Energy Efficient Wet Grinder by Pedaling

A Project Report

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report entitled "**Energy Efficient Wet Grinder by Pedaling**" is the bonafide work of

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ABSTRACT

In the competitive world, people find it very difficult to cope up with work requirements and health related activities due to the time constraints. New home appliances added comforts to the human being while discouraging physical fitness. Few human beings do physical exercise at their convenience by putting there extra time and cost. An attempt has been made in this project work to combine the wet grinding and physical exercises, so that energy could be saved marginally in every family. For this purpose, a conceptual design is proposed to combine cycling with wet grinding through a gear transmission and chain drive system.

A detailed design is made to transmit the power produced while a man or woman exercises with a cycle used for grinding the nuts/grains. CATIA software has been employed to design the parts and assembled. At the successful completion of animated design, drawings have been prepared for fabricating the equipment. It is experimented that this equipment is found to be viable alternative to cater to the physical fitness while grinding is made. The productivity issues could be studied further to enable the equipment for the commercial uses in small scale hotels, etc. A software code has also been written to design the gear from the given input data.

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LIST OF SYMBOLS

Symbols	Abbreviations
m	module
Z1	Number of teeth on pinion
Z2	Number of teeth on gear
PCD	Pitch circle diameter
P_d	Diametrical pitch
i	Velocity Ratio(or) Transmission Ratio
R	Cone Distance (or) Pitch cone Distance
D	Pitch circle Diameter
P	Transmitted Power
T	Torque
a	Centre Distance
L	Length of the Chain
m_t	Transverse module
P_s	Tension due to sagging
N	Speed
v	velocity
K_s	Service factor
Fsw	Working factor of safety
lp	number of links
$[M_t]$	Initial design torque
b	Face width
F_t	Tangential force

CHAPTER-1

INTRODUCTION

1.1 SCOPE OF PROJECT

The pedaling system of the wet grinder is mainly fabricated to serve the society. The system combines two processes so that the energy dissipated in one process will be the source of other process. By having this pedaling system the extra time we spend for exercise by various ways is reduced and also saves the electrical energy. The system is less cost of manufacturing and more efficient.

1.2 OBJECTIVES

- ✓ To fabricatc a system that uses the energy wasted by human beings in his routine life for the purpose of being fit and to lead a healthy life.
- ✓ To reduce the money and time spend by the men for the betterment of life and a system that can be used at any condition and no need for the electrical power.

1.3 THE SEQUENCE OF PROJECT

The load and torque transmitted in the conventional wet grinder through belt drive from motor is calculated and how the mechanical power is being transmitted in a bicycle through chain drive was studied.

The study shows that the mechanical power from bicycle is enough to run the wet grinder and so the energy can be utilized instead of wasting during the exercise processes. Both the wet grinder and pedaling process was combined and the design was carried out to form the system.

CHAPTER-2

LITERATURE SURVEY

2.1 INTRODUCTION

Wet grinders are very popular tools in South Indian kitchen used to make paste out of soaked consisted of a large rock with a hole in it. Where a cylindrical rock with a wooden handle fit in. The grain and lentil mixture was poured in water and the cylinder rotated by the handle on the top to grind the food together. The ground paste is used for various food items like idli, dosa and vada.

The invention of electricity has led to the development of electric-powered wet grinders. These electric models were first introduced in restaurants and later moved into the home.

Popular brands include:

- Ultra Wet Grinder
- Santha Tilting Wet Grinder
- Sowbaghya Wet Grinder
- Premier Grinder
- SPL Wet Grinder

Most modern models still have stone Components for the grinding action. The stone is usually granite stone. The old manual grinding stones used to be refinished for better results. Modern stones usually don't need refinishing and they last much longer.

2.2 MATERIAL SELECTIONS

The knowledge of their material and their properties are the great significance for a engineer. The machine elements should be made of such a material, which has properties suitable for the conditions of operation. In addition to this, an engineer must be familiar with effects, which the manufacturing process and heat treatment have on the properties of materials. Now we shall discuss the commonly used engineering materials and their properties in machine design.

2.2.1Classification of engineering materials

The engineering materials are mainly classified as

Metals and their alloys, such as iron, copper etc

Non-metals, such as glass, rubber, plastic etc

The metals may be further classified as

Ferrous metals

Non-ferrous metals

The ferrous metals are those, which have iron as their main constituent, such as cast iron, wrought iron and steel.

The non-ferrous metals are those, which have metal, other than iron as their main constituent, such as copper, aluminum, brass, tin etc.

2.2.2 Selection of materials:

The selection of a proper material, for engineering purpose, is one of the most difficult problems for the designer. The best material is one which serves the desired objective at minimum cost. The factors to be considered while selecting are

1) Availability of materials
2) Suitability of the materials for working condition.
3) Cost of the materials

The important properties, which determine the utility of material, are physical, chemical and mechanical properties.

2.3 MATERIAL REQUIREMENTS

The material selection for any fabrication is an important aspect. It should satisfy the following requirements.

1) Fabrication requirements
2) Service requirements
3) Economic requirements

2.3.1 Fabrication Requirements

The material chosen should have the following properties, according to the fabrication requirement.

➢ **Machinability**

It is the property of a material which refers to a relative case with which a material can be cut. The machinability of a material can be measured in a number of ways. By comparing the tool life for cutting different materials or thrust required to remove the material at some given rate or the energy required to remove a unit volume of the material. It may be noted that brass can be easily machined than steel.

➢ **Ductility**

It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. Ductility is usually measured by the terms, percentage elongation and percentage reduction in area. The ductile material commonly used in engineering practice (in order of diminishing ductility) are mild steel, copper, aluminium, nickel, zinc, tin and lead.

➢ **Malleability**

It is a special case of ductility which permits materials to be rolled or hammered into thin sheets. A malleable material should be plastic but it is not essential to be so strong. The materials commonly used in engineering practice are leads, s<?ft steel, wrought iron, copper.

2.3.2 Service Requirements

The material selected for the purpose must stand up to the service demands such as:

- **Strength**

  It is the ability of a material to resist the externally applied forces without breaking or yielding.

- **Stiffness**

  It is the ability of a material to resist deformation under stress. The modulus of elasticity is the measure of stiffness.

- **Toughness**

  It is the property of a material to resist fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of energy that a unit volume of the material has absorbed after being stressed upon the point of fracture.

2.3.3 Economic Requirements

Economic requirements demand that the engineering fact should be made with minimum overall cost. This may be achieved by proper selection of both material and variable.

2.4 SELECTIONS OF GEAR DRIVES

2.4.1 Types of gear drives

TABLE 2.1 TYPES OF GEAR DRIVES

TYPE	NOTES
Spur	Majority of gears are spur. Relatively easy to design and make. Parallel shafts. High efficiency (99% per train). No side thrust. Can back drive. Single Ratio upto 1:10. Can be made very accurate with low vibration/noise. Normally steel pinions require lubrication. Plastic gears can be used requiring no lubrication
Internal Spur	Similar performance to normal spur. Results in compact drive geometry. Used in manufacture of epicyclic/planetary gears.
Helical	Single Helical have similar properties to spur. However drive results in axial thrust. Gears are smoother/quieter for the same size/spec. The gears can run at high speeds upto large diameters. Higher torque/life capabilities for same size as spur.
Double - Helical	Similar benefits to single helical but with no generated side thrust. Higher performance compared to single helical
Crossed – Helical	Shaft at 90o Difficult to make accurately. Smooth drive.
Worm	Offset shafts at 90. Very high ratios possible in single stage. Sliding action. One gear is normally copper allow (bronze). Low efficiency at higher ratios and low speeds. Lubrication essential for mechanical and thermal reasons. Cannot back drive at high ratios.
Bevel Gear	Mainly used for drive transmission through 90. Only low ratios used (4:1 and less). Lubrication required. Some vibration on spur type: Helical type smoother.
Spiroid	Perform a similar function to worm boxes but the gears have characteristics which combine those of the bevel and worm gears. High powers and speed ratios are possible and mechanical efficiencies higher than worm boxes for equivalent ratios.

2.4.2 Brief comparisons of gears

TABLE 2.2 COMPARISON OF GEARS

TYPE	NORMAL RATIO RANGE	PITCH LINE VELOCITY	EFFICIENCY RANGE
SPUR	1:1 to 6:1	25	98-99%
HELICAL	1:1 to 10:1	50	98-99%
DOUBLE HELICAL	1:1 to 15:1	150	98-99%
BEVEL	1:1 to 4:1	20	98-99%
WORM	5:1 to 75:1	30	20-98%
CROSSED HELICAL	1:1 to 6:1	30	20-98%

2.5 TRANSMISSION SYSTEM

2.5.1 Chain Drive

The chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of vehicles. It is also used in a wide variety of machines besides vehicles.

The power is conveyed by a roller chain known as drive chain, passing over a sprocket gear. With the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into system.

2.5.2 Chain versus Belt Drive

- Drive chain are similar to drive belts in many ways and which device is used is subject to several design trade offs. Drive chains are most often made of metal, which belts are often rubber, plastic (or) other substances. This makes drive chains heavier, so more of the work put into the system goes into moving a chain versus moving a belt.
- On the other hand, Well-made chains often stronger than belts also drive belts can often slip (unless they have teeth) which means that the output side may not rotate at a precise speed, and some works gets lost to the friction of the belt against rollers.
- Chains are often narrower than belts, and this can make it easier to shift them to larger or smaller gears in order to vary the gear ratio.

2.5.3 Sprocket

A Sprocket is a gear or wheel with metal teeth that meshes with a chain or track sprockets are used in bicycles, motorcycles and other machinery. In case of bicycle chains by varying the size of sprockets on each side of chain, modifying overall gear ratio of the chain drive is possible.

2.6 FABRICATING OPERATIONS

2.6.1 Arc welding

Arc welding uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is sometimes protected by some type of inert or semi-inert gas, known as a shielding gas, and/or an evaporating filler material. The process of arc welding is widely used because of its low capital and running costs.

One of the most common types of arc welding is shielded metal arc welding (SMAW), which is also known as manual metal arc welding (MMA) or stick welding. An electric current is used to strike an arc between the base material and a consumable electrode rod or 'stick'. The electrode rod is made of a material that is compatible with the base material being welded and is covered with a flux that protects the weld area from oxidation and contamination by producing CO_2 gas during the welding process. The electrode core itself acts as filler material, making separate filler unnecessary. The process is very versatile, requiring little operator training and inexpensive equipment.

However, weld times are rather slow, since the consumable electrodes must be frequently replaced and because slag, the residue from the flux, must be chipped away after welding. Furthermore, the process is generally limited to welding ferrous materials, though specialty electrodes have made possible the welding of cast iron, nickel, aluminium, copper and other metals. The versatility of the method makes it popular in a number of applications including repair work and construction.

Welding can be a dangerous and unhealthy practice without the proper precautions; however, with the use of new technology and proper protection the risks of injury or death associated with welding can be greatly reduced. Because many common welding procedures involve an open electric arc or flame, the risk of burns is significant. To prevent them, welders wear protective clothing in the form of heavy leather gloves and protective long sleeve jackets to avoid exposure to extreme heat.

2.6.2 Turning

Turning is the removal of metal from the outer diameter of a rotating cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Often the work piece will be turned so that adjacent sections have different diameters.

Choose a tool bit with a slightly rounded tip, like the one described above in the tool grinding section. This type of tool should produce a nice smooth finish. For more aggressive cutting, if you need to remove a lot of metal, you might choose a tool with a sharper tip. Make sure that the tool is tightly clamped in the tool holder.

Adjust the angle of the tool holder so the the tool is approximately perpendicular to the side of the work piece. Because the front edge of the tool is ground at an angle, the left side of the tip should engage the work, but not the entire front edge of the tool. The angle of the compound is not critical; I usually keep mine at 90 degrees so that the compound dial advances the work .001" per division towards the chuck.

Make sure the half nut lever is disengaged and, if you have one that the carriage locks is not tightened down. If necessary, back off the cross slide until the tip of the tool is back beyond the diameter or the work. Move the carriage until the tip of the tool is near the free end of the work piece, then advance the cross slide until the tip of the tool just touches the side of the work. Move the carriage to the right until the tip of the tool is just beyond the free end of the work.

2.6.3 Drilling

The alignment between the headstock and tailstock of the lathe enables you to drill holes that are precisely centered in a cylindrical piece of stock. I tried doing this once with my drill press and vise before I had the lathe; it did not turn out too well. Before you drill into the end of a work piece you should first face the end as described in the facing operations section. The next step is to start the drill hole using a center drill – a stiff, stubby drill with a short tip. Before drilling you need to make sure that the drill chuck is firmly seated in the tailstock.

With the chuck arbor loosely inserted in the tailstock bore, crank the tailstock bore out about 1/2". Lock the tailstock to the ways, then thrust the chuck firmly back towards the tailstock to firmly seat the arbor in the Morse taper of the tailstock. (The chuck is removed from the tailstock by cranking the tailstock ram back until the arbor is forced out).

Choose a center drill with a diameter similar to that of the hole that you intend to drill. Insert the center drill in the jaws of the tailstock chuck and tighten the chuck until the jaws just start to grip the drill. Since the goal is to make the drill as stiff as possible, you don't want it to extend very far from the tip of the jaws. Twist the drill to seat it and dislodge any metal chips or other crud that might keep the drill from seating properly. Now tighten the chuck. It's good practice to use 2 or 3 of the chuck key holes to ensure even tightening (but all three may be impossible to reach given the tight confines of the 7x10).

2.6.4 Facing

You must consider the rotational speed of the work piece and the movement of the tool relative to the work piece. Basically, the softer the metal the faster the cutting. Don't worry too much about determining the correct cutting speed: working with the 7x10 for hobby purposes, you will quickly develop a feel for how fast you should go.

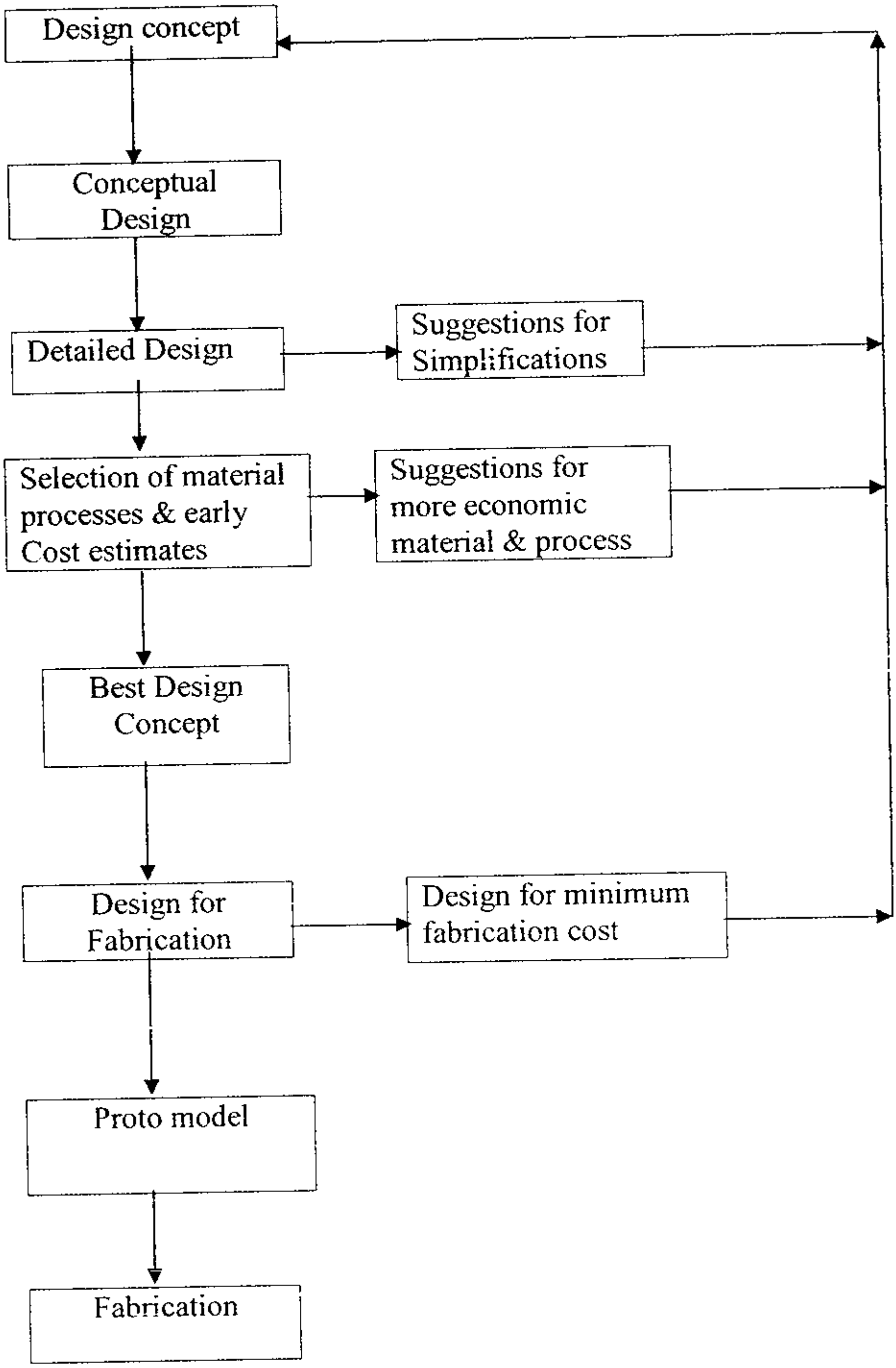
Until you get a feel for the proper speeds, start with relatively low speeds and work up to faster speeds. One of the great features of the 7x10 is that you can adjust the rotational speed without stopping to change belts or gears. Most cutting operations on the 7x10 will be done at speeds of a few hundred RPM - with the speed control set below the 12 O'clock position and with the HI/LO gear in the LO range. Higher speeds, and particularly the HI range, are used for operations such as polishing, not cutting.

CHAPTER-3

DESIGN PROCESS

3.1 FLOW CHART

Z



3.2 Specifications of wet grinder:

Diameter of the motor pulley d_1 = 1.25 inches = 31.75 mm

Diameter of the wet grinder pulley d_2 = 11 inches = 279.4 mm

Wet grinder motor speed N_1 = 1440 rpm

Wet grinder drum speed N_2 = $N_1/N_2 = d_1/d_2$

= 163.636 rpm = 164 rpm

Velocity ratio = 8.8

So we want to attain 164 rpm (around) in our project so we introducing a gear transmission system and chain drive. The designing of the gears and chain drive are follows:

3.3 DESIGN PROCEDURE FOR CHAIN DRIVE:

To increase the speed ratio we take the transmission ratio as 2.

Transmission ratio = driven speed/ driver speed

i = 2 (assumed)

Number of teeth on the driven sprocket (Z_1) = 27(i = 2 to 3) (assumed)

Number of teeth on the driver sprocket (Z_2) = $i*Z_1$

(Z_2) = 54

Centre distance, a = (30 – 50)*P

Standard pitch, (from data book) = 15.875mm (P.N 7.74)

Simplex chains drive to be selected. Chain number is **10A-1 R50** taken from data book. (P.N 7.72)

3.3.1 Calculation of total load on the driving side of the sprocket (P_T):

(i)Tangential force due to power transmission (P_t) = 1020*N/v

N – Transmitted power in KW

v - Chain velocity in m/s

v = $Z_1*P*N_1/60*1000$

Z_1 - Number of teeth on the driven sprocket

N_1 – Speed of the driven sprocket in rpm

= 27*15.875*60/60*1000

= 0.4286m/s

Power developed, $N = 170$ KW (assumed)

$P_t = 1020*170/0.4286$

$P_t = 403.73$ N

(ii)Centrifugal force $P_c = mv^2$

m – mass/meter in kg/m

Taken from data book (P.N 7.72) $m = 1.01$ kg/m

$P_c = 0.1855$ N

(iii)Tension due to sagging $P_s = k*w*a$

From data book (P.N 7.78)

Coefficient for sag, (for horizontal) $k = 6$

w - Weight of the chain $w = m*g = 17.468$ N

a – Centre distance in meter = 0.5 m (assumed)

$P_s = 52.386$ N

Total load $P_T = P_t + P_c + P_s$

$P_T = 456.2915$ N

Service factor $K_s = K_1*K_2*K_3*K_4*K_5*K_6$

Following all the factors taken from data book (P.N 7.76, 7.77)

K_1 - Load factor (variable load) = 1.5

K_2 - Factor for distance regulation (fixed centre distance) = 1.25

K_3 - Factor for centre distance of sprockets = 1

K_4 - Factor for position of sprockets (Inclination o the line joining the centres of the sprockets to the horizontal upto 60 degrees) = 1

K_5 - Lubrication factor (Periodic) = 1

K_6 - Working rating factor (Single sift 4 hours/ day) = 1

$K_s = 1.875$

Design Load $= P_T*K_s = 456.2915*1.875$

$= 855.546$ N

Working factor of safety F_{sw} = Q/Design load

Q - Breaking load = 22200 N (taken from data book P.N 7.72)

$= 22200/855.546$

$F_{sw} = 25.948$

Minimum value of factor of safety is **7.8** (taken from data book P.N 7.77). Therefore the working factor of safety is greater than the recommended minimum factor of safety. Thus **the design is safe and satisfactory.**

Bearing stress in the roller = P_t*K_s/A

A – Bearing area in mm^2 = 70 mm^2 (taken from data book P.N 7.77)

Bearing stress in the roller = 10.814 N/mm^2

Smaller sprocket speed of 60 rpm and pitch 15.875 mm, maximum value of allowable bearing stress is **31.5 N/mm^2**(taken from data book P.N 7.77). Therefore the induced stress is less than the allowable bending stress. Thus **the design is safe and satisfactory.**

3.3.2 Length of chain (L):

Following formula's are taken from data book (P.N 7.75)

Number of links l_p = $(2*a_p) + (Z_1+Z_2/2) + (Z_1-Z_2/2*3.14)$ ^2/a_p

a_p = a_o/p

a_p – Approximate centre distance in multiples of pitches

a_o – Initially assumed centre distance in mm = 500 mm

p – Pitch in mm = 15.875 mm

a_p = 31.496

l_p =104.07 = 104 links(rounded off to even number)

Actual length of chain L = l_p*p

= 1651 mm

Centre distance a = [e+ (e^2-8*M) ^0.5)*p]/4

M - Constant

e = l_p - $(Z_1+Z_2/2)$

= 63.5

M = $(Z_1-Z_2/2*3.14)$ ^2

= 18.465

a = 499.37 mm

Decrement in centre distance for an initial sag = 0.01*a

= 4.9937 mm

Exact centre distance = a – 0.01*a

= 495 mm

3.3.3 Specifications of chain and sprockets:

1. Pcd of smaller sprocket d_1 = p/sin (180/ Z_1)

   = 136.74 mm

2. Sprocket outside diameter d_{o1} = d1+0.8*dr

   d_r – Diameter of roller(taken from data book P.N7.72) = 10.16 mm

   = 144.868 mm

3. Pcd of larger sprocket d_2 = p/sin (180/Z_2)

   = 308.38 mm

4. Sprocket outside diameter d_{o2} = d_2+0.8*dr

   = 316.51 mm

5. Chain pitch p = 15.875 mm

6. Width between inner plates b_1 = 9.55 mm

   (taken from data book P.N7.72)

7. Roller seating radius r_i = $(r_i)_{max}+(r_i)_{min}/2$

   $(r_i)_{max}$ = 0.505* dr+ (0.069* dr)^1.3

   = 5.28 mm

   $(r_i)_{max}$ = 0.505* dr

   = 5.1308 mm

   r_i = 5.206 mm

8. Roller seating angles = 125 degrees

9. Tooth flank radius r_e = 32.675 mm

10. Tooth height h_a = 4.2 mm

11. Tooth side radius r_x = p

    = 15.875 mm

12. Tooth width b_f = 0.95 b_1(p>12.7 mm)

    = 9.07 mm

13. Tooth side relief b_a = 0.15*p

= 2.38 mm

To convert the horizontal direction to vertical direction a Bevel Gears used. The design of Bevel gear as follows:

3.4 DESIGN PROCEDURE FOR BEVEL GEAR DRIVE

The Bevel gear design is follow by **Lewis and Buckingham's equation** due to reduce the power losses we select the transmission ratio as 1.

Transmission ratio i = 1

Pitch angles = 1/tan (1)

= 45 degrees

Pinion & gear made by the same material as cast iron, Grade 35 heat treated.

We assume gear life as 20000 hours.

Gear life in cycles = 20000* N*60

N – Speed of the gear drive in rpm = 60 rpm

= 72000000 cycles (assumed)

Initial design torque $[M_t]$ = M_t*K*K_d*K_o

Torque M_t = 60*P/2*3.14*N_1

P – Power transmitted in KW = 0.17 KW

N_1 – Speed of the gear drive in rpm = 60 rpm

K – Load concentration factor

K_d – Dynamic load factor

K_o – Service/ shock factor = 1.5 (assumed medium shock)

M_t = 27.056 N-m

Initially assumed K*K_o = 1.3

$[M_t]$ = 52759 N-mm

Equivalent young's modulus E_{eq} =1.6677*10^5 N-mm^2

(for cast iron, tensile strength >280 N/mm^2, from the data book P.N 8.14)

Design bending stress =1.4*K_{bl}*endurance limits stress/n*K_c

K_{bl} = (10^7/N) ^1/9

K_{bl} – Life factor for bending

n- Factor of safety = 2 (taken from data book P.N 8.19)

K_c – Stress concentration factor = 1.2

N - Gear life in cycles

$K_{bl} = 0.803$

Design bending stress $= 60.57\ N/mm^2$

Design contact stress $= C_B * HB * K_{cl}$

C_B – Coefficient depending on the surface hardness = 2.3 (taken from Data bookP.N8.16)

HB - Brinell hardness number = 200

K_{cl} - Life factor for surface strength

$K_{cl} = (10^7/N)^{1/6}$ (for cast iron material)

$K_{cl} = 0.7196$

Design contact stress $= 331.01\ N/mm^2$

Cone distance $R = 48.85 = 49$ mm

Transverse module $m_t = R/0.5*(Z_1^2+Z_2^2)^{0.5}$

Z_1 – Number of teeth on the driven gear

Z_2 - Number of teeth on the driver gear

$m_t = 3.46 = 4$ mm

Recalculations:

Cone distance $R = 0.5*m_t*(Z_1^2+Z_2^2)^{0.5}$

$= 56.57$ mm

Face width $b = R/3$

$= 18.856$ mm

Average module $m_{av} = m_t - (b*\sin 45)/Z_1$

$= 3.33$ mm

Average Pcd of pinion $d_{1av} = m_{av}*Z_1$

$= 66.67$ mm

Pitch line velocity $v = 3.14* d_{1av}*N_1/60$

$= 0.1396$ m/s

Design torque $[M_t] = M_t*K*K_d*K_o$

P – Power transmitted in KW = 0.17 KW

N_1 – Speed of the gear drive in rpm = 60 rpm

(From the data book P.N 8.15)

K – Load concentration factor = 1.1 ($b/d_{1av} < 1$)

Assume IS quality is 6 bevel gear (from the data book P.N 8.16)

K_d – Dynamic load factor = 1

K_o – Service/ shock factor = 1.5 (assumed medium shock)

M_t = 60*P/2*3.14*N_1

= 27.05 N - m

[M_t] = 44632.5 N - mm

Induced bending stress $= \dfrac{R*(i^2+1)^{0.5}*[M_t]}{(R-.5)^2*b*m_t*Y_{v1}}$

Y_{v1} – Form factor (taken from data book P.N 8.18) = 0.437

i – Transmission ratio

= 40.73 N/mm^2

Design contact stress < Induced bending stress. So **the design is satisfactory.**

Induced contact stress $= \dfrac{(((i^2+1)^3)^{0.5}*E_{eq}*[M_t]/i*b)^{0.5}*0.72}{(R - 0.5 * b)}$

= 118.658 N/mm^2

Induced contact stress< Induced contact stress. So **the design is satisfactory.**

3.4.1 Specification of Bevel Gear

1. Transverse module m_t = 4 mm
2. Number of teeth Z_1 & Z_2 = 20
3. Pitch circle diameter d_1 & d_2 = m_t*Z
   =80 mm
4. Cone distance R = 56.57 mm
5. Face width b = 19 mm
6. Pitch angles = 45 degrees
7. Tip diameter d_{a1} & d_{a2} = $m_t(Z_1 + 2\cos45)$
   =85.65 mm
8. Height factor f_o = 1
9. Clearance c = 0.2
10. Addendum angles = $m_t * f_o/R$
    =4.044 degrees

11. Dedendum angles $= m_t(f_o + c)/R$

$= 4.85$ degrees

12. Tip angles = pitch angle + addendum angle

= 49.05 degrees

13. Tooth height = 7.52 mm

14. working depth = 6.8 mm

3.5 DESIGN PROCEDURE FOR SPUR GEAR

The spur gear design is designing by using **Lewis and Buckingham's equation (or gear design based on beam strength)**, which is recommended by **AGMA** (American Gear Manufacturers Association).

To increase the speed ratio we take the transmission ratio as 2.

Both the Pinion and Gear are made of **Cast Iron grade 35**, BHN = 260.

Number of teeth on pinion $Z_1 = 18$ (assumed)

Velocity ratio $i = 2$

Number of teeth on pinion $Z_2 = i * Z_1$

$= 36$

Tangential load on tooth $F_t = P*K_o/v$

$v = 3.14*m*Z_1*N_1/60*1000$

$= 0.113*m$ m/s

P- Transmitted power in Watts = 170 W (assumed)

K_o – Service or shock factor = 1.5(medium shock)

v- Pitch line velocity in m/s

N_1 – Speed of the gear drive in rpm

$F_t = 2256.637/m$

Initial dynamic load $F_d = F_t/C_v$

$C_v = 6/6+V_m$

C_v – Velocity factor

V_m – Mean velocity in m/s

Initially assumed $V_m = 12$m/s

	C_v	$= 0.3333$
	F_d	$= 6769.911/m$
Beam strength	F_s	= 3.14*m*b*y*bending stress

m – Module in mm

b – Face width in mm, initially we assumed b = 10*m

y – Form factor = 0.308 for 20 degrees full depth (taken from data book P.N 8.53)

F_s	$= 395.84m^2$
F_s	$\geq F_d$
$395.84m^2$	$= 6769.911/m$
m	= 2.5764 mm = 3 mm

Calculation of actual value:

Module	m	= 3 mm
Face width	b	= 10*m
	b	= 30 mm
Pitch circle diameter	d_1	$= m*Z_1$
	d_1	= 54 mm
Pitch line velocity	v	= 3.14*d1*N1/60
	v	= 0.226 m/s
Beam strength	F_s	= 3562.194 N
Accurate dynamic load	F_d	= 2863.45 N

$F_s < F_d$ The gear has adequate beam strength and it will not fail by breakage. Therefore **the design is satisfactory.**

Maximum wear load	F_w	$= d_1*b*Q*K_w$
	F_w	= 4600.8 N

$F_w < F_d$ The gear has adequate wear capacity and it will not wear out. Therefore **the design is satisfactory.**

3.5.1 Specifications of Spur Gear:

Module	m	= 3mm
Number of teeth	Z_1	= 18
	Z_2	= 36

Pitch circle diameter	d_1	= 54 mm
	d_2	= 108 mm
Centre distance	a	= 81 mm
Face width	b	= 30 mm
Height factor	fo	= 1
Bottom clearance	c	= 0.75 mm
Tip diameter	d_{a1}	= 60 mm
	d_{a2}	= 114 mm
Root diameter	d_{f1}	= 46.5 mm
	df2	= 100.5 mm
Tooth depth	h	= 6.75 mm

CHAPTER-4

DESIGNED DRAWINGS

4.1 ASSEMBLED VIEW

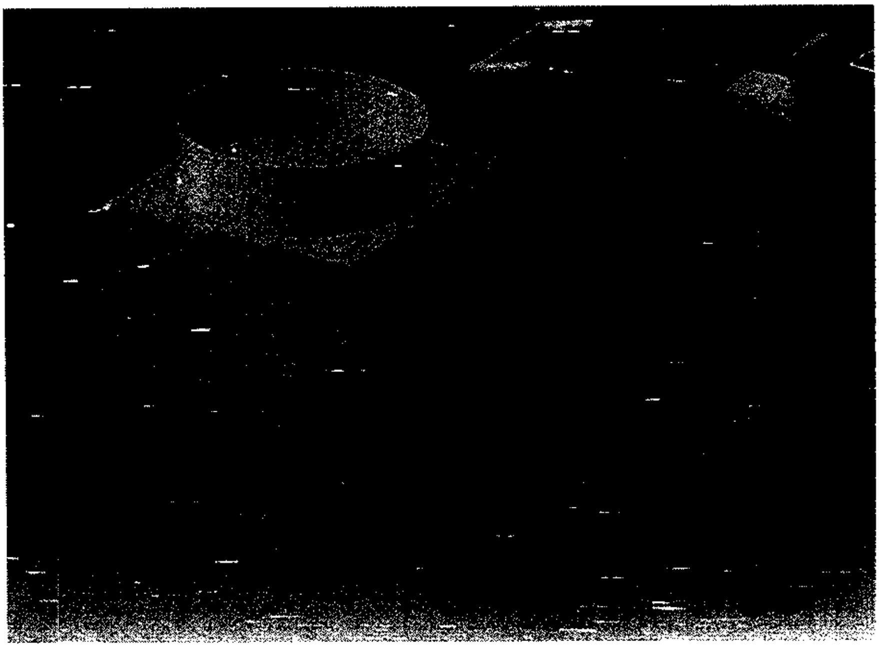


FIG 4.1 ASSEMBLED VIEW

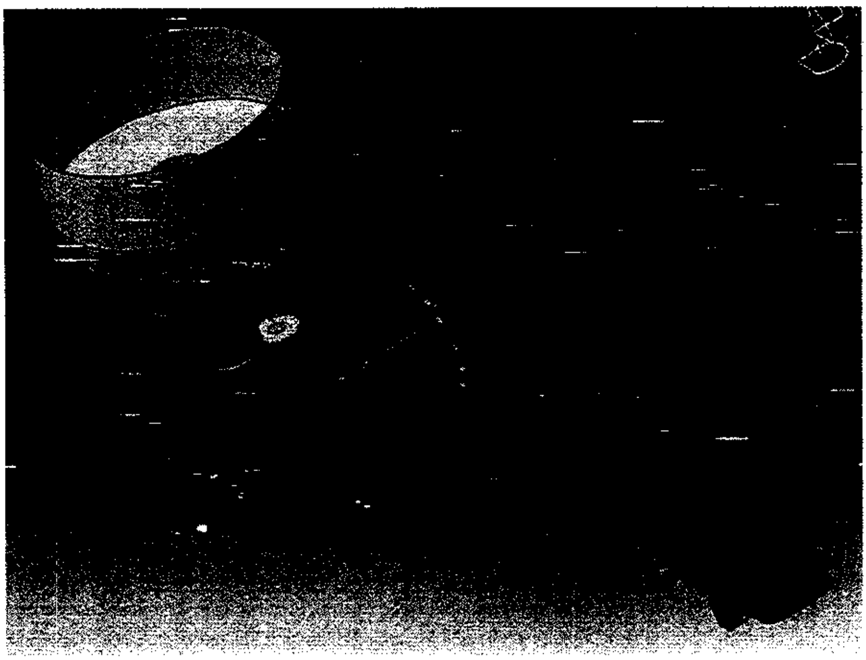


FIG 4.2 ISOMETRIC VIEW

4.2 PARTS VIEW

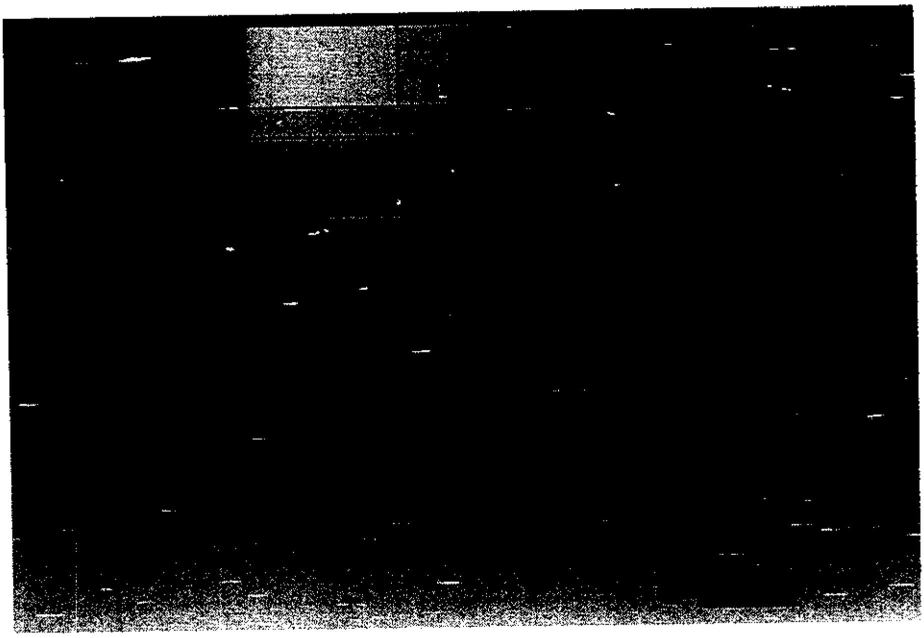


FIG 4.3 FRONT VIEW

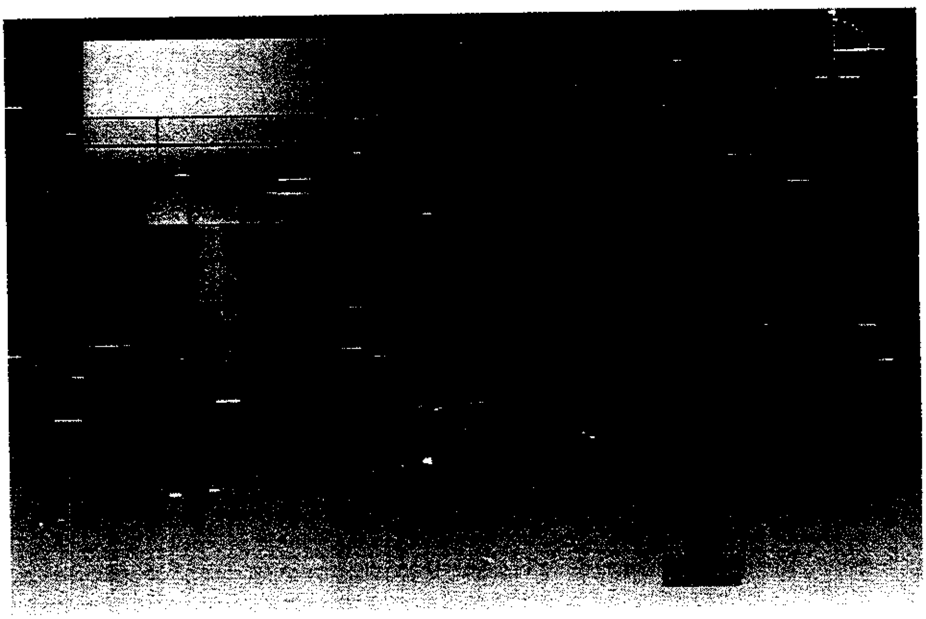
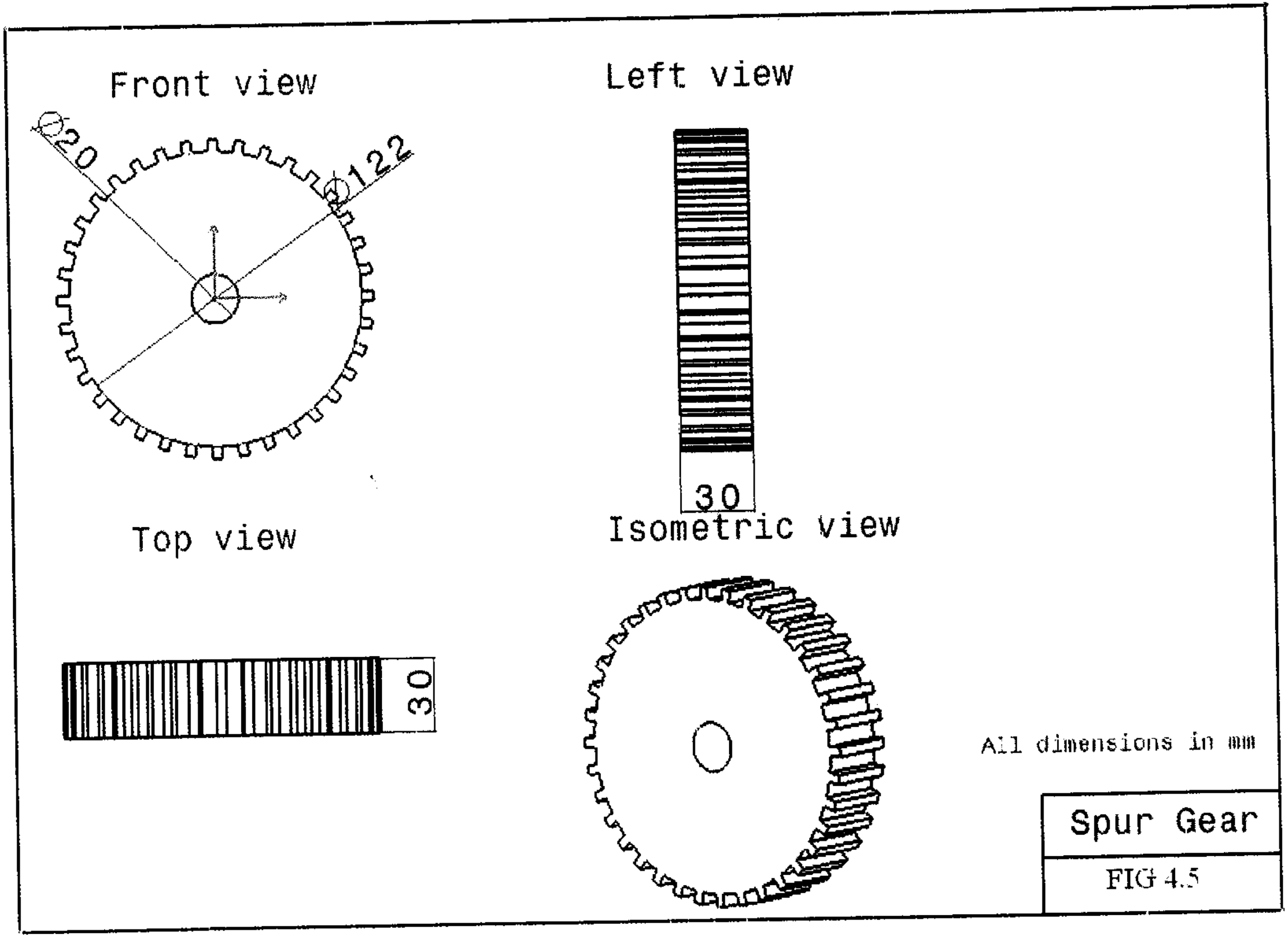
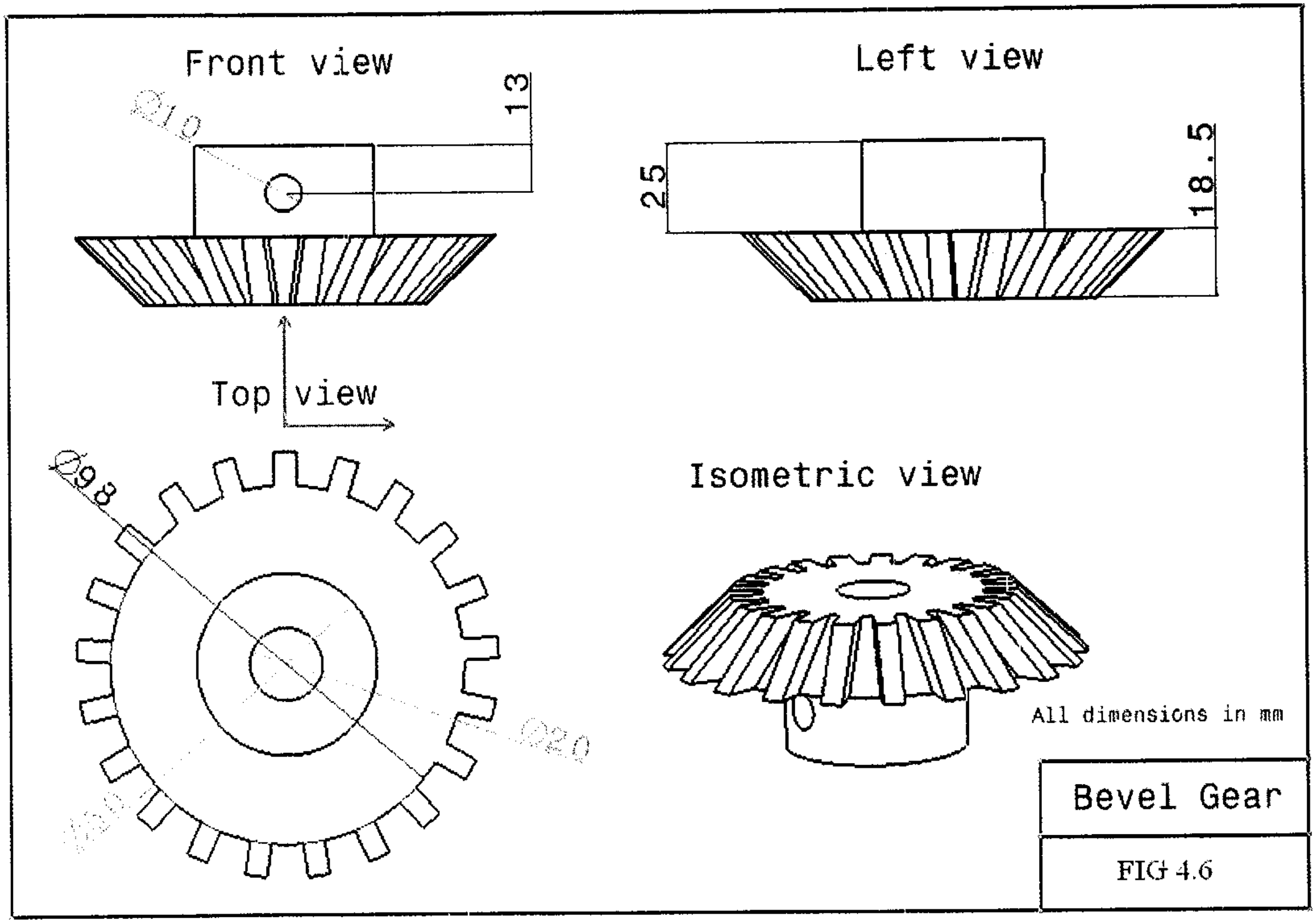


FIG 4.4 SIDE VIEW


Front view
Ø20
Ø122
Left view
30
Top view
30
Isometric view
All dimensions in mm
Spur Gear
FIG 4.5


Front view
Ø10
13
Left view
25
18.5
Top view
Ø98
Ø20
Isometric view
All dimensions in mm
Bevel Gear
FIG 4.6

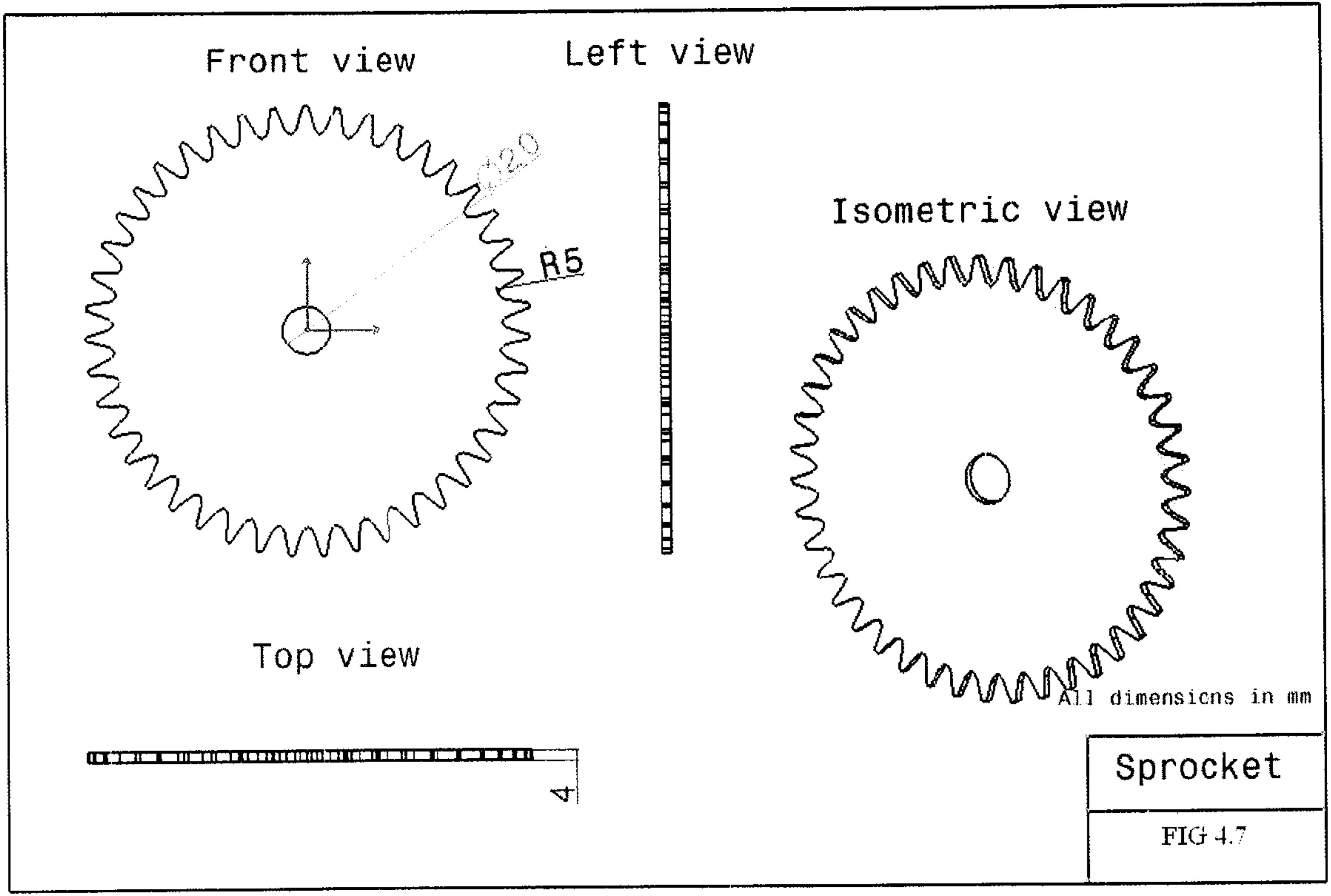

Front view
Left view
Isometric view
Ø20
R5
Top view
4
All dimensicns in mm
Sprocket

FIG 4.7

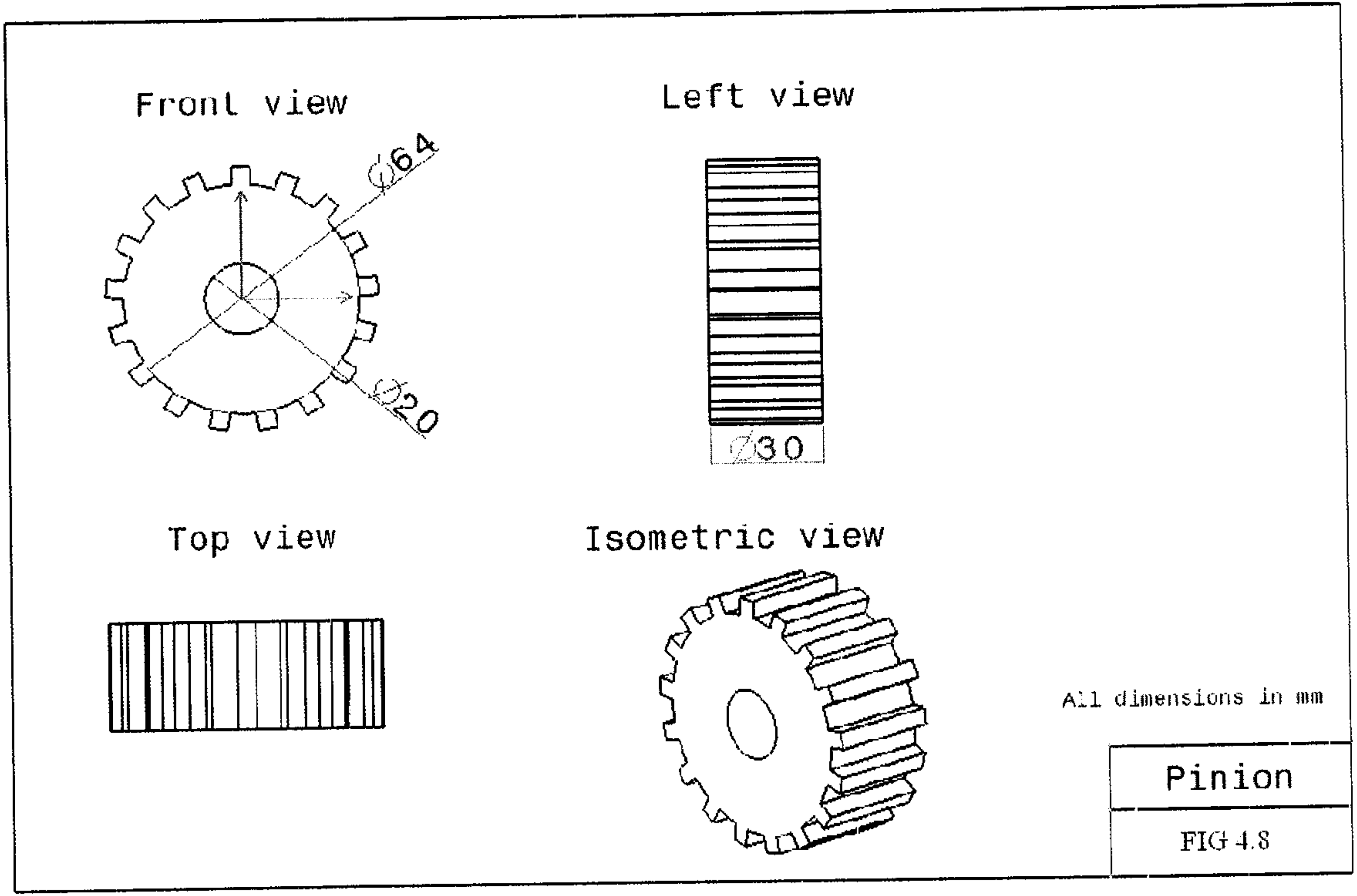

Front view
⌀64
⌀20
Left view
⌀30
Top view
Isometric view
All dimensions in mm
Pinion

FIG 4.8

4.3 MATERIAL SELECTED

The most important factor affecting selection of material in relation to the intended above three requirements. The choice of materials for our machine which gives greater efficiency and effectiveness in operation are ,

- ✓ **MILD STEEL**

  Mild steel is selected because of its ability to increase hardness and strength of the steel. Since it is a ductile material it can withstand tensile stresses produced.

- ✓ **CAST IRON**

  Cast iron usually refers to grey cast iron. The amount of carbon in CI range is 2.1 –4 %. It is used due to its good fluidity, castability, excellent machinability and wear resistance.

- ✓ **EN8**

  It is one of type of carbon steels with proportion of

  C – 0.36 to 0.44 %

  Mn – 0.60 to 1.00 %

  Si – 0.10 to 0.4 %

  It gives good surface finish, impact resistance and increase strength.

CHAPTER-5

BILL OF MATERIALS

TABLE 5.1 BILL OF MATERIALS

SL.NO	NAME OF PARTS	NO OF PARTS	MATERIAL USED	STATUS
1	Wet grinder	1	Stone	B
2	Frame	1	CI	M
3	Post	1	MS pipe	M
4	Spur gear	2	CI	B
5	Bevel gear	2	CI	B
6	Plumber block	2	CI	B
7	Bearing	2	Carbon steel	B
8	Sprocket	2	MS	B
9	Chain	1	Steel	B
10	Tripart	1	Carbon steel	B
11	Shaft	2	EN-8	B
12	L-angle	5	Steel	B
13	Plate	2	CI	M
14	Bolt, nut	8	Steel	B
15	Stand	1	Steel	B

B-BOUGHT, M-MADE

CHAPTER-6

DESCRIPTION OF PARTS

6.1 WET GRINDER

Wet grinders are very popular tools in the South Indian kitchen used to make paste out of soaked grains and lentils. At one time, a wet grinder consisted of a large rock with a hole in it, where a cylindrical rock with a wooden handle fit in. The grain and lentil mixture was poured in with water and the cylinder rotated by the handle on the top to grind the food together. The ground paste is used for various food items like idli, dosa, and vada.

The wet grinder we using is a normal conventional domestic wet grinder. The capacity of the grinder is 2litre. The grinder consisted of a large rock with a hole in it, where a cylinderal rock with a wooden handle fit it.

6.2 FRAME

The frame is constructed from a steel plate of L-angles. It is used to support the whole assembly to the ground. The driving parts are fixed on the frame body.

Dimensions of the frame

Height = 15 inch =38cm

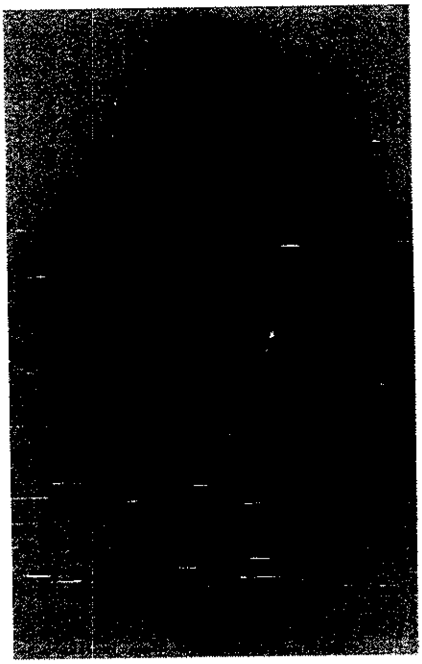
Length = 47cm

Width = 32cm

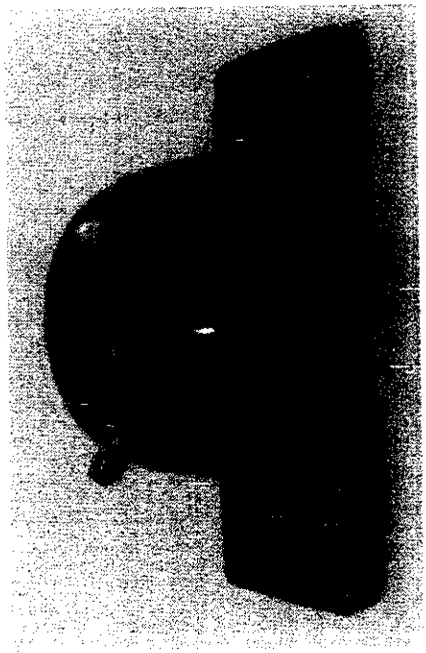
6.3 PLUMBER BLOCK

The plumber block is used to hold the shaft and to provide rotational motion of the shaft. The slide sleeve, bearing are fixed in the plumber block, so its shows like whole assembly. Four bearing are used, two for vertical support and two for horizontal support.

A bearing is a device to permit constrained relative motion between two parts, typically rotation or linear movement. Bearings may be classified broadly according to the motions they allow and according to their principle of operation. Common motions include linear/axial and rotary/radial. A linear bearing allows motion along a straight line, for example a drawer being pulled out and pushed in. A rotary bearing or thrust bearing allows motion about a center, such as a wheel on a shaft or a shaft through housing. Common kinds of rotary motion include both one-direction rotation and oscillation where the motion only goes through part of a revolution. Other kinds of bearings include spherical bearings such as ball joints which are used in car suspensions and some computer mice.



(a)Vertical support



(b)Horizontal support

FIGURE 6.1 PLUMBER BLOCK

Low friction bearings are often quite important for efficiency and wear and facilitate high speeds. Essentially, bearings can reduce friction by shape, by its material, or by introducing a fluid between surfaces

6.4 SPUR GEARS

Spur gears are the simplest, and probably most common, type of gear . Their general form is a cylinder or disk (a disk is just a short cylinder). The teeth project radially, and with these "*straight-cut gears*", the leading edges of the teeth are aligned parallel to the axis of rotation.Spur gears are wheels with teeth that mesh together. Spur gears are used to change the speed and force of a rotating axle. How much the speed and force change depends on the gear ratio. The gear ratio is the ratio of the number of teeth on the pair of gears that are meshed. The first gear in the pair is on the input axle.

For example, this could be the gear on the axle of the motor. The second gear in the pair is on the output axle. This could be the axle of the wheel. The gear ratio is the ratio number of teeth of the gear on the output axle to the number of teeth of the gear on the input axle

The spur gear is relatively easy to design and to make parallel shafts. High efficiency (99% per train) is obtained. Two spur gear of 1:2 ratio which is available in the market is used to transit the motion.

FIGURE 6.2 SPUR GEAR

Spur gears change the direction of rotation. If the input axle rotates clockwise, then the output axle would rotate counter clockwise.

6.5 BEVEL GEARS

Bevel gears are essentially conically shaped, although the actual gear does not extend all the way to the vertex (tip) of the cone that bounds it. With two bevel gears in mesh, the vertices of their two cones lie on a single point, and the shaft axes also intersect at that point. The angle between the shafts can be anything except zero or 180 degrees. Bevel gears with equal numbers of teeth and shaft axes at 90 degrees are called miter gears.

Types of bevel gears:

- ✓ Straight bevel gears

  If the teeth on the bevel gears are parallel to the lines generating the pitch cones, they are called straight bevel gears.

- ✓ Spiral bevel gears

  When the teeth of the bevel gear are inclined at an angle to the face of the bevel, they are known as spiral bevel gears.

- ✓ Zero bevel gears

  Zero bevel gears have teeth which are curved along their length, but not angled and it is a zero degree spiral angle.

- ✓ Hypoid gears

  Hypoid gears are similar in appearance to spiral bevel gears. They differ from spiral gears in that the axis of pinion is offset from the axis of the gear

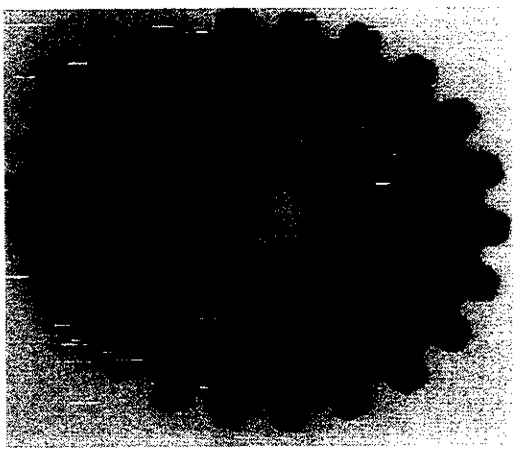


FIGURE 6.3 BEVEL GEAR

Spiral bevel gears have the same advantages and disadvantages relative to their straight-cut cousins as helical gears do to spur gears. The bevel gears are mainly used for drive transmission through 90 degree. Here 1:1 ratio is used for power transmission. It is made of casting material.

6.6 SPROCKET

A sprocket is a gear or wheel with metal teeth that meshes with a chain or track. Sprockets are used in bicycles, motorcycles, cars, tanks, and other machinery.

In the case of bicycle chains by varying the size (and therefore, the tooth count) of the sprockets on each side of the chain, modifying the overall gear ratio of the chain drive is possible. A 10-speed bicycle, by providing two different-sized driving sprockets and five different-sized driven sprockets, allows up to ten different gear ratios. The resulting lower gear ratios make the bike easier to pedal up hills while the higher gear ratios make the bike faster to pedal on flat roads. In a similar way, manually changing the sprockets on a motorcycle can change the characteristics of acceleration and top speed by modifying the final drive gear ratio.

In the case of tanks the engine-driven toothed-wheel transmitting motion to the tracks is known as the *drive sprocket* and may be positioned at the front or back of the vehicle, or in some cases, both.

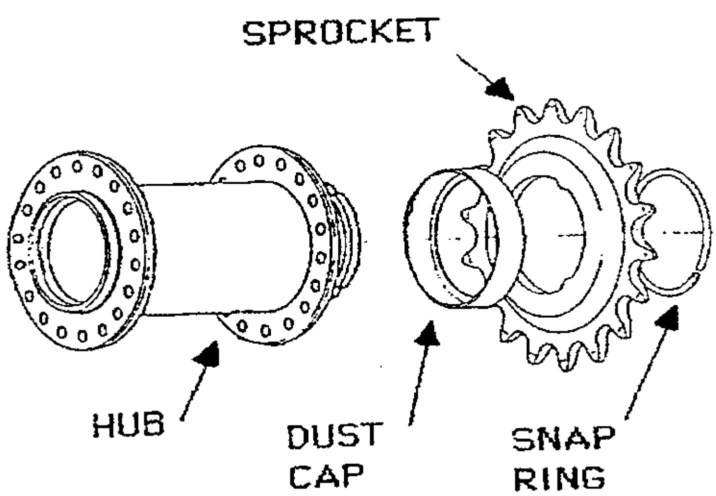


FIGURE 6.4 SPROCKET

The sprocket is used for chain transmission. The power is given in the big sprocket and it is transmitted through chain to the small sprocket. The sprockets are in 1:2 ratio. The sprocket used here is the normal sprocket which is used in bicycles.

6.7 CHAIN DRIVE

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drive chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system.

Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered, so that, for example, the pedals of a bicycle can spin all the way around more than once for every rotation of the gear that drives the wheels.

The chain used is the normal bicycle drive transmission chain, made of casting. The power is being conveyed by a roller chain, passing over a sprocket gear with the teeth of the gear meshing with the holes in the links provided in the chain.

FIGURE 6.7 CHAIN DRIVE

Advantages of chain drives compared with belt and gear drives.

- ✓ They can be used for long as well as shot distances.
- ✓ They are more compact than belt and gear drives.
- ✓ There is no slip between chain and sprocket. so they provide positive drive.
- ✓ One chain can be arranged to drive several sprockets.
- ✓ Higher efficiency (upto 98%) of the drive.
- ✓ They transmit more power than belt drives.
- ✓ They can be operated under adverse temperature and atmospheric conditions
- ✓ Smaller load on the shafts than in belt drives

6.8 TRIPART OF CYCLE

For the seating arrangement and to hold the chain drive assembly a tri part is needed. A bicycle was brought and dismantled to get the tri part of the bicycle. The tri part is being welded to the frame of the system and it is being fixed in the proper alignment. The big sprocket is connected to the tri part and the small sprocket is connected to the horizontal shaft of the system.

CHAPTER-7

FABRICATION

7.1 INTRODUCTION

In the fabrication of any part there are many operations that may be performed before the part is to be finished. The complete process of fabric are done as per Conventional machining process like turning shaping, grinding, milling, welding, facing and gas cutting etc. We can select anyone of those methods depending on the part to be produced and the selected method should be economical.

7.2 THE SEQUENCE OF STEPS INVOLVED IN OUR FABRICATION PROCESS

Step 1:

The first and foremost stage of our fabrication process is searching of the gears in the market and outside according to the design calculations we made.

Step 2:

The gears (spur gears and bevel gears) with the specification DB8 was mostly matches to our design calculation and hence bought it. The gears are made up of casting material.

Step 3:

The support is the main process by which the gears are to be alignment in a proper way for the vertical and horizontal motion of the shaft. The plumber block with the bearing is to hold the shaft and a side sleeve had been selected for the supports. We bought four plumber blocks, two for the vertical support and two for horizontal support.

Step 4:

The shaft which holds the gear assembly is made of EN8 material of 20mm diameter. The material was selected to provide a smooth surface finish. it comes under the carbon steels.

Step 5:

The house hold 2 liter conventional wet grinder was bought from manoj engineering works. The grinder was bought without the motor assembly setup for the fabrication.

Step 6:

According to the design calculation the tri part of the bicycle, sprockets (big and small), the chain drive, stand, bolt and nuts were bought.

Step 7:

For the easy assessment and proper alignment the height of the wet grinder was increased. A stand was made f height 15 inch's from the L-shaped steel plates. The stand is welded to the bottom of the wet grinder.

Step 8:

The gears were fitted to the shaft by providing a keyway between the shaft and gear. The proper alignments of the horizontal and vertical shafts were made by fixing the supports at the appropriate places.

Step 9:

The one end of the horizontal shaft was fitted with small sprocket and other end with the bevel gear. This sprocket is being connected to the big sprocket by means of chain drive.

Step 10:

The whole assembly setup was welded together with the tri part of the cycle and the complete system was tested for further modifications.

CHAPTER-8

TESTING AND EXPERIMENTS

8.1 DESIGN VALUES

Initial torque at sprocket	T	= Ft*R
Tangential force	Ft	= 300 N (Assumed)
Radius of the sprocket	R	= 158 mm
		= 300*158
		= 47.4 N-m
Speed of sprocket	N	= 30 rpm
Initial power at the sprocket	P	= 2*3.14*N*T/60
		= 2*3.14*30*47.4/60
		= 148.91W
Speed of small sprocket		= 60 rpm

Speed increased in smaller sprocket. So the torque is reduced.
Speed is inversely proportional to the torque.

Torque at small sprocket	= T/2 = 23.7 N-mm
Speed of Bevel Gear	= 60 rpm (i = 1)

If speed is not changed the torque also same. So the smaller sprocket and bevel gear torque are same.

Torque at the Bevel Gear	= 23.7 N-mm (i = 1)
Speed of Spur Gear	= 60 rpm
Torque at Spur Gear	= P*60/2*3.14*60
	= 23.7 N-m
Speed of pinion	= 120 rpm
Torque at pinion	= P*60/2*3.14*120
	= 11.85 N-m

(Assume power losses can be negligible)

8.2 EXPERIMENTAL VALUES

Initial torque at sprocket	T = Ft*R
Tangential force	Ft = 300 N (Assumed)
Radius of the sprocket	R = 180 mm
	= 300*180
	= 54 N-m
Speed of sprocket	= 50 rpm
Initial power at the sprocket	P = 2*3.14*N*T/60
	= 2*3.14*50*54/60
	= 282.74 W
Torque at small sprocket	= T/2 = 27 N-m
Speed of Bevel Gear	= 100 rpm
Torque at the Bevel Gear	= 27 N-m (i = 1)
Speed of Spur Gear	= 100 rpm
Torque at Spur Gear	= P*60/2*3.14*100
	= 27 N-m
Speed of pinion	= 200 rpm
Torque at pinion	= P*60/2*3.14*200
	= 13.5 N-m

(Assume power losses can be negligible)

CHAPTER-9

COST ESTIMATION

9.1. COST OF PURCHASED MATERIAL

TABLE 9.1 MATERIAL COST

S.NO	Materials	Cost(Rs)
1.	Wet grinder	1000
2.	Spur Gear	250
3.	Bevel Gear	250
Total		Rs 1500

9.2. RAW MATERIAL AND FABRICATION COST

TABLE 9.2 FABRICATION COST

S.NO	Parts	Cost(Rs)
1.	Plumber block(vertical)	220
2.	Plumber block(horizontal)	180
3.	Sprocket (big and small)	200
4.	Frame (Stand)	200
5.	Shaft(EN8)	120
6.	Tri part of cycle	200
7.	Chain Drive	100
8.	Bolt and nut	30
9.	Sleeve	50
Total		Rs 1300

9.3. TOTAL COST OF MANUFACTURING

TABLE 9.3 TOTAL COST

S.NO	Description	Cost(Rs)
1.	Cost of purchased material	1500
2.	Raw material and Fabrication Cost	1300
3.	Painting Cost	100
4.	Overheads Cost	300
	Total Manufacturing Cost	Rs 3200

CHAPTER-10

RESULTS AND DISCUSSION

10.1 ELECTRICAL POWER CONSUMPTION

Wet grinder power	= 0.5 HP = 372.85 W
Power taken by using Wet grinder/day	= 373W (approximately)
Charge for 1 unit power	= Rs.1.50 (approximately)
Cost for electricity by using Wet grinder/family/day	= Rs.0.5595
Assume the use of wet grinder per month is 12	
Cost for electricity by using Wet grinder/month	= Rs.6.714
Govt. spending amount for electricity / unit (Producing from public sector power plants)	= Rs.3.50
Govt. spending amount for electricity/unit (Buying from private sector power plants)	= Rs.5.50

Benefits of our system

Number of families living in our state	= 1, 46, 65,983
(According to the Census 2001)	
Number of families using our system	= 30% of families (assumed)
	= 4399795
Power consumption of government/day	= 1641124 units=1641124 KW
Money consumption of government/day	= 1641124*4.50
	= Rs. 73, 85,058
Money consumption of government/month	= Rs. 8, 86, 20,696

COMPARISON BETWEEN MANUAL AND PROPOSED EQUIPMENT

10.2 MEDICAL ADVANTAGE OF OUR SYSTEM

- ✓ Reduce cholesterol
- ✓ Lung volume increases
- ✓ Oxygen carrying capacity of RBC increases
- ✓ Cardiac output increases
- ✓ Lactic acid production increases
- ✓ Excess urine excreted with sweat
- ✓ Metabolism rate increases
- ✓ Avoid obesity

10.3 MEDICAL DISADVANTAGE OF THE DOMESTIC CONVENTIONAL SYSTEM

- ✓ Bone wear
- ✓ Decalcification of vertebral column
- ✓ Synovial fluid in joints will be used up and friction of bones
- ✓ Arthritis may develop
- ✓ Spinal cord disk prolapse
- ✓ Dislocation of joints

CHAPTER -11

CONCLUSION

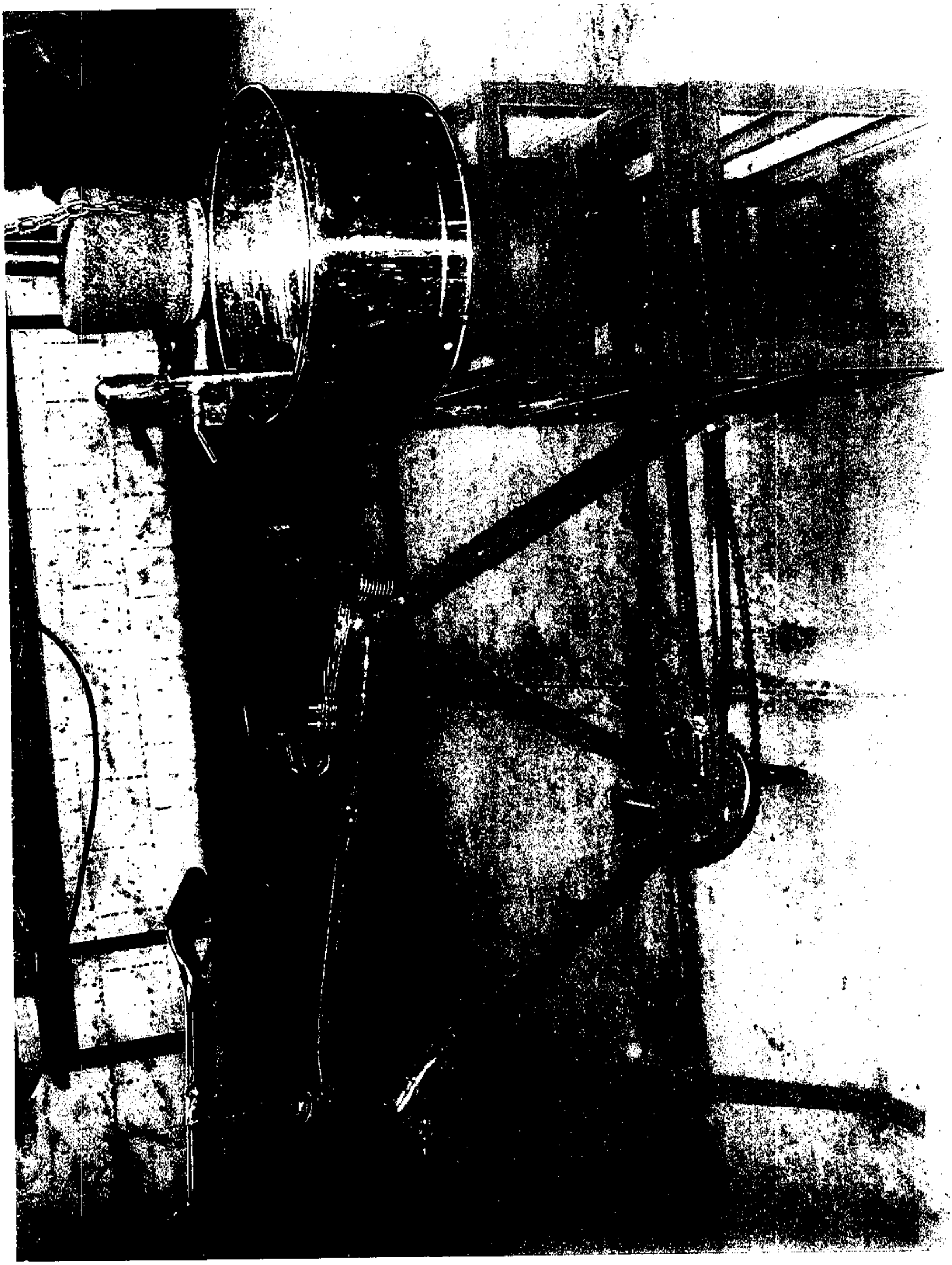
CONCLUSION

A novel idea of combining physical fitness exercise and wet grinding in a house hold application is demonstrated in this project while energy could be saved marginally at a state level. Energy saving is quite possible if this project is made as a commercially available house hold appliance convincing the user. For this purpose a proto model has been designed using CATIA software. The detailed drawings have been prepared and the parts are either fabricated or selected from the market. The proto model has been successfully assembled.

The cost for manufacturing this experiment is very less as we compared with the other physical fitness exercise instruments and the design concepts are very simple and easy to fabricate. This pedaling system has lot of Medical advantages. In large scale production the system will be more economic, so that it can easy reach the middle class families. We have included various photography of the system for better understanding of the operation.

An approximate calculation leads to a saving of Rs 8, 86, 20,696 amounts per month in a state like Tamil Nadu. However, design of wet grinder by pedaling must be put into use and a survey must be conducted before it is launched for commercial use.

PHOTOGRAPHIC VIEWS



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