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Design and Fabrication of Unified Wheel Opener

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Abstract
Today the life of man is simple and comfortable as various resources are available for each and every process that a person has to perform in his day to day life, and these resources and equipment's helps the person to perform his work in efficient and less time consuming manner. Today, the four wheeler means, a car available for more than 70% peoples in the urban areas. There are many equipment's that are designed so that any operation required to be done on a car can be carried easily and in a shorter period of time as possible. There is a problem that can be considered as time consuming and requires more effort which is the opening of wheel of a car for its replacement, service or any other operation. Today the unit of a wheel are opened by one of which requires more efforts and consume a lot of time. For this problem the unified wheel opener is a designed to troubleshoot.

Unified wheel opener is a special purpose tool made to open/close all the nuts of a wheel in one time with less effort. Although various methods of opening nuts are used, but they require a lot of effort to open a single nut one by one. With the help of Unified Wheel opener we made arrangement to open/close all the nuts by amplifying the torque. Different types of gears are arranged in such a way that if we apply certain amount of torques then it gets multiplied resulting in amplified torque as output for combined operation. In the work, we concentrate only one application domain i.e. Wheels of car- Alto K10. The main objective of work is to develop a mechanism in one assembly, which can be used in automobiles. It can be successfully used as a standard tool provided with a new vehicle. Also it can be used in assembly line of automobiles, workshops and service stations. Design is simple, easy workable, and economical and try to satisfy all the aspects of design consideration.

Chapter-1

1.0 Introduction

1.1 Introduction:

Engineering in general, and Mechanical engineering in particular, deals with a wide spectrum of products, ranging from large and complex systems comprising of numerous elements down to a single component.

Apart from being a physical object, a product can also be a service that requires the application of engineering knowledge, skills and devices to be useful to society. A service falls under the category of a system in that it is carried out with the help of personnel, facilities and procedures. The service offered by an automobile maintenance and repair garage would be a typical example from mechanical engineering. Even computer software could be treated as an engineering product. It is also created using engineering knowledge and skills. In the following, the term product when used alone denotes the object to be designed and made with the help of engineering knowledge and skills, irrespective of whether it is a large system, a simple machine, a component or a service. Specific reference to design of computer software is not attempted in the following although many of the generalities apply to it also.

A general understanding of the nature of product is a prerequisite for designing it. A complex product can be sub divided into sub-assemblies or sub system, component etc. Frequently the planning, layout and design of a complex multi element product is an interdisciplinary effort, requiring the expertise and skills not only of several engineering specialization but even non engineering ones. It is always preferable that our work should be easy and fast. But easy and fast working requires some technical skills to work effectively.

In our daily life we face many problems where we need a lot of effort and time to do that specific work. A little but important work we do often is opening a tyre of a vehicle. It is a fact that a huge effort is required to open a single nut of a car wheel and it will become a tedious task to open the wheel in extreme atmospheric conditions. It also creates problem when we are in hurry.

Here we get the solution of the problem mentioned above, Unified Wheel Opener is a special tool designed by us which will open a tyre easily. It is so designed that it can open all the four nuts of a car wheel in one time. And the most desired achievement we get is that total effort and time needed in the process is very less. It can open and also refit the tyre with the same tool easily. **Tool is simple in design, easy to use and easily portable along with the vehicle.**. Great efforts are made to satisfy each and every technical aspects of the design.

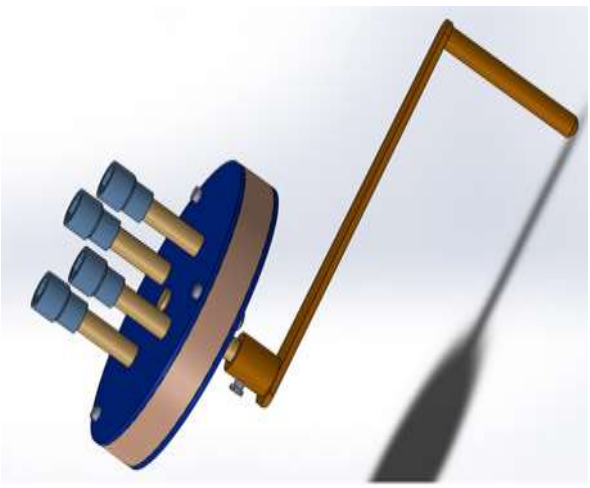

Figure 1-1Isometric view of unified wheel opener.

SR. NO.	PART NAME	Qty.
1	MAIN GEARS(spur)	1
2	PINIONS(spur)	4
3	PLATES	2
4	ARM	1
5	SOCKETS	4
6	PINION SHAFTS	4
7	MAIN SHAFTS	1
8	SCREWS	7
9	HANDLE	1

Table 1-1 List of Parts

1.2 List of Parts

Chapter 2

2.0 Literature review

2.1 epicyclic gearing or planetary gearing:

It is a gear system consisting of one or more outer gears, or ***planet*** gears, revolving about a central, or ***sun*** gear. Typically, the planet gears are mounted on a movable arm or ***carrier*** which itself may rotate relative to the sun gear. Epicyclic gearing systems also incorporate the use of an outer ring gear or ***annulus***, which meshes with the planet gears. Planetary gears (or epicyclic gears) are typically classified as simple and compound planetary gears. Simple planetary gears have one sun, one ring, one carrier, and one planet set. Compound planetary gears involve one or more of the following three types of structures: meshed-planet (there are at least two more planets in mesh with each other in each planet train), stepped-planet (there exists a shaft connection between two planets in each planet train), and multi-stage structures (the system contains two or more planet sets). Compared to simple planetary gears, compound planetary gears have the advantages of larger reduction ratio, higher torque-to-weight ratio, and more flexible configurations.

The axes of all gears are usually parallel, but for special cases like pencil sharpeners and differentials, they can be placed at an angle, introducing elements of bevel gear. Further, the sun, planet carrier and annulus axes are usually coaxial.

Epicyclic gearing is also available which consists of a sun, a carrier, and two planets which mesh with each other. One planet meshes with the sun gear, while the second planet meshes with the ring gear. For this case, when the carrier is fixed, the ring gear rotates in the same direction as the sun gear, thus providing a reversal in direction compared to standard epicyclic gearing.

2.2 Project overview:

This project report presents the design of the planetary gear train in order to acquire the necessary torque for successful operation of the task.

Planetary gear train mechanism:

A planetary gear train mechanism consists of one main gear (sun) and the rest of the planet gears. Most commonly the main gear is the driver gear where the rest acts as the driven gears. These result in input from the main gear to the driven gears that is transmission of the rotary motion from one component to the other.

Compared to simple planetary gears, compound planetary gears have the advantages of larger reduction ratio, higher torque to weight ratio and more flexible configurations.

The gear ratio of an epicyclic gearing system is somewhat non-intuitive, particularly because there are several ways in which an input rotation can be converted into an output rotation. The ratio of input rotation to output rotation is dependent upon the number of teeth in each gear.

Figure 2-1Planetary gear train
(Source: anonymous)

Other requirements:

Two discs and a wall to enclose the whole planetary mechanism. Pinion shafts required for the mounting of the driven gears. These pinion shafts act as both shafts and socket holders. The main shaft is connected to the link to which the handle is an integral part.

Chapter-3

3.0 Material Selection

3.1 Introduction To Engineering Materials:

The selection of a material for a particular application is governed by the working condition to which it will be subjected, ease of Manufacturing and the cost considerations, pure metals find few applications in pure condition and secondly they generally have poor strength in pure form. Various desired and special properties can be achieved by addition of different material to form alloys. Alloy comprises of a base metal and one or more alloying elements. The typical properties associated with working condition are tenacity elasticity toughness and hardness, toughness and typical properties associated with manufacturing process is ductility, malleability and plasticity.

3.2 Engineering Material for Product Design:

All physical objects are made out of some material substance or other. Mother Nature has her own set of building material for the objects of her creation, living or non-living. Over the millennia, man has observed and adapted many of these for making objects of his invention and design. For engineering purposes, we now use a very wide spectrum of materials. These generally fall under the following categories:-

Materials as found in nature used after only very minor preparation such as cutting to size, sun-drying, mixing with water. Some examples are coal, wood and stones.

Natural materials that are modified/ refined before use through some physical, chemical or thermal processes that improve their utilization.

Synthesized materials that are rarely found freely in nature. These are derived from one or more natural raw materials through major transformation processes. Most of the materials used in modern mechanical engineering belong to this category.

3.3 Selection Criteria:

The designer selects the materials of construction for his product based on several criteria such as its cost, the desirable properties that it should possess, its availability, the preferred manufacturing processes that are to be employed, etc. The overall economy is influenced by all these factors. In special cases, essentiality and /or urgency of the need for the product can supersede the economic considerations. The main criteria for material selection are discussed below:

3.3.1 Cost of the Material:

The amount of raw materials, their composition, quality, any special heat-treatment that is required, etc. influence the unit cost of materials. The unit cost generally depends also on the quantity of raw material that is purchased in a single lot. Special steel materials, for example, cost much more in the market when purchased in small quantities from a retailer than in bulk directly from the steel mill/stockyard.

3.3.2Availability:

The material should be readily available in adequate quantities. Material availability is closely linked with the variety and level of technology obtained in a given geographic location. Procuring materials from far and wide can be expensive, due to the additional cost for transport, for transporter taxes and duties etc.

3.3.3 Manufacturing Process:

Facilities for shaping and treating the selected material into the finished product or component must be available for economic production. Otherwise, the production cost goes up. For example, the selection of forged alloy steel for a connecting rod design necessarily assumes that a suitable forging facility is available along with the necessary dies and other accessories.

3.3.4 Properties of the Material:

The desired function and performance of any product depends to a great extent on the use of materials with the right physical and chemical properties. In general mechanical engineering these properties can be classified into different categories depending on how a particular property affects the function and life of a component. The main property groups are:-

Chemical Composition, specifying the contents of all the different elements contained.

Properties of state, such as solid, liquid or gas, density, porosity, temperature.

Strength related properties, such as ultimate strengths in tension, compression and shear, yield strength/ 0.2% strength, fatigue strength, notch sensitive, hardness, impact strength, effect of high/low temperatures on strength, etc.

Strain related properties, such as elongation at fracture, elastic module, ductility, malleability etc. these help to ensure the desired rigidity/ elasticity, formability etc.

Wear related properties that determine the erosion, abrasion, friction etc. between components in contact / relative motion.

3.4Selection of Material:

Carbon steel is an alloy of iron and carbon with varying quantities of phosphorus and sulphur. To this alloy is added a deoxidizer to remove or minimize the last traces of oxygen. Manganese is added to such an alloy to neutralize sulphur, either alone are in combination with silicone or other deoxidizers.

In carbon steel the maximum content of the following elements does not exceeding the limits given against each:

Manganese	…..	1.65%
Silicone	…..	0.60%
Copper	…..	0.60%

Carbon contents are very important in determining the properties of steel. The tensile strength of steel increases with increase in carbon contents up to 0.83% and beyond this it drops quickly. Hardness increases as the carbon contents increases. Ductility and weld ability decreases with increase in carbon contents.

Manganese: Tensile strength and hardness increases with increase in manganese content weld ability decreases by increase in manganese. Manganese content in steel varies from 0.2 to 0.8%.

Silicon: It is the principal deoxidizer used in the carbon steel Presence of silicon in steel promotes increase of grain size and deep hardening properties. Its addition is very useful in making steel adaptable for case carburizing. Presence of the silicon varies from 0.1 to 0.35%.

Copper: Though it is not an essential constituent of carbon steel yet it is added up to 0.25% to increase the resistance to atmospheric corrosion.

The most important composition for carbon used as engineering material having carbon % 0.02 to 0.30. Their merchantability is quite good. Such steel are used in making small forging, crank pin, Gear, Valve, Crank shaft, railway axles, cross head, connecting rods, rims for turbine gears, armature shafts and fish plates.

Mild Steel: Plain carbon steel in which carbon contents ranges from 0.08 to below 0.3 are known as mild steel. Those mild steel in carbon contents is less than 0.15% are known as dead mild steel. Mild steel are not such effected by heat treatment processes, especially hardening process. A decrease in carbon content improves the ductility of mild steel. These steels possess good machinability and weld ability. These are mainly used for making wires, rivets, nut, bolt, screw, sheets, plates, tube, roads, shafts, structural steel section and for general workshop purposes etc.

Mild steel (low carbon):

It consists of 0.05 to 0.025 percentage of carbon content. Its less strong and cheap but easy to shape, surface hardness can be increased through carburizing.

Medium carbon steel :

Approximately 0.29% to 0.54 % carbon content is present. This results in properties such as ductility and strength and has good wear resistance, used for large parts, forging and car parts.

Chapter-4

4.0 Design procedure

4.1 design and product cycle:

All engineering activities necessarily begin with some ideas with high or low innovative content, translated into definite plans for their realization in the form of products. This is the essence of design engineering. The ultimate success depends on a thorough consideration of how the product will be made and used as well as on the attention to detail paid by the design engineering. This is applicable equally for a minor redesign of a existing product or for a most innovative one. A good understanding of how the various phases of the product cycle can influence the design is therefore essential.

4.2 The Challenges of Design Engineering:

Lesser time available for design, development and testing of the product before it reaches the user. Demands from the users for affordable cost combined with high quality of performance and appearance.Increasing number of competition which can supply a product of equivalent value. On one side, the scientific cooperation and exchange of information have become international. On the other side, industrial activities and communications network have become globalized. Given the present day ease of access to technology, major breakthrough in product innovation and design are not really essential for industries to produce and prosper.

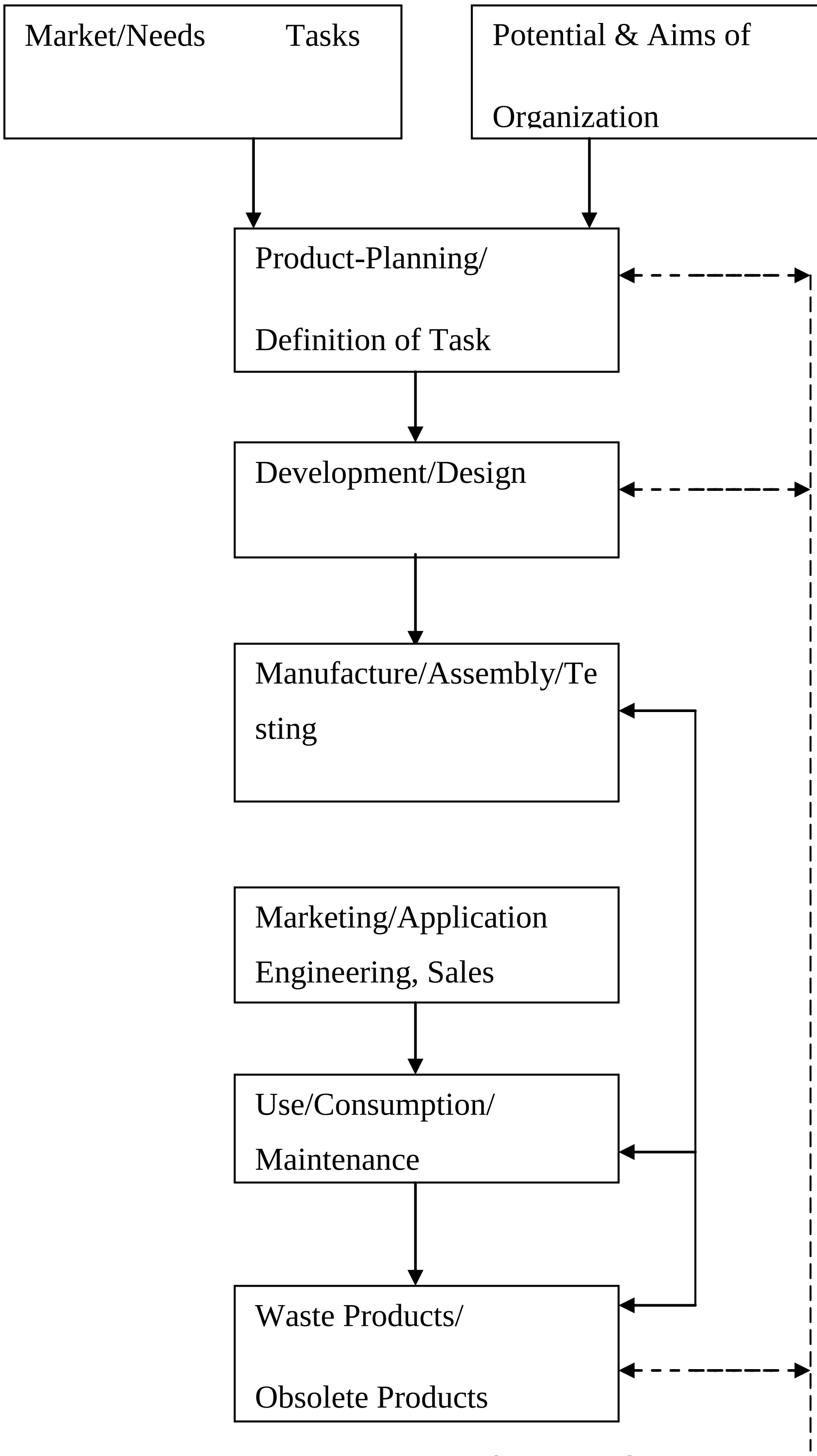

Figure 4-1Life Cycle of a Product

4.3 Qualities of a Good Design:

A good product design should satisfy the expectations of the customer/user. These can be summarized in the following conditions.

1) The product must carry out the desired functions reliably.
2) Appeal both technologically and psychologically.
3) Be economical to acquire and to use.
4) Be easy and safe to use.
5) Be easy to maintain in working order.
6) In order to ensure the conditions, not only must the design concept be novel and sound but the design must be well engineered. This engineering part of design consists of the following:
    - Drawing up the main parameters for function and performance.
    - Deciding the material, shape and dimensions of the components.
    - Ensuring that the component dimensions satisfy the functional and strength requirement.

4.4 Introduction to Design Software:

Solid works is a Para-solid based solid modeler and utilizes a parametric feature based approach to create model and assemblies. Parameter refers two constraints whose value determines the shape or geometry of the model or, assembly. Parameters can be either numeric parameters such as line length or circle diameters or geometric parameters such as tangent, parallel, concentric, horizontal or vertical, etc. numeric parameters can be associated with each other's through the use of relations, which allow them to capture design intent.Solidworks is a solid modeler and utilizes a parametric feature based approach to create models and assemblies.

Parameters refer to constraints whose values determine the shape and geometry of model or assembly. Parameters can be either numeric parameters, such as the line lengths or circle diameters, or geometric parameters such as tangent, parallel, concentric, horizontal or vertical etc. Solid works also include additional advanced mating features such as gear and cam follower mates, which allow modeled gear assemblies to accurately reproduce the rotational moment of an actual gear train. Thus, solid works helps the user to design the desired component with an ease and accuracy.

4.5 Designing:

4.5.1 Schematic representation of wheel nuts of alto k10:

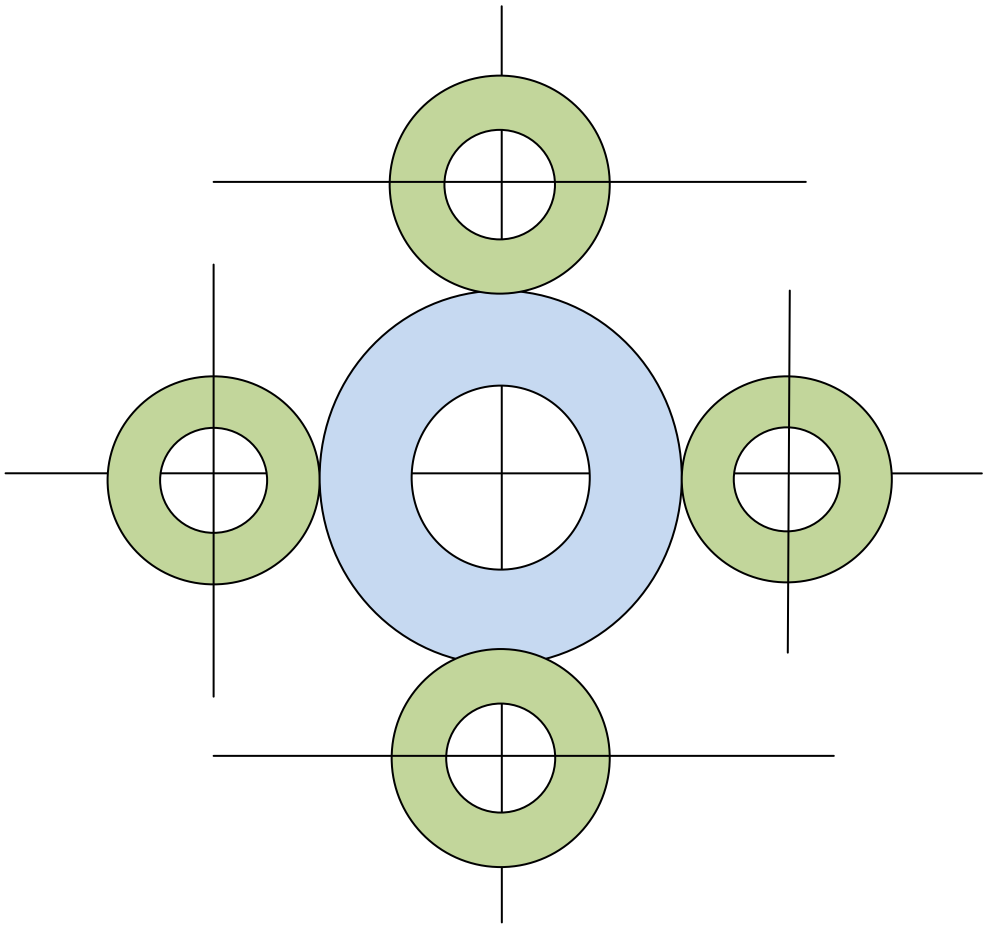

Figure 4-2 Representation of wheel nuts of alto k10

This is a schematic representation of the assembled nuts of a tyre. **In this schematic the green circles indicates the nuts, where the Centre distance from the origin of blue circle to the origin of the next corresponding green circle is 4.85 cm.**

Thus giving a total length of 9.6mm from one centre of the nut to the next, where these dimensions are the primary numerical required to begin the designing procedure with.

Considering conditions and assuming an maximum force of 637 N applied, where the multiplication of the torque depends on many factors such as the length of the link which is assumed to be 12 inches, which is experiencing the load as shown in the below fig.

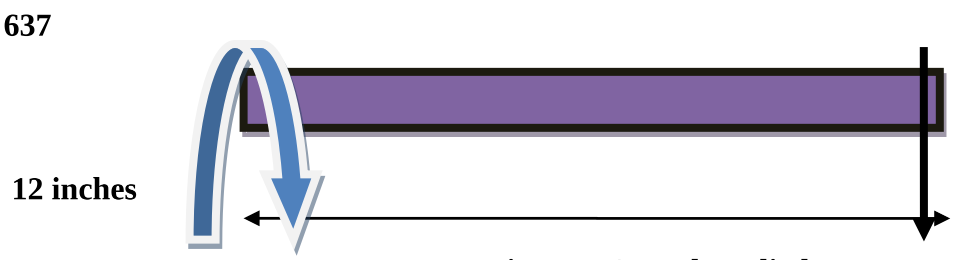

Figure 4-3Load applied on arm

The applied force perpendicular to the moment arm results in multiplication of the torque due to arm length. Considering the Centre distance as discussed in the above schematic in order to attain perfect alignment we require a set of gears that would fulfill the requirements for the task. Hence, consideringthe set of gears with such geometry that would fulfill the requirement of the Centre distance, leading to perfect alignment after assembling of all the components.

Set of gears assumed with an outside diameter of 53mm and 48mm .i.e D_g,$D_p$respectively.

4.6 Design calculations for gear and pinion:

Abbreviations Used:

Table 4-1 Abbreviations used

M	Module
M	bending moment
D_P	Pitch circle diameter of pinion
D_G	Pitch circle diameter of gear
D_g	Diameter of gear shaft
W_T	Tangential load
W_D	Dynamic load
Y_P	Lewis form factor
Σ	Allowable stress
T	Twisting moment
T_e	Equivalent twisting moment
T_p	Number of teeth on pinion

Gear ratio:

$G = D_g/D_p = T_g/T_p$

G = 53/48 = 1.1 mm ------------ (1)

Assuming an standard module of 2.75 mm

We have the relation,

m = D/T ------------(2)

where ,

D is the diameter of gear

T is the no. of teeth

$2.75 = D_g/T_g = 53/T_g$

$T_g=19$ ----------- (3)

Similarly for pinion we get,

$2.75 = D_p/T_p = 48/T_p$

Tp = 17 ----------- (4)

Circular pitch:

$P_c = \pi * m$

$P_c = \pi * 2.75$

$P_c = 8.63$mm -------------(5)

Diametrical pitch:

$\pi/Pc = \pi/8.63$

π/Pc =0.364mm------------ (6)

Face width:

b = 25mm ------------ (7)

4.6.1 Standard tooth system for spur gears:

Table 4-2 Standard tooth system for spur gears

Sno.	Item	20degree stub	Numerical
1	Addendum	0.8m	2.22mm
2	Dedundum	1m	2.75mm
3	Clearance	0.2m	0.55mm
4	Working depth	1.6m	4.4mm
5	Total depth	1.8m	4.95mm
6	Tooth thickness	1.571m	4.32mm
7	Fillet radius	0.3m	0.825mm
8	Top land	0.25m	0.6875mm
9	Backlash	2mm	2mm

4.7 Load calculations for gears:

4.7.1 Tangential load (WT):

$W_T = \sigma_w \times b \times P_c \times Y_p$

Where ,

$\sigma_w = \sigma_o \times C_v$ ------------(8)

The value of allowable static stress is considered from the table below.

Table 4-3Tabular values of allowable static stress(σ_o):

Material	*Allowable static stress* (σ_o) *MPa or N/mm*^{2}
Cast iron, ordinary	56
Cast iron, medium grade	70
Cast iron, highest grade	105
Cast steel, untreated	140
Cast steel, heat treated	196
Forged carbon steel-case hardened	126
Forged carbon steel-untreated	140 to 210
Forged carbon steel-heat treated	210 to 245
Alloy steel-case hardened	350
Alloy steel-heat treated	455 to 472
Phosphor bronze	84
Non-metallic materials	
Rawhide, fabroil	42
Bakellite, Micarta, Celoron	56

$\sigma o = 140 N/mm^2$ ------------(9)

Pitch line velocity:

$v = \frac{\pi DN}{60}\ m/s$ ------------(10)

assuming N = 20 r.p.m

hence we have,

$v = \frac{\pi(48)(20)}{60}\ m/s$

v = 0.0510 m/s --------------(11)

for ordinary cut gear for general operations for velocity less than 12 m/s.

$C_v = 3/3+v$

$C_v = 3/3+0.0510$

$C_v = 0.9845$

Hence $C_v = 1$ ---------------(12)

From equation (8) we get,

$\sigma_w = 140\ 1$

$\sigma_w = 140$ N/

from equation (7),

$W_T = \sigma_w \times b \times Pc \times Y_p$-----------------(13)

$W_T = \sigma_w \times b \times \pi * m \times Y_p$

Where $Y_p = 0.175 - 0.841/T_p$ -----------------(14)

$Y_p = 0.175 - 0.841/17$

$Y_p = 0.1255$ ------------------(15)

Substituting all the acquired values in equation(7),

$W_T = 140 \times 25 \times 3.14 \times 2.75 \times 0.1255$

$W_T = 3805$ N-m ------------(16)

4.7.2 dynamic loading:

$W_D = W_T + ((21v)\ (bc + Wt)\ )/(21v\ )\sqrt{(bc + Wt)})$---------(17)

Where,

C is the deformation factor

The values of deformation factor(C) is obtained by an relation of the following

Material

Involute tooth form

Tooth error in action(e)

4.7.3Tooth error in action(e):

The value of "e" is obtained by the relation between pitch line velocity "v" and module "m" of the gear as shown in the following tables

Table 4-4Values OF maximum allowable tooth error in action(E) versus pitch line velocity for well-cut commercial gears:

Pitch line velocity (v) m/s	Tooth error in action (e) mm	Pitch line velocity (v) m/s	Tooth error in action (e) mm	Pitch line velocity (v) m/s	Tooth error in action (e) mm
1.25	0.0925	8.75	0.0425	16.25	0.0200
2.5	0.0800	10	0.0375	17.5	0.0175
3.75	0.0700	11.25	0.0325	20	0.0150
5	0.0600	12.5	0.0300	22.5	0.0150
6.25	0.0525	13.75	0.0250	25 and over	0.0125
7.5	0.0475	15	0.0225		

Table 4-5Values of tooth error in action versus module:

Module (m) in mm	Tooth error in action (e) in mm		
	First class commercial gears	Carefully cut gears	Precision gears
Upto 4	0.051	0.025	0.0125
5	0.055	0.028	0.015
6	0.065	0.032	0.017
7	0.071	0.035	0.0186
8	0.078	0.0386	0.0198
9	0.085	0.042	0.021
10	0.089	0.0445	0.023
12	0.097	0.0487	0.0243
14	0.104	0.052	0.028
16	0.110	0.055	0.030
18	0.114	0.058	0.032
20	0.117	0.059	0.033

Where,

C is the deformation factor

The values of deformation factor(C) is obtained by an relation of the following

- Material
- Involute tooth form and
- Tooth error in action(e)

Table 4-6Values of deformation factor(C):

Material		Involute tooth form	Values of deformation factor (C) in N-mm				
			Tooth error in action (e) in mm				
Pinion	Gear		0.01	0.02	0.04	0.06	0.08
Cast iron	Cast iron	$14\frac{1}{2}°$	55	110	220	330	440
Steel	Cast iron		76	152	304	456	608
Steel	Steel		110	220	440	660	880
Cast iron	Cast iron	20° full depth	57	114	228	342	456
Steel	Cast iron		79	158	316	474	632
Steel	Steel		114	228	456	684	912
Cast iron	Cast iron	20° stub	59	118	236	354	472
Steel	Cast iron		81	162	324	486	648
Steel	Steel		119	238	476	714	952

b is face width i.e 25mm

W_D = 3805 + 100.276

W_D = 3905.27 N-m ------------(18)

4.7.3 Static tooth loading:

$Ws = \sigma_e \times b \times Pc \times Y_p$ -------------(19)

$Ws = \sigma_e \times b \times \pi * m \times Y_p$

Where,

σ_e= 252 N/m …..from the table below

Table 4-7Tabular values of flexural endurance(σ_e):

Material of pinion and gear	*Brinell hardness number (B.H.N.)*	*Flexural endurance limit (σ_e) in MPa*
Grey cast iron	160	84
Semi-steel	200	126
Phosphor bronze	100	168
Steel	150	252
	200	350
	240	420
	280	490
	300	525
	320	560
	350	595
	360	630
	400 and above	700

Ws = 252 × 25 × 3.14 × 2.75 × 0.1255

Ws = 711.73 N-m ------------(20)

4.7.4 Comparison of static loading with tangential and dynamic loading:

For different conditions we have different relations as follows

$W_s \geq 1.25\ W_D$ light shocks

$W_s \geq 1.35\ W_D$ medium shocks

$W_s \geq 1.50\ W_D$ heavy shocks

$W_s \geq 1.5 \times 3905.27$

$W_s \geq 5857.905$

Hence the relation is satisfied and the design is safe.

4.7.5 Main gear:

The most important machine component in the assembly, which acts as the source for transmission of rotating motion to the rest of the pinions. It carries the main shaft and is in mesh with rest of the four pinions.

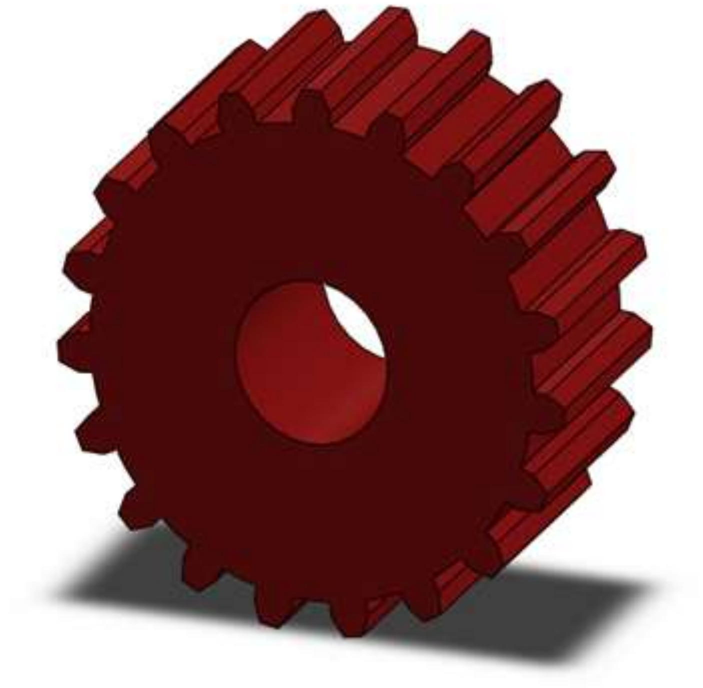

Figure 4-4Isometric view of main gear

4.7.6 Pinion:

Pinion is the machine component which transfers the gained rotating motion from the main gear to the integrated shafts which its driving which acts as the output shafts. All the pinions are mounted on the pinion shafts.

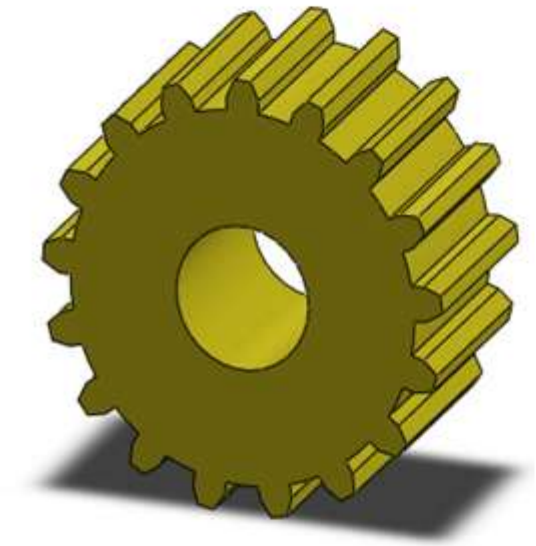

Figure 4-5Isometric view of pinion

4.8 Design calculations For Shaft:

Abbreviations Used:

Table 4-8 Abbreviations used

T_e	Twisting moment
M	Bending factor
T	Torque
M_e	Bending moment
D	Diameter of shaft

According to maximum shear stress theory, equivalent twisting moment:

$T_e = \sqrt{M^2 + T^2}$ ----------- (i)

M = Bending moment on shaft. N-m

T = Torque. N-m

Assumptions:

Bending moment(M) = 1 N-m

Torque(T) = 120 N-m

$T_e = \sqrt{(1 \times 10^3)^2 + (120 \times 10^3)^2}$

$T_e = 120 \times 10^3$ N-mm

$T_e = 120$ N-m ------------- (ii)

We also know that,

$T_e = \pi/16 \times \tau \times d^3$

Where we have $\tau = 140 N/mm^2$

$D^3 = 4378.76$ mm

D = 16.36 mm

Hence, taking D = 16.5 mm ------------- (iii)

According to maximum normal stress theory, equivalent bending moment:

$M_e = 0.5 \times (M + \sqrt{M^2 + T^2}) = 0.5\ (M + T_e)$ -------------(iv)

$M_e = 0.5 \times [(1 \times 10^3) + (120 \times 10^3)]$

$M_e = 60502$ N-m

We also know that,

$M_e = \pi/32\ (\sigma_b \times D^3)$ where, bending stress

$(\sigma_b) = 0.66 \times f_y$ i.e. (248) Gpa

Hence, $(\sigma_b) = 165 N/mm^2$

$M_e = \pi/32\ (165 \times D^3)$

$D^3 = 3734.95$ mm

D = 15.51 mm ------------- (v)

Hence taking the larger of above two values for safe design considerations i.e. D = 16.5 mm

4.8.1 Shafts:

Shafts are the machine components which are known for the application of transferring power i.e. rotating motion from one component to the other.The pinion shaft plays two important roles.

- Transferring the motion from one component to the other.
- A holder for the removable socket heads.

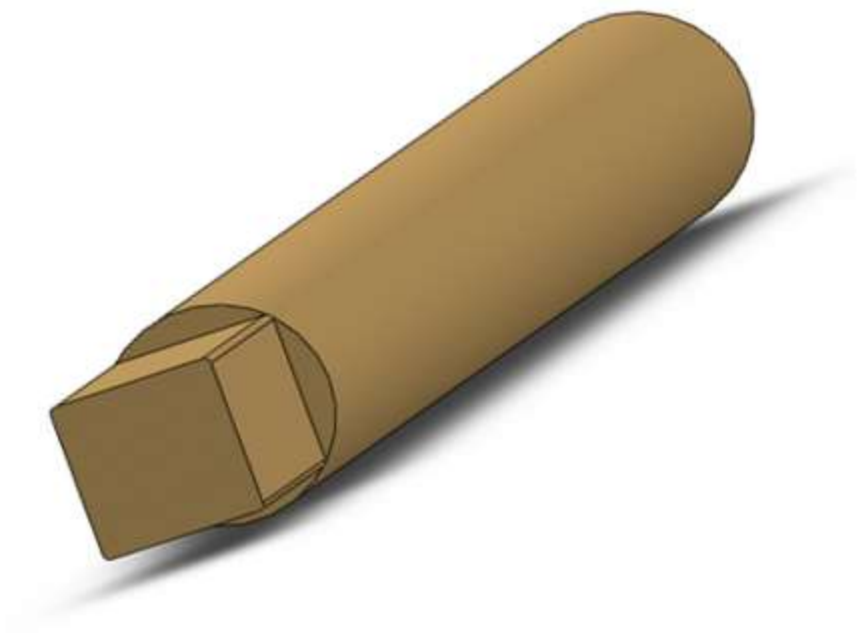

Figure 4-6Isometric view of pinion shaft

Chapter-5

5.0 Manufacturing process

6.0 5.1 Gears:

The commonly used generating processes used for the generation of gear teeth are:-

1) Gear Shaper Process
2) Rack Planning Process
3) Hobbing Process.

5.1.1 Gear Shaper Process:

In this process a pinion shaped cutter is used which carries clearance on the tooth face and sides. It carries a hole in the center for mounting on the stub arbor or spindle of the machine. The cutter is mounted with the axis vertical and is reciprocated up and down by sliding the spindle head along the vertical ways on the machine. In addition to the reciprocating motion, the cutter and the gear blank both are rotated slowly their own axis. The relative speed of rotation of the two is the same as the gear to be cut will have with a pinion of the same number of teeth as the cutter. It is accomplished by providing a gear train between the cutter spindle and the work spindle. The cutter in its rotation generates the tooth profile on the gear blank. All gears cut by the same cutter will mesh correctly. This is a specific advantage of this process over the forming process using rotary cutters. Also it is a much faster process than rotary cutting.

5.1.2 Gear Planning:

In this process rack type cutters are used for generating spur profile. Involutes rack has straight edges and sharp corners and hence can be manufactured easily and accurately. The cutters generate as they are cut and as the name implies, the machine cuts the teeth by reciprocating planning action of the cutter. This is a true generating process since it utilizes the principle that an involute curve can be formed by a straight generator when a gear blank is made to roll without slip relative to the generator.

5.1.3 Gear Hobbing:

In this process, the gear blank is rolled with a rotating cutter called the HOB. A majority of the involute gears are produced by this method. A gear hob looks like a worm, but carries a number of straight flutes (gashes), cut all around, parallel to its axis. This results in the production of separate cutting teeth and cutting edges. In operation, the hob is rotated at as suitable speed and fed into the gear blank. The blank also rotates simultaneously. The speeds of the two are so synchronizes that the blank rotates through one pitch distance for each complete revolution of the hob. There is no intermittent motion of the two and the generating continues steadily. The hob teeth are just like screw threads, i.e. having a definite helix angle.

The hob is, therefore tilted to its own helix angle while cutting the gear so that its teeth are square with the blank and produces a true involutes' shape.

5.1.4 Gear Milling:

Milling is one of the metal removal process best known for making gear. Here a firm cutter is passed through the gear blank to affect the tooth gap, helical gear, worm & worm wheel and bevel gear can be manufactured by milling.

Gear milling is less costly and less accurate process and it is employed for the following:-

1) Coarse pitch gear
2) Racks of all pitches
3) Worms
4) Toothed parts as sprockets and ratchets.

The production capacity in this method is low since each space is machined separately and the time is lost in retuning the job to its initial position and in indexing for each tooth. In actual practice a series of cutters are selected for a number of teeth to be milled.

Out of all above processes we select the Gear Shaping for the manufacturing of all the gears. The various reasons for selection of this process are as following:-

This process of making gears is cheaper than hob cutter.

1) Gear shaping machines are easily available.
2) All gears can be made of same pitch by same cutter.

5.2 Shafts:

In the manufacturing of the shafts following operations are used:-

- Facing
- Turning
- Finish turning
- Milling

5.2.1 Facing:

Facing operation machines the ends of the work piece. It provides a surface which is square with the axis of the work piece from which to start the job. Facing is done by feeding the cross slide or compound in or out.

In facing the cutting tool moves from the center of the job towards its periphery and vice – versa. Facing is primarily used to smooth off a saw- cut end of a piece of bar stock or to smooth the face of rough casting.

5.2.2 Turning:

It may be defined as the machining operation for generating external surfaces of the revolution by the action of the cutting tool on a rotating work piece. When the same action is applied to internal surfaces of the revolution, the process is termed as boring.

5.2.3 Finish turning:

It may be defined as the machining operation which is employed at high speeds in order to attain high surface finish.

5.2.4 Milling:

Milling is the process of removing extra material from the work piece with the multipoint cutting tool called milling cutter .the machine tool employed

For milling is called milling machine milling operation has an feature of interrupted cutting action, each cutting edge take part in cutting only during the part of cutting revolution. small chips are produced, thickness of chip is not constant and varies from zero to max or vice versa depending upon the direction of rotation of cutter.

5.3 Plates:

These plates are obtained from a mild-steel sheet by performing gas welding. These plates are used as covering discs in order to enclose the mechanism in between the wall or casing.

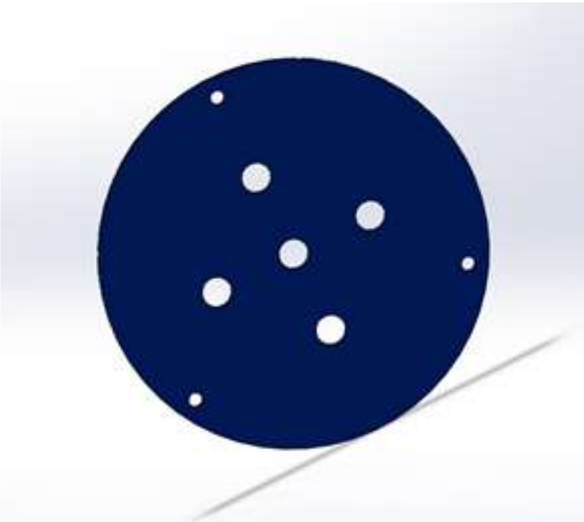

Figure 6-1Isometric view of plate

5.3.1 Gas welding:

Oxy/fuel gas equipment has many uses - welding, cutting, heating, and straightening.

Cutting:

For cutting, the setup is a little different from welding. A cutting torch has a 60- or 90-degree angled head with orifices placed around a central jet. The outer jets are for preheat flames of oxygen and acetylene. The central jet carries only oxygen for cutting. The use of several preheating flames rather than a single flame makes it possible to change the direction of the cut as desired without changing the position of the nozzle or the angle which the torch makes with the direction of the cut, as well as giving a better preheat balance.

5.3.2 Drilling:

Drilling is the process of making holes in a work piece. Either the work piece rotate or drill is stationary or vice-versa. When drilling on the lathe is being done, generally the work piece rotates in the chuck and the drill held in the tail stock is fed into the work piece by means of the hand wheel on the outer end of the tail-stock assembly. It is possible to do drill by holding and rotating the drill in the lathe spindle while keeping the work stationary, supported by a special pad mounted in tail-stock quill. Since drill feed is by hand, care must be taken, particularly in drilling small holes. Coolant should be withdrawn occasionally to clear chips from the hole and to aid in getting coolant to cutting edges of the drill.

5.3.3 Grinding:

Here, for making the rough surfaces and sides of the wall or casing hand grinder is a good machine and with this technique we can get better smoothness thus we can remove sharp corners on the work piece.

This is a hand operation. A clean, sharp, single cutter is held in the device which is held in one hand and the work piece is placed on the work table or the other hand. The cutter is held at a slight angle and not at right angles to the work piece. For carrying out of this operation, the cutter is pressed lightly on to the work piece and moved forward so that the work piece is in contact during the cutting stroke. Pressure on the work piece is relieved during its return strokes. Generally long strokes are taken and the device is cleaned.

5.4 Wall or Casing:

A circular wall of 8inch outer diameter and 5mm thick is obtained from a circular cut piece by gas welding. This part is used to provide a circular cover in which the whole mechanism is placed.

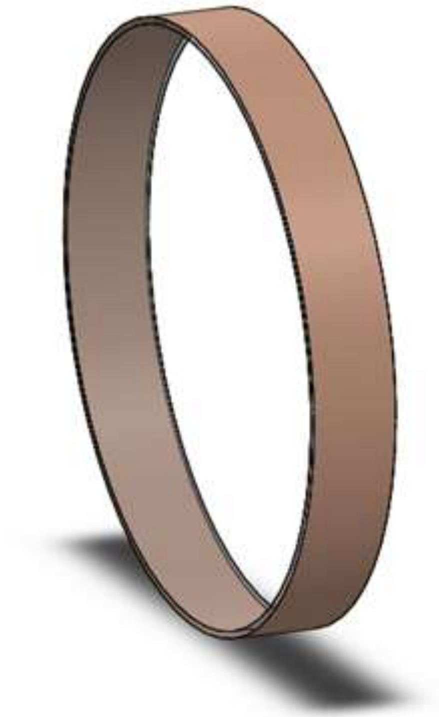

Figure 6-2Isometric view of wall

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5.5 Link with handle:

A circular rod which acts as handle is welded to a gradually decreasing rod of rectangular geometry. A hub is attached to the other end which fits on the main shaft, where the perpendicular load is applied onto the handle.

Figure 6-3Isometric view of link

5.6 Material Purchase:

Rest of the part of unified wheel opener is purchased from market. This constitutes the different material of different parts according to our requirement. All these parts are purchased by considering our design Material purchased are sockets, screws.

5.6.1 Socket head:

These are the components which are fitted on to the square end of the output shaft .these socket heads act similar to the common spanner used to remove the nuts of the wheel.

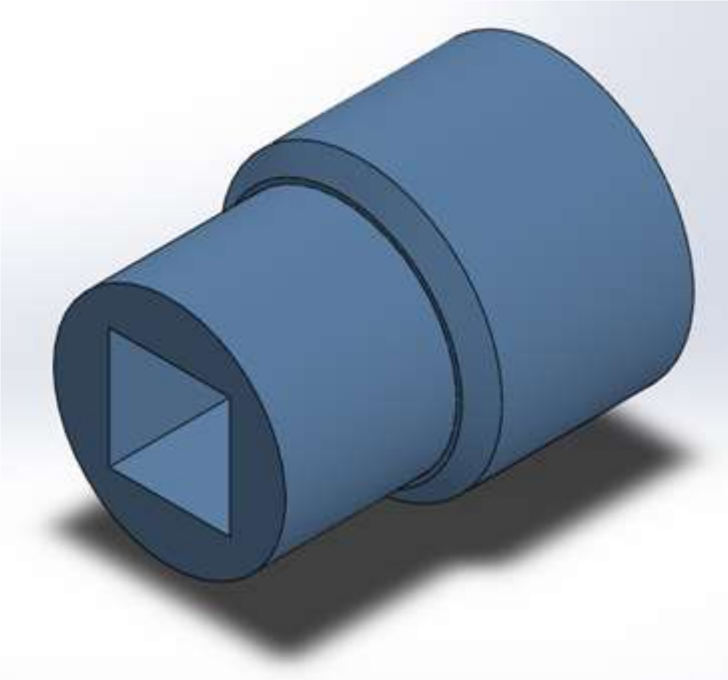

Figure 6-4Isometric view of socket head

5.7 Assembly model of unified wheel opener:

All above parts are assembled as shown below in order to complete the unified wheel opener.

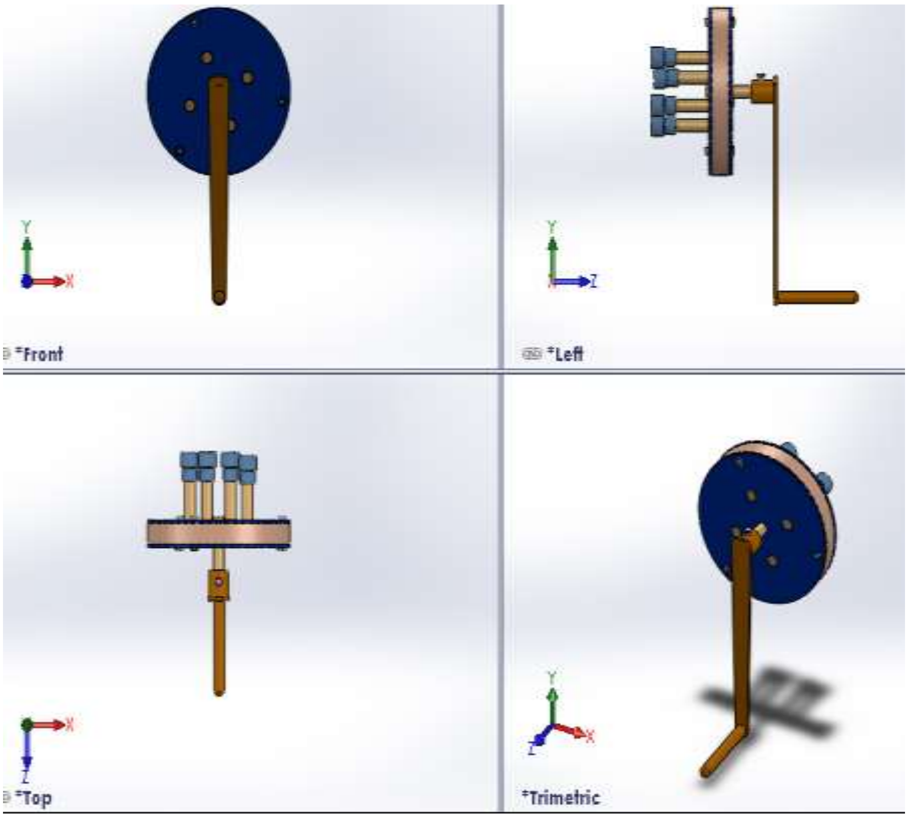

Figure 6-5 Four view of assembly.

CHAPTER- 6

7.0 FABRICATED MODEL OF UNIFIED WHEEL OPENER

Chapter – 7
7.0 validations and testing:

The following steps have been reviewed in order to avoid any failures in fabricated model and design parameters.

7.1 Design review:

Design is the most basic step in order to produce any fabricated model, where the obtained design should be safe in order to skip any types of failures when tested practically. As keeping in mind the steps for obtaining safe design as shown in the above design procedure the design is suitable for application of torque in a desirable range of 150 to 200 N/m and to a desirable load range of 550 to 650 N.

7.2 Demo of unified wheel opener:

The fabricated demo model is tested by performing the operation for removal of nuts on a wheel, where the unified wheel opener is first aligned to the nuts of the wheel and then after achieving perfect alignment, the link is the element onto which the desirable load is been applied.

The link displaces due to the application of load which in turn results in the twisting moment of the main shaft onto which the main gear is mounted, this results in the transfer of rotating motion from the main gear i.e. sun gear to the rest of the pinions i.e. the planet gears which are mounted on the output shafts or pinion shafts to which the socket heads are attached, where the whole acts as a unit and provides sufficient amount of torque for the removal of nuts. Thus unified wheel opener has been operational.

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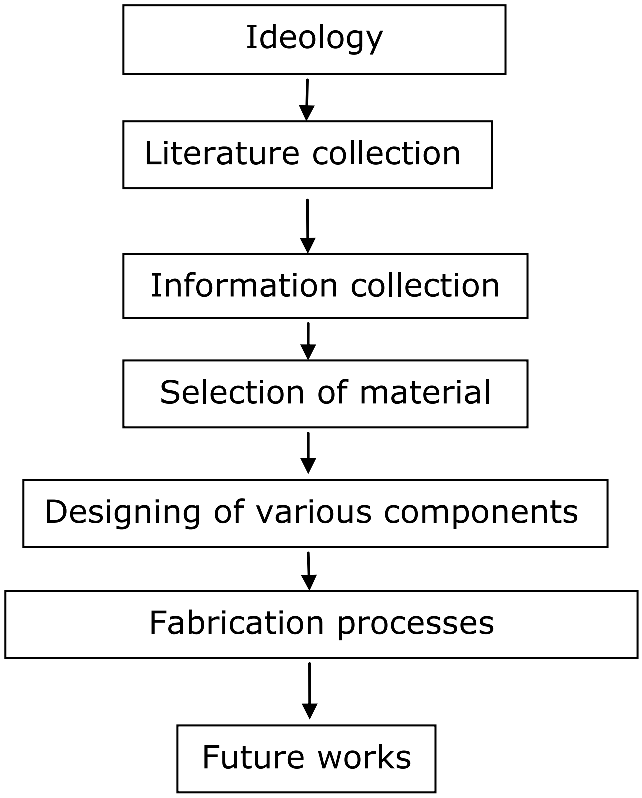
CHAPTER- 8

8.1CONCLUSION:

A theoretical idea turned fabricated model i.e. unified wheel opener has proven its capabilities by successfully performing the desired operation. It has been proved to be a less time consuming and one time effort process.

By taking the idea from all research paper which is included in the literature review. We came to a point that by using gear-train mechanism we can make a system which is used to open the nut of a wheel with minimum torque so, as to eliminate the hard-work of person with minimum time. Where it is been noted that the model can even be changed from manual to a power driven drive by means of few alterations.



The fig. above shows the various steps included in the project work.

Costs incurred in the preparation of the demonstration model:

Part name	Quantity	Cost	Final cost

Spur gears	5	212	**850**
Plates	2	190	**380**
Shafts	5	14	**70**
Wall	1	100	**100**
Socket head	4	95	**380**
Link + handle	1	60	**60**
Screws 8mm/0.5 inch	7	6	**42**
M/c operations		1500	**1500**
Total cost	-	-	**3400**

8.2 Future Works:

As the time period in a semester is limited therefore we have only studied and manufactured a basic design of unified wheel opener all the facts about the Unified Wheel Opener such as material required, designing of each component, selection of manufacturing process, cost consideration, reliability etc have been carried out. The different component of unified wheel opener has been manufactured and checked for suitability, and then this component has been assembled to make the tool unified wheel opener and its working have been checked. Thus with the help of gear trains mechanism more number of nuts can also be removed in different types of automobiles with the help of adjustable unified wheel opener.

8.3 Applications:

- Unified wheel opener can be used in service stations for its functionality and time boosting feature
- It can be used as a standard equipment provided with new vehicle for the purpose of open/close of nuts of wheels
- Compared to pneumatic guns which are restricted to availability of power source where as it is completely different when compared to manually operated unified wheel opener.

8.4 Suggestions:

- Sudden application of load over the link should be avoided in order to skip any loading failures.
- Proper greasing of gears in contact with each other is to be maintained to achieve sound meshing of gears.
- Gear should be in a perfect mesh in order to receive rotatory motion.
- The mechanism should be enclosed as per the designed geometrical parameters in order to avoid any misalignments.
- A Proper support should be provided to the unified wheel opener to maintain its alignment.

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