DESIGN, CONTRUCTION AND TESTINT OF A PACKAGING MACHINE

BY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ENGINEERING FEDERAL UNIFVERSITY OF TECHNOLOGY MINNA, IN PARTIAL FULFILMENT OF THE REQUIREDMENT FOR THE AWARD OF FIRST DEGREE (B.ENG.) AGRICULTURAL ENGINEERING

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CERTIFICATION

This is to certify that this project work was carried out by Taiwo, Babatope in the department of Agricultural Engineering, Federal University of Technology, Minna, Niger state.

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DEDICATION

This project work is dedicated to the glory of God. and the sweet memory of my late mum Mrs. Bintu Taiwo

ACKNOWLEGEMENT

If God does not build the house the builders labour in vain, on these note, I must appreciate God who has provided both material and intellect that I needed to make this project a success.

In the same vain, I thank my friend, my brother, and above all my father Mr. Taiwo Tunde Emmanuel not just for his support for this project but also for his fatherly care in every stages of my life. He urged and spurred me on and when necessary. Thank you may God bless.

To my late mum Mrs. Bintu Taiwo. The make of a mother is without a price; my love for you is forever.

The HOD Dr. D. Adgizi, my able supervisor Dr. Mrs. Zinach Osunde I count myself privileged to carry out this project under her motherly supervision my thanks to you is countless. The staff and the student of agricultural engineering. I thank you all. Indeed, I thank Dr. M.G. Yisa whose door is always open to me when ever I need information on this project.

I cannot but thank my dear brothers, sisters, uncle whose love I so much count the like of Kunle, Aduke, Sola Sunday, Kayode, Deji, Jhimon, and Bukola, Tolulope, Tosin,Tope and Tobi,

My sincere appreciation goes to Mrs. Titilayo Taiwo who is a great inspiration to me, she support me both morally and fanatically .May the Lord continue to be with you.

My able friends, Abioye Taiwo,(Elect./ Elect. Unad.) Akafowowe Alaba,(Chemical Engin. Unilag)Bra. Peter Omonola, Eugene Bukesemi, Eesuola Olusola, Busari Rahseed, Peace Oyebanji, Segun, Akande Ade, Ayoola Sunday, Adejumon Toyin, Adela Adetutu, Olusola Bukola Doherty Mobolaji you are all wonderful and lovely friends I keep you so dearly.

To my lovely fellowship CACSF F.U.T. Minna chapter I will never forget you.

The beam is not balance if I forget to acknowledge the entire body of agricultural engineering both staffs and students or this noble institution, most especially those that their metric number start with 99/------ and the direct entry students that join this set for their understanding and tutorial aids as at when due may you all be blessed.

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ABSTRACT

As we approach a new era industrially and technologically as a developing nation, the use of electrically operated equal filling device cannot be over estimated and preservation of food in powdery form cannot be over emphasized in the existence, therefore, the need to design and fabrication of an equal powder bag filler arises to meet the growing need of packaging of powdery materials into a the bag.

In the light of this, an equal bag packaging machine was designed and fabricated to add to the already existing one. It is design and fabricated to fill powder into a bag at equal weight to prevent an eyes gesture and using of sub-standard measurement like bowl, tin, mudu, handful and so on which can lead to un-equal measurement.

Hence, this project is intended to provide an inexpensive bag packaging machine to discourage the crude means of packaging powders into a bag. Therefore, the focus was to obtain a model that would run with less power, cheap, and at high efficiency.

CHAPTER ONE

1.0 INTRODUCTION

1.1 PACKAGING

Early man developed his own packaging technology using leaves for wrapping purposes and the skin of goat for the flexible packing materials in the transport of water and wine. Early container made by plaiting reeds and small wooden cases produce by similar methods to those by coopers today were some in evidence. The ancient Egyptians ware masters of the art preservation and this demonstrated in the tombs of the Pharos, not only in preservation of bodies but also other materials (Ajibola, 2002)

Packing is an integral part of food processing. It performs two main functions: to advertise foods at the point of sale, and to protect foods to a pre-determined degree for the expected shelf life.

A food package has to perform five primary functions:

1. It must keep the product clean and provide a barrier against dirt and other contamination.

2. It must provide protection to the food against physical damage moisture, oxygen and light.

3. It must function smoothly, efficiently and economically on packaging time during the actual operation of putting the food into the package. This means it must be designed to run on already existing machinery or on new machinery which is going to be brought to laid for the purpose.

4.It must have a degree of convenience built into its design which will not only supply the ultimate consumers with, say on easy-opening or closure but also must provides convenience at the intermediate stage in handling through warehouse and the transport during distribution in particular, the size, shape and the weight of the unit must be conserved.

5. It must be provided with identification, information and sales appeal.

All five functions in a sense control the possibilities for spoilage and microbiological infection.

In addition, the package should not influence the product (for example, by migration of toxic compounds, by reaction between the pack and the food or selection of harmful micro-organisms in the package food) Other requirements of packaging are smooth efficient and economical operation on the production line, resistance to breakage (for example, fractures,tears or dents caused by filling and closing equipment, loading/unloading or transportation) at minimum total cost.

The main marketing considerations are:

1. The brand image and style of preservation required for the food.

2. Flexibility to change the size and design of the container and

3. Compatibility with the method of handling distribution, and the requirements of legislative requirements concerning labeling of food.

1.1.1. TYPES OF PACKAGING MATERIALS

There are two mains types of packaging materials:1. Shipping container which contain and protect the contents during transport and distribution (including wooden, metal or fireboard cases, creates, barrels, drums, pallet and sacks)

2.Retail containers(or consumer unit) which protect and advertise the food in convenient quantities for retail sale and home storage (for example metal cans, glass ,bottles, jars rigid and semi-rigid plastic tubes, collapsible tube, paper board cartons and flexible plastic bags, sachets and over wraps.

1.1.2 MATERIAL HANDLING

Materials handling is the movement in the most efficient manner at the right time to and from the right place in the required quantity with the maximum economy of space.

It is very important to ensure the maximum handling efficiency during all the movements of the materials:

1. as a raw material from supply print to store or process.
2. as material in process between stages during processing.
3. as finished product to packaging store and dispatch.

Hence material handling is concerned with these five elements:

1. Movement.
2 Times
3. Place.
4. Quantities.
5. Space.

Case study indicates that substantial savings can be effected by changing from manual to mechanized handling. Savings of the order of the 50% of the labors bill are not uncommon. An example of this is given in fig. 1.1 which shows reduction in labor changes 40-90% these changes are partially offset by increased capital charges but the overall effect is a large reduction in operation costs

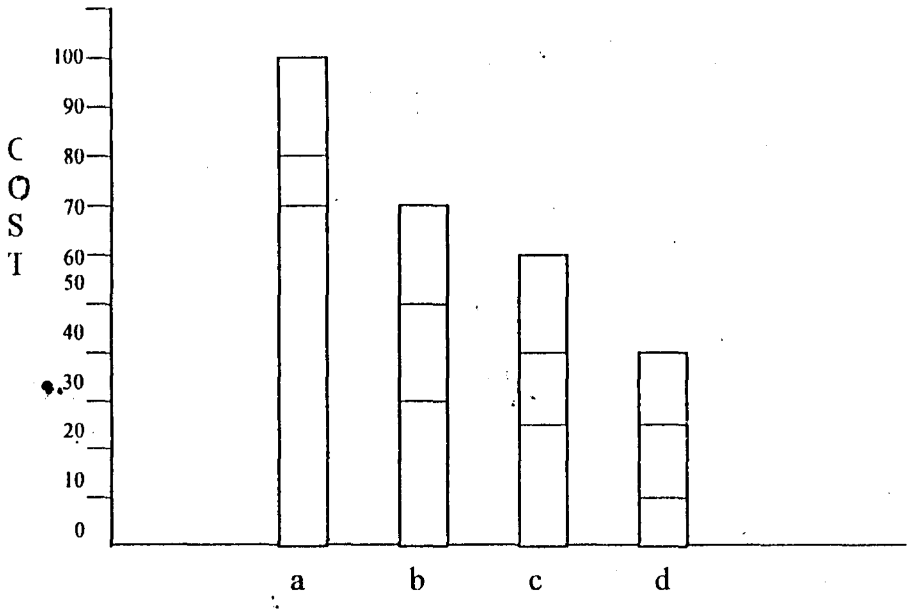


Fig 1.1. Relative cost bar chart

Fig 1.1.0 is a comprehensive of costs of handling of flour in a mill producing at a rate of 75ft/24hrs.

Where

a. Is flour bagged from mill and handle manually in bags.

b. Flour bagged from mill and handle mechanically in bag.

c. 50% as (a) and 50%bulk handle pneumatically.

d. 100% bulk handle pneumatically.

In addition to direct savings good handling techniques confer other advantages such as.

1. Improved utilization of man machines and storages space

2. Reduced material wastage.

3. improved control and rotation of stock.

4. Improved working condition and reduced operation fatigue. Hence these result in increased productivity, improved product quality and reduced absenteeism

1.2.0 OBJECTIVES

The objectives of this project work is to design, fabricate and test an electrically powered bag packaging machine that will be acceptable locally and boost the nation economy, simple in design ease of operation, durable and cost effectiveness

1.3.0 JUSTIFICATION OF THE PROJECT

The justification of this project is primarily centered on the simplicity of the construction and its application and its worth, for it economical potential benefit for food processing industries.

This project will go a long way in solving the problem of acurat packaging confronting local food processing industries. The machine is electrically accurate powered machine and more economical and best used in packaging of powders in food processing industries.

CHAPTER TWO

2.1.0 LITERATURE REVIEW.

Packaging is a very special and unique aspect of sales promotions. It is the tantalizing strings, which continues to pull the consumer. In a competitive world or in a situation where you have many producers trying to acquire a percentage of the market of a particular product, care must be taken in the design, selection and manufacture of a package for a product. This becomes very important and critical when the product are meant for foreign market or for export. The packaging of a product therefore mirrors the image of its product at a glance. It is the clothing for the product and a visual assurance that the product will meet the consumers' demand, (Adebayo,2000).

In view of the foregoing, it is necessary for an exporter to look into the conditions and standards a packaging for export trade must satisfy to attract adequate market. Among these conditions are the followings:

The packaging must be such that would protect the product from any form of contamination or degradation. It may be necessary to carry out laboratory lists of properties of such materials will not have any advertise-action on the product it contains. This exercise becomes very important when the product is a food item otherwise any such contamination may lead to litigations and serious consequences on the Product.

2.1 TYPES OF PACKAGING MATERIALS

2.1.1 FIBERITES (OUT CASE)

These are manufactured from Kraft paper and fluting using the corrugators machine.

The breweries, floor mills, detergent and bar soap manufacturers and even manufacturers of light industrial products (like air conditioners) are the major consumers of this product.

The outer cases provide very good protection for the products during the transportation and distribution. There are various grades of ferrites .The mode of transportation, handling, and distribution, storage amongst others, influences the grade of ferrites used in the design and manufacturing of outer cases. Generally the quality of pointing on outer cases is not high.

The packaging supplier should be able to advice on the appropriate grade suitable for packaging.

2.1.2 DIE-CUTS

Die-cuts, manufactured from ferrites, are similar to outer cases. The main difference being that, they are specially perforated to allow for good air circulation. This makes them particularly suitable for agricultural products.

2.1.3 FOLDING CARTONS /BOXES

There are usually industrial unit packages made from paperboard. Most products are usually packed in individual units before being packed in individual units before being packed in multiples of twelve into outer cases, these packages, are generally used for products like detergent, toilet soaps, body and skin care products e.t.c.

FLEXIBLE

Flexible packaging materials developed from the suitable combination of two or more of the following substances:

Paper, plastic film, aluminum foil, hot melt, laminating wax and adhesive.

The desired properties of the packaging material determine the substrate to be used and in what order they are combined. Excellent barrier properties can generally be obtained by using flexible packaging material.

Flexible technology allows for the development of substrates that meets the specific requirements of a product and the same time, satisfy local environmental laws on disposal of packaging materials.

Flexible technology for the development of substrates that meets the specific requirements of a product and at the same time, satisfy local environmental laws on disposal of packaging materials.

The major product areas for flexible are: pharmaceutical industries, soap industries, seasoning cubes, ice cream and snakes foods.

2.1.5 LABELS / WRAPPERS

The packaging materials, made from paper, are either primary packaging materials or additional to the primary packaging material. For example, labels are used by the brewery industry and the canned products industries to distinguish and promote their products while wrappers are used as the primary packaging materials for soaps, batteries and pharmaceutical products.

2.2.4 PACKAGING MACHINES

A good packaging solution for solid foods should not ignore packaging machines, and the complex interactions between the machine and the packaging material.

The following are types of packaging machines:

i) Material packaging machine

ii) Horizontal form-fill seal machine

iii) Vertical pouch form-fill- seal machine

iv) Over wrapping machine

v) Over wrapping machine with adjustment for product size.

vi) Vacuum packaging machine.

The suitability of a packaging machine for a certain packaging material and product can be explained as follows:

a.) The angle at which the wrapping material comes in contact with the folding former is important, as it may cause a make or even a cut in the material. The tightness of the packaging film depends on the shape of the former.

b.) The quality of heat-sealing of the packaging material depends on temperature control, pressure and dwell time. The optimal results are obtained when the dwell time at the melting temperature of the coating or copolymer is long enough to ensure tightness without damage to the basic material.

c.) The wrapping material should slip easily after sealing at high temperature. In some cases, it is even necessary to cool the plate fixed above the sealing rollers.

d.) The quality of cutting depends on the knife, the cut angle, the position of the knife in relation to the sealing jaws etc.

e.) Over wrapping also requires compatibility between the machine and the wrapping material, and prevention of static electricity, poor slip under hot conditions, temperature control disruption and rolling of the film. It is necessary that the packaging material be sealable on both sides and that the sealing area is sufficient and that the structure (soft or rigid) of the solid food does not affect the shape and sealing surface if food gas tightness is desired. (Varsary, 1985)

2.2.1 PACKAGING MACHINERY AND TECHNIQUES

Filing and sealing bottles: bottles filling machines for liquids can be divided into four basic types: vacuum filling, measured dosing, gravity and pressure filling.

a) **Vacuum filling machine**: filling by vacuum is the cleanest and most economical way to handle many products. In spite of the care that is taken in making bottles and cleaning them, there is always a percentage with holes, chips, or cracks. Vacuum-filling machines automatically avoid such bottles. Vacuum filling is neat and efficient, and it is unnecessary to wash or wipe the bottles before the labeling. The vacuum system requires a supply tank that is below the level of the bottles to be filled; from the supply tank run pipes or lines to which are attached filling nozzles. Also connected with the supply tank is an airtight overflow receptacle. When the machine is started vacuum is created in the overflow receptacle, and in turn in the lower end of the air line or at the suction ends of the nozzles. When the suction nozzles making an airtight seal, a vacuum is created in the bottle (unless the bottle is imperfect). The vacuum draws the liquid from the supply tank, through the tube and into the bottle. When the liquid reaches the end of the overflow or suction airlines, it automatically breaks the vacuum, causing a cessation of the flow of liquid into the bottle. The filling stream is then withdrawn and the bottle passes to the closure plant.

b) **Measured dosing machine**: the height of fill is not constant. Each filling unit consists of a calibrated cylinder and a piston. As the piston begins its down stroke a valve opens, allowing free passage of liquid into the cylinder. At the end of the stroke the cylinder is charged with a measured quantity, and when a container is correctly positioned, a delivery valve opens and the liquid into the container on its return stroke, and the sequence repeats.

c) **Gravity filling machine**: there are two types of gravity- filling machines. One of which fills on a controlled-time cycle and the other by using a measuring chamber.

In the first, the presentation of the container to the filling head opens a valve that permits the liquid to flow for a predetermined time. The valve then closes and the container is taken away. The open time is determined by the viscosity of the product and the diameter of the filling orifice; control may be mechanical, by time clock, or electronic.

In the second type o f gravity filler, a supply valve opens to admit liquid to a calibrated chamber. When a container closes and a delivery valve opens, this charging the container with the measured amount.

d) **Pressure Filling Machines**: pressure filling is basically similar to time-cycle gravity filling. An artificial head pressure is induced to the liquid by a pump or by air pressure within a closed tank. Gravity and pressure filing are appropriate to moderately fast filling of law viscosity liquids, such as fruit juices, but they are considerably slower than vacuum filling, (Woollen1969).

2.2.2 DRY GOODS POWERED AND GRANULAR FORM:

Granules or tablets are sometimes counted by sorting equipment with electronic counters, but more usually they are simply loaded into containers by one of two basic methods, (1) volumetric filling and (2) filling after weighing.

Volumetric filling may be by vacuum, by the use of auger (screw), or the use of a flask. The vacuum method is similar to that described for liquids. In auger fillers, the quantity delivered that described by turning the auger a certain number of cycles. And, in flask fillers, the volume of the flask determines the quantity delivered.

Weight filling is the best way to meet the requirements of weights and measures regulations. In all the different weighing techniques (scale beams, compressed air, or electronic measurement systems). The basic principle is to divide the supply of product into a bulk feed and a fine seed. At the beginning of the weighing cycle both the bulk and the fine feed operate to fill the weighting pan until 80 or 90 percent of the required material has been added. At this point the bulk feed stops and the fine feed continues until the exact balance is reached, as the fine feed is cut off the load is discharged, usually by tipping into the container. (Gordon, 1963)

2.2.3 BAG-FILLING AND CLOSING EQUIPMENT

This equipment performs four operations: feeding the bag to the loading point; opening the bag and keeping it; loading the product; and making the closure.

The initial opening is usually achieved by an air-blowing device, after assisted by the incorporation of lips and bag. Mechanical pincers are also used either alone or to assist the air-opening device. The bag may be held open and the product guided into it by a scoop or other means, or, for certain products. The scoop is inserted into the bag, and the bag pulled over the product. The principle of moving the bag rather than the product enables bagging to be performed on products with little resistance to distortion or crushing, such as sliced bread. Ties, clips, staples, tapes, and heat seals are all widely employed as closures (Preston, 1965).

CHAPTER THREE

3.0 DESIGN CONSIDERATION AND DESIGN CALCULATION

In designing of electrical powered bag packaging machine, certain facts were taken into consideration. These include things which could enhance accuracy and utmost performance of the machine with little additional loss on the part of the user; therefore, the following were taken into consideration:

a. Rigidity: Since the machine is to carry varying loads, it is design for maximum stability or rigid at varying operational loads.

b. Cost Of Production: since this is of considerable importance enough attention paid to local sourcing of the material required was strictly adhere to in order to minimize overall cost of the parts of the machine this was due to it strength, availability and cost effectiveness.

c. Portability: Though the machine is expected to stationary permanently within the industry, possibility of the movement of the industry from one place to another can not be totally ruled out. Therefore, the machine will be design in such a way that it can easily be moved.

d. Engronomics Relationship: The principle surrounding the man machine relationship has been strictly observed in such a way that an average person can easily operate the machine. Bearing in mind that the machine can be located in a static place in the workshop/industry care will be taken to ensure that the machine not too high and the neckoning instruments have been seen strategically positioned for easy observation and reading. Therefore by this design the equipment could be

Operated safely effectively and maintained adequately

e. Serviceability And Maintainability: The will be quit easy to service and maintained. The fabrication of the part can be achieved through a simple workshop operation and the installation or assembly can easily be done. Joining of the metal is done by welding which ensure permanent joint. Since most of the machine is open this can facilitate detections of failure damage as well as the rectification of these faults which may entails part replacement

3.1 STRENGHT

A part is said to be adequately strong if its shape and size are such that no undue deformation or breakdown or surface fracture would occur in service. The main part of the machine will include:

1. hopper
2. shaft
3. frame
4. spring
5. auger
6. bearing
7. belt drive
8. electric motor

1. THE HOPPER: This is the feeder through which the powder is introduced into the machine. It will be made of mild steel.

2. THE SHAFT: Through this power is transmitted from motor to in action chamber. It will be made of mild steel that can withstand the stress of both tortional and bending forces

3. FRAME: This will be made of angle iron [mild steel] it will be responsible for the support of the entire body of the machine.

4. AUGER: This will be responsible for the movement of the material.

5. SPRING: Compressive helical spring will be use the strength will be consider adequate to support the maximum load expected on the spring

6. BAERING: Rolling contact bearing will be use because of it economical and adaptability to rotational motion

7. ELECTRIC MOTOR: This will be the source of power for the machine.

8. BELT DRIVE: V-belt will be used because of it suitability for the operation.

3.2.0 THEORETICAL ANALYSIS

The machine will consist of tow parts namely; the hopper and the powder movement and the weight measurement assembly. Theoretical analysis discusses into details the required analysis for these parts of the machine depends on these various parts

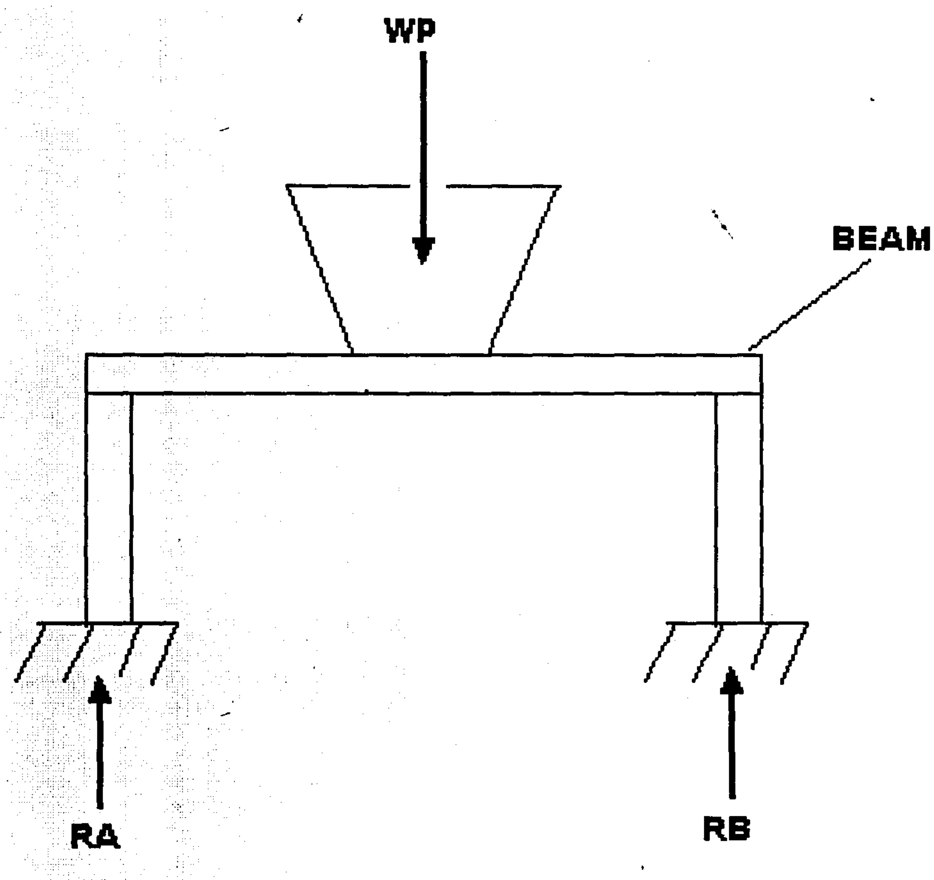


Fig3.0. The hopper assembly.

Where

W_P= weight of the package product

R_A and R_B=Reactions at the supports

3.2.1 DESIGN CALCULATIONS

3.2.2 DESIGN ASUMPTION

1. Maximum mass of powder charged = 15KG

2 Length of the shaft = 700mm

3. Force moving the powder = 300N

4. Speed of the motor = 1450 rpm

5. Time taken for the operation = 60 sec.

6. Diameter of the cylinder = 150mm

Rate of material movement (R_t) = capacity of the machine (Cm)/ time of operation.

R_t = 15/60 = 0.25kg/ sec.

3.2.2 V-BELT DESIGN

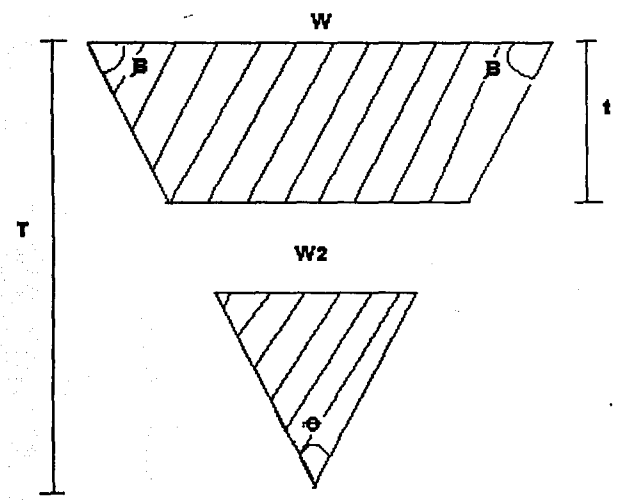


Fig. 3.1 CROSS-SECTIONAL AREA OF A V-BELT.

Where W1 = v-belt width

β = Angle of contact

t = Normal depth of the belt

θ = Sheave groove angle.

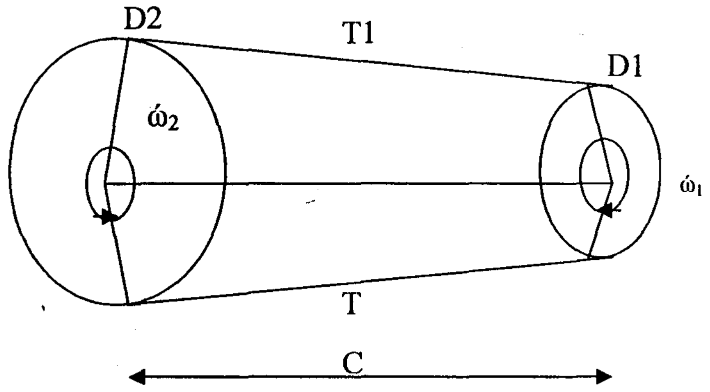


Fig 3.2 Arrangement of a V- belt and pulley

D_1= pitch diameter of driving pulley.

D_2= pitch diameter of driven pulley

M_1,M_2 = angle of wrap

U_1,U_2 = pulley arc of contact.

The belt speed is obtain by

V_B= ΠDN (Khurmi and Gapta 1979)

D_1 = diameter of driving pulley =75mm

N_1= speed of the motor = 1450rpm=24.17rps

N_2= 290rpm speed of driven pulley

V_B = speed of the belt

$V_B = (\Pi * 0.075 * 24.17)/60$

$== 0.095$m/s

Speed ratio = (N_1/N_2) = 290/1450 = 0.2

The pitch diameter is found from

$D_p = D_1 * F_b$

Where

D_p= pitch diameter

F_b = small diameter correction factor (table three)

D_1 == smaller diameter

$D_2 = 250$

$F_b = 1.14$

D_p= 1.14*75= 85.5mm

The larger pulley diameter is obtain from

$D_2 = (D1\ N\eta / N_2)$

Where

η= assumed efficiency

$D_1 = 75$mm

$N_1 = 1450$ rpm

D_2=?

$\eta = 0.75$

$D_2 = (75 * 1450 * 0.75)/ 290$

$= 281.25$

The diameter will be 290 mm

Speed ratio = $D_2/D_1 = 290 / 75 = 3.8:1$

The angle of wrap $\theta = 180\text{-}\beta/2 = (180 - 70)/2$ Where $\beta = 55°$

The centre distance between the pullies is calculated from

$\sin \beta = R - r / c$ (schauns outline series 1989)

Where β = angle of wrap = 55 °

R = the radius of the larger pulley = 145mm

r= the radius of smaller pulley= 37.5 mm

c= center distance =?

c= 145 – 37.5 / sin55°

Determination of normal pitch length of the belt is given by

$L = 2c + \Pi/2\ (D_2 + D_1) + (D_2 - D_1)^2$ (khurmi and gupta 1979)

Where L = the length of the belt

C= centre distance

D_2= diameter of the pulley = 290mm

D_1 = diameter of the driven pulley = 75

$L = 2 * 131.2 + \Pi\ (290+75)/2 + (290 - 75)^2$

= 262.46 + 573.34 + 46.225

= 47060.8mm = 47.06m

Determination of operating torque

The torque is obtained from

T = Frc (Khurmi and Gupta 1979)

Where 1/2diameter of the cylinder + 150/2 = 75mm

T = 300 * 0.075

T = 22.5 μm

Twisting moment = 22.5Nm

The tortional moment of the driven pulley is given by

$Mt = (T_2 - T_1)\ R_2$ (Khurmi and Gupta 1979)

T2 = Mt/R (j – 1)

Where

T_2 =\ tension in the tension side of the belt

T_1 = tension is the stable side of the belt

$J = T_1/ T_2 = 5$; for V belt from table3

$T_1 = 22.5 (5 -1) / 1.5 = 60N$

$T_2 = 5 T_1 \quad = 5 * 60 = 300N$

Design of the belt

The bottom of the belt is calculated from equation

$T = ½ W_1 \tan \beta$ from fig 3.1

W_1 = width of the belt

β = angle of contact

T = tension on the belt

W_1 = 13mm for 3 V type belt

Angle of wrap = 55 °

$T = ½ * 1.7 \tan 70$

T = 23.35 N

From similar triangle

$W_2/W_1 = t / T$

t= 8mm

$W_2 = 8* 13 / 23.35 = 4.45mm$

The belt cross sectional area can be obtained from

$A = (W_1+W_2)/2 * t = (13 + 4.45) / 2 * 8 = 69.8\ mm^2$

This is a 13c standard belt (8)

Determine of the density of the belt using

$M_b = \rho_B * A_B$ (Khurmi and Gupta 1979)

Where ρ_B = density of the belt material kg/m^3

$\rho_B = 970$ kg/m^3 for rubber belt

$M_b = 970 * 69.8 * 10^{-6}$

$= 0.068$kg

Determination of arc of contact

$\alpha = 180^\circ \pm 2\sin^{-1}(R\text{-}r/c)$ (Khurmi and Gupta 1979)

$= 180 \pm 2\sin^{-1}(145\text{-}37.5/131.2)$

$= 180 \pm 2\sin^{-1}0.8193$

$= 180 \pm 2 * 55.02$

$= 180 \pm 110.04$

$\alpha_2 = 290.04$

$\alpha_1 = 69.96$

Determination of the belt tension considering centrifugal tension is given by

$(T_1\text{-}T_c) / (T_2 - T_c) = e^{(f\,\alpha/\sin 1/2\theta)}$ (Khurmi and Gupta 1979)

Where

Tc = centrifugal force = wv2 / 2g

F = coefficient of friction 0.25

W = belt weight/ unit length

V = belt velocity m/ sec2

g = acc. Due to gravity m/sec.2

α = arc of belt contact rad = 290 rad

$\theta = 60°$.

$W = 0.068*9.81 = o.67N$

$T = e^{(0.25*290*\pi/180)/\sin 30\pi/180}$

$= e^{(0.25*290\pi/180)}$

$= 1.31N$

3.3.0 DETRMINATION OF CENTRIFUGAL FORCE

$Tc = wv^2/2g$

$= 0.67 *0.095/ 9.81$

$= 0.0065$

3.3.1 POWER REQUIRED

This is given by:

$P = 2\Pi TN/60$

$N = 1450$

$T = 22.5Nm$

$P = 2\pi*22.5*1450/60$

$= 3416.48$

$= 3.416Kw$

3.3.2 ANGLE OF CONTACT OF THE SHAFT

The amount of twist permissible depends on particular application and varies by about 0.3 degree/ m for machine line shaft (Raseed 1998)

Angle of twist is giving by:

$\Theta = 554mtl/ Gd^4$

Where l = length of the shaft = 700mm =0.7m

Mt = torsional moment = 22.5 Nm

G = torstional modulus of elasticity = 80GPa

D = diameter of the shaft = 25 mm

Θ = 554*22.5*0.7/ 80*10^9*(0.025) ^{4}

= 0.275dgree/m

Therefore, the angle of twist of the tortional rigidity is within the allowable range, since permissible varies about 0.3 deg. / m for machine line

3.3.6 SPRING DESIGN

The active number of turns n' = 13

The internals diameter of the spring d = 17mm

The external diameter of the spring D = 21mm

The free length of the spring L_{f}=74mm

The diameter of the wire d_w = 2.8mm

The solid length is giving by

Ls = n'd (Krumi and Gupta (1979)

Ls = 13*2.8 = 36.4mm

The spring constant is giving by: D/d

= 21/17

=1.235

The spring rate: This is the spring rate or stiffness or spring constant of the spring

This is the load required per unit deflection of the spring this is giving by:

K = w/s

Where

K = spring rate

W = expected load = 30kg

δ = deflection

$\delta = 8w*^{D3}*n/Gd^3$ (Khurmi and Gupta (1979)

GD = modulus of rigidity = $84kN/mm^2$

$\delta = 8*30*21^2 *13/ 84*10^3$

=16.38mm

k = 30/16.38 = 1.832

Shear stress τ = Load W/cross-sectional area A

$\tau = W/ (\pi d^2/4) = 4W/\pi d^2$

= 30*4/π*17

= 2.246 Nmm^2

3.3.7 END CONNECTIONOF THE SPRING

The type of end connection that will be use is ground connection

For solid length = n d

= 13*17

=221mm

3.3.8 THE PITCH DIAMETER OF THE COIL (P)

P = FL/n-1 (Khurmi and Gumpta 1979)

= 74/ (13-1)

= 6.61mm

The maximum deflection can be calculated from

$l_f = n*d + d\ max + 0.15dmax$

Where d max is maximum deflection

$d\ max = lf - n*d/1.15$

$= (74-13*17)/1.15$

$=-127.8mm$

3.4.0 THE AUGER DESIGN

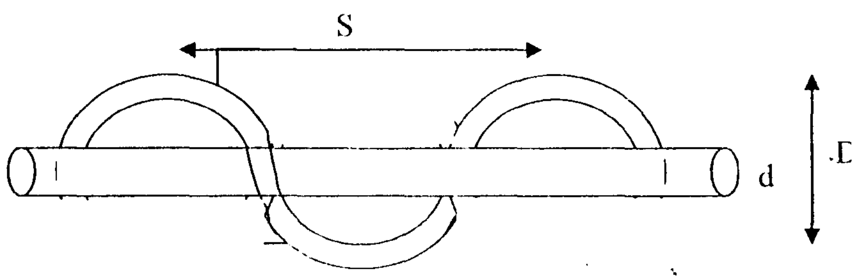


FIG 3.3 The schematic diagram of an auger

Where

d = internal diameter

D = external diameter

If the auger is going to be used for the following operation the relationship between D and S is giving by:

S = (0.2- 0.3)*D for porting (personal contact with Dr. M.G Yisa)

D = 35mm

d = 20mm

S = 0.25 *35 = 8.75mm

3.4.1 THE CAPACITY OF THE AUGER

The capacity of the auger is giving by

$Qu = (\pi * D^2 * \omega * K * \delta * Þ * S)/4$

Where:

Qu = capacity of the auger

D = external diameter of the worm = 35mm =0.035m

n = number of revolution = 5

ω = auger velocity = 60 rpm

K = coefficient due to angle of inclination of the auger (1.0-0.6) for (0-20)

δ = co-efficient depend on ratio of small diameter to large diameter from (0.1-0.5)

Þ = density of the material (1239.95kg/m^3) (Maize by Mahion 1970)

$Qu = (\pi * 0.035 * 0.0088 * 60 * 1 * 0.35 * 1239.95)/4$

Qu = 6.29

3.4.2 HOPPER DESIGN

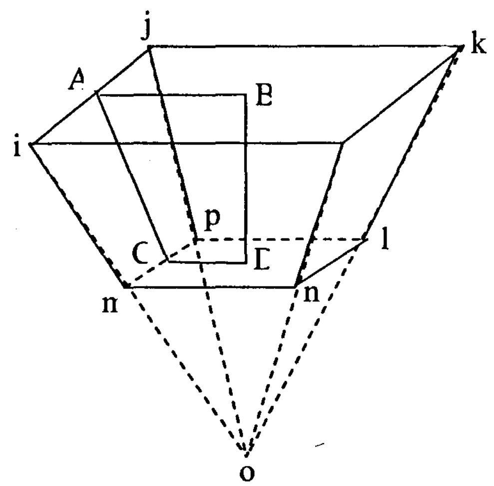


Fig 3.4A

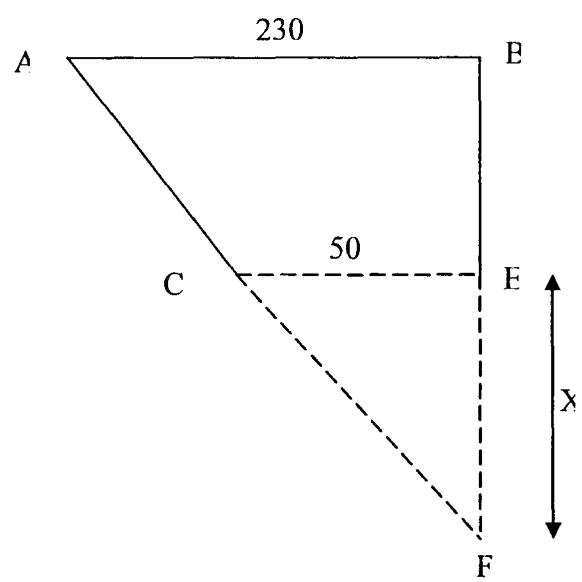


Fig 3.4 B

A. The pyramid form by the hopper I, j, k, l, m, n, o.

B the similar tri angle form from the pyramid

AB = 230mm = 0.23m

CD = 50mm = 0.05m

DE = Xm

From fig B by similar triangle principle

AB/BE = CD/DE

i.e. 0.23/0.273+X = 0.05/X

X = 0.0136/0.18

= 0.076mm

The hopper is a hollow object with thickness 2mm

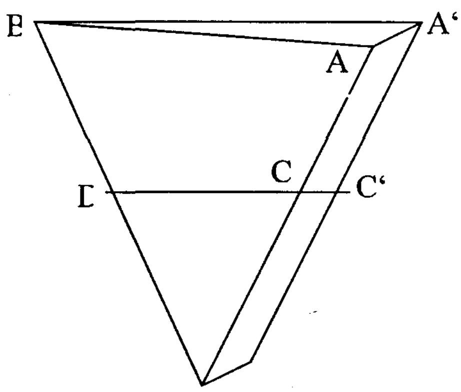


FIG 3.5 Showing the thickness of the hopper

A'B = 0.23- 0.02 = 0.228

C'D = 0.05-0.02 = 0.048

The volume of the pyramid is giving by V = 1/3*A*h

Let the volume of large pyramid + thickness = V_L

Let the volume of smaller pyramid + thickness = V_S

Let the volume of lager pyramid = V_{L1}

Let the volume of smaller pyramid = V_{L2}

$V_L = 1/3*A*h_L$

Where h_L = height of the pyramid = 0.273 + 0.076

= 0.349

$V_L = (0.23^2*0.349)/3$

$=6.15*10^{-3}m^3$

$V_S = (0.05^2*0.076)/3 = 6*10^{-5}m^3$

$V_{S2} = (0.048^2*0.076)/3 = 5.6*10^{-5}m^3$

$V_{L1} = (0.2282*0.349)/3 = 6*10^{-3}m^3$

The volume of the smaller hopper = V_L-V_{L2}

$= 6.15*10^{-3} - 6*10^{-3}$

$= 1.5*10^{-4}m^3$

The volume of the larger hopper = $V_S - V_{S2}$

$= 6.15*10^{-5}-6*10^{-3}m^3$

The volume of the hopper = $1.5*10^{-4}-2*10^{-6}$

$= 1.48*10^{-4}m^3$

The density of the hopper = mass (M)/ volume (V)

(The density of the mild steel is (7849kg)

Mass = density *volume

$=1.48*10^{-4}*7840$

= 1.09kg

Force = Mass*9.81

= 10.69N

3.4.3 SHAFT DESIGN

The weight acting on the centre of the shaft is the weight of the hopper + the maximum weight of the load expecting in the hopper. This is equal to

15*9.81+10.69 = 157.84N

The weight acting on the pulley = T1+ T2

T1 = 60

T2 =300N

T1+T2 = 360N

The shaft is expected to be loaded as shown below

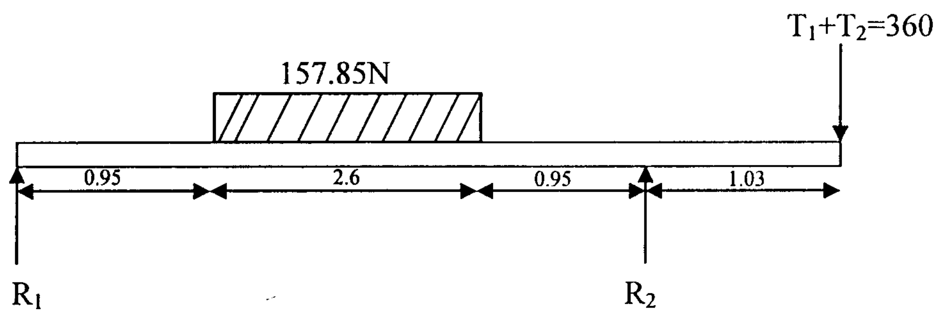


Fig 3.6

Summation of the forces

Efy = 0

Thus: (157.84*2.6) + 360 – R1-R2 = 0

=410.38 +360 =R1 + R2

=770.38 = R! + R2

$EMR_1 = 0$

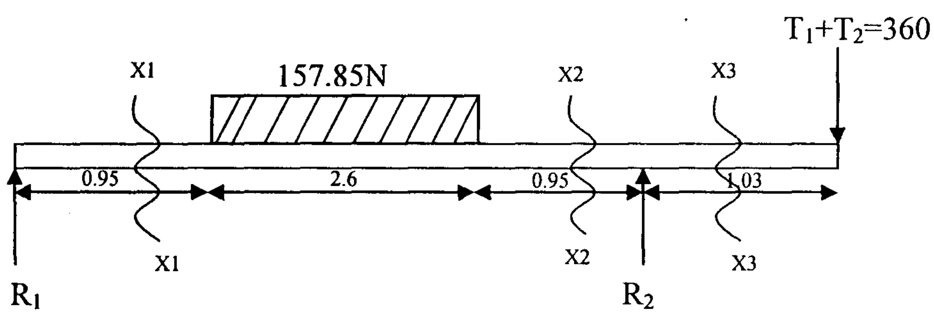
$R_1*4.5 - 360*1.03 = 0$

$R_1 = 370.8/4.5$

$R_1 = 82.4$

$R_2 = 687.98$

3.4.4 SHEAR FOCES AND BENDING MOMENT DIAGRAM



For 0<= X<=0.95

$BMXX_1 = R_1X$

When = 0

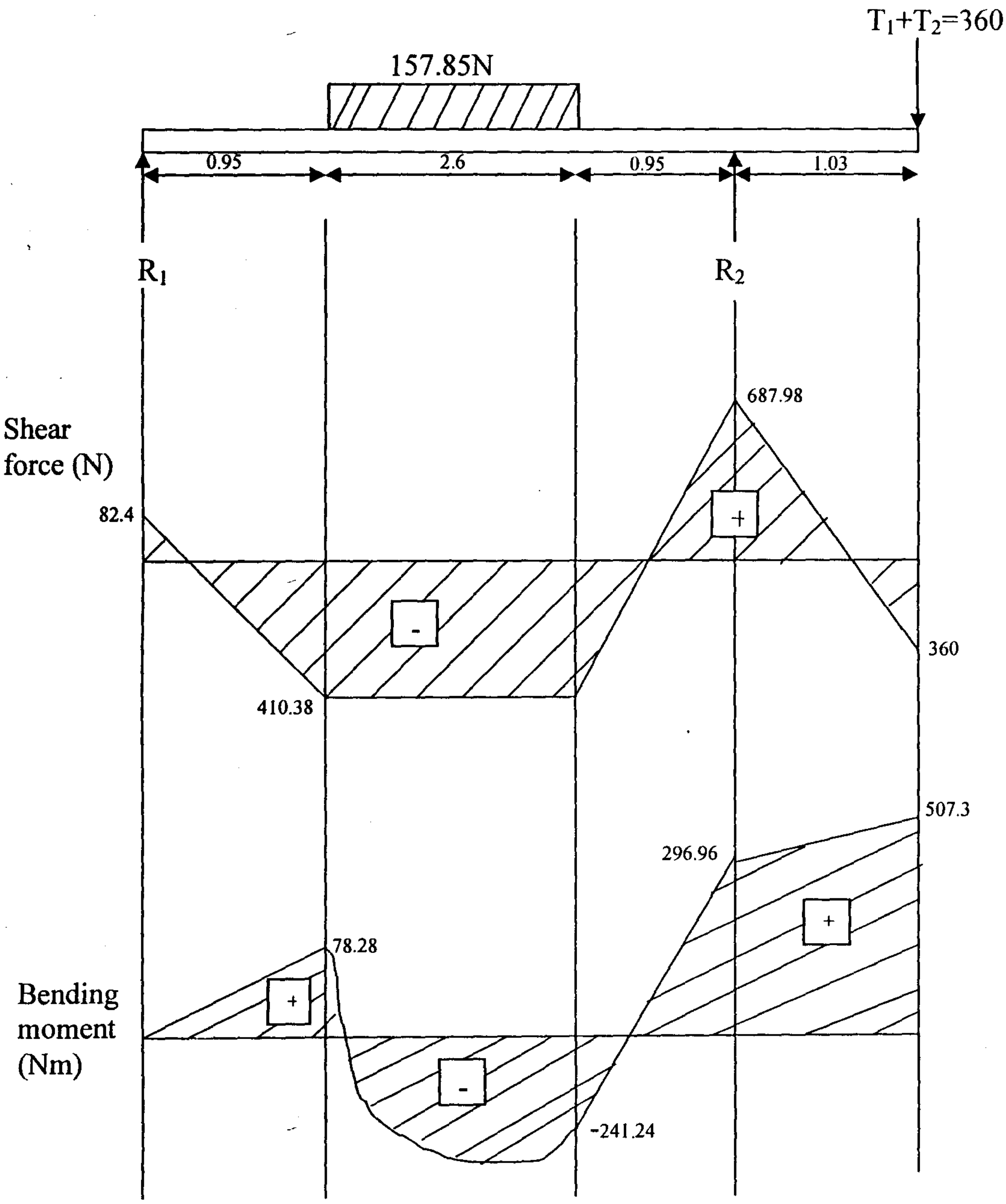
BMXX = 0

When X = 0.95BMXXI =78.28Nm

For 0.95<=x<=3.55

BMXX = 82.4X- (410.38*(X-0.95))/2

3.4.5 BENDING MOMENT AND SHEAR RORCES DIAGRAM



DETERMINATION OF SHAFT DIAMETER

$d^3 = 16/\pi ss\ [(MbKb)^2 + MtKt)^2]^{1/2}$(Khurmi and Gupta 1979)

Where:

d = diameter of the shaft

ss = maximum shear stress for the shaft without allowable for key way = (56Mp)

Mb = maximum bending moment

Mt = torsional moment

Kt = combine shock and fatigue factor for torsion

Kb = combine shock and fatigue factor for bending

Kb = 1.5 and Kt = 1.0 for gradual apply load

Mt = 9550*kW/1450

Mt = 9550*3.416/1450

Mt = 22.50 and Mb = 507.3

$d^3 = 16/3.142*56*10^6[(1.5*507.3) + (1*22.50)]^{1/2}$

$d^3 = 9 * 10^{-8}[2.82*10^{-6}]^3$

d = 14.13mm

The diameter that will be use is 25mm because 25mm is a standard shaft.

3.5.0 BEARING SELECTION

To select bearing the following parameter must be known

Fr = P/2πr (Esemikose1995)

Where

P = power transmitted =3.14kW = 3416.48W

N = speed of rotation = 290rpm

r = radius of the shaft = 0.0125m

Fr = 3416.48/ (2*π*0.0125)

= 43499.97N

3.5.1 THE LOAD ACTING ON THE BEARING

The equivalent load acing on the bearing is giving by:

P_E = (XFr+YFa)*S (Esemikose 1995)

X = radial load factor = 1

Y = thrust factor = 1.5

Fa = the axial load acting on the bearing = 687.98N(the maximum on th bearing)

PE = Equivalent load

PE = 1*43499.97 + 0*687.98

PE = 65249.96N

3.5.2 EXPECTED LIFE IN HOURS (Lh)

Lh = 16666/N*(c/PE) T (Esemikose1995)

Where

Lh = required life of the bearing

N = speed of rotation = 290rpm

c = dynamic factor

T = 10/3 for line contact = 3.33

Therefore to obtain the value of c/P from table that is rpm against life in hours L ; for this type of load the life in hours is btween4000-8000 hours with the average of 6000hours

c/P = 212

Substituting these values into in the equation above:

Lh = $(16666*1.12)^{3.33}/290$

= $5.67*10^{11}$hrs.

3.5.3 THE REQUIRED LIVE OF THE BEARING

L = number of revolution per seconds of the shaft *operating life of the bearing (Esemikose 1995)

$L = 1*5.76*10^{11}$

$L = 5.76*10^{11}$hrs.

3.5.4 DYNAMIC CAPACITY OF THE BEARING

$L = c/Fr$

$c = L*Fr*1/3$ (Esemikose 1995)

$c = (5.76*10^{11}*65249.96)/3$

$c = 1.25*10^{16}$

But in kgf for the dynamic capacity is $1.25*10^{16}/9.81$

$= 1.28*10^{15}$

The bearing corresponding to the beam is ISI NO 30 BC 03 of SKF6306 (Design Data PSA tech.)

CHAPTER FOUR

4.0.0 MATERIAL SELECTION, CONSTRUCTIONAL DETAILS, TESTING AND COSTING.

The material used for the fabrication of the various parts of the machine was mild steel. Mild steel was used for the following reasons:

i) It is easily available and inexpensive compared with the other type of steel.

ii) It has good properties in service or is adequately strong and stiff.

iii) Since the machine will not be exposed to moisture and intense heat, mild steel cannot corrode easily and this eliminates the treatment particularly welding.

MATERIAL USED

Serial	Part	Description of material	Quantity
1	Feeder hopper	1mm thick plate	1
2	Barrel or cylinder	30 mm diameter pipe	1
3	Shaft	20mm diameter mild steel road	1
4			
8	End cover plate	3mm thick mild steel plate	2
5	Screw conveyor	6mm thick mild steel plate	1

6	Frame	40mm angle iron	1
7	bearing	Internal diameter: 20mm External diameter: 27mm Bearing code: 6204	-

4.1.0 CONSTRUCTIONAL DETAIL

During fabrication of machine, various tools and equipment are used for accuracy and food surface finishing. They should be operational under food supervision to produce a food accurate machine.

5.2.1 TOOLS REQUIRED

For the fabrication and assembly of the machine, the following tools are required.

i) Marking out table

ii) Marking out tools like scrubber, steel rule, protractor, punch, hammer fy square.

iii) Hack saw

iv) Milling machine

v) Welding machine electrodes

vi) Paint brush

vii) Vice

viii) Sand paper (emerald cloth)

ix) Drilling m/c with bits

x) Die and temperature

xi) Lathe machine

4.2.0 FABRICATION AND MACHINERY PROCEDURES

1. MARKING OUT

i) The material is placed on a marking out table and the aid of a steel rule, its useful length is measured out and this marked with a scriber. Also, the place of drilling, welding of supports are marked out.

ii) The required length of angle plates are marked out

iii) The required length of supports are marked out

iv) The plate necessary for the weight hanger is marked out

v) The plate necessary for the grain passage is marked out.

vi) The triangular shape required, for the knife-edge on the support frame.

2. CUTTING OUT

The marked out materials in (i to vi) above are cut out by firing them, in turn, on a vice and the aid of a hacksaw, powered saw, electric arc welding machine they are cut out.

3. GRINDING

For the entire cut out above their edges are ground on a grinding machine in order to ensure smooth/ straight edges.

4. WELDING

Joining is done by the use of electric arc welding machine both the frame the legs, the hopper and stands. Gauge 12 electrode was used for the all the part welding

With the aid of a drilling machine, the support plates for the hopper assembly were drilled to provide places of attachment by bolts and nuts. The hole for the attachment of the weighing container is also drilled on the overhangs

5 DRILLING

All the tuning processes carried out on the shaft were done on the lathe machine.

6. COUPLING

The hopper assembly which comprises of the hopper, the legs the weighing assembly and the auger were coupled to the main machine by welding. The weight bag and the weight anger were also coupled into main machine

7 CLEANING AND PAITINGS

Cleaning is carried out by using sandpaper (emerald cloth) to rub the entire parts to remove rush and dirt's. Painting is then done

4.2.1 FEEDER HOPPER

Mild steel of 2mm thickness was used. It was cut in pyramid shape with the side cut into four pieces and then welded together. The upper side has a wider opening and the lower side has a similar opening. It was welded directly to the shaft casing

4.2.2 THE SHAFT AND SCREW CONVEYOR

This is mild steel rod turned to 25mm diameter. It is 650mm long. It was cut out a long rod with hacksaw. Facing operator at one end of the shaft was done. Small hole was drilled at one end of the shaft to facilitate fixing of crank lever and the other end was step turned to 25mm for it to pass through the bearing.

The circular plate was firmly welded along the length of the shaft. The plate was 2mm thick mild steel, the center was drilled about and they were marked at welded together end to end to form a continuous screw, then it is tacked together, then the pitch of 30mmwas gotten..

4.2.3 THE FRAME

The frame is made of 40mm angle iron. The height of the frame is 930mm, the breadth is 540mm the width is equal to breadth. Hacksaw was used in cutting the parts and the legs were at 90^0 to each other. All welding were carried out and with the aid of a welding machine.

4.3.0 COST ANALYSIS

The cost of the materials used in construction of the electrical operated bag packaging machine were stated bellow;

.S/N	Description of parts	Quantity	Unit price (₦)	Amount (₦)
1	2mm thick plate	1	3000.000	3000.00
1	Cylindrical casing	1	800.00	800.00
3	Mild steel rod	1	1250.00	1250.00
4	3 mm thick plate	1/4	1500.00	1500.00
5	40mm angle iron	2 length	1500.00	3000.00

6	Bearing	2	350.00	700.00
Sub-total cost				10,250

4.3.1 LABOUR COST

This is the cost involve in machining, welding and painting equal to ₦ 7,500.00

4.3.2 OVERHEAD COST

Overhead cost are other expenses or costs other than the labor and material cost

=₦ 2,050.00

4.3.3 TOTAL COST

This is the sum of all incurred in the manufacturing of the machine: cost plus material cost plus overhead cost.

= ₦ (10,250 + 7500 + 2050)

= ₦ (19800)

It is pertinent to mention here that the above costing were valid as at the time this project work was being carried out and are subject to changes depending on inflationary trends.

4.4.1 EXPERIMENTAL TESTING

Maize powder was used to test the machine and the result was recorded below. Human factors have to be ignored so as to get assumed perfect and steady operation .

4.4.1 RESULTS

Weight(kg)	First	Test	Second	test	Third	test
	weight (kg)	Time (mins.)	Weight in (kg)	Time(mins.)	Weight (kg)	Time (minute)
10	10.39	8.1	10.5	7.5	10.4	7.9
15	15.30	9.2	15.6	9.5	14.7	8.2

Average weigh for 10kg test weight.

$$= \frac{10\ 4 + 10.5 + 10.4}{3}$$

= 10.43 kg.

Average time for measurement of 10 kg

$$= \frac{8.1+7.5+79}{3}$$

= 7.83mins.

Average rate of filling = $\frac{10.\ 43}{7.83}$ = 1.33kg/mins.

Average weight for is kg

$$= \frac{15.30 + 15\ .55 + 14.70}{3}$$

= 15. 18 kg.

Average time taken for the filling = $\underline{9.2+ 9.5 + 10.5}$

= 9.733

$$\text{Average rate of filling} = \frac{15.18}{9.733}$$

$$= 1.55 \text{ kg/mins.}$$

$$\text{The rate of filling of the machine} = \frac{\text{total average rate of filling for 10and 15 kg}}{2}$$

$$= \frac{1.559+1.33}{2}$$

$$= 1.44 \text{ kg/mins.}$$

4.4.2 DISCUSSION OF RESULTS

The design, construction and testing of the machine has been carried out to confirm its effectiveness when in operation. The result obtained was tabulated as shown in table 5.4.1.There is closeness in weight of the package material and the standard weight. The very small difference may be attributed to unnecessary vibration generated during the operation of the machine since provision was not made for dumping. The very small difference could be neglected. The rate of filling was calculated to be 1.44kg/mins. All the materials used for the construction the machine were sourced locally. From the cost point of view the designed machine was calculated to be ₦ 19,800 which when compared to the similar types in the market is cheaper and easier to maintain.

4.5.0 MAINTAINANCE AND SAFTY

The most important consideration in engineering machineries and and other systems is maintenance and safety. For machine to be in its best working condition at all time proper and regular maintenance of the machine component is necessary. Failure to administer proper and regular maintenance causes in efficiency and untimely break dawn and consequently, large sum of money might require to put the machine in order. Some of the maintenance that should carry out in the machine includes:

1. Regular and proper lubrication of the ball of the bearing with grease to avid the seizure.
2. The lubricant to be used must not be contaminated with water metal chips abrasive particle, or other acidic compound.
3. The unit must be kept clean with the use of vacuum cleaner.
4. Bearing must be check often so that worn out bearing can be detected and replaced immediately.
5. The belt tension should be checked regularly and tightened up when slacked.
6. the machine should be kept clean immediately after used.
7. The machine must be kept in a cool and dry place
8. The weighing platform should not be over loaded.
9. The spring under the weighing balance must be checked from time to time to ensure that it maintained its normal compressive properties

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1.0 CONCLUSION

Machine which can package powder into a bag using locally available materials has been successfully designed, constructed and tested. The major difficulty encountered during the construction of the machine was non-availability of standard spring which could be use to give a perfect compressive properties. The spring used was selected locally without knowing its accurate properties as a result of lack of adequate information.

The machine was tested and the result obtained was giving in the table above , this shows that the machine work is effective.

The cost analysis indicates the cheapness of the machine and availability of parts and maintenance makes it affordable for local users.

The existing machine parts such as the vibrator was modified in such a way that the vibrator is not needed in proper discharge of the machine instead, the hopper has been constructed directly to the machine for effective discharge of the grains.

5.2.0 RECOMMENDATION

For further modification of this project. It is recommended that:

i) The effect of gravity should be taken into consideration.

ii) Using of stainless steel should be encouraged to avoid coating with paint.

iii) The weight of the frame should be able to counterbalance the vibration from the machine operation.

iv) The capacity of the machine should be increased.

v) Lastly, student projects are sometimes very costly. The amount required to successfully run the project may not be available to the student. Hence, a special plan should go to the government to help in the financing of the project.

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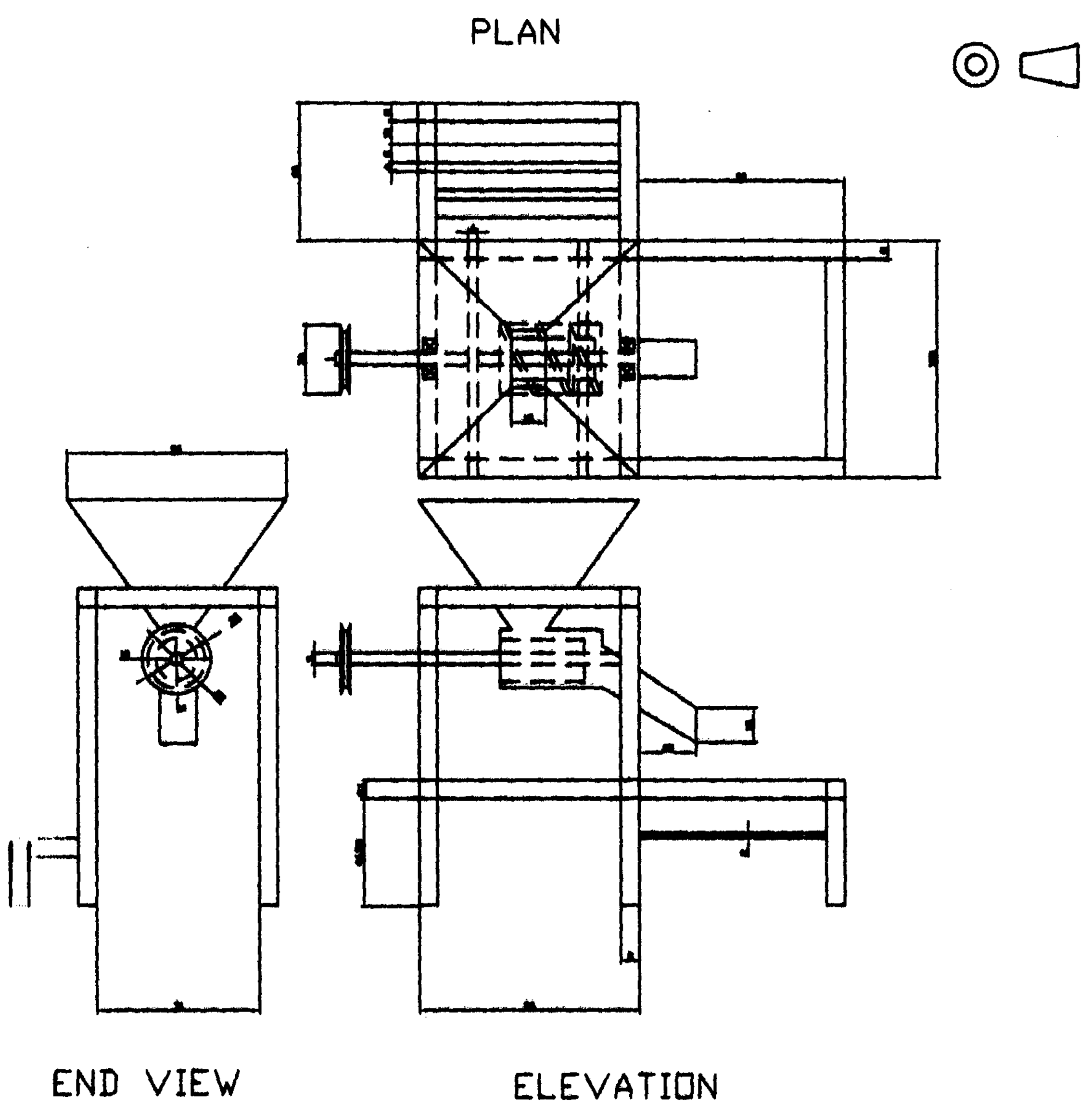
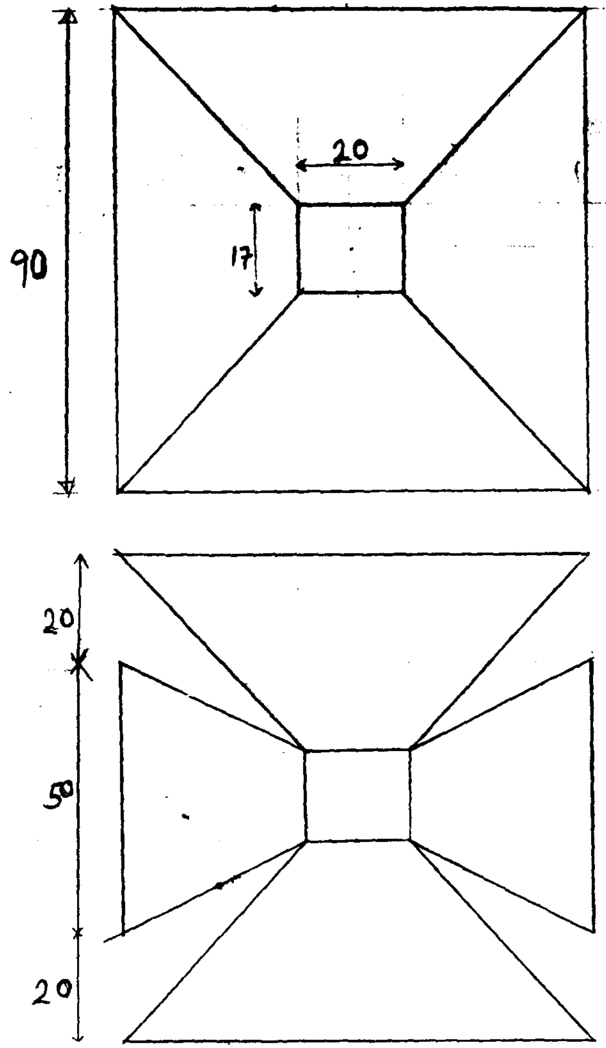
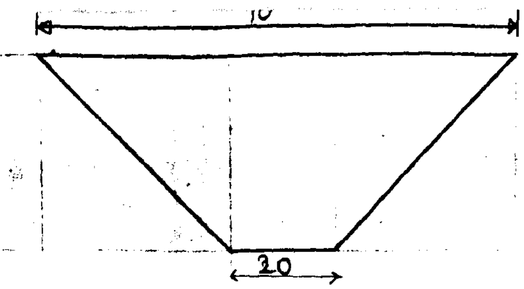
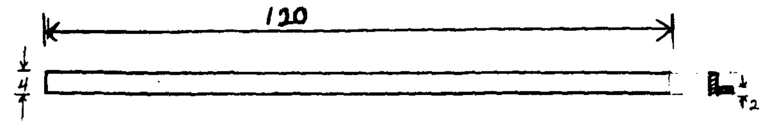

PLAN
ELEVATION
END VIEW

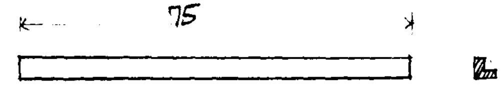




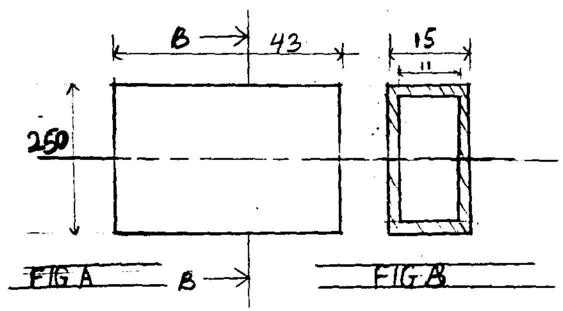
FEEDING HOPPER DETAILS.



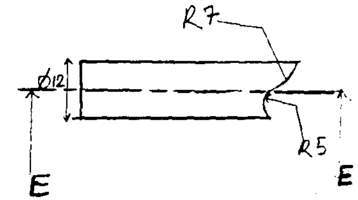
LEG DETAILS QTY. REQ. X4



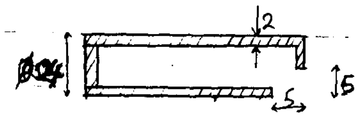
BRAZE DETAILS QTY. REQ. X6.



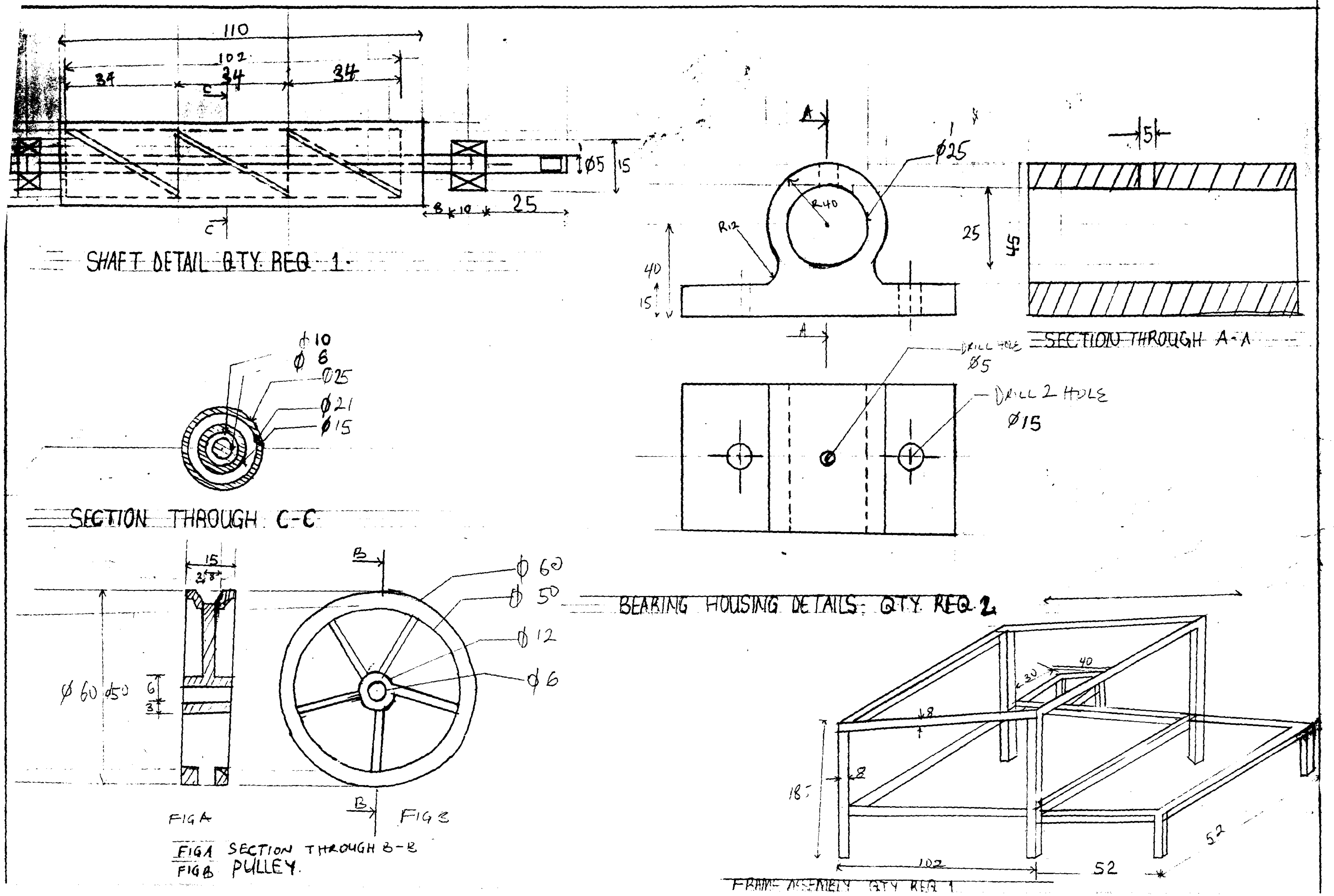
A- OUTLET DETAILS. QTY. REQ 1.
B- CROSS SECTION THROUGH B-B.

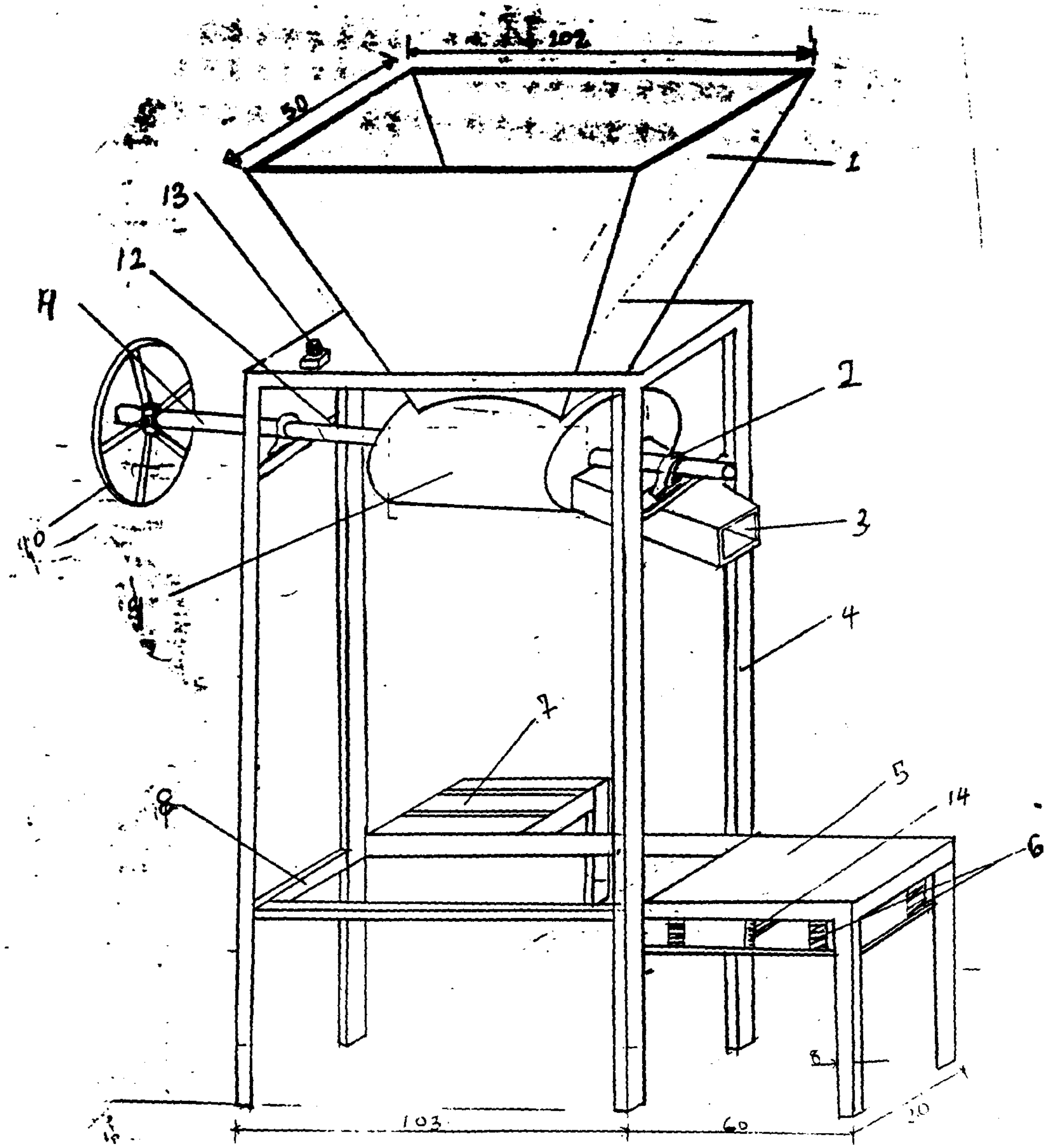


AUGER CASING DETAILS. QTY. REQ. 1



CROSS-SECTION TROUGH E-E.


110
102
34
34
34
C
C
Ø5
15
8
10
25
SHAFT DETAIL QTY REQ 1.
Ø10
Ø 6
Ø25
Ø21
Ø15
SECTION THROUGH C-C
A
A
Ø25
R40
R12
40
15
25
45
5
SECTION THROUGH A-A
DRILL HOLE
Ø5
DRILL 2 HOLE
Ø15
BEARING HOUSING DETAILS: QTY REQ 2
15
Ø 60 Ø50
6
3
B
B
Ø 60
Ø 50
Ø 12
Ø 6
FIG A
FIG B
FIG A SECTION THROUGH B-B
FIG B PULLEY.
40
30
8
8
18
102
52
52
FRAME ASSEMBLY QTY REQ 1



ISOMETRIC DRAWING OF THE PACKAGE MACHINE

LABELLING PARTS

1	HOPPER
2	BEARING
3	OUTLET
4	FRAME
5	WAIGHING PLATFORM
6	SPRING
7	MOTOR STAND
8	BRACE
9	AUGER CASING
10	PULLEY
11	SHAFT
12	BEARING SUPPORT
13	VARIABLE SWITCH
14	SCALE

FEDERAL UNIVERSITY OF TECHNOLOGY MX.

DEPERTMENT OF AGRICULTURAL ENGINEERING

NAME	TAIWO O. BASATOPE	DATE	SIGN	SCALE 5 : 1
REG. NO.	99/6384EA			
CHECKED BY	A. O	ISOMETRIC DRAWING OF BAG PACKAGE M		
APPROVED BY	DR. MRS ZINASH D. OSUNDE			
MATERIAL	MILD-STEEL			

ALL DIMENSION IN MM