Design of Manual Multi-spindle for Nut removal

A CAPSTONE PROJECT REPORT

Submitted in partial fulfillment of the
requirement for the award of the
Degree of

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

by

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JANUARY 2020

CERTIFICATE

This is to certify that the Capstone Project work titled "**Design of Manual Multi-spindle for Nut removal**" that is being submitted by **KOLLA KARTHIKEYA(17BME7010)** is in partial fulfillment of the requirements for the award of Bachelor of Technology, is a record of bonafide work done under my guidance. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

Dr. Pankaj Balakrishna Tambe
Guide

The thesis is satisfactory / unsatisfactory

Internal Examiner **External Examiner**

Approved by

PROGRAM CHAIR
B. Tech. MECH

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ACKNOWLEDGEMENTS

The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely privileged to have got this all along the completion of my project. All that I have done is only due to such supervision and assistance and I would not forget to thank them.

I respect and thank Dr pankaj tambe sir, for providing me an opportunity to do the project work under him and giving me all support and guidance which made me complete the project duly. I am extremely thankful to him for providing such nice support and guidance, although he had a busy schedule managing the college affairs.

I would not forget to remember Amit sir, Manikanta sir, Rama sreekanth sir, Manoj kumar sir for their encouragement and more over for their timely support and guidance till the completion of my project work.

I am thankful to and fortunate enough to get constant encouragement, support and guidance from all Teaching staffs of the Mechanical department which helped me in successfully completing my project work.

ABSTRACT

A nut remover is a device which helps the person to remove the nuts from a car tyre.As we all know Tire plays a Important role in the performance of the car.Without the proper fitting of the tire there will be many disadvantages.

Removal of tires is a really difficult task and consumes a lot of time. Not All people can remove nuts of the tire and fit it back as the products are pretty much complicated and need lot of manforce. These Nut removers come in automatic and manual.

Multi spindle Nut removers are those where you could remove all the Nuts of a car wheel at a time.The current state of Manual Multi spindle for nut removal is very complicated and the design of them is not Satisfactory.

This saves a lot of time and effort put in by the operator.So we have decided to design a compatible nut remover where every person can use it with ease and remove the nuts without any struggle.

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Introduction:

Automobiles are something which most of the people own these days. As they became the Need for many people. Tire plays a major role in the working of the car. It is the reason for the movement in the cars. Whenever there is puncture in the tires, the removal and fitting of a new tire is a very difficult task(especially women) and consumes a lot of time in garages. With the help of this manual Multi Nut remover we can remove and fit the tires with ease.

So I have taken the PCD(pitch Circle Diameter) of 112 mm. I have calculated and designed the nut remover in AUTOCAD. The main objective of this project is to design an efficient 5 Nut remover with the pitch circle diameter of 112 mm. which will help the owners and workers to remove the tires of all cars with pcd of 112 mm.

The torque required to remove a single nut is 80-90 N-m and so as we have 5 nuts, The total torque required to remove all the nuts will be 450 N-m. And the Amount of power the person will be supplied is taken as 500 N. As the Nut remover is to be designed, the calculations were performed using machine design equations. As the Factor of Safety was above the required FOS it was further designed in AUTOCAD

Calculations:

The PCD of the wheel is 112 mm so the center distance between both the spur gears should be 56 mm.

The diameters of gear has been taken as **76** mm

The diameter of the pinion has been taken as **36** mm.

Pressure angle = **20 degrees**

Gear ration = Dia of gear/ Dia of pinion = 76/36 = **2.1**

Then Teeth on pinion has been taken as = **16**

Teeth on gear = gear ratio x Teeth on pinion = 33.7 = **34**(approx.)

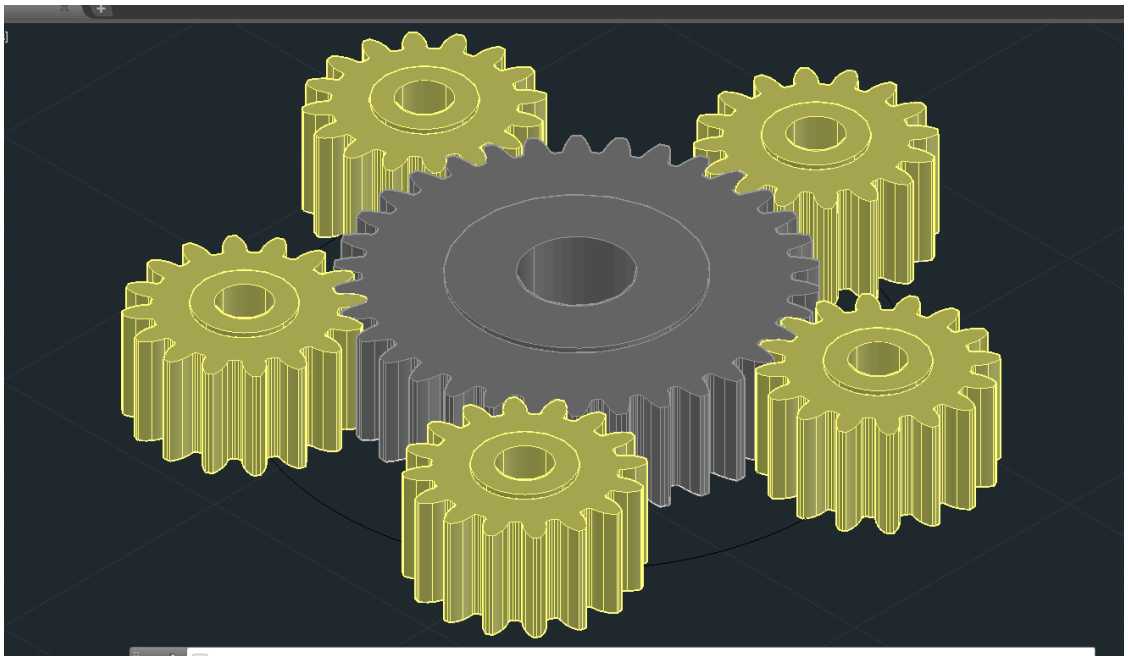
Module = Diameter of Gear/ teeth of gear

= 76/34 = **2.23**

Face width = 10 x 2.23 = **22.3** mm

Addendum = 1x module = **2.23** mm

Dedendum = 1.125 x module = **2.508** mm



Circular pitch = pi x PCD/ Number of teeth on pinion = 3.14x36 / 16

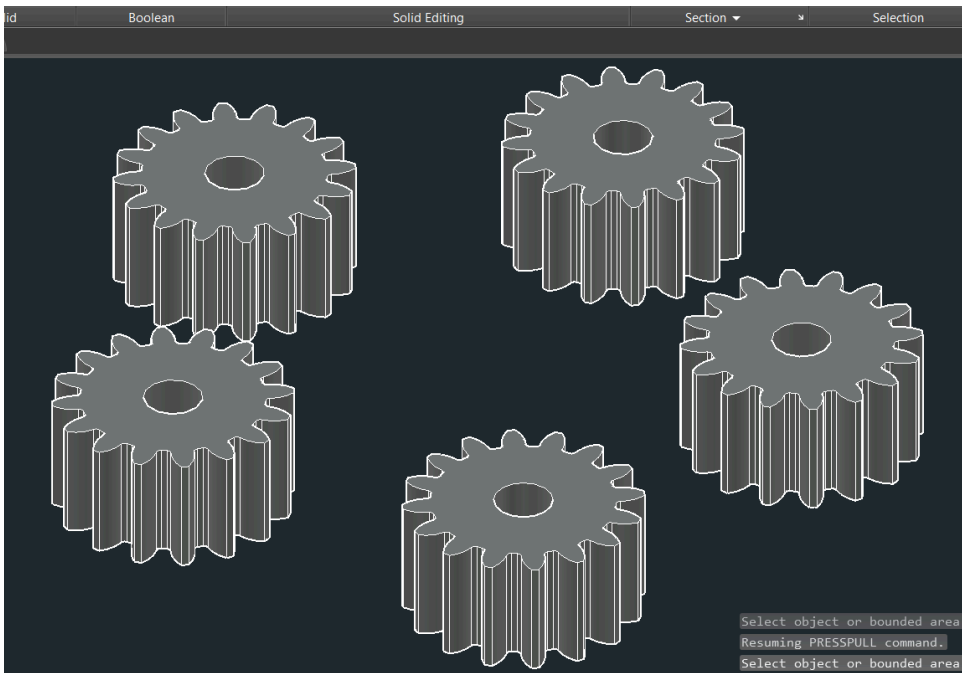
= **7.065**

Tooth Thickness = Circular pitch / 2 = 7.065/2 = **3.532 mm**

Face width of gear = 10 x 2.23 = **22.3 mm**

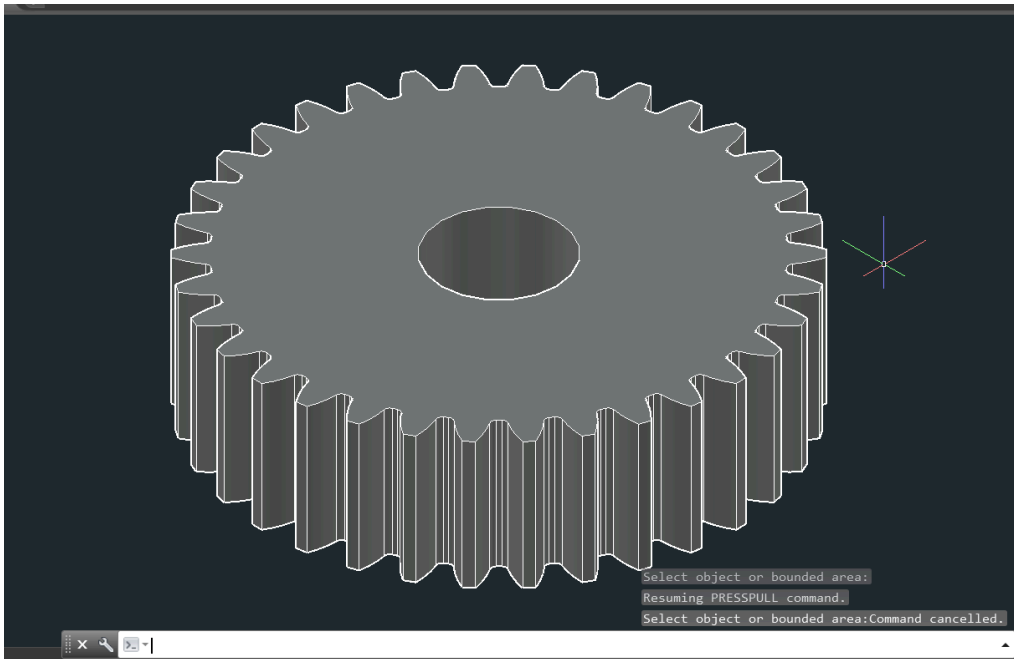
Face width of pinion = 9 x 2.23 = **20.07 mm**

Pinion



Root Diameter	30.98 mm
Pitch Diameter	36 mm
Outer Diameter	40.46 mm
Tooth thickness	3.53 mm
Circular pitch	7.065

Gear



Root Diameter	70.98 mm
Pitch Diameter	76 mm
Outer Diameter	80.46 mm
Tooth thickness	3.53 mm
Circular pitch	7.065

Pitch Dia: PCD+(2xAdd) = **70.98 mm**

Root Dia: PCD = **76**

Outer Dia: PCD-(2xDed) = **80.46 mm**

Medium Carbon Steel (AISI1045) is used for the Designing of Gears.

Ultimate Tensile Strength = **560 MPA (or) 560 N/mm2**

Tensile Strength, Yield = **310 Mpa**

Poisson's Ratio = **0.29**

Young's Modulus = **200 Gpa**

Average Force By Human = **500 N**

Rotations per minute = **30.**

As the same material is used we need to calculate for pinion as it is the weakest member.

Circular Pitch = pi x pcd/ No of teeth = pi x 36/16 = **7.065**

Velocity ratio = 1/ gear ratio = ½.1 = **0.476**

Radial Force = F x Sin 20 = 500 x sin 20 = **171.01**

Tangential Force = F x Cos 20 = 500 x cos 20 = **469.84**

Geometry factor of spur gear = J = sin20cos20/2 [gear ratio/gear ratio +1] =

0.108

Power transmitted = 2 x pi x N x T/ 60 = 2 x 3.14 x 30 x 450 / 60

= 1413 w = **1.43 Kw**

Torque transmitted = 2.1 x 450 = **945 Nm**

Permissible bending stress = 1/3 (ultimate tensile strength)

= 1/3 x 560 = **186.66**

Effective Loads on gear tooth = ka x km x Tangential force / kv

= **1295.5 N**

Ka = **1.25**(moderate Shock & precise Gearing)

Km = **1.2** (Face width up to 50 mm)

V = **20 m/s** (fine hobbing)

Kv = 5.6/ (5.6 + √20) = 0.544

Fb = FOS x F eff

FOS = Fb/ F eff

Fb = module x Face width x Y x permissible bending stress

= 2.23 x 22.3 x 0.295 x 186.66 = **2738.31**

Y = lewis form factor table

FOS = 2738.31 / 1295.5 = **2.11**

As factor safety is 2.1 which is greater than 1.5 the design is in the given limits and we further designed it in AUTOCAD.

The Pentagon shape outlet(outer shell) is inscribed in a circle of 200mm.

The outer ring thickness is 32 mm

Plate thickness is 1 mm

Nut size of 19M Female has been made (hexagonal)

As per the design calculations the diameters of shafts has been obtained 16mm and 20 mm

And the appropriate Bearings were Used to support the movement of the shafts.

Shafts

Design of shaft for gear:

Normal load : **500 N**

Weight of the gear = 0.00188(34) x 22.5 x (2.23)^2 = **4.489**

Resultant Load acting on the gear =

[(500)^2 + (4.489)^2 + 2(500) x 4.489 cos 20]^ 0.5

= **504.22**

The gear is overhung by 7mm

M = 504.22 x 7 mm = **3529.54**

T = tangential load x (dia of gear /2) = 469.84 x (76/2) = 17853.92

Te = (M^2 + T^2)^0.5

= **18119.45**

Te = pi/16 X 50 X d^3 [50 = allowable shear stress]

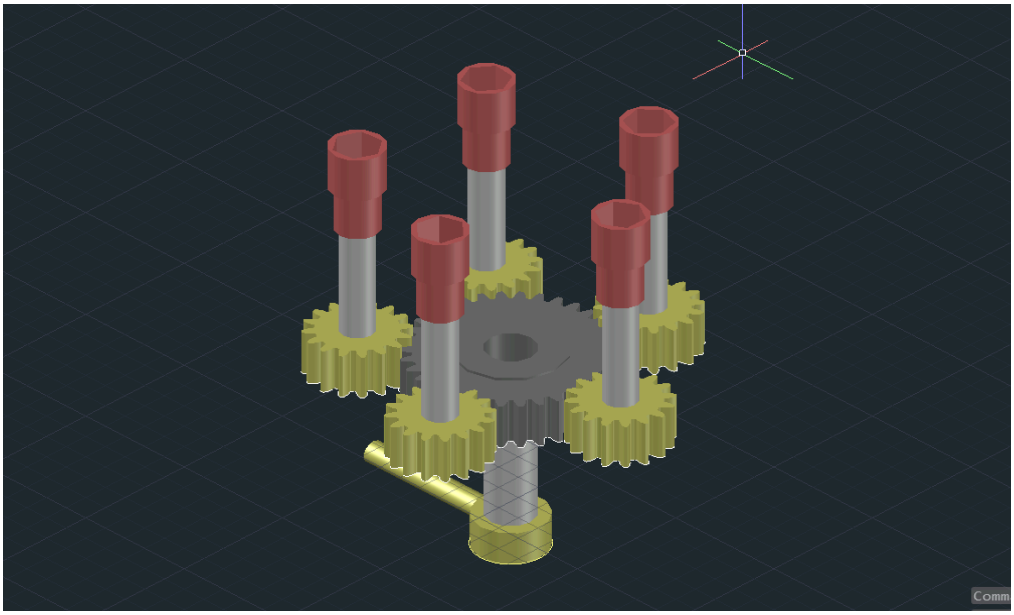
D= 12.26 = **20** (approx. and for high strength)

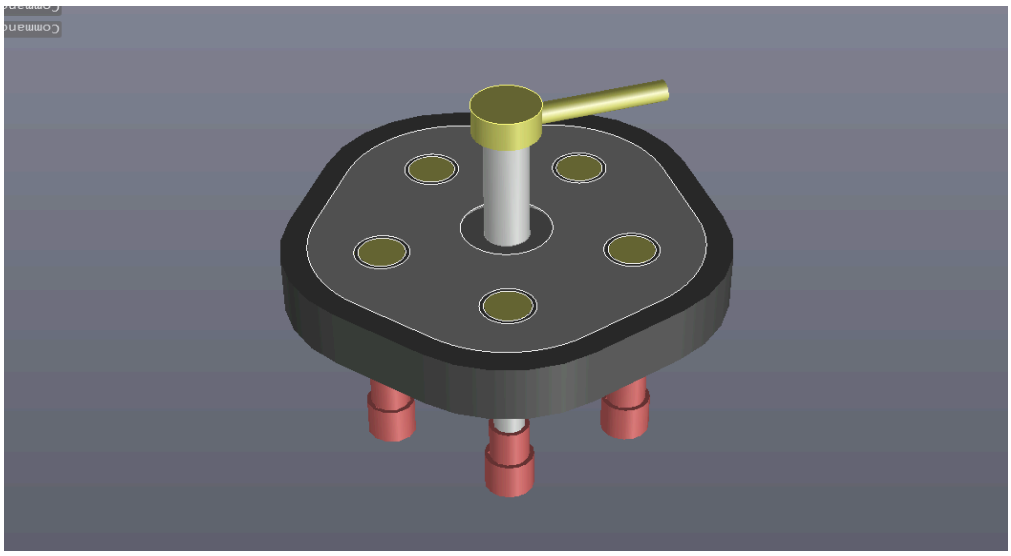
Same way you need to do for pinion and the values of shaft for pinion with **16mm**

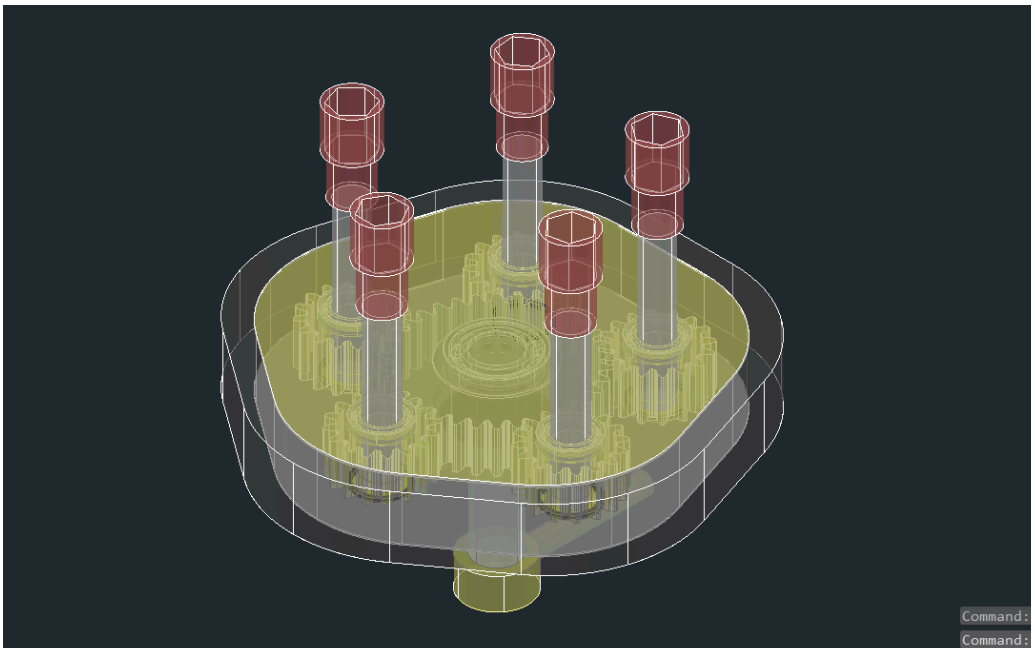
Product

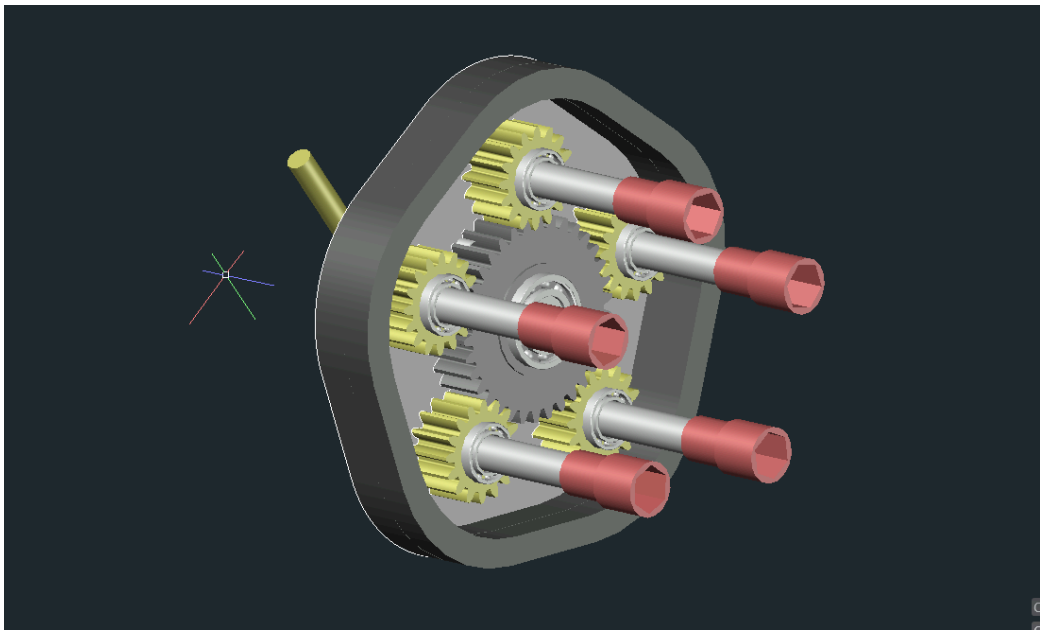
Our main objective was to make an easy to understand and easy to use manual multi spindle nut remover design which can be used by every person who owns a car. And we were able to design a manual multi spindle nut remover by following the design rules and calculations. And the product has been designed.

As we have calculated the required calculations for the product and as the FOS is above the 1.5 we have designed the product in AUTOCAD. This is how the final product of multi nut remover looks like.









Conclusion :

Manual Multi-spindle for Nut removal has been designed in AUTOCAD for the material Aisi 1045 of gears. And for the shafts low carbon steel material was used . FOS of the Gear pair is higher than that of the design factor of safety; the design of the gear pair is safe.

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