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Efficient Mechanical Wrench

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Abstract: **Wheel cap nuts must be kept tight. Reduced and inconsistent wheel clamping condition can cause wheels to loosen and disengage from the vehicle, causing serious injury or death. The Effective Mechanical Wrench(EMW) is a newly designed wheel wrench for easy loosen truck, bus tyres lug nut or car tyres by using less labor to reach a sufficient output torque without impact. EMW tool is used in the place of conventional tool (wheel spanner and rod) .In the conventional means about 800 N-m (80 m-kg) means almost 80 kg weigh man is needed to put up the required amount of force to unscrew the wheel nut. Also 1.2-2 min is required to unscrew one nut , means as there are 10 nuts in a single bus tyre ,around 14-18min will be required to open up a tyre. With the newly designed EMW, the torque required by conventional 80 m-kg has got reduced to 40 m-kg, means a normal person with a weight of at least 40 kg can unscrew the nut of the tyre with 1 meter rod. The time required that is 14-18 min in the conventional method has got reduced to half i.e. 6 – 8 min during unscrewing/screwing of one wheel nuts.**

1. INTRODUCTION

At present, to unscrew/screw the bus wheel nut at road side, we are using one and a half meter long metallic rod fitted with a spanner and socket (goti) which tightly fits to nut of tyre. Then two men stand over the rod and give jerk force on it to unscrew/screw the nuts.

With this conventional process to unscrew/screw 8-10 nuts of a wheel in a heavy duty vehicle it consumes about 10-15min. All this makes the process is lethargic and relatively time consuming. One of the modern technique used are pneumatic guns which work effectively in the workshops.

These guns are the fastest means as it requires only 5-6 sec to unscrew the single nut. But the problem is that it can only be used in a work shop due to heavy set up and cannot be available at road side.

There are several types of mechanical torque wrenches that are routinely used to tighten fasteners to specified torque levels. The Efficient Mechanical Wrench that is newly designed by us make an audible click to let the user feel comfortable by applying very less torque when relatively compared with traditional torque. Simultaneously completes the task of removing all the nuts in relatively very less time by removing 2 nuts at a time instead of one during unscrewing/screwing.

2. DESCRIPTION

Setup of EMW consists of Mechanical elements like

- Sprockets
- Chain drives
- Solid input shaft, hollow output shafts.
- Supporting plates with embedded ball bearings.

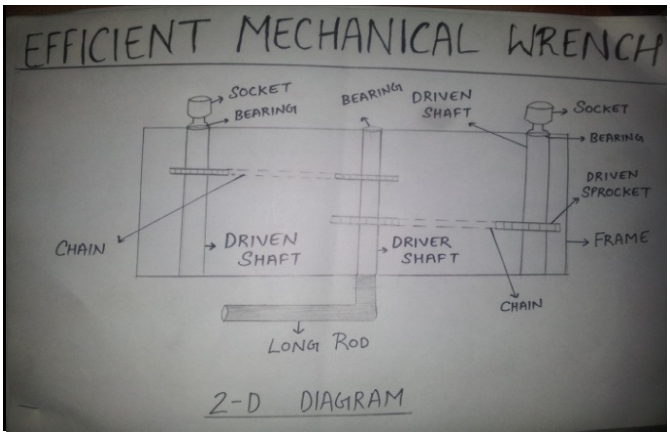

Fig.1 Efficient Mechanical Wrench

Mechanical elements are connected in above manner. The sockets (at the top of tool) get fitted into the two diagonally opposite nuts of the wheel and from the input shaft. Input is

given with help of a rod. Input torque is transmitted to the output shaft (which carries sockets) with the help of chain drive and sprocket sets. During the transmission of the power the torque is amplified with the help of "Sprocket ratio". Thus this tool out as a "Mechanical Amplifier". Fig.1 Efficient Mechanical Wrench

Different elements of the tool are discussed below separately.

- SUPPORTING PLATE:

Supporting plates are the main frame of the tool which carries the shafts and all elements of the tool. Supporting plate has a ball bearing fitted in them(in which shafts has to be press fitted)

- INPUT AND OUTPUT SHAFTS:

Three shafts are used in the tool i.e one input shaft and two output shafts.

Input shafts carries two small size sprockets having 9 teeth and output shaft carries the larger sprocket with 35 teeth. All the sprockets are keyed/welded on the shafts as shown.

- SPROCKET AND CHAIN DRIVE SET:

As mentioned this tool acts as a "Mechanical Torque Amplifier". The torque amplification is done with the help of sprocket ration of 1:4 .i.e Number of teeth in small sprocket are 9 and Number of teeth in large sprocket are 36.

Sprocket Ratio= 9:36 = 1:4

Hence torque is being increased to 4 times the input torque.

- ROD AND SOCKETS(GOTI):

Sockets a detachable part of tool which gets fitted as the output shaft and then along with the tool it is fitted into the nuts. Rod is used to give input to the tool .It is also a detachable part.

Fig. 2 Testing EMW tool working on DTC low floor bus

3. DERIVATION FOR THE REDUCTION OF TORQUE REQUIRED TO UNSCREW/SCREW THE NUTS:

- D_1=Diameter of the small sprocket
- D_2 =Diameter of large sprocket
- N_1 =Speed of small sprocket in r.p.m
- N_2 =Speed of large sprocket in r.p.m
- T_1=torque transmitted by smaller sprocket
- T_2= torque transmitted by larger sprocket

Length of chain that passes over the small sprocket in min. = $\Pi . D_1 . N_1$

Similarly length of the chain that passes over the larger sprocket in one minute = $\Pi . D_2 . N_2$

Now , since length of chain that passes over the small sprocket and big sprocket is equal .Hence

$\Pi . D_1 . N_1 = \Pi . D_2 . N_2$
$N_2/N_1 = D_1/D_2$ (1)

As we know that diameter of the large sprocket used in efficient mechanical wrench is 4 times of the diameter of smaller sprocket used so.

$D_2 = 4 . D_1$ (2)

From (1) and (2)
$N_2/N_1 = 1 / 4$

$N_1=4N_2$ (3)

From Conservation of energy , we know power input = power output

Hence Power of smaller sprocket = Power of larger sprocket (4)

Power of smaller sprocket = $(2.\Pi . N_1 . T_1)/60$
Power of larger sprocket = $(2.\Pi . N_2 . T_2)/60$
From (4) $(2.\Pi . N_1 . T_1)/60 = (2.\Pi . N_2 . T_2)/60$
$N_1/N_2 = T_2/T_1$ (5)

From (3) and (5) $T_2 = 4 T_1$
i.e Torque transmitted by the large sprocket (output shaft) is four times of the torque applied by the small sprocket(input shaft). Since this torque is being distributed on the two output sprocket and then to the output shaft

Then the final torque on the output shaft and the socket will be the twice of the applied torque.

Torque obtained at the socket = 2 x Torque applied (6)

4. PROOF OF DERIVATION

The below data taken from DTC workshop, Delhi.

Torque required to unscrew the single nut of the DTC low floor bus =75-80 Kg-m =750-800 N-m torque

So Torque required at the socket= T2=800N-m

From equation (6)

Torque applied by human effort = T2/2

=800/2

=400 N-m

=Half of torque required to unscrew the single nut of DTC bus.

5. FUTURE SCOPE

TOOL FOR ANY 4 WHEELER: This EMW with a little modifications can be made fit to any 4 wheeler wheel and its nut size for unscrewing/screwing nuts of a wheel.

MOTORIZED EMW SYSTEM: EMW can be made a part of Mechatronics system by using a high torque motor so as to get the input torque from motor instead of hand and power can be grabbed from the batteries of the vehicle.

6. CONCLUSION

Testing for EMW tool is done in TEHKHAND DTC DEPOT, Delhi where the two nuts of the DTC low floor bus wheel opened simultaneously in just 1min 20sec with 40kg man giving the torque. Hence with the newly designed EMW, the torque required by conventional means 80 kg got reduced to 40mkg, means a normal person with a weight of at least 40 kg can unscrew the nut of the tyre. The time required by conventional means of opening 10 nuts is 14-18 min got reduced to half i.e 6 – 8 min during unscrewing/screwing of one wheel nuts.

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