storage**
Compressed air is relatively insensitive temperature fluctuations. This ensures reliable operation, even under extreme conditions.	**Temperature**
Compressed air offers no risk of explosion or fire.	**Explosion Proof**
Un-lubricated exhaust air is clean. Any un-lubricated air that escapes through leaking pipes or components does not cause contamination.	**Cleanliness**
The operating components are of simple construction and therefore relatively inexpensive.	**Components**
Compressed air is a very fast working medium. This enables high working speeds to be attained.	**Speed**
Pneumatic tools and operating components can be loaded to the point of stopping and are therefore overload safe.	**Overloads Safe**

Table 3.3 Disadvantages of pneumatic systems

Disadvantages of Pneumatic Systems	
Compressed air requires good preparation and constant piston speeds.	**Preparation**
It is not always possible to achieve uniform and constant piston speeds with compressed air.	**Compression**
Compressed air is economical only up to a certain force requirement. Under normal working pressure of 600 to 700 KPa (6 to 7 bar) and dependent on the travel and speed, the output is limited between 40 000 to 50 000 Newton.	**Force Requirement**
The exhaust air is loud. This problem can be solved by the use of sound absorption material and silencers.	**Noise Level**

Table 3.4Main five categories for elements of pneumatic systems.

Pneumatic System Elements

Supply elements Compressor Reservoir Pressure regulating valve Air service unit	
Input elements Push button valves Limit switches Proximity switches	
Processing elements Directional control valves Nonreturnable valves Pressure control valves Timers, counters	
Final control elements Directional control valves	
Power elements (actuators) Pneumatic cylinders Pneumatic motors	

Hydraulic pressing

Pumps perform the function of adding energy to the fluid of a hydraulic system for transmission to some output location. Hydraulic actuators and motors do just the opposite. They extract energy from a fluid and convert it to mechanical energy to perform useful work.

Fluid power can be transmitted through either linear or rotary motion by using linear actuators called “hydraulic cylinders” or rotary actuators called “hydraulic motors”. Hydraulic cylinders extend and retract to perform a complete cycle of operation. They sometimes include cushions in their end plated=s to prevent shock loading, which can damage the moving piston or the stationary cylinder and plates. Rotary actuators can be of the limited rotation or the continuous rotation type.

Limited rotation motors are frequently called “oscillation fluid motors”because they produce a reciprocating motion. Continuous rotary hydraulic motors (or simply hydraulic motors). In reality, are umps that have been redesigned to withstand the different forces that are involved in motor applications. As a result, hydraulic motors are of the gear, van, or piston configuration. Also, as in the case of pumps, piston motors can be either fixed or variable displacement unit.

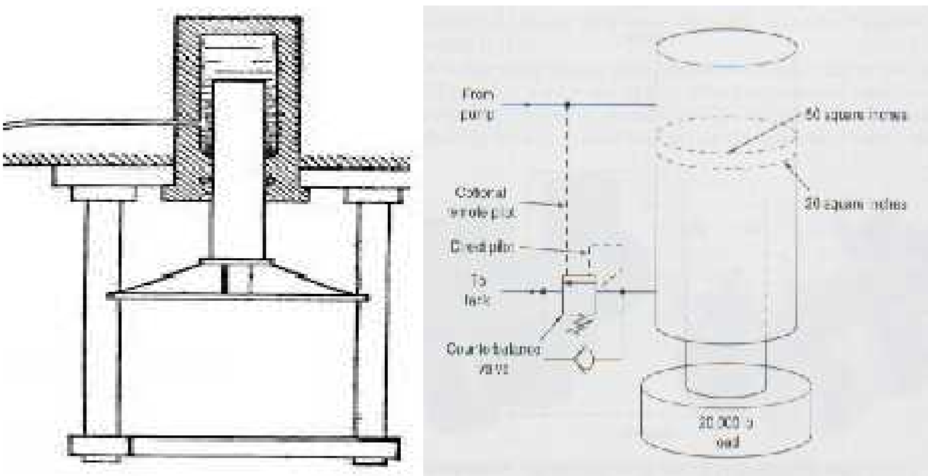


Figure 3.6 hydraulic pressing piston.

The output force (F) and piston velocity (υ) of double-acting cylinders are not the same for extension and retraction. This is explained as follows: During the extension stroke, fluid enters the blank end of the cylinder through the entire circular area of piston (A_p).

The retraction velocity is greater than the extension velocity for the same input flow rate.

3.3 Part II: Electrical Devices Selection for the Machine

3.3.1 Electrical motors:

Electrical motors are used to efficiently convert electrical energy into mechanical energy. Magnetism is the best of their principles of the operation. They use permanent electromagnets, and exploit the magnetic properties of material in order to create these machines.

There are several types of electric motors available today. The following outline give an over view of several popular ones. There is two main classes of motors: AC and DC.

Ac motors require an alternating current or voltage source to make them work. Dc motors require a direct current or voltage source to make them work.

Figure3.7: common type of motors.

3.3.2DC motor construction

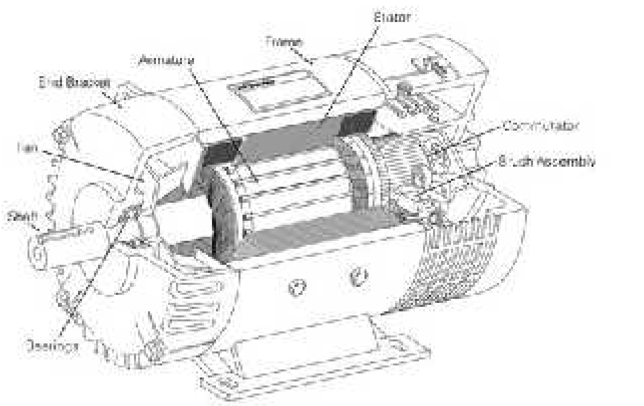


Figure 3.8: general arrangement of dc motors

The stator of the DC motor has poles , which are excited by dc current to produce magnetic fields.

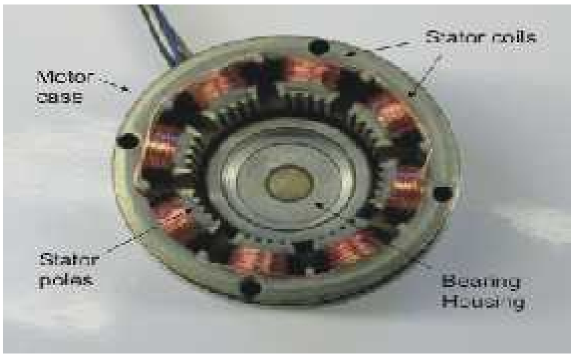


Figure 3.9 the stator of the dc motor

-In the neutral zone, in the middle between the poles, commutating poles are placed to reduce sparking of the commentator.

-the commutating poles are supplied by dc current.

-Compensating windings are mounted on the main poles. These short-circuited windings damp rotor oscillations.

- The poles are mounted on an iron core that provides a closed magnetic circuit.

-The motor housing supports the iron core, the brushes and the bearings.

-The rotor has a ring-shaped laminated iron with slots.

-Coils with several turns are placed in the slots. The distance between the two legs of the coil is about 180 electric degrees.

- The coils are connected in series through the commentator segment

-The ends of each coil are connected to a commentator segments.

- The commentator consists of insulated copper segments mounted on an insulated tube.

-Two brushes are placed in the neutral zone, where the magnetic fields is close to zero

- The commentator switches the current from one rotor coil to the adjacent coil.

-The sudden interruption of an inductive current generates high voltages.

-The high voltage produces flashover and arcing between the commentator segment and the brush.

3.3.3 DC Motor Operation

There are five different methods for supplying the dc current to the motor:

1- Separate excitation.
2- Shunt connection.
3- Series connection.
4- Compound.
5- Permanent magnet (Wiper Motor).

3.3.4 AC Motors:

AC Motors can be divided into two major categories:

Asynchronous and synchronous:

The induction motor is the most common form of asynchronous motor and is basically an AC transformer with a rotating secondary. The

primary winding (stator) is connected to the power source, and the shorted secondary (rotor) carries the induced secondary current.

Torque is produced by the action of the rotor (secondary) current on the air gap flux.

The synchronous motor resembles a dc motor turned inside out, with the permanent magnets mounted on the rotor. As an alternative, some are constructed using a wound rotor excited by a dc voltage through slip rings. The flux created by the current carrying conductors in the stator rotates around the inside of the stator in order to achieve motor action.[4]

3.3.5 Advantages and Disadvantages of AC Motors:

*Advantages of AC Motors:

-Variety of Mounting Styles.

-Low Cost.

-Reliable Operation.

*Disadvantages of AC Motors

-Expensive speed control.

-Inability to operate at low speeds.

-Poor position control.

3.3.6Relays

Relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits should be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit.[6]

Figure 3.8 relay

3.3.8 Overload

It is of three thermal related to the motor in series. It has graduation which is adjust to the same value of the current intensity draw by the contactor function the main function of the over load is to protect the motor from any increase in current intensity.

Figure3.9: overload contactor

3.3.9 Switches

Switch is an electrical component that can break an electrical circuit , interrupting the current or diverting it from one conductor to another .

There are many types of switches like , on/off switches , push button switch and limit switch .

3.3.10 Microcontroller family

Microcontroller is one of the most important kind of controllers these days and specially in industrial machines .

There are many kind of microcontroller like arduino and pic.

Microcontrolleris also a single integrated circuit that accepts and executes coded instructions for the purpose of manipulating data and controlling a digital system similar to a microprocessor.

The difference between a microcontroller and a microprocessor is that the microcontroller also contains RAM, ROM, and I/O circuitry in that single IC package.

This allows miniaturization of single application, microprocessor controlled, digital systems because the required associated circuitry is contained within the integrated circuit of a microcontroller.

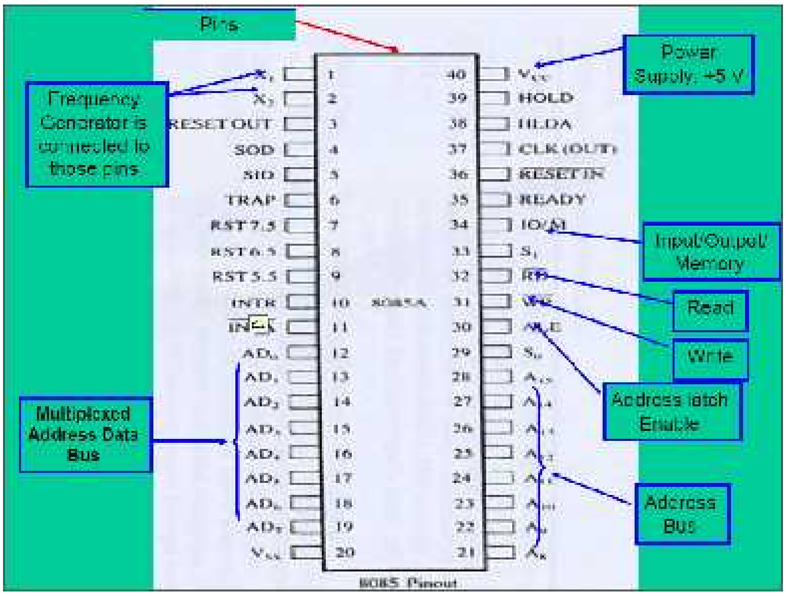


Figure 3.10 PIC Microcontroller

4

Chapter Four

Squeeze Grape Machine Mechanical Design

4.1 Overview

This chapter is showing the design of the system and discussed all parts of the project. Also, it introduces an overall explanation for every unit used in the machine. Additionally, features and detailed schematic diagrams for each component are shown.

Sometimes the strength required of an element in a system is an important factor in the determination of the geometry and the dimensions of the element. In such a situation the strength is an important design consideration. When we use the expression design consideration, some characteristic that referred to, influences the design of the element or, perhaps, the entire system. Usually quite a number of such characteristics should be considered and prioritized in a given design situation. Many of the important ones are as follows (not necessarily in order of importance):

1. Functionality
2. Strength/stress
3. Wear
4. Safety
5. Reliability
6. Cost
7. Friction
8. Weight
9. Life
10. Size
11. Volume

Some of these characteristics have to do directly with the dimensions, the material, the processing, and the joining of the elements of the system. Several characteristics is interrelated, which affects the configuration of the total system.

Some of the standards and codes, as well as addresses, can be obtained in most technical libraries or on the Internet. The organizations of interest to mechanical engineers are:

-Aluminum Association (AA)
-American Bearing Manufacturers Association (ABMA)
-American Gear Manufacturers Association (AGMA)
-American Institute of Steel Construction (AISC)
-American Iron and Steel Institute (AISI)
-American National Standards Institute (ANSI)
-American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
-American Society of Mechanical Engineers (ASME)
-American Society of Testing and Materials (ASTM)
-American Welding Society (AWS)
-ASM International
-British Standards Institution (BSI)

-Industrial Fasteners Institute (IFI)

-Institute of Transportation Engineers (ITE)

-Institution of Mechanical Engineers (IMechE)

-International Bureau of Weights and Measures (BIPM)

-International Federation of Robotics (IFR)

-International Standards Organization (ISO)

-National Association of Power Engineers (NAPE)

-National Institute for Standards and Technology (NIST)

-Society of Automotive Engineers (SAE)

These standardsarehelpingthe project to accomplish the need of the calculations.

4.2 Shaft Design

This section is to design the shaft selected in chapter 3.

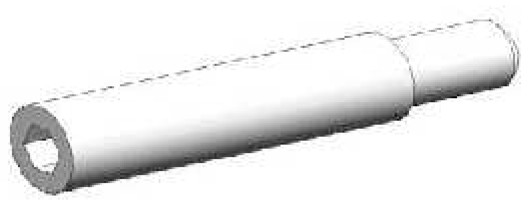


Figure 4.1 rotating shaft

The required mass production of 25 kg/min of grapes is needed in the tank before squeezing it to juice. And so the first stage is to produce an amount equal to 416.7g/s. upon this the tank size should be considered to meet the specification.

The shaft is made to roll 416.7 g/sec, by experiment the shaft speed is to be 400 rpm= 41.9rad/sec to get the specified weight. The force exerted by the grape equal to 5N.

Necessary strength to resist loading stresses affects the choice of materials and their treatments. Many shafts are made from low carbon, cold-drawn or hot-rolled steel, such as ANSI 1020-1050 steels.

The shaft size need to be bigger than the grape size in order to pull it very easy and all of it at once.

An annealed AISI 1018 steel with a cold work factor ‘W’ of 15% is used for the shaft. The nominal diameter of the bar can be left un-machined in areas that do not require fitting of components. For large shafts requiring much material removal, the residual stresses are tended to cause warping [7].

The Hollow shaft is to be 15 cm in outer diameter, and 10 cm inner diameter.

When designing the shaft, stresses due to bending and torsion are given by:

$$P = T\omega \qquad (4-1)$$

$$\tau_{max} = \frac{S_y}{2n} \quad 4-2$$

Where

P: power (Watt).

T : torque(N.m).

w : speed (rad/sec).

τ_{max}: Maximum shear stress (kpa).

Sy: tensile strength (kpa) .

n: factor of safety.

Table 4.1 Results of Tensile Tests of Some Metals

					Strength (Tensile)		
Number	Material	Condition	Yield S_{yt} MPa (kpsi)	Ultimate S_{ut} MPa (kpsi)	Fracture, σ_f, MPa (kpsi)	Coefficient σ_0, MPa (kpsi)	Strain Strength, Exponent m
1018	Steel	Annealed	220 (32.0)	341 (49.5)	628 (91.1)†	620 (90.0)	0.25
1144	Steel	Annealed	358 (52.0)	646 (93.7)	898 (130)†	992 (144)	0.14
1212	Steel	HR	193 (28.0)	424 (61.5)	729 (106)†	758 (110)	0.24
1045	Steel	Q&T 600°F	1520 (220)	1580 (230)	2380 (345)	1880 (273)†	0.041
4142	Steel	Q&T 600°F	1720 (250)	1930 (210)	2340 (340)	1760 (255)†	0.048
303	Stainless steel	Annealed	241 (35.0)	601 (87.3)	1520 (221)†	1410 (205)	0.51
304	Stainless steel	Annealed	276 (40.0)	568 (82.4)	1600 (233)†	1270 (185)	0.45

From the catalog Sy=220, MPa. at a factor of safety to be 3.

$$maximum\ shear\ stress = \tau_{max} = \frac{220 * 10^6}{6} = 36.7 MPa$$

$$maximum\ stress = \sigma_{max} = \frac{220 * 10^6}{3} = 73.3\ MPa$$

In the machine there is a need for a two rotating shafts. The upper diameter is 10cm (100mm), and the inner diameter is 9.7cm (97mm). A length of 40 cm (300mm) long.

Table 4.2: American standard pipe.

Nominal Size, in	Outside Diameter, in	Threads per inch	Wall Thickness, in Standard No. 40	Extra Strong No. 80	Double Extra Strong
$\frac{1}{8}$	0.405	27	0.070	0.098	
$\frac{1}{4}$	0.540	18	0.090	0.122	
$\frac{3}{8}$	0.675	18	0.093	0.129	
$\frac{1}{2}$	0.840	14	0.111	0.151	0.307
$\frac{3}{4}$	1.050	14	0.115	0.157	0.318
1	1.315	$11\frac{1}{2}$	0.136	0.183	0.369
$1\frac{1}{4}$	1.660	$11\frac{1}{2}$	0.143	0.195	0.393
$1\frac{1}{2}$	1.900	$11\frac{1}{2}$	0.148	0.204	0.411
2	2.375	$11\frac{1}{2}$	0.158	0.223	0.447
$2\frac{1}{2}$	2.875	8	0.208	0.282	0.565
3	3.500	8	0.221	0.306	0.615
$3\frac{1}{2}$	4.000	8	0.231	0.325	
4	4.500	8	0.242	0.344	0.690
5	5.563	8	0.263	0.383	0.768
6	6.625	8	0.286	0.441	0.884

From the standard shaft inner and outer diameter is to be 4inch and 3.5 respectively (10cm, 9.7cm)

The volume of the shaft is to be

$$volum = V = \pi * (D - d)^2 * l \qquad (4-3)$$

$$V = \pi * (0.1 - 0.097)^2 * 0.6 = 0.016 * 10^{-3} m^3$$

The density of the cast iron is to be 7840 kg/m3.

The mass is to be the density multiplying by the volume =0.13 kg.

So the force exerted by the shaft is to be 1.3N

Table 4.3 physical constants of materials

Material	Modulus of Elasticity E		Modulus of Rigidity G		Poisson's Ratio ν	Unit Weight w		
	Mpsi	GPa	Mpsi	GPa				
Aluminum (all alloys)	10.4	71.7	3.9	26.9	0.333	0.098	169	26.6
Beryllium copper	18.0	124.0	7.0	48.3	0.285	0.297	513	80.6
Brass	15.4	106.0	5.82	40.1	0.324	0.309	534	83.8
Carbon steel	30.0	207.0	11.5	79.3	0.292	0.282	487	76.5
Cast iron (gray)	14.5	100.0	6.0	41.4	0.211	0.260	450	70.6
Copper	17.2	119.0	6.49	44.7	0.326	0.322	556	87.3
Douglas fir	1.6	11.0	0.6	4.1	0.33	0.016	28	4.3
Glass	6.7	46.2	2.7	18.6	0.245	0.094	162	25.4

By experiment the required force to crash the grape is to be 2N, including the shaft and the grape force

So

The total force = weight of grape + 2 * weight of roll + crashing force

$F_T = 2 + 2*1.3 + 2 = 6.6$ N

$T = F * R = 6.6 * 0.025 = 0.16\ N.m$

The two shafts is not in contact to each other and the space between them is to be less than the diameter of the grape,so by experiment the space between two shaft is to be 2cm.

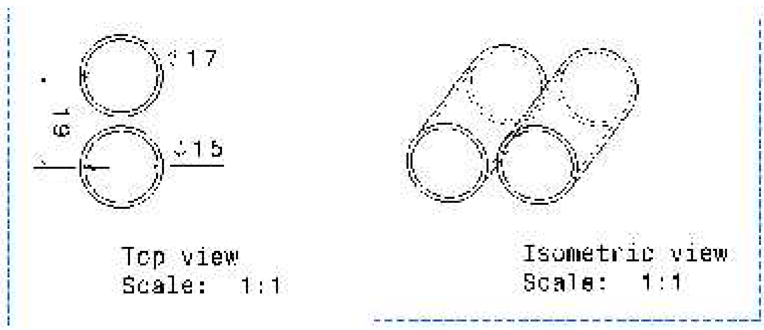


Figure 4.2 Two shafts with a distance of 19cm between the two centers

4.3 Shafts Container Design

In chapter 3 the selection of the container of the roll position and its component is presented. This section is to design the size of the container and the gears that drive the rolls.

In order to design the container, its components need to be shown in order to contain them; here is the element that is inserted to the container:

- Rolls, two rolls.
- Gears, each roll are connected to a gear.
- Motor and gear box

According to the calculation made for the two shafts, the gear the tank contain them is to be 450mm width, 650mm long, 600mm height. This container has an open side with an angle to allow the grape to exit to the conveyor belt.

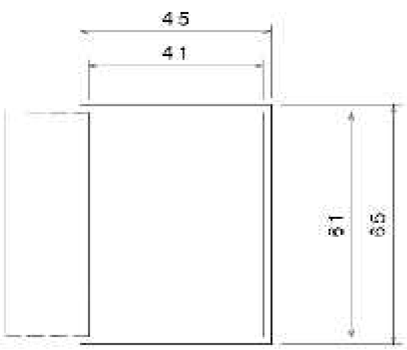
The volume of the container is

$V = 0.45 - 0.41 * (0.65 - 0.61) * 0.6 = 0.00096\, m^3$

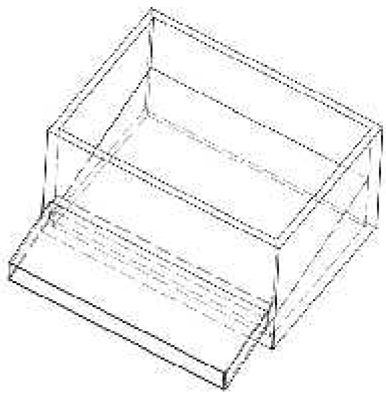
$m = \rho * V = 7840 * 0.00096 = 8\, Kg$

From a torque of 0.16 N.m and with a velocity of 800 rpm(83.7 rad/sec). The produced power is

$P = T * \omega = 0.16 * 83.7 = 13.4\, watt$



Top view
Scale: 1:1



Isometric view
Scale: 1:1

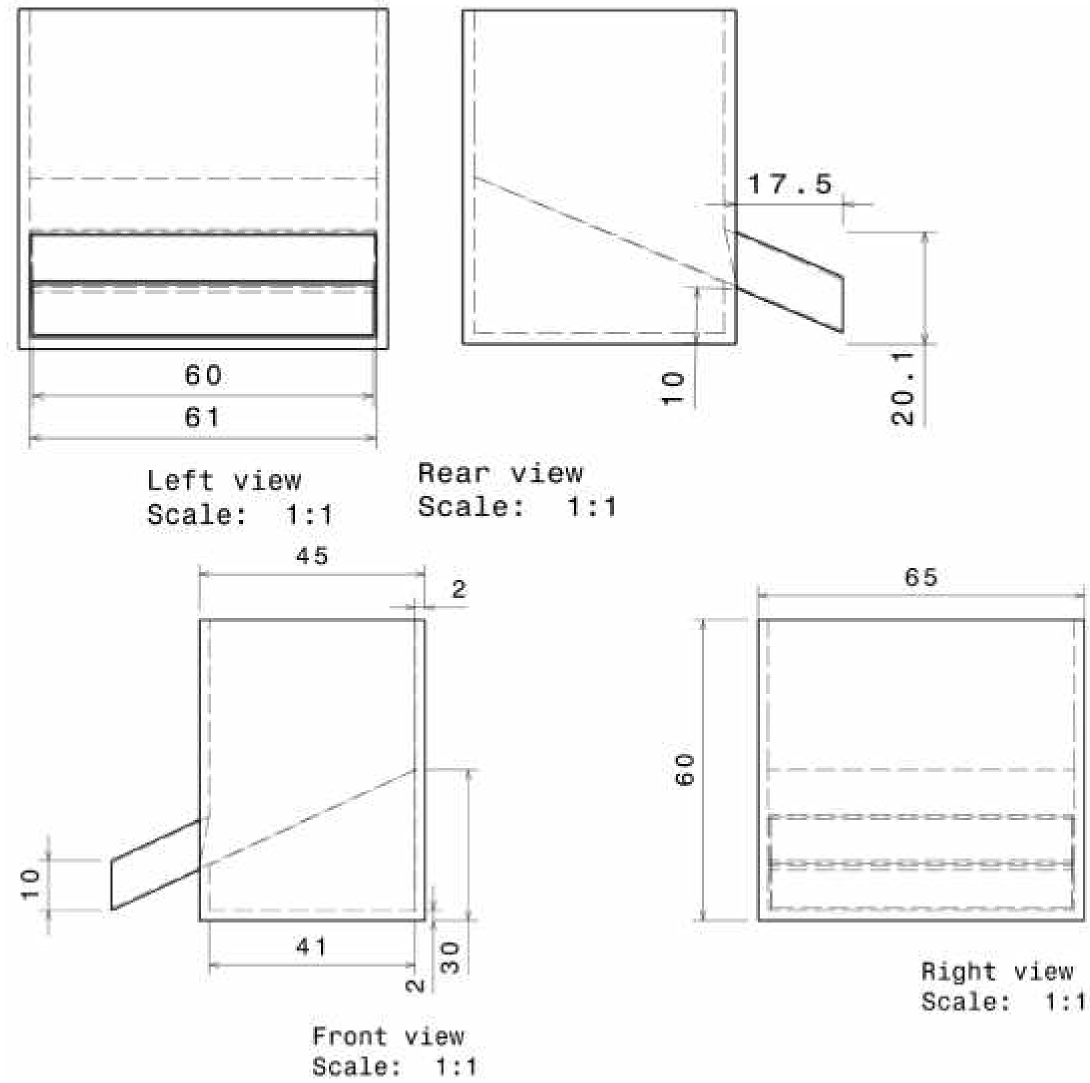


Figure 4.3 shafts container design drawing by 3rd angle projection

4.5 Conveyor Belt Design

In case of producing a juice from the action of rotating shafts, conveyor belt should be designed to keep this juice in it and not sliding outside the conveyor belt.

According to this assumption the conveyor belt sides is to be closed at a certain height. Another problem is found that the last one does need an initial tension. So the new design is to select another type of belts to do the perfect job and is the flat belt.

the conveyer belt consist of two cylinders of the same diameters having D=15cm in diameter. Flat-belt drives produce very little noise and absorb more torsional vibration [9].

The values given in Table 4–5 for the allowable belt tension are based on a belt speed of 600 ft/min. For higher speeds

Table 4-5 Properties of Some Flat- and Round-Belt Materials.

Material	Specification	Size, in	Minimum Pulley Diameter, in	Allowable Tension per Unit Width at 600 ft/min, lbf/in	Specific Weight, lbf/in³	Coeffici of Frict
Leather	1 ply	$t = \frac{11}{64}$	3	30	0.035–0.045	0.4
		$t = \frac{13}{64}$	$3\frac{1}{2}$	33	0.035–0.045	0.4
	2 ply	$t = \frac{18}{64}$	$4\frac{1}{2}$	41	0.035–0.045	0.4
		$t = \frac{20}{64}$	6^a	50	0.035–0.045	0.4
		$t = \frac{23}{64}$	9^a	60	0.035–0.045	0.4
Polyamide[b]	F–0[c]	$t = 0.03$	0.60	10	0.035	0.5
	F–1[c]	$t = 0.05$	1.0	35	0.035	0.5
	F–2[c]	$t = 0.07$	2.4	60	0.051	0.5
	A–2[c]	$t = 0.11$	2.4	60	0.037	0.8
	A–3[c]	$t = 0.13$	4.3	100	0.042	0.8
	A–4[c]	$t = 0.20$	9.5	175	0.039	0.8
	A–5[c]	$t = 0.25$	13.5	275	0.039	0.8
Urethane[d]	$w = 0.50$	$t = 0.062$	See	5.2^e	0.038–0.045	0.7
	$w = 0.75$	$t = 0.078$	Table	9.8^e	0.038–0.045	0.7
	$w = 1.25$	$t = 0.090$	17–3	18.9^e	0.038–0.045	0.7
	Round	$d = \frac{1}{4}$	See	8.3^e	0.038–0.045	0.7
		$d = \frac{3}{8}$	Table	18.6^e	0.038–0.045	0.7
		$d = \frac{1}{2}$	17–3	33.0^e	0.038–0.045	0.7
		$d = \frac{3}{4}$		74.3^e	0.038–0.045	0.7

The belt is to be made of polyamide A-3

$$\theta_d = \pi - 2\sin^{-1}\frac{D-d}{2C} \qquad (4-15)$$

Where

D= diameter of large pulley

d= diameter of small pulley

C= center distance

θ= angle of contact

L=the length of the belt

$$\theta_D = \pi + 2\sin^{-1}\frac{D-d}{2C} \quad 4-16$$

$$L = \sqrt{4C^2 - (D-d)^2} + \frac{1}{2}(D\theta_D + d\theta_d) \ [5] \qquad (4-17)$$

Where the center distance C=80cm, D=15cm, d=15cm, b =60cm.

$\theta_d = \pi - 2\ \sin^{-1} 0 = 180^\circ$

$\theta_D = \pi + 2\sin^{-1} 0 = 180.0^\circ$

$L = \sqrt{4 * 80^2 - (20 - 20)^2} + \frac{1}{2}(15 * 180 + 15 * 180) = 2860mm = 290cm$

$$\upsilon = \pi dn \qquad (4-18)$$

υ=282.6 m/min=4.71 m/sec

$$w = 12\gamma bt \quad \left(\frac{lbf}{ft}\right) \qquad (4-19)$$

Where

w: The weight *w* of a foot of belt

γ:the weight density *γ* in lbf/in^3

b: belt width , in

t: thickness , in

υ:The velocity.

$$w = 12 * 0.042 * 23.62 * 0.13 = 15.47 \quad \left(\frac{lbf}{ft}\right) = 22.6 \ \left(\frac{N}{m}\right)$$

$$F_c = \frac{w}{g}\left(\frac{V}{60}\right)^2 \qquad (4-20)$$

Fc = hoop tension due to centrifugal force

$$F_c = \frac{226}{9.81}\left(\frac{4.71}{60}\right)^2 = 0.014\ N$$

The belt cylinder is to be hollow of outer diameter of 17cm and inner diameter of 15cm; such that in the shaft size, so the volume is to be $0.18 * 10^{-3} m^3$

At force of 15N,Thebelt rotates at low speed at 600rpm=21 rad/sec. The required force to rotate the belt and the grape, and weight at it respectively is to be

Weight of grape + 2* weight of roll + weight of conveyer

Total force=0.5kg*10 + 2*0.15+3=11 N

$T = F * R = 11 * 0.1 = 1.1 N.m$

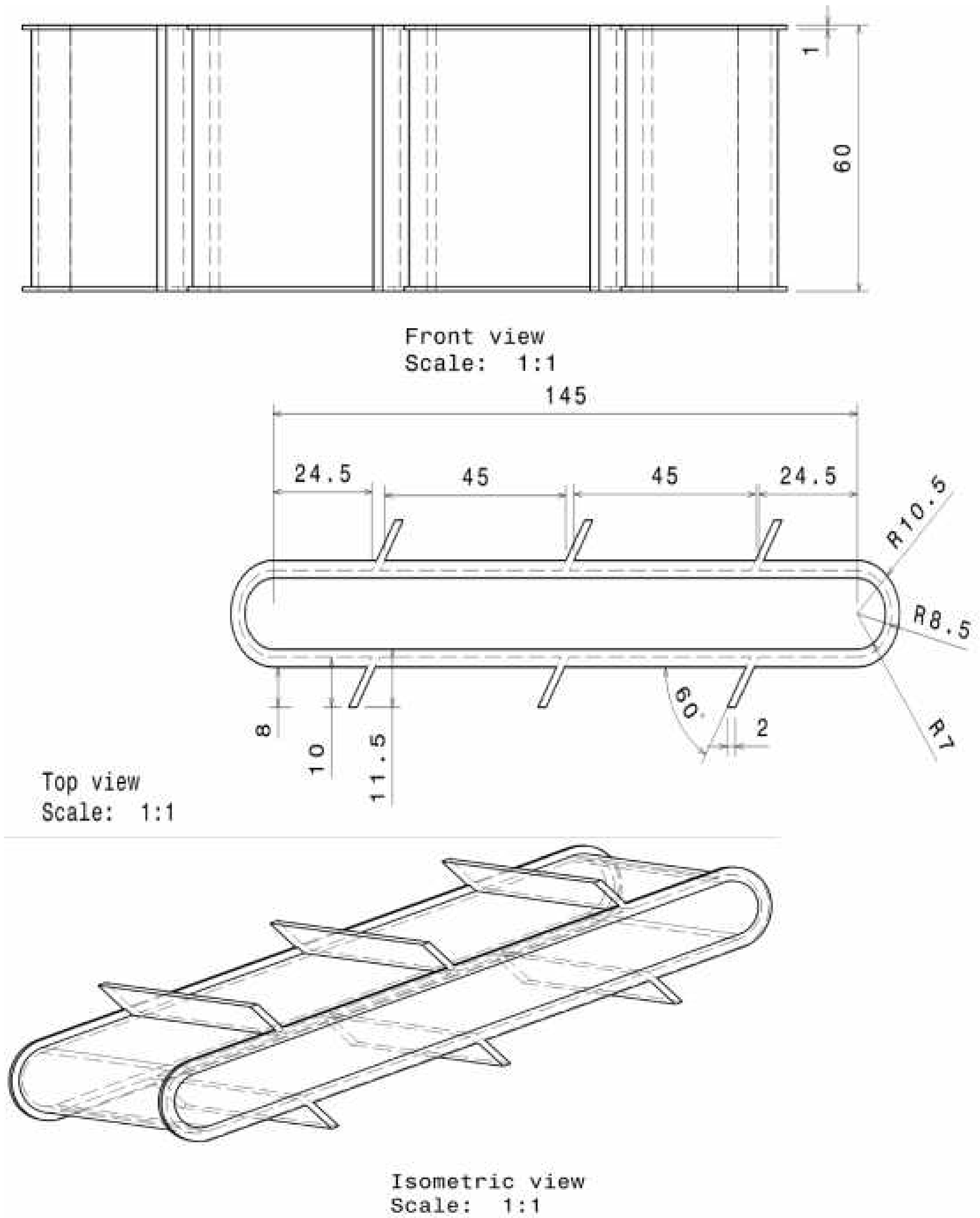


Figure 4-4 conveyer belt

4.6 Pressing system

A pneumatic system "as shown in fig.4.9" is to be used in this machine since the power screw mechanism is too expensive for us to use and the hydraulic system can't be used in this machine because it cause dirt for the juice.

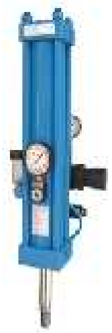


Figure 4.5pneumatic pressing systempiston.

After the pressing system is done.The next step is to push the squeezed tank to the rubbish tank by the mean of another pneumatic piston as shown in fig 4.9.

the force to be pressed is 25 kg plus 1kg of the steel piece that attach to the piston, and the area is to be $60\ cm\ length * 60\ cm\ width = 0.36\ m^2$

then the pressure needed is to be

$$pressure = \frac{Force}{area} = \frac{26}{0.36} = 722.2\ Pascal = 722.2 * 10^{-5} bar$$

The used piston can work on 5 bar and can handle the used pressure

4.7 Tank "for Squeezing" Design

This tank is supposed to handle 25 kg of the smashed grape and by experiment these amount of weight have a volume to be the mass divided by the density of the grape (1.54g/cm3)

$$V = \frac{m}{\rho} = \frac{25000}{1.45} = 17242 cm^3$$

is the volume of the tank

And the volume is to be the base area multiplying by the height, assuming the radius of the tank is to be 15cm, and then the height is

$17242 = \pi * 15^2 * H$

$$H = \frac{17272}{\pi * 15^2} = 25cm$$

Allow a clearance of 5 cm for the tank diameter, 10cm for the height. Then the final size of the tank is to have:

D=40cm in diameter

H=40 cm long

The tank is designed to be open from the bottom and from the top of the tank. The tank design is allowing just the juice to get out from the tank. This is done by drilling the tank with a small hole to be 0.5 cm in diameter.

The tank is landing at a blat that is also filter the incoming juice to get a pure juice. Cleaning the tank is done by connecting a slide crank mechanism to move the tank with its rubbish in to a rubbish reservoir the slider crank mechanism is moving by the action of the motor rotation.

The tank is to be made of cast iron, with inner diameter of 40cm, outer diameter of 44cm for the thickness of the tank.

Tank weight is to be the density by the volume

$$V = \pi * (0.22 - .2)^2 * 0.4 = 0.0005024\ m^3$$

$$m = \rho * V = 7840 * 0.0005024 = 4Kg$$

And 2.5N from the grape, the net force is to be 2.5+4=2.9N

This is the force required for the motor to move the tank. Thus the torque required is to be the force by the force arm of the crank slider rod, and it is 60cm.

$$T = F * R = 2.9 * 0.6 = 1.74N.m$$

The reservoir that is containing the juice and the rubbish is drowned in figure 4-15 and its size to be 40X40X20cm

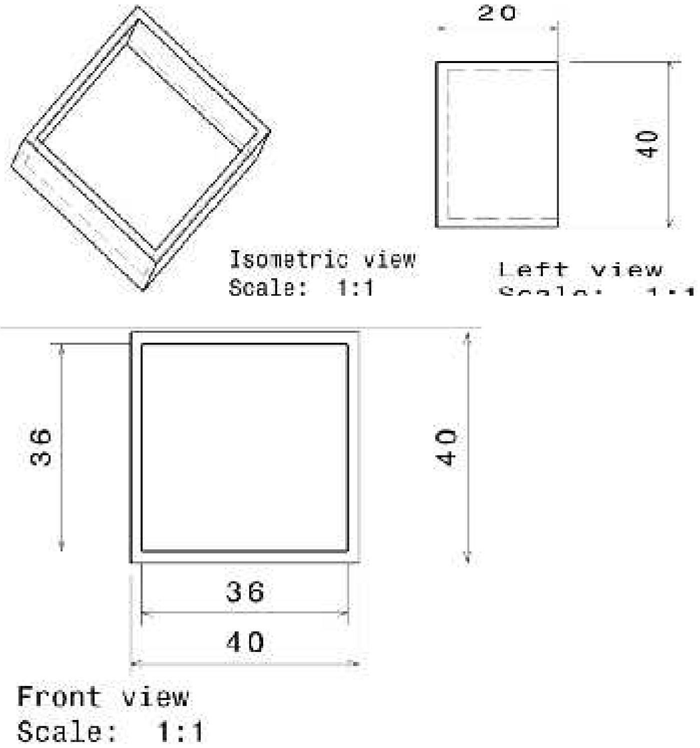


Figure 4.6reservoirs for the juice and the rubbish.

Pushing process:

There is a need for getting out the rest that is no need for it to the rubbish tank and this happens with the pneumatic piston that push the squeezing tank toward the rubbish tank.

The pressure that the squeezing tank applied is the force divided by the area

The tank force is 40N and the area for the square tank is

$$(0.4 + 0.4) * 0.4 = 0.32\text{m}^2$$

$$pressure = \frac{force}{area} = \frac{40}{0.32} = 0.125\ kpa = 125 * 10^{-5} bar$$

So 5 bar of piston pressure can easily push the tank.

5

Chapter Five

Electrical and Control System Design

5.1 Overview

This chapter is illustrating the exact instrument that is used in the squeeze grape machine and the electrical control system of the machine

5.2 Selection of the Motors

The third chapter illustrated the kind of motors that is used in this project and the advantages or disadvantages of each type.

AC motors

A- Rolls motor :

From the produced power that is calculated in chapter 4 The motor with this characteristic is shown below

Type	Rated output		Full speed				Locked rotor current (A)	Tst /TN	Tmax /TN
	KW	HP	Speed rpm	Current (A)	Eff %	Power factor			
Yc712-2	0.25	1/3	2800	2.9	64	0.74	15	3	1.8

The first motor is used in the machine is the one which is responsible of moving the first roll, the torque of the load is (10.7 N.m) and the speed of the rolls 100 rpm.

$$T1 * N1 = T2 * N2 \qquad (5-1)$$

$0.16 * 800 = T2 * 2800$

$T2 = 0.05\ N.m$

Where

T1: the load torque.

N1: The load speed.

T2: The motor torque.

N2: The motor speed.

The output power of the motor

$$P_{out} = T * \omega \qquad 5-2$$

Where

T: Torque.

w: Angular velocity

P_{out}: output power of the motor

$$\omega = \frac{2\pi * N}{60} \qquad (5-3)$$

N: the rated speed of the motor

So the angular velocity

$$\omega = \frac{2 * \pi * 2800}{60} = 293\ rad/s$$

The resultant output power $=$ $0.05 * 293 = 14.65$ watt

In horsepower

$$\frac{14.65}{746} = 0.02\ hp$$

The input power is needed, to get the rated current for the selection of the motor, the needed efficiency is to be 70%.

$$efficincy = \frac{P_{out}}{P_{in}} \qquad (5-4)$$

$$P_{in} = \frac{14.65}{0.7} = 21\ watt$$

$$P_{in} = V * I * PF \qquad (5-5)$$

Pin: Input Power.

V: Rated Voltage.

I: Rated Current.

PF: Power Factor.

The power factor = 0.74, so by using equation 5.4

$$I = \frac{21}{220 * 0.74} = 0.128\ A$$

- The second motor is for the second roll with the same calculations

B- Conveyer motor

The torque of the conveyer motor is 1.1N.m as found in chapter four and the speed is 600 rpm, depending on equation 5.3 the resultant angular velocity for this motor 62.8 rad/second , by using equation 5.2 the output power

$$P_{out} = 62.8 * 1.1 = 69\ watt$$

$$P_{out} in\ hp = \frac{69}{746} = 0.09\ hp$$

The needed efficiency is 70%, from using equation 5.4 the Input power is

$$P_{in} = \frac{69}{0.7} = 98.5\ watt$$

Assuming the power factor is 0.8 so by using equation 5.5 the rated current is

$$I = \frac{89.5}{220 * 0.74} = 0.6\ A$$

5.3 Electrical Instrument

The electrical instrument which will be used for the system consists from electronic components and electro pneumatic components.

5.3.1 Electronic component

A-Voltage Regulators

is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

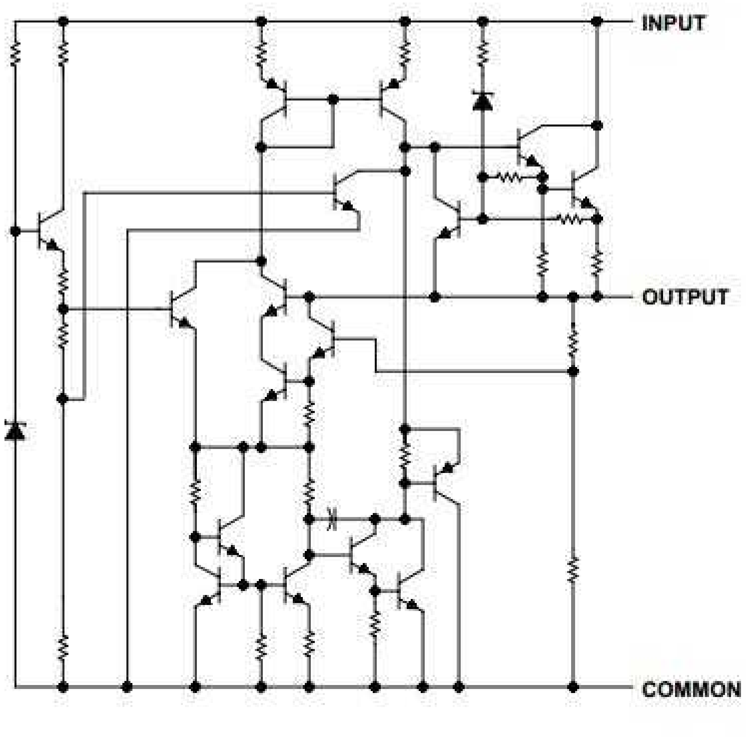


Figure 5.1 internal circuit of voltage regulator

The used regulator in the system is Lm7805 which give pure 5 dc volt we need .

B_ NPN Transistors

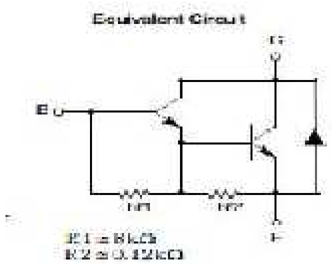


Figure 5.2 internal circuit of NPN transistor

Is a type of transistor that relies on the contact of two types of semiconductor for its operation. BJTs can be used as amplifiers, switches, or in oscillators. BJTs can be found either as individual discrete components, or in large numbers as parts of integrated circuits.

The used transistor in the system is tip122 which has high biasing.

C_ relays

The relay function had been illustrated in section 3.3.7

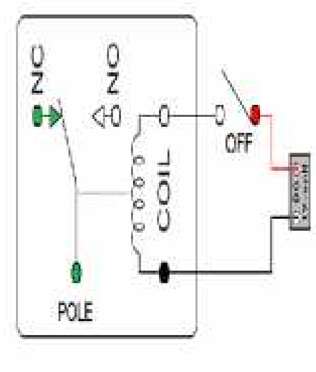


Figure 5.3 internal circuit of the relay

D_ diodes

A diode is a specialized electronic component with two electrodes called the anode and thecathode. Most diodes are made with semiconductor materials such as silicon, germanium, or selenium.

The used diodes in the system is for protecting from reversing current and used as freewheelingdiode .

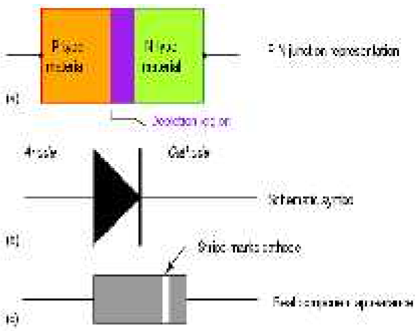


Figure 5.4 symbol and internal circuit of diode

5.3.2 Electro pneumatic system

The electro-pneumatic action is a control system for pipe organs, whereby air pressure, controlled by an electric current and operated by the keys of an organ console, opens and closes valves within wind chests, allowing the pipes to speak. This system also allows the console to be physically detached from the organ itself. The only connection was via an electrical cable from the console to the relay, with some early organ consoles utilizing a separate wind supply to operate combination pistons.

Figure 5.5 electro pneumatic valve.

5.4 Switches and Sensors

Switches are the main keys that are used to turn the machine on/off or as sensors in some cases, in the machine there are three types of switches that are used .

Sensorsare electrical device convert the physical quantity to electrical quantity.

5.4.1 Switches

1_on/off switch

There are two on/off switches in the machine the first one will be used to turn on or off the whole machine which will be connected from the power supply to the power circuit directly, and the second will be for turning on the motors which will be connected from the power supply to the arduinocontroller.

Figure 5.6 the electrical symbol of on/off switch

Figure 5.7 on/off switch

2_ Limit switches

There is one limit switch in the system and its function is to define the position if the first tank reaches the last limit of its distance while emptying it. The limit switch will be connected from the power supply to the arduino controller.

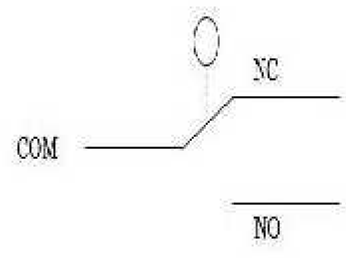


Figure 5.8 the electrical symbol of limit switch

Figure 5.9 limit switch

3_Emergency switch

The switch is used to stop equipment and facilities in emergencies. And it will be connected from the power supply to the arduino controller.

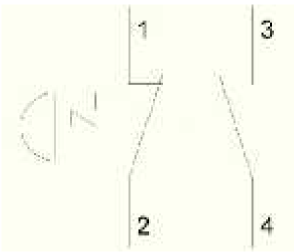


Figure 5.10 the electrical symbol of emergency switch

Figure 5.11 Emergency switch

5.4.2 Sensors

Sensorsare electrical device convert the physical quantity to electrical quantity thismachinecontain three sensors.

There are two sensors which are Adjustable IR Reflection Sensors and is used to identify the level in the first and the third tank.

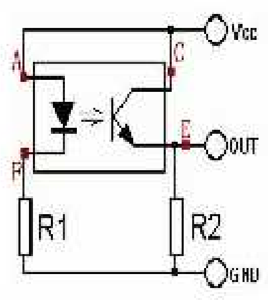


Figure 5.12 the electrical circuit of the sensor

Figure 5.13 Adjustable IR Reflection Sensors

5.5 Arduino Microcontroller

The main controller of the system is the arduinoUno which is the brain of the all system which will be programmed in the sequence of the machine which will be illustrated in section 5.6 .

The Arduino Uno is a microcontroller board based on the ATmega328 .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

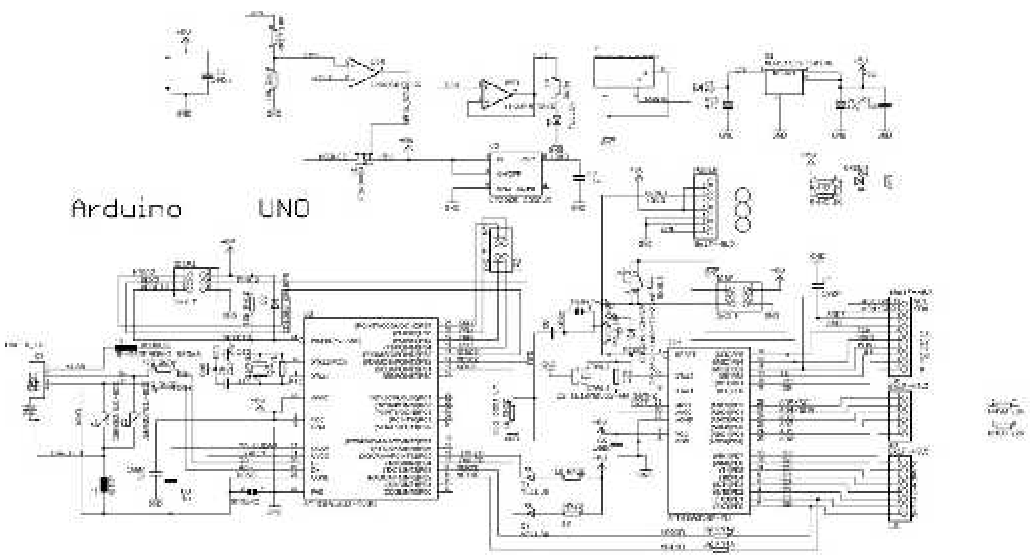


Figure 5.14 arduinoUno internal circuit

Figure 5.15 arduinoUno kit

5.5Control sequence

The sequence of the squeezing operation will go on through multi stage and they are as follows

1_ Turn the machine on.

2_Turn the motors' switch on , when the motors switch is turning on the signal will go through the arduino which will give the conveyer's motor and the rolls motors to begin until the first tank being filled with smashed grape .

3_When the first tank become full which will be examined by first sensor, the sensor will give signal to arduino.

4_After that the arduino will turn off the motors and give the first electro-pneumatic valve to work .

5_The cylinder will go down beginning squeezing the smashed grape in order to squeeze it **,**and this operation will be repeated three times in order to be sure that all smashed grape has been squeezed.

6_After that the arduino will turn-off the first electro-pneumaticvalveand turn on the second electro-pneumatic valve to move the tank in order to empty it in the third tank.

7_When the moved tank hit the limit switch , the limit switch will give signal to arduino and the arduino will turn of the second electro-pneumatic valve which will move the first tank back.

8_The all operation will be repeated until getting signal from the second sensor which illustrate the level in the tank of the rest of the grape if it got filled full and that will turn off the all system until emptying the last tank.

9_In case of emergency or danger there is emergency switch which will turn of the total system.

5.6Control circuits

There are two main interface circuits in the electrical system between the controller (arduino) and the electrical laod .the first one for the motor and the second one for electro-pneumatic valve.

5.7.1 Motor control circuit

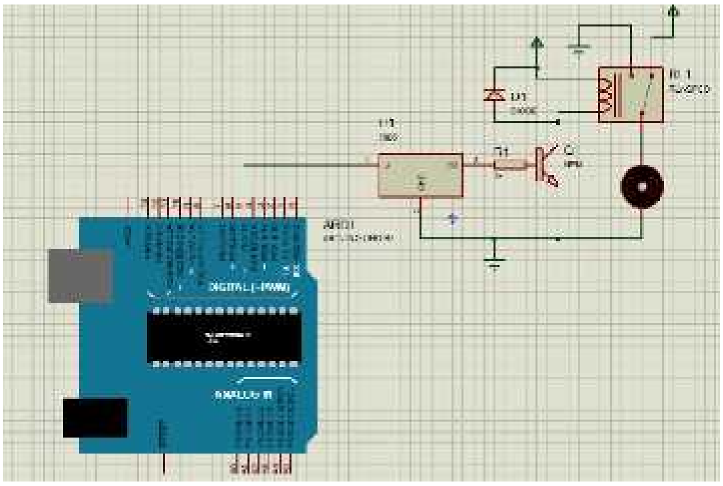


Figure 5.16 motor control circuit

The circuit consists from 5 volt regulator, 1kilo ohm resistance,NPN tip122 transistor, relay and freewheelingdiode.

Each component in the circuit and its function has been illustrated previous in this chapter.

This circuit is responsible for driving the motor and protecting the arduino from the load , when the arduino give out signal the regulator make the signal pure and this signal which will activate the bias of the transistor then the transistor activate the coil if the relay after that the relay will turn on from N.C to N.O will pass the current to the motor and finally the diode is for protecting from the freewheeling diode.

5.7.2 electro-pneumatic valve

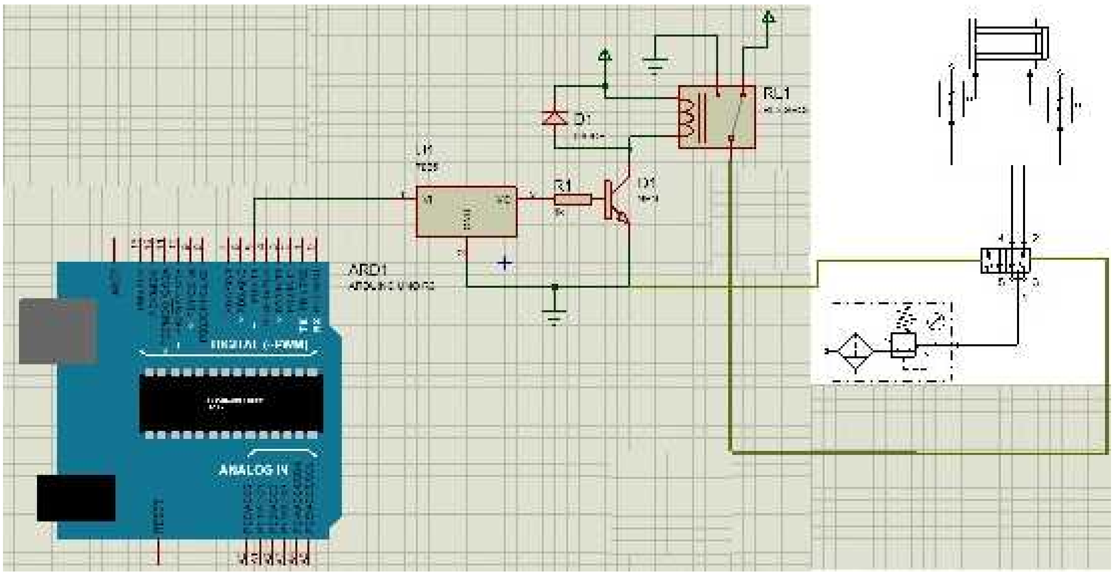


Figure 5.17 elect pneumatic control circuit

This circuit has the same component as previous one and with the same operation butits different in the load.

The load here has tow throttling in order to control the pressure of the air in the cylinder, when the current pass in the solenoid of the selector will let the air pass to move the cylinder go on and when the current is off the cylinder will let the air pass from the another chamber to get the cylinder back.

5.7.3 Thetotal control circuit

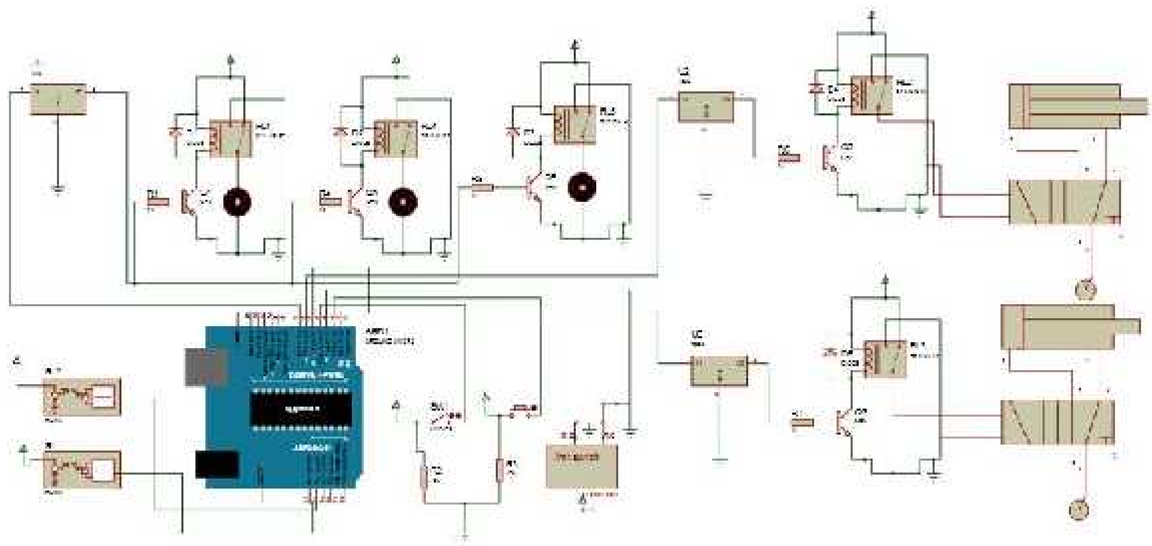


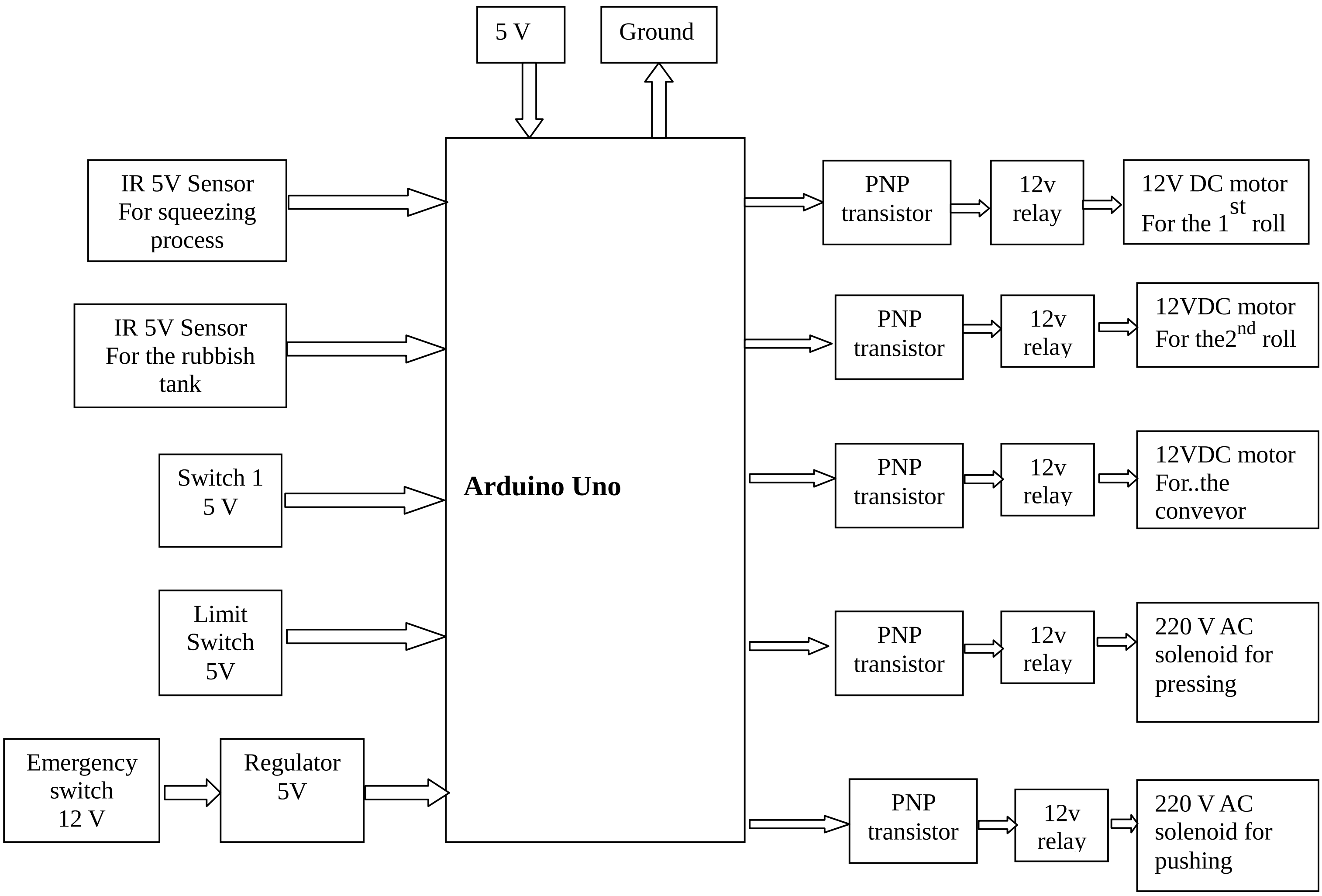
Figure 5.18the total control circuit

The previous circuit shows the total electrical and electro_pneumatic systems And each component has been illustrated and each circuit has been explained previously.

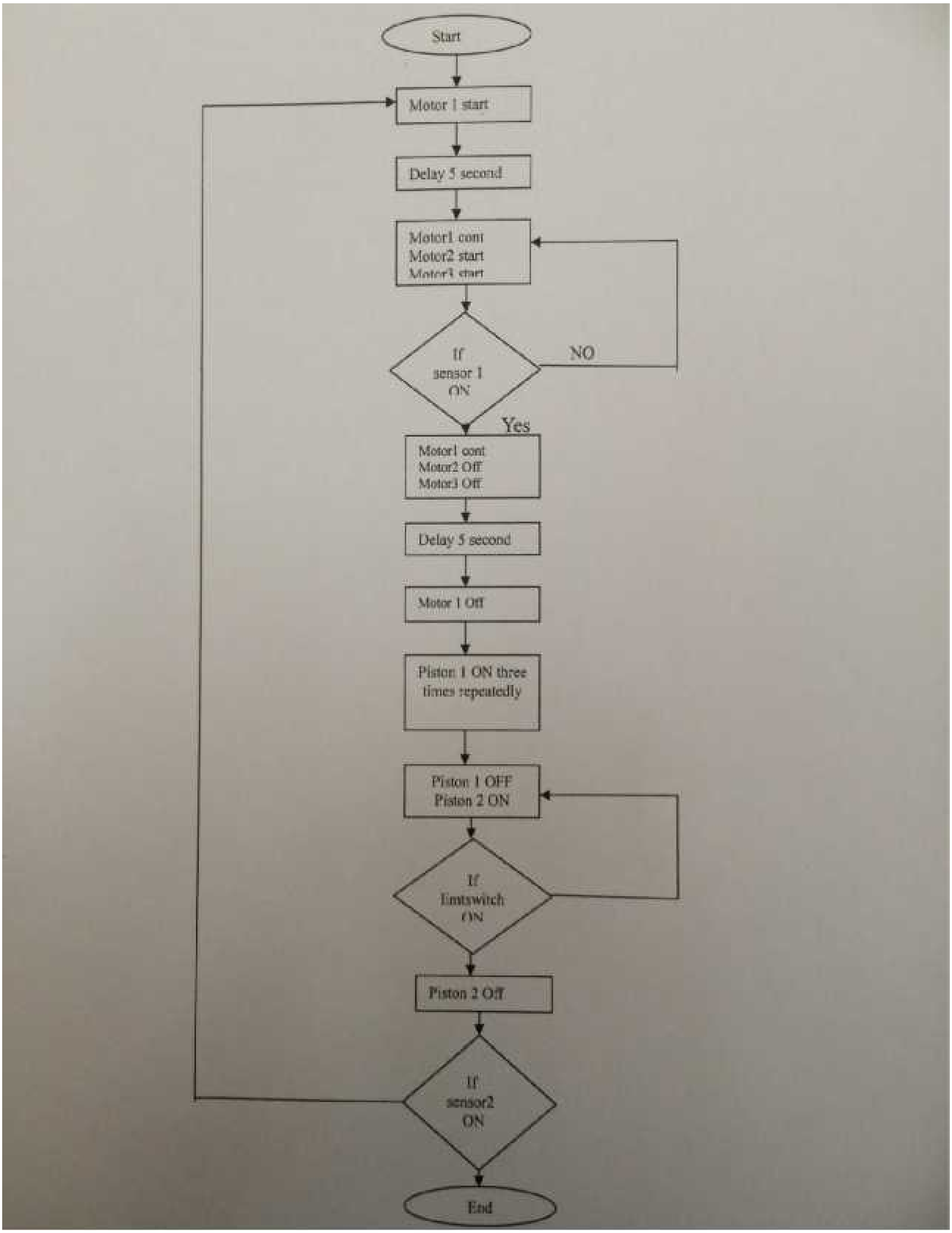
Note: the second motor will work counter clock wise but the other will work clock wise.

5.8 System Block Diagram and Flow Chart

5.8.1 System Block Diagram


5 V
Ground
IR 5V Sensor For squeezing process
IR 5V Sensor For the rubbish tank
Switch 1 5 V
Limit Switch 5V
Emergency switch 12 V
Regulator 5V
Arduino Uno
PNP transistor
12v relay
12V DC motor For the 1st roll
PNP transistor
12v relay
12VDC motor For the2nd roll
PNP transistor
12v relay
12VDC motor For..the conveyor
PNP transistor
12v relay
220 V AC solenoid for pressing
PNP transistor
12v relay
220 V AC solenoid for pushing

5.8.2 Flow chart of the machine system



6

Chapter six

Implementation and Recommendation

6.1 Overview

This chapter illustrates the mechanical and electrical implemented systems. and shows the implemented body.

6.2 Implemented Mechanical System

In this section all mechanical parts are shown. Thus the implemented machine parts are as follows:

- ✓ Rotating rolls
- ✓ Conveyor belt
- ✓ Pneumatic pistons
- ✓ Container tanks
- ✓ Structural case for the overall machine.

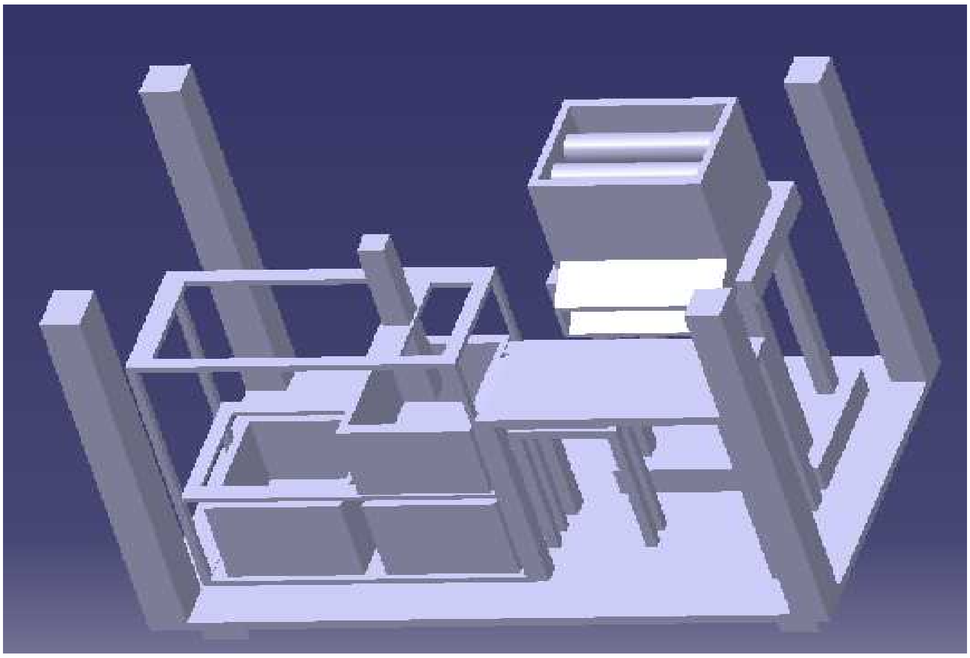


Figure 6.1:implemented grape squeeze machine using Catia program

6.2.1 Implemented rotating rolls and its container

The used rolls dimensions is 5cm outer diameter for each roll, a thickness of 4 mm and 30 cm long

The volume of this roll is

$$volum = V = \pi * \; D - d \;^2 * l = \pi * \; 5 - 4.6 \;^2 * 0.3 = 0.015 * 10^{-3} \, m^3$$

The density of the cast iron is to be 7840 kg/m3.

So the mass of it is $mass = M = 7840 * 0.015 * 10^{-3} = 0.120 \, kg$

The container that the rolls is inside it has the following dimensions

The container length is 20 cm, 20 cm width and 15 cm height.

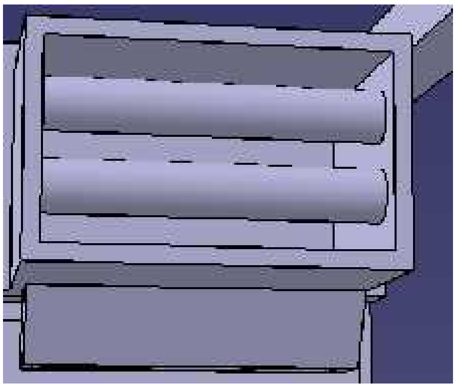


Figure 6.2: implemented rolls for the smashing process of the grape.

6.2.2 Implemented conveyor belt

The used conveyor belt is 50 cm length and 20 cm width.

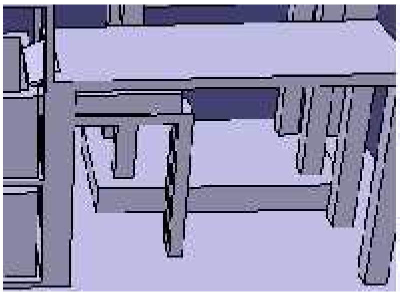


Figure 6.3 : implemented conveyor belt

6.2.3 Implemented pressing system

Two pneumatic pistons are used in this machine working at 4 bar, one for the pressing part and another for pushing the squeezing tank to the rubbish tank.

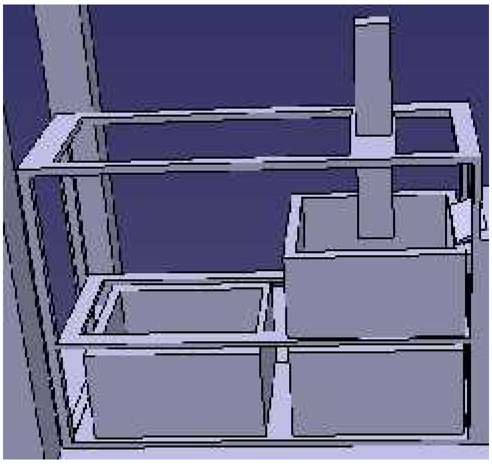


Figure 6.4 : implemented pneumatic pressing system.

6.2.3 Implemented squeezing container tanks

There is three container tanks. One is used for the pressing system from the pneumatic piston, this tank has no base, so under it there is small piece of steel that is Pierced with small holes of around 5mm in diameter.

The dimensions of this tank are 20cm length, 20 cm width and 15 cm height.

The second tank is used for the cleared juice that is placed under the squeezing container tank.

The last tank is used for the rubbish that the pushing pneumatic piston is push the squeezing tank towards it

6.2.3 Implemented structural case for the overall machine

The machine is welded well in the structure with its specific dimensions, and with tolerances of $\pm$ 4 mm.

Structural case for the rolls container dimensions is 22cm length as shown in figure 6.1.

6.3 Implemented Electrical System

6.3.1 Used motors

The used motors are universal series motors which can be used as an ac/dc motor has a rated power 50 watt and implemented voltage 12 volt .

6.3.1.1 Rolls' motors

Figure 6.5 :ZD2531D motor.

The scale between theoretical and implemented values of the motor.
1:10.

Rated values of the used motors:

Rated voltage : 12 volt.
Rated power : 50 watt.
No_loadcurrent :2.5 ampere.
No_loadspeed : 65 rpm.
Load current : 5 ampere.
Load speed : 40 rpm .
6.3.1.2 Conveyor belt motor

The scale between theoretical and implemented values of the motor.
1: 5.

Rated values of the used motors:

Rated voltage : 12 volt.
Rated power : 150 watt.
No_loadcurrent : 2.5 ampere.
No_loadspeed : 65 rpm.
Load current : 5 ampere.
Load speed : 40 rpm .

6.3.2 Implemented Control circuit

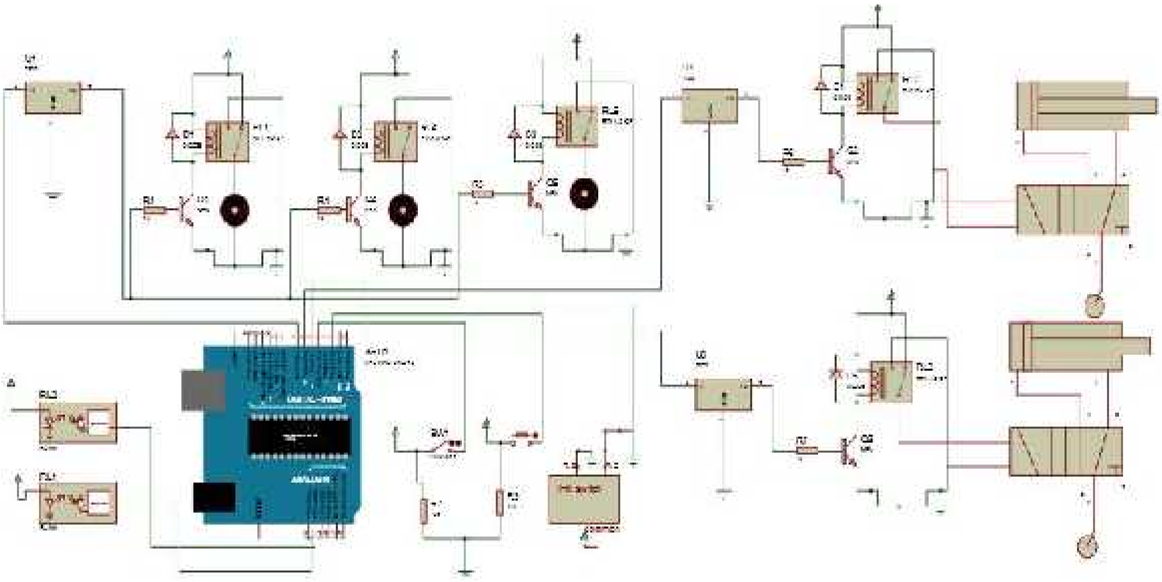


Figure 6.5: implemented control circuit using arduino Uno programming device

Components:

1_12dc/230ac relay.

2_ transistor npn tip122

3_5volt regulator.

4_resistors 1k ohm.

5_ 5 v infrared sensor (3-80)cm.

6_silicon diode.

7_electro pneumatic solenoid .

8_arduino Uno.

9_on/off switches.

10_emergency switch.

11_limit switch.

12_ac source.

13_dc power supply

6.4 Recommendation

1_use the same model that has been illustrated in chapters 4 and 5 .

2_use stainless steel for the machine to have high accuracy.

```
 if( (digitalRead(I1)==HIGH) && stage==1 )
  stage=2;
 if(analogRead(A2)<512 && stage==2)
  stage=3;

// if(analogRead(A2)>512 && stage==8)
 // stage=6;
if((digitalRead(Limit_switch)==HIGH) && stage==8)
 stage=6;

  if(analogRead(A0)<512 )
stage=9;
 switch(stage)
 {
  case 1:
  delay(1000);

  break;

  case 2:
  digitalWrite(Q0,HIGH);
   delay(3000);
  digitalWrite(Q1,HIGH);
  digitalWrite(Q2,LOW);
  digitalWrite(Q3,LOW);
  delay(1000);

  break;

  case 3:
  for (int i =0;i<3;i++)
  {
  digitalWrite(Q1,LOW);
   delay (2000);
  digitalWrite(Q0,LOW);
  delay(1000);
  digitalWrite(Q2,HIGH);
 delay (3000);
  digitalWrite(Q0,LOW);
  digitalWrite(Q1,LOW);
  digitalWrite(Q2,LOW);
//delay (3000);
 }
```

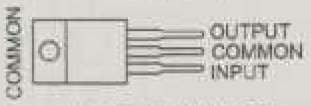
```
stage=4;
break;

case 4:
// delay(60000);
delay(3000);

digitalWrite(Q1,LOW);
digitalWrite(Q2,LOW);
stage=5;
delay(1000);
break;

case 5:
digitalWrite(Q0,LOW);
digitalWrite(Q1,LOW);
digitalWrite(Q2,LOW);
digitalWrite(Q3,HIGH);
stage=8;


break;

case 6:
digitalWrite(Q0,LOW);
digitalWrite(Q1,LOW);
digitalWrite(Q2,LOW);
digitalWrite(Q3,LOW);
stage=7;
break;

case 7:
// delay(10000);
delay(1000);
stage=1;
break;

case 8:
//delay(500);
break;

case 9:
digitalWrite(Q0,LOW);
```

```
   digitalWrite(Q1,LOW);
   digitalWrite(Q2,LOW);
   digitalWrite(Q3,LOW);
      break;

  }
  }


//void EME()
/*{   digitalWrite(Q0,LOW);
   digitalWrite(Q1,LOW);
   digitalWrite(Q2,LOW);
   digitalWrite(Q3,LOW);
   stage=1;
   Serial.println("EME");

   delay(2000);

}*/
```

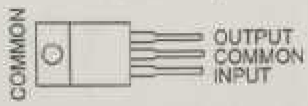
Appendix B

- 3-Terminal Regulators
- Output Current up to 1.5 A
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation

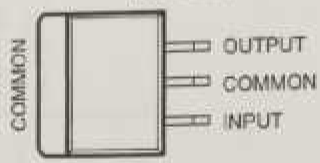
KC (TO-220) PACKAGE
(TOP VIEW)



KCS (TO-220) PACKAGE
(TOP VIEW)



KTE PACKAGE
(TOP VIEW)



description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

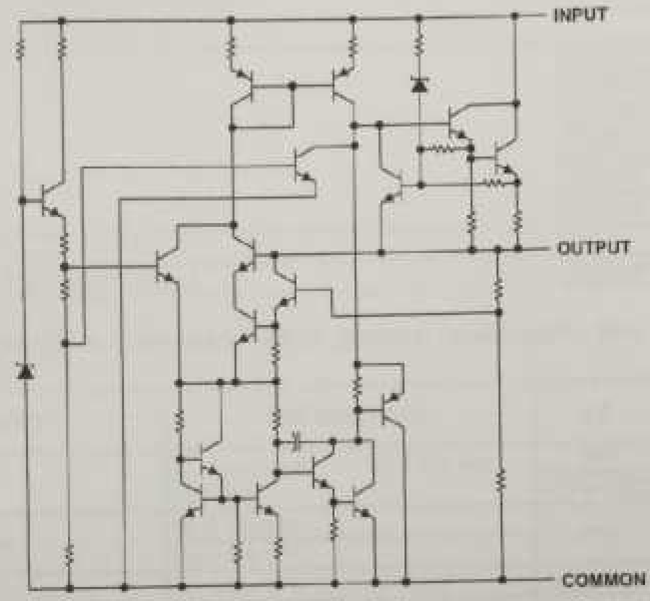
ORDERING INFORMATION

T_J	$V_{O(NOM)}$ (V)	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 125°C	5	POWER-FLEX (KTE)	Reel of 2000	µA7805CKTER	µA7805C
		TO-220 (KC)	Tube of 50	µA7805CKC	µA7805C
		TO-220, short shoulder (KCS)	Tube of 20	µA7805CKCS	
	8	POWER-FLEX (KTE)	Reel of 2000	µA7808CKTER	µA7808C
		TO-220 (KC)	Tube of 50	µA7808CKC	µA7808C
		TO-220, short shoulder (KCS)	Tube of 20	µA7808CKCS	
	10	POWER-FLEX (KTE)	Reel of 2000	µA7810CKTER	µA7810C
		TO-220 (KC)	Tube of 50	µA7810CKC	µA7810C
	12	POWER-FLEX (KTE)	Reel of 2000	µA7812CKTER	µA7812C
		TO-220 (KC)	Tube of 50	µA7812CKC	µA7812C
		TO-220, short shoulder (KCS)	Tube of 20	µA7812CKCS	
	15	POWER-FLEX (KTE)	Reel of 2000	µA7815CKTER	µA7815C
		TO-220 (KC)	Tube of 50	µA7815CKC	µA7815C
		TO-220, short shoulder (KCS)	Tube of 20	µA7815CKCS	
	24	POWER-FLEX (KTE)	Reel of 2000	µA7824CKTER	µA7824C
		TO-220 (KC)	Tube of 50	µA7824CKC	µA7824C

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

schematic



absolute maximum ratings over virtual junction temperature range (unless otherwise noted)†

Input voltage, V_I:	µA7824C	40 V
	All others	35 V
Operating virtual junction temperature, T_J		150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		260°C
Storage temperature range, T_{stg}		–65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

package thermal data (see Note 1)

PACKAGE	BOARD	θ_{JC}	θ_{JA}
POWER-FLEX (KTE)	High K, JESD 51-5	3°C/W	23°C/W
TO-220 (KC/KCS)	High K, JESD 51-5	3°C/W	19°C/W

NOTE 1: Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

recommended operating conditions

			MIN	MAX	UNIT
V_I	Input voltage	µA7805C	7	25	V
		µA7808C	10.5	25	
		µA7810C	12.5	28	
		µA7812C	14.5	30	
		µA7815C	17.5	30	
		µA7824C	27	38	
I_O	Output current			1.5	A
T_J	Operating virtual junction temperature	µA7800C series	0	125	°C

electrical characteristics at specified virtual junction temperature, V_I = 10 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7805C MIN	µA7805C TYP	µA7805C MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 7 V to 20 V, $P_D \le$ 15 W	25°C	4.8	5	5.2	V
		0°C to 125°C	4.75		5.25	
Input voltage regulation	V_I = 7 V to 25 V	25°C		3	100	mV
	V_I = 8 V to 12 V			1	50	
Ripple rejection	V_I = 8 V to 18 V, f = 120 Hz	0°C to 125°C	62	78		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		15	100	mV
	I_O = 250 mA to 750 mA			5	50	
Output resistance	f = 1 kHz	0°C to 125°C		0.017		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−1.1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		40		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.2	8	mA
Bias current change	V_I = 7 V to 25 V	0°C to 125°C			1.3	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		750		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, V_I = 14 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7808C MIN	µA7808C TYP	µA7808C MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 10.5 V to 23 V, $P_D \le 15$ W	25°C	7.7	8	8.3	V
		0°C to 125°C	7.6		8.4	
Input voltage regulation	V_I = 10.5 V to 25 V	25°C		6	160	mV
	V_I = 11 V to 17 V			2	80	
Ripple rejection	V_I = 11.5 V to 21.5 V, f = 120 Hz	0°C to 125°C	55	72		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		12	160	mV
	I_O = 250 mA to 750 mA			4	80	
Output resistance	f = 1 kHz	0°C to 125°C		0.016		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−0.8		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		52		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	V_I = 10.5 V to 25 V	0°C to 125°C			1	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		450		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, V_I = 17 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7810C MIN	µA7810C TYP	µA7810C MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 12.5 V to 25 V, $P_D \le 15$ W	25°C	9.6	10	10.4	V
		0°C to 125°C	9.5	10	10.5	
Input voltage regulation	V_I = 12.5 V to 28 V	25°C		7	200	mV
	V_I = 14 V to 20 V			2	100	
Ripple rejection	V_I = 13 V to 23 V, f = 120 Hz	0°C to 125°C	55	71		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		12	200	mV
	I_O = 250 mA to 750 mA			4	100	
Output resistance	f = 1 kHz	0°C to 125°C		0.018		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		70		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	V_I = 12.5 V to 28 V	0°C to 125°C			1	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		400		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, V_I = 19 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7812C MIN	µA7812C TYP	µA7812C MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 14.5 V to 27 V, $P_D \leq$ 15 W	25°C	11.5	12	12.5	V
		0°C to 125°C	11.4		12.6	
Input voltage regulation	V_I = 14.5 V to 30 V	25°C		10	240	mV
	V_I = 16 V to 22 V			3	120	
Ripple rejection	V_I = 15 V to 25 V, f = 120 Hz	0°C to 125°C	55	71		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		12	240	mV
	I_O = 250 mA to 750 mA			4	120	
Output resistance	f = 1 kHz	0°C to 125°C		0.018		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		75		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.3	8	mA
Bias current change	V_I = 14.5 V to 30 V	0°C to 125°C			1	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		350		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, V_I = 23 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7815C MIN	µA7815C TYP	µA7815C MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 17.5 V to 30 V, $P_D \leq$ 15 W	25°C	14.4	15	15.6	V
		0°C to 125°C	14.25		15.75	
Input voltage regulation	V_I = 17.5 V to 30 V	25°C		11	300	mV
	V_I = 20 V to 26 V			3	150	
Ripple rejection	V_I = 18.5 V to 28.5 V, f = 120 Hz	0°C to 125°C	54	70		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		12	300	mV
	I_O = 250 mA to 750 mA			4	150	
Output resistance	f = 1 kHz	0°C to 125°C		0.019		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		90		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.4	8	mA
Bias current change	V_I = 17.5 V to 30 V	0°C to 125°C			1	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		230		mA
Peak output current		25°C		2.1		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

electrical characteristics at specified virtual junction temperature, V_I = 33 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	µA7824C			UNIT
			MIN	TYP	MAX	
Output voltage	I_O = 5 mA to 1 A, V_I = 27 V to 38 V, P_D ≤ 15 W	25°C	23	24	25	V
		0°C to 125°C	22.8		25.2	
Input voltage regulation	V_I = 27 V to 38 V	25°C		18	480	mV
	V_I = 30 V to 36 V			6	240	
Ripple rejection	V_I = 28 V to 38 V, f = 120 Hz	0°C to 125°C	50	66		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		12	480	mV
	I_O = 250 mA to 750 mA			4	240	
Output resistance	f = 1 kHz	0°C to 125°C		0.028		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		−1.5		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		170		µV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.6	8	mA
Bias current change	V_I = 27 V to 38 V	0°C to 125°C			1	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		150		mA
Peak output current		25°C		2.1		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-µF capacitor across the input and a 0.1-µF capacitor across the output.

APPLICATION INFORMATION

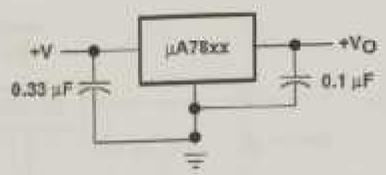
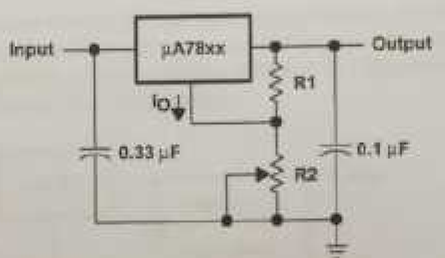


Figure 1. Fixed-Output Regulator

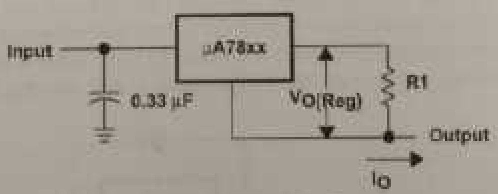
Figure 2. Positive Regulator in Negative Configuration (V_I Must Float)



NOTE A: The following formula is used when V_{xx} is the nominal output voltage (output to common) of the fixed regulator:

$$V_O = V_{xx} + \left(\frac{V_{xx}}{R1} + I_Q\right)R2$$

Figure 3. Adjustable-Output Regulator



$I_O = (V_O/R1) + I_O$ Bias Current

Figure 4. Current Regulator

APPLICATION INFORMATION

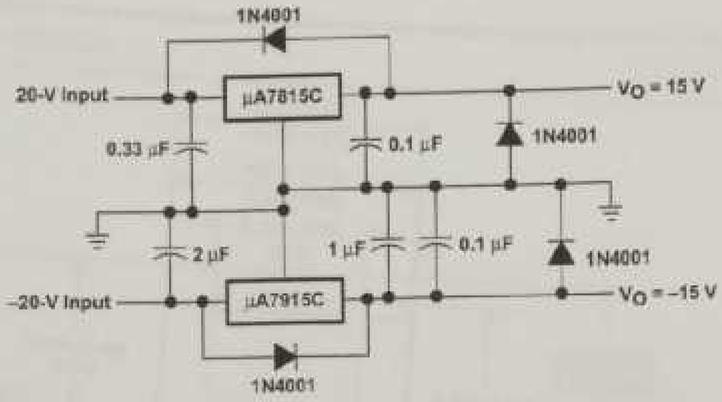


Figure 5. Regulated Dual Supply

operation with a load common to a voltage of opposite polarity

In many cases, a regulator powers a load that is not connected to ground but, instead, is connected to a voltage source of opposite polarity (e.g., operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in Figure 6. This protects the regulator from output polarity reversals during startup and short-circuit operation.

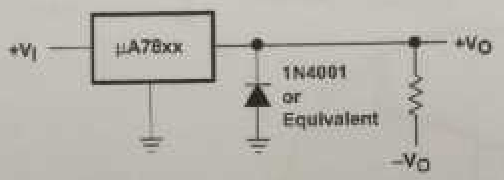


Figure 6. Output Polarity-Reversal-Protection Circuit

reverse-bias protection

Occasionally, the input voltage to the regulator can collapse faster than the output voltage. This can occur, for example, when the input supply is crowbarred during an output overvoltage condition. If the output voltage is greater than approximately 7 V, the emitter-base junction of the series-pass element (internal or external) could break down and be damaged. To prevent this, a diode shunt can be used as shown in Figure 7.

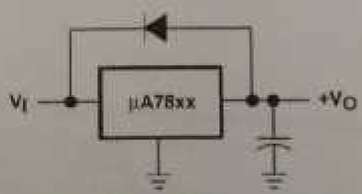
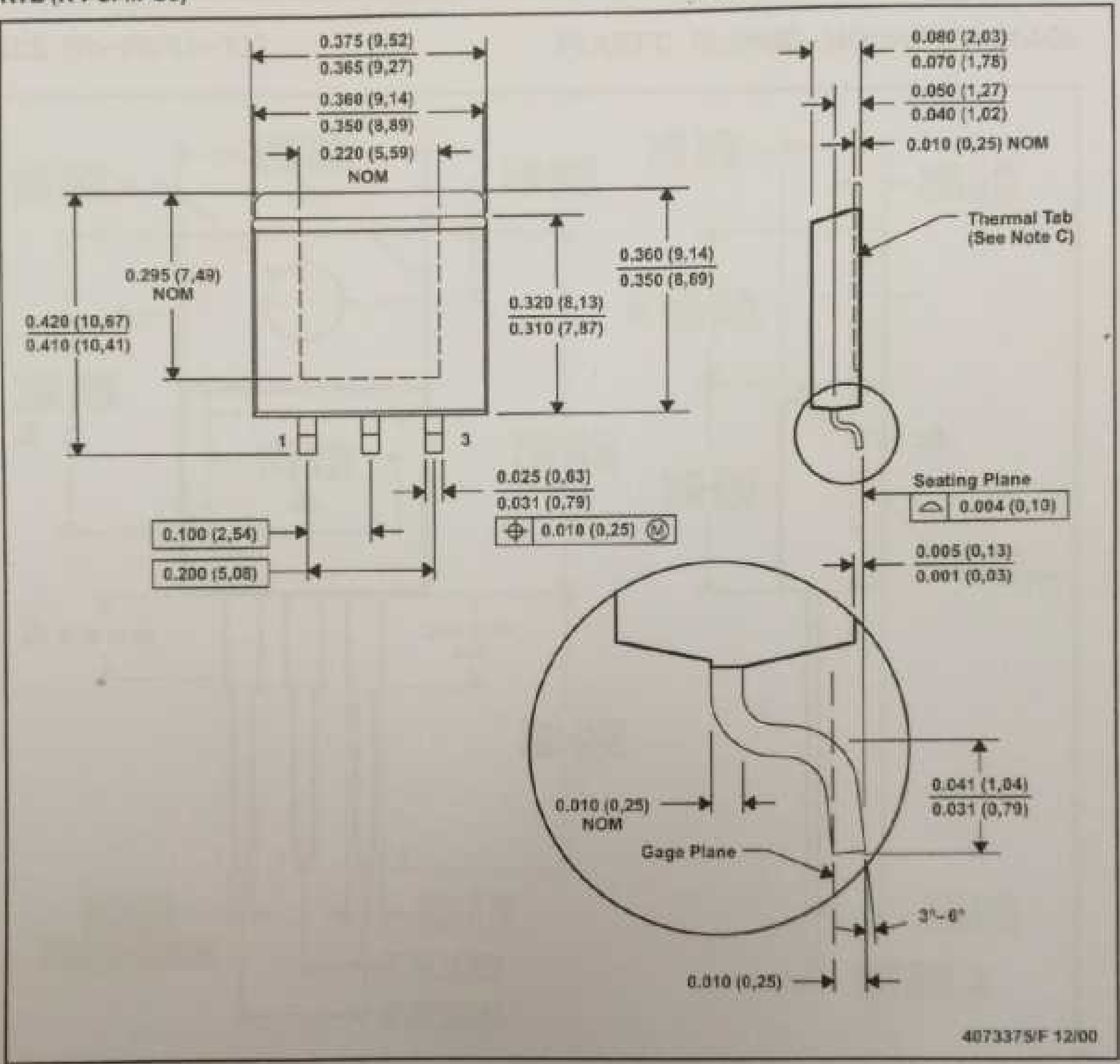


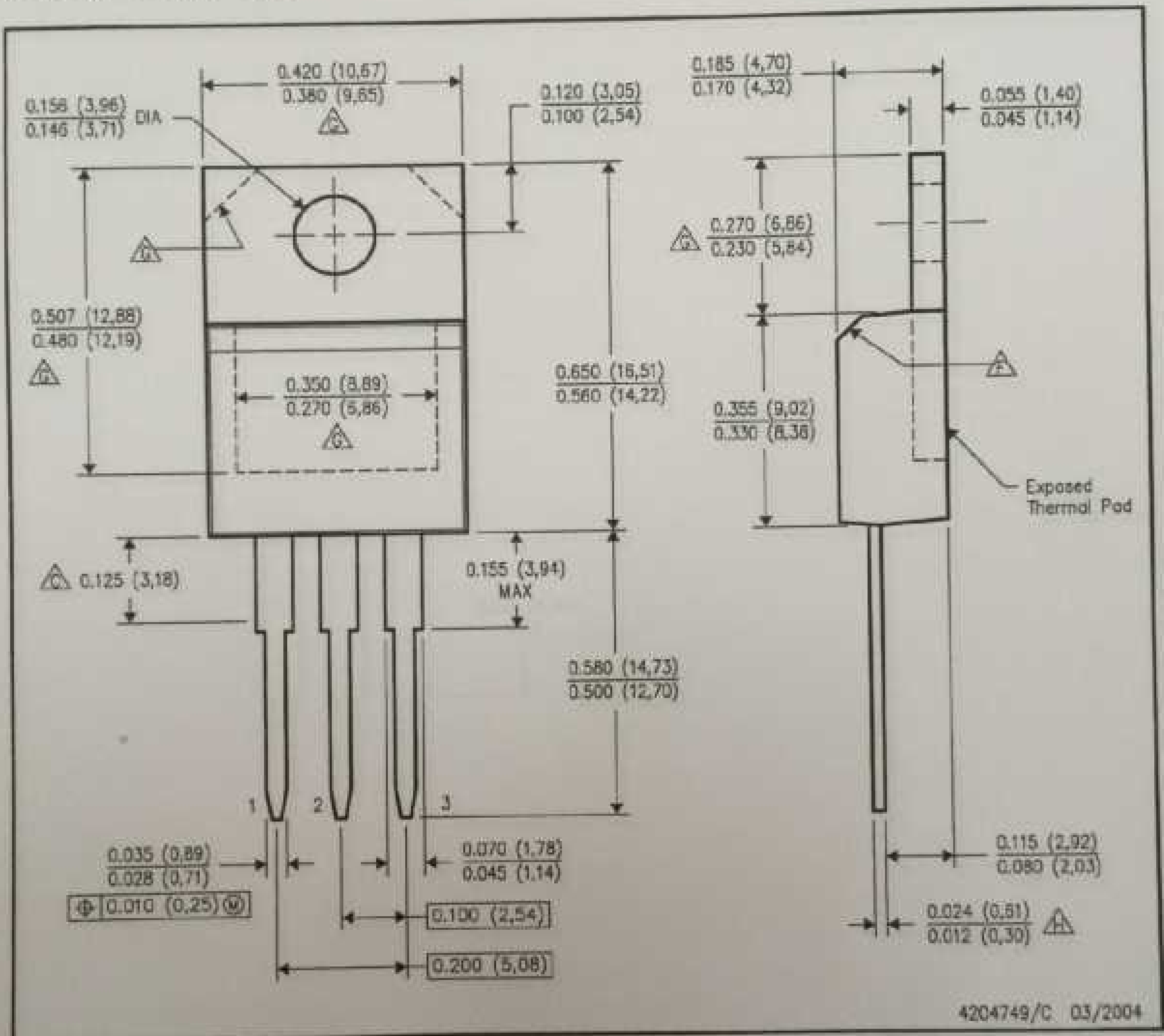
Figure 7. Reverse-Bias-Protection Circuit

KTE (R-PSFM-G3) **PowerFLEX™ PLASTIC FLANGE-MOUNT**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. The center lead is in electrical contact with the thermal tab.
D. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).
E. Falls within JEDEC MO-169

KCS (R–PSFM–T3) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Lead dimensions are not controlled within this area.
- D. All lead dimensions apply before solder dip.
- E. The center lead is in electrical contact with the mounting tab.
- F. The chamfer is optional.
- G. Thermal pad contour optional within these dimensions.
- H. Falls within JEDEC TO–220 variation AB, except minimum lead thickness.

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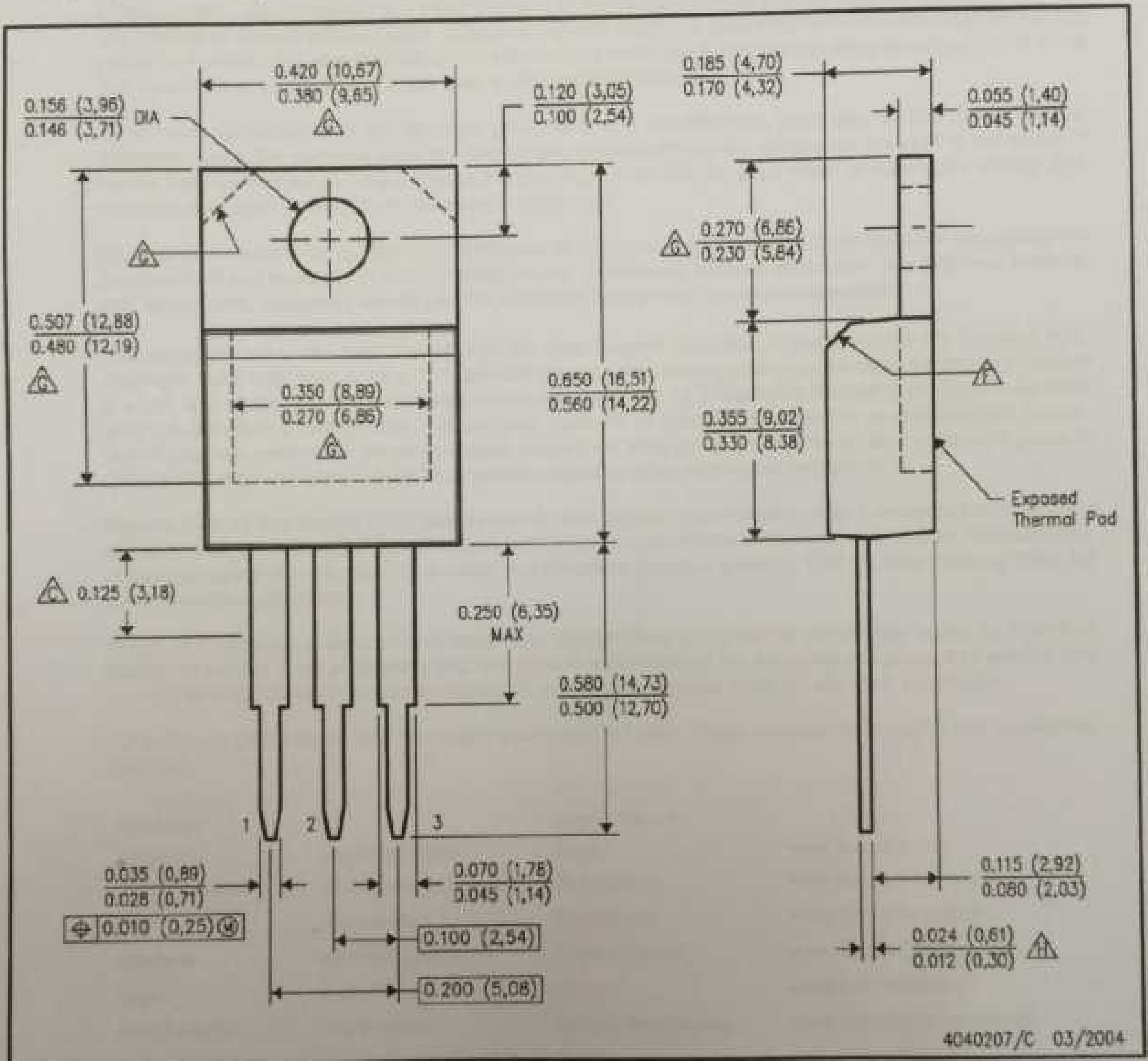
KC (R–PSFM–T3) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area.
D. All lead dimensions apply before solder dip.
E. The center lead is in electrical contact with the mounting tab.
F. The chamfer is optional.
G. Thermal pad contour optional within these dimensions.
H. Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

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Infrared Proximity Sensor

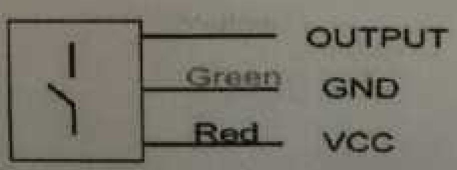
DESCRIPTION:

Arduino infared proximity switch module is a reflection-type photoelectric sensor which integrates transmitting and receiving infared beams function. Infrared proximity switches work by sending out beams of invisible infrared light. A photodetector on the proximity switch detects any reflections of this light. These reflections allow infrared proximity switches to determine whether there is an object nearby.

The trigger distance can be anywhere between 30 - 800mm, by manual adjustment of the potentiometer in the sensor.

technical parameters

- Voltage :DC 5V
- Current :100mA
- Type :DC 3 Wire NPN-NO (Normal Open)
- Sensory Distance: 3-80 cm adjustable
- Sensory distance regulator and output indicator light on product back
- Control signal level:
- High : 2.3V≤Vin≤5V
- Low : -0.3V≤Vin≤1.5V
- Ambient temperature: -25 - 70 degree C
- Guard mode: reverse polarity protection
- Sensor dimension: 18mm diameter x 45mm length
- Cable length: 180mm



FAIRCHILD
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October 2008

TIP120/TIP121/TIP122

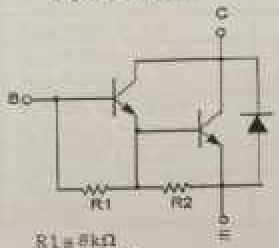
NPN Epitaxial Darlington Transistor

- Medium Power Linear Switching Applications
- Complementary to TIP125/126/127

TO-220

1.Base 2.Collector 3.Emitter

Equivalent Circuit



R1 ≅ 8kΩ
R2 ≅ 0.12kΩ

Absolute Maximum Ratings* T_a = 25°C unless otherwise noted

Symbol	Parameter	Ratings	Units
V_{CBO}	Collector-Base Voltage : TIP120 : TIP121 : TIP122	60 80 100	V V V
V_{CEO}	Collector-Emitter Voltage : TIP120 : TIP121 : TIP122	60 80 100	V V V
V_{EBO}	Emitter-Base Voltage	5	V
I_C	Collector Current (DC)	5	A
I_{CP}	Collector Current (Pulse)	8	A
I_B	Base Current (DC)	120	mA
P_C	Collector Dissipation (T_a=25°C)	2	W
	Collector Dissipation (T_C=25°C)	65	W
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	- 65 ~ 150	°C

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Electrical Characteristics* T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
$V_{CEO}(sus)$	Collector-Emitter Sustaining Voltage : TIP120 : TIP121 : TIP122	I_C = 100mA, I_B = 0	60 80 100			V V V
I_{CEO}	Collector Cut-off Current : TIP120 : TIP121 : TIP122	V_{CE} = 30V, I_B = 0 V_{CE} = 40V, I_B = 0 V_{CE} = 50V, I_B = 0			0.5 0.5 0.5	mA mA mA
I_{CBO}	Collector Cut-off Current : TIP120 : TIP121 : TIP122	V_{CB} = 60V, I_E = 0 V_{CB} = 80V, I_E = 0 V_{CB} = 100V, I_E = 0			0.2 0.2 0.2	mA mA mA
I_{EBO}	Emitter Cut-off Current	V_{BE} = 5V, I_C = 0			2	mA
h_{FE}	* DC Current Gain	V_{CE} = 3V, I_C = 0.5A V_{CE} = 3V, I_C = 3A	1000 1000			
$V_{CE}(sat)$	* Collector-Emitter Saturation Voltage	I_C = 3A, I_B = 12mA I_C = 5A, I_B = 20mA			2.0 4.0	V V
$V_{BE}(on)$	* Base-Emitter On Voltage	V_{CE} = 3V, I_C = 3A			2.5	V
C_{ob}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 0.1MHz			200	pF

* Pulse Test: Pulse Width≤300μs, Duty Cycle≤2%

Typical characteristics

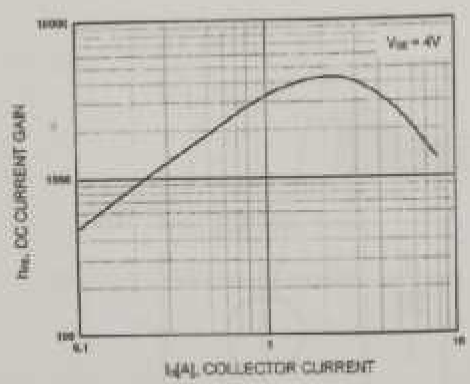


Figure 1. DC current Gain

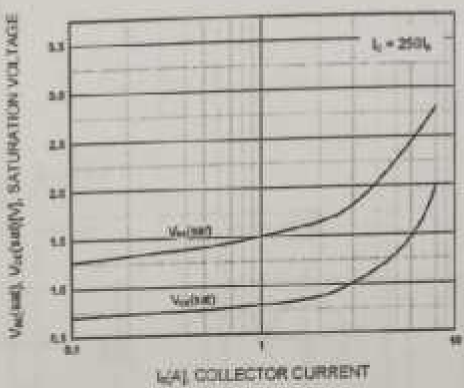


Figure 2. Base-Emitter Saturation Voltage
Collector-Emitter Saturation Voltage

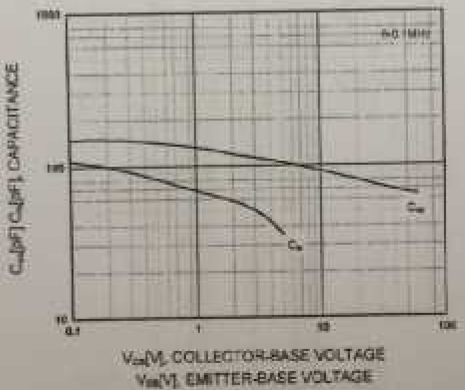


Figure 3. Output and Input Capacitance vs. Reverse Voltage

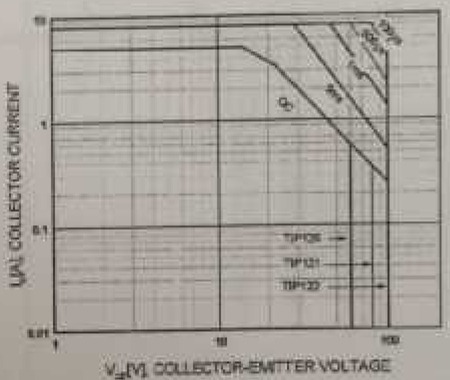


Figure 4. Safe Operating Area

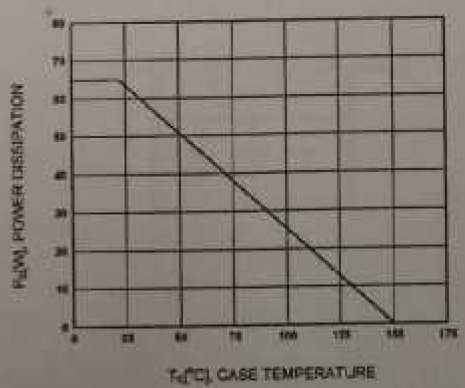
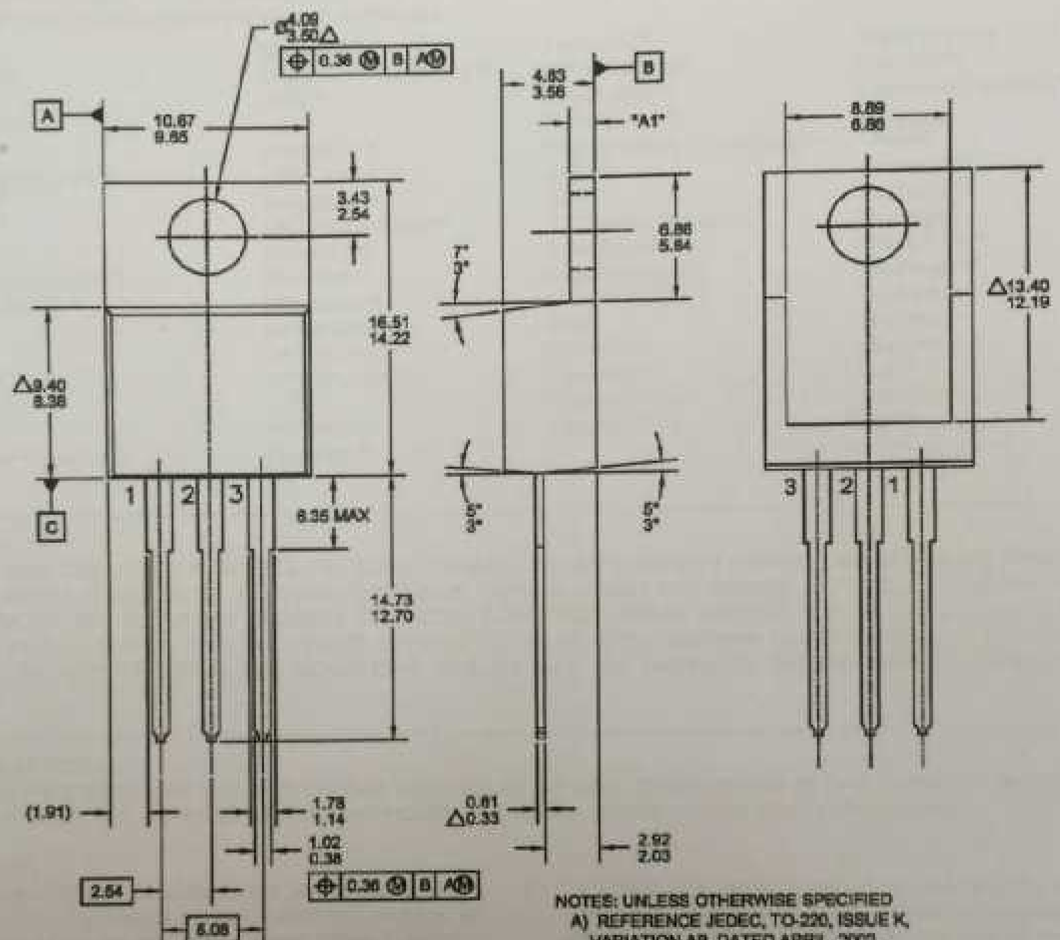
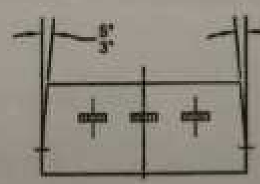


Figure 5. Power Derating

Mechanical Dimensions

TO220





NOTES: UNLESS OTHERWISE SPECIFIED
A) REFERENCE JEDEC, TO-220, ISSUE K, VARIATION AB, DATED APRIL, 2002.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONING AND TOLERANCING PER ANSI Y14.5 - 1973
D) LOCATION OF THE PIN HOLE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
E) DOES NOT COMPLY JEDEC STANDARD VALUE.
F) "A1" DIMENSIONS REPRESENT LIKE BELOW:
SINGLE GAUGE = 0.51 - 0.61
DUAL GAUGE = 1.14 - 1.40
G) DRAWING FILE NAME: TO220B03REV6

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SMART START™
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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

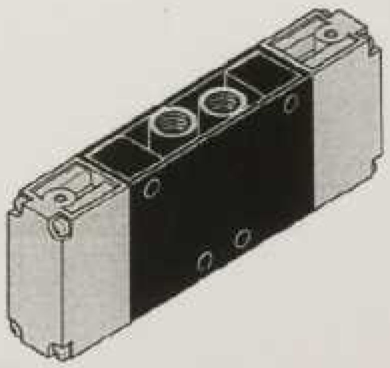
Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Rev. I31

Appendixes C

5/2 & 5/3 Way G1/4 Double Pilot

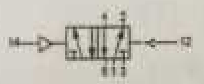


Technical information

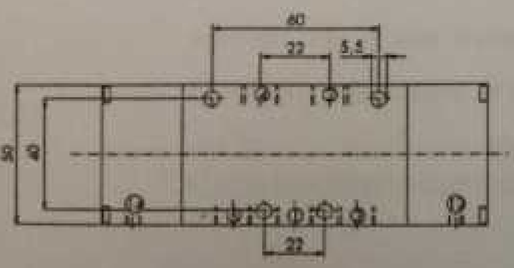
Pressure range:	2.5-10 bar
Control pressure:	2.5-10 bar
Temperature range:	-15°C...+50°C
Housing:	Die-cast and lacquered zinc alloy
Seals:	NBR
Lubricant:	Not required
Operating medium:	5 micron filtered, lubricated or non-lubricated compressed air

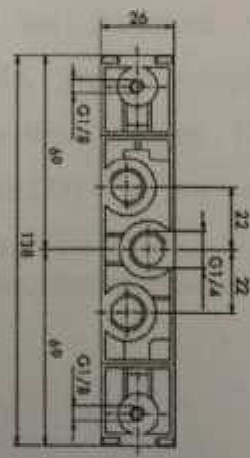
Other information

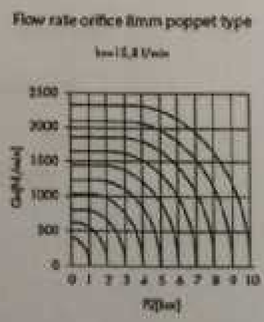
For ATEX certification use suffix code "EX" for example 76.XXX.XX.XX.EX
For NPT ports use prefix code "75" for example 75.XXX.XX.XX

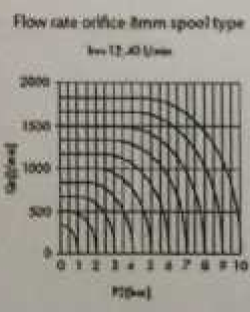
Symbol	Description	Type	Orifice	Ports	Order code
	5/2 way double pilot	Poppet	8mm	G1/4	**76.047.81.42**
	5/2 way double pilot	Spool	8mm	G1/4	**76.043.81.42**
	5/2 way double pilot with priority	Poppet	8mm	G1/4	**76.047.81.47**
	5/2 way double pilot with priority	Spool	8mm	G1/4	**76.043.81.47**
	5/2 way double pilot with priority	Spool	8mm	G1/4	**76.043.81.47**
	5/3 way spring return to centre all ports closed	Spool	8mm	G1/4	**76.044.81.38**
	5/3 way spring return to centre all ports open	Spool	8mm	G1/4	**76.044.81.28**

Dimensional drawings









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