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Design and Manufacturing of Multi-nut operated Spanner

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Abstract: *DMMOS concept of the proposed system is nut fitting & removing with human help for driving. Nut fitting arrangement (spanner) and spur gear arrangement. The main objective of the model is to remove the nuts of a wheel at once and not one at a time. The principle of the model is the usage of spur gear to transmit relative motion to other gears. Each of a plurality of couplers is attached to one of the secondary axles. The operator should lift the model and place at the appropriate place to tighten or remove the nut. So in this project we are going to develop the Multi nut remover set up for Maruti Alto wheel (PCD 114 mm).*

Keywords: *DMMOS Design and Manufacturing of Multi-nut operated Spanner*

I. Introduction

Multi nut remover is a kit invented to reduce the effort and time in replacing the wheels of the vehicle. The plurality of lug nuts can be removed at one time without the usage of an electric motor or any hydraulic and pneumatic devices. The planetary shafts are arranged exactly in the pitch circle position of the lug nuts. This method can be used to remove any number of lug nuts but the design of gear varies according to the certain parameters like number of lug nuts, pitch circle diameter.

The device is not a symbol of luxurious anymore. It is a need for every family. People need car due to several reasons. Some of them are, to get to a destination, to travel conveniently, to do daily job and to move things to a greater distance. The problem occurs the most during car operation is the problem with tyre puncture . The flat tyre needed to be replaced with spare tyre. Therefore, drivers need to know basic knowledge of tyre replacement procedure if such problem occurs. In order to change the flat tyre, one requires minimal skills. Virtually every car has a tyre replacement tools such as the L-shaped nut remover and jack supplied by the manufacturer .

II. Procedure

Work Procedure

Experiments are conducted on the wheel of Maruti 800 car having PCD 114mm. The fixer is supported by using frame. The size of nut is 19mm having at angle of 90 degree with each other having four nut. The fixer is fitted on the wheel. The power is given to Input shaft, the spur gear is mounted on input shaft which mesh with the spur gear of output shaft. The output shaft rotates with less rpm with higher torque because less size with respect to input gear. On the output shaft steps are created to support bearing. At the end of output shaft 19mm box spanner is fitted. As we gives power to input shaft gears rotates and gives power to output shaft and all the spanner rotates with same velocity. The out shaft rotates opposite to the input shaft direction. As we gives anti-clock wise direction nuts are removed as opposite, we gives clock wise direction nuts are tighten.

Conventional Arrangement

Multinut Remover Arrangement

III. Design Of Experiment

1 Major points / steps involved in design of Test rig.

- Design of gear shaft.
- Selection of bearing.

1.1Design of gear shaft.

Total torque on crank = 150 x 400 = 60000N-m

T = Max Torque generated to rotating Crank

б = 145 N/ mm2 considering factor of safety = 4

As per Design data book shaft material is selected Carbon steel C40

$C40 \Rightarrow Sut = 580\ N/mm^2 \quad Yield = 435\ N/mm^2$

σ = 145 N/mm2

As per ASME code

0.3 X Yield strength N/mm2

0.18 X ultimate strength N/mm2} whichever is smaller

0.3 x 330 = 99 N/mm2 …….(a)

0.18 x 580 = 104 N/mm2 ……..(b)

From equation (a) & (b)

Allowable stress value will be 99 N/mm2

If key ways will provide to shaft then

τ = 99 x 0.75 = 74.25 N/mm

Max torsional moment equation is given by

we know,

Where $T_e = \frac{\pi}{16} d^3 \tau$

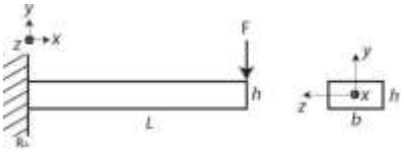
T = 60000N-mm

By using above equation drive shaft dia d = 16.10mm …….A

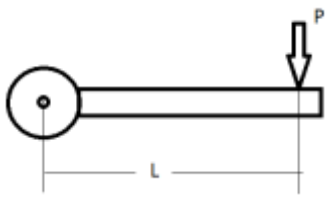
Considering extra torque and load we have considered 20 mm dia.

1.2 Design of lever.

Hence per rev one can will get crush by single crank mechanism.



RA = Support reactions. = 150 N



Load on lever = 150 N

Length of lever = 400mm

Cross section of crank arm

$I_{N.A} = \frac{BD^3}{12}$

This equation is known as the Bending Theory Equation.

$$\frac{\sigma}{y} = \frac{M}{T} = \frac{E}{R}$$

We know that,

σ = 145 N/mm2 Allowable stress
y = D/2
D = 30 mm
B = 5 mm
Hence we will check for allowable stress
From above equation σ = 92.16 N/ mm22 < 145 N/mm2
Hence selected section for crank arm is safe.
The force required for removing four numbers of nuts is,
F = 4τ / (lRG) (1)
Where, F is the applied force,
SPEED RATION OF GEAR-

* Two Spear Gear of size 70mm and 46mm diameter used having no. of teeth 40 and 27 respectively.

Speed calculation
Both gears have same module
So,
N1/ N2 ------ D2/D1
If we gives 1 revolution to input, out speed is as,
N1---- 1 Revolution
1/N2 ------- 70/46
N2—0.6571 revolution

* The total assembly is mounted on the steel l plate of size 170mm in square and thickness 8mm.

Design of Planetary Spur Gear Box

The following dimensions are assumed for the gear drive train,

Sun gear

Module = D/t—1.7mm
No. of teeth = 27

Planet gear

Module = 1.7mm. No. of teeth = 40

Speed = 60 rpm

Face width b = 12 mm

T design = 60000 Nmm.

Sut pinion = Sut gear = 600 N/mm2 ---------- both giving same material

Service factor (Cs) = 1.5

dp =46

Now; T = Pt x $\frac{dp}{2}$

Pt=Tangential force = $\frac{2\times60000}{46}$ = 2608.69 N.

Peff = $\left(\frac{Pt\times Cs}{Cv}\right)$.

Peff = $\left(\frac{Pt\times 1.5}{Cv}\right)$.

Cv = $\left(\frac{3}{3+v}\right)$.

V=$\frac{\pi DN}{60\times10^3}$.

V = $\frac{\pi\times46\times60}{60}$

V = 0.144 m/sec.

Cv = 0.955

Peff = $\left(\frac{2608.\times1.5}{0.95}\right)$.

Peff = 4117.89 N……1

Lewis Strength equation

WT = (sy) × b × m × Y

Where;

Y=0.484 – 2.86/Z

Y = $0.484-\frac{2.86}{27}$ = 0.378

Sy =600/2 =300

Pinion and gear both are of same material so we design for pinion.

Sy = 300

WT = (sy) × b × m × Y

4117.89= 300 ×12 × m.

m=1.14

Selecting standard module =1.70mm

So design is safe

Gear Data

No. of teeth =26

Module = 1.70 mm

IV. Conclusion and Results

This invention reduces the time consumed in removing the lug nuts. In conventional method, certain torque has to be applied to remove a single lug nut. In this invention, the torque applied for removing/tightening of one lug nut is adequate for removing/tightening of all the lug nuts in the wheel. So the process of replacement of the wheels can be done so faster and it reduces the time. This device can be operated manually and no external power is consumed. It doesn't cost more as compared to hydraulic and pneumatic devices. In this mechanism, a sun and planet gear system is used.

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