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ELECTRIC BOTTLE CAR JACK

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Abstract:

Road side emergency like tyre puncher, is a problem commonly observed in cars. . Changing a flat tire is not a very pleasant experience.Conventional car jacks uses mechanical advantage to allow a human to lift a vehicle by manual force. This paper analyses the modification of the current bottle jack by incorporating an electric DC motor in the screw in order to make load lifting easier for emergency use with using power of car battery (12 Volts), Gear ratio is used to increase the lifting speed. The significance and purpose of this work is to modify the existing car jack in order to make the operation easier, safer and more reliable in order to save individual internal energy and reduce health risks especially back ache problems associated with doing work in a bent or squatting position for a long period of time.

Fabrication work has been done using with milling, drilling, grinding, and welding machine. The developed car jack is tested on car

Keywords: Fabrication**,** bottle jack , Gear ratio

1. Introduction

Car jacks usually use mechanical advantage to allow a human to lift a vehicle by manual force. More powerful jacks are using hydraulic power to provide more lift over greater distances. This paper presents the development of the car jack for emergency use with using internal car electric power (12volts). The automatic easy car-jack utilizes this power source to save individuals having to exert any energy. To increase the lifting power in order to ensure the power is adequate, gear ratio was used. The car jack was developed utilizing the Solid works and its analyses to check the safety factor and force acting. The fabrication work has been done with milling and grinding machine. The car jack will be tested and it predicted to have enough power to lift and holding the car as normal car jack.

An automotive jack is a device used to raise all or part of a vehicle into the air in order to facilitate vehicle maintenances or breakdown repairs. Most people are familiar with the basic car jack that are manually operated and it's included as standard equipment for most of the new cars. Vehicle owners who would like to rotate their tires themselves either front to back.Changing a flat tire is not a very pleasant work. Nowadays, a variety of car jacks are available for lifting an automobile from a

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ground surface. Available car jacks, however, are typically manually operated and need human effort. Such jacks present difficulties for the elderly and handicapped persons.

Commercial automobile repair and service stations are commonly equipped with large and hi-tech car lift, such lifts are raised and lowered via electrically-powered systems. However, due to their size and high costs of purchasing and maintaining electrically-powered vehicle lifts, such lifts are not available to the average light motor vehicle owner. Such electrical-powered portable jacks not only remove the arduous task of lifting an automobile via manually-operated jacks, but further decrease the time needed to repair the automobile. Such a feature can be especially advantageous when it is necessary to repair an automobile on the side of a roadway or under other hazardous conditions.

Objective and goals

A specified jack purposed to hold up to 1000 kilograms, but tests undertaken by Consumer Affairs has revealed that is fails to work after lifting 250 kilograms and may physically break when it has a weight close to its 1000 kilograms capacity. Tests have proven that the jack has the propensity to buckle well under the weight it is promoted to withstand, and it doesn't meet the minimum or performance requirements of the Indian Standard for vehicle jacks.

Methodology:

Preliminary survey to determine which type of car jack is preferred. Determining the number of components which are going to be bought and which are going to be manufactured. Application of SOLIDWORK software for providing a detailed 2D and 3D drawings, material selection and simulation for the car jack. Manufacturing all needed components at the workshop. Testing the project so is to check it.

The purpose of this project is to develop a car jack which is easy to be operated safe and able lift and lowering the light motor vehicle without involving much physical effort and time and the cost of this jack is less as much as possible.

Parts used

- Scissor jack
- Power window motor
- Pinion
- Gear
- Frame holder
- Two way switch
- Electric wire

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- Adapter

The entire requirement from the drawing is then transform onto the real prototype. It also included a switch buttons system to raise and lowering the jack. Scissor jack has been collected from the junk yard and it still can be used. The Scissor jack is the best jacks available in the market. The pneumatic and hydraulic jack is not safe because usually need maintenance and sometime leaked. The development will be based on this scissor jack. The screw shaft which can be rotated and raise the head load up and down.

After the pinion is fabricated, it is inserted into the slot of the power window motor and welded. The frame is fabricated base on the design to hold the motor. It is fabricated using 3mm low carbon metal and then cut using grinder into small pieces according the dimensions. The cut pieces are then welded on the end of the scissor jack and welded together with other pieces.

Using the welding machine base which is made from the iron barand then is screwed and welded on the base of the scissor jack. This is to stabilize the scissor jack with increasing of the surface area will increase the stability.

Switch for the scissor jack to be lifted and lowered are controlled by a 2 way switch. This switch circuit is to make the motor enabled to rotate clockwise and counter-clockwise without changing the terminal positive and negative. It is time consumable to change the terminal every time when using this jack, so by using two way switch, it is more flexible and easier for the user. The switch also contains 2 relays which will act when a lifting button is press, it will actuate one of the relay and it will rotate the motor to the desire level. The most important part is that when the button is release it will stop directly. Let say if the button is pressed to right, then it will actuated the coil in relay 1 and then it will change over the switch and supply will flow to the motor and to the second relay which will go directly to negative terminal and the motor will rotate clock-wise and Vice versa.

Jack Definition:

A jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. A mechanical jack employs a screw thread for lifting heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Mechanical jacks are usually rated for a maximum lifting capacity (for example, 1.5 tons or 3 tons). More powerful jacks use hydraulic power to provide more lift over greater distances and can be rated for many tons of load.

Bottle car jack:

This type consists of a power screw that converts the rotary motion to a linear motion. This type of jack is extremely versatile, and can not only help lift vehicles, but can also aid in pushing vehicles around. These jacks are compact in size, but are designed and built for performance. Lifting capacities range from heavy duty 1 ton bottle jack up to 30 ton bottle jack.

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Theory:

The mechanism of the ELECTRICAL CARJACK is to make the jack drops and rises by the use of motor and spur gears. There will be two gears, one will be mounted on the motor shaft and the other one will be mounted on the rotary part of the jack. The motor and the jack will be fixed in a metal base in a way that the two gears are in mesh perfectly, when the motor rotate clockwise, the gears will rotate and transmit motion and the jack will raise up and when the motor rotates anti-clockwise the jack will drop down.

Motor:

The motor is from the junk yard and it is from used car power window motor. From the manufacturer and calculated value for the torque it supplied 5.877N.m torque which is high enough and suitable for the project. There is also the pinion (small) and the gear (large) which is the main gearing system. The reduction gearing system which increases the torque up to 17.631N.m. Furthermore, the frame is the holder for the power window motor. It is also good for flat surface when jacking the car.

The motor which the original gear needed to be discarded because pinion and gear are manufactured using gear cutting machine. All the specification of the gears according to the torque needed to be applied on the system

Gear:

The gearing system is the crucial thing as it is the lifting mechanism powered from the motor. The torque from the motor will be supplied to the pinion and then transmit to the gear and it rotated the screw shaft clockwise or counter- clockwise.

A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part to transmit torque, in most cases with teeth on the one gear being of identical

shape, and often also with that shape on the other gear. Two or more gears working in a sequence (train) are called a gear train or, in many cases, a transmission; such gear arrangements can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine. Geared devices can change the speed, torque, and direction of a power source. The most common situation is for a gear to mesh with another gear; however, a gear can also mesh with a non-rotating toothed part, called a rack, thereby producing translation instead of rotation. An advantage of gears is that the teeth of a gear prevent slippage. 12 When two gears mesh, and one gear is bigger than the other (even though the size of the teeth must match), a mechanical advantage is produced, with the rotational speeds and the torques of the two gears differing in an inverse relationship.

Spur gears:

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form (they are

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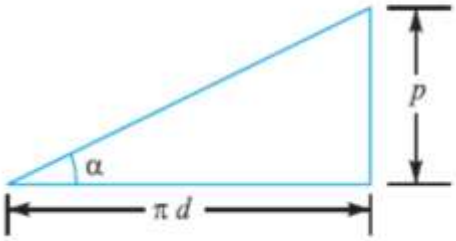
usually of special form to achieve constant drive ratio, mainly involute), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.

Bevel gears:

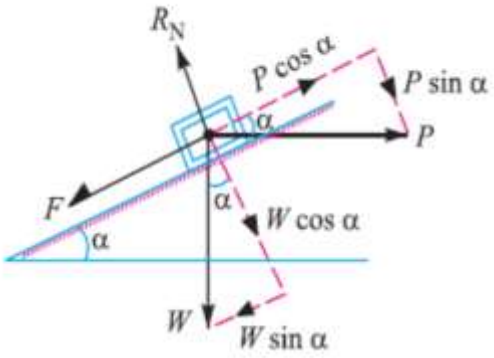
A bevel gear is shaped like a right circular cone with most of its tip cut off. When two bevel gears mesh, their imaginary vertices must occupy the same point. Their shaft axes also intersect at this point, forming an arbitrary non-straight angle between the shafts. The angle between the shafts can be anything except zero or 180 degrees. Bevel gears with equal numbers of teeth and shaft axes at 90 degrees are called mitre gears.

Torque required to raise load by the power screw:

A little consideration will show that if one complete turn of a screw thread be imagined to be unwound, from the body of the screw and developed, it will form an inclined plane



Development of screw.



Forces acting on the screw

Where:

p = Pitch of the screw,

d = Mean diameter of the screw,

α = Helix angle

P = Effort applied at the circumference of the screw to lift the load,

W = Load to be lifted, and

μ = Coefficient of friction, between the screw and nut

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$\mu = \tan \varphi$, where φ is the friction angle.

From the geometrywe find that:

$$\text{Tan } \alpha = p / \pi d$$

Since the principle, on which a screw jack works is similar to that of an inclined plane, therefore the force applied on the circumference of a screw jack may be considered to be horizontal

Since the load is being lifted, therefore the force of friction ($F = \mu.RN$) will act downwards.

All the forces acting on the body.

Resolving the forces along the plane:

$P \cos \alpha = W \sin \alpha + F = W \sin \alpha + \mu.RN$ ... (i)

And resolving the forces perpendicular to the plane:

$RN = P \sin \alpha + W \cos \alpha$ ... (ii)

Substituting this value of RN in equation (i), we have:

$P \cos \alpha = W \sin \alpha + \mu (P \sin \alpha + W \cos \alpha) = W \sin \alpha + \mu P \sin \alpha + \mu W \cos \alpha$ Or

$P \cos \alpha - \mu P \sin \alpha = W \sin \alpha + \mu W \cos \alpha$ Or

$P (\cos \alpha - \mu \sin \alpha) = W (\sin \alpha + \mu \cos \alpha)$

$\therefore P = W \text{ x } [(\text{Sin } \alpha + \mu \text{ Cos } \alpha) / (\text{Cos } \alpha - \mu \text{ Sin } \alpha)]$

Substituting the value of $\mu = \tan \varphi$ in the above equation, we get:

$P = W \text{ x } [(\text{Sin } \alpha + \tan\varphi \text{ Cos } \alpha) / (\text{Cos } \alpha - \tan\varphi \text{ Sin } \alpha)]$

Multiplying the numerator and denominator by cos φ, we have:

$P = W \text{ x } [(\text{Sin } \alpha \text{ Cos}\varphi + \text{Sin } \varphi \text{ Cos } \alpha) / (\text{Cos } \alpha \text{ Cos}\varphi - \text{Sin}\varphi \text{ Sin } \varphi)]$

$= W \text{ x } [\text{Sin}(\alpha+\varphi) / \text{Cos}(\alpha+\varphi)] = W \text{ x tan } (\alpha + \varphi)$

∴ Torque required to overcome friction between the screw and nut:

$T = P \text{ x } (d/2) = W \text{ x tan } (\alpha+\varphi) \text{ x } (d/2)$

Calculations:

By dismantling the carjack the following dimensions were determine:

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Nominal diameter (d_1)	Major diameter		Minor diameter	Pitch	Depth of thread		Area of core (A_c) mm^2
	Bolt (d)	Nut (D)	(d_c)	(p)	Bolt (h)	Nut (H)	
30	30	30.5	27	3	1.5	1.75	573

Pitch = 3 mm

Dp (mean diameter) = 30 – (pitch/2) = 30 – 1.5 = 28.5 mm

Lead = 3 mm

μ (coefficient of friction) = 0.15

Power factor = 1.2

$\tan\gamma$ = p / π d = $(3/\pi x\ 28.5)$ $>\gamma = 1.919$

W (assumed load) = 750 kg

750 x 9.81 = 7357.5 N

Torque = $\{W\times dp\times(\mu cos\gamma+sin\gamma)\div 2(cos\gamma-\mu sin\gamma)]$

= $[\{7357.5\times28.5\times(0.15\times\cos(1.919)+\sin(1.919))\}\div\{2\times1000\times(\cos(1.919)-0.15\sin(1.919))\}$ = 19.336 N.m Maximum lift = 23 cm = 0.23 mm

Assumed lifting time = 75 seconds = 1.25 minute

N = $Maximumlift\div Pitch$=> 0.23÷0.003 = 76.667 Revolutions per 1.25 minutes

N = 76.667÷1.25 = 61.333 rpm

ω = $(2\ \pi\times N)\div 60$ =$(2\ \pi\times61.333)\div60$ = 6.422 rad/sec

Power = Torque X ω X Power factor = 19.336 X 6.422 = 124.175 watt

Gears design:

First the carjack were dismantled to know the reduction ratio.

We found that: Pinion teeth= 12 teeth,

And the teeth on the driven gear = 27 teeth.

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Reduction ratio = $Teethonthedrivengea \div Teethonthedrivergear$

= 27 / 12 = 2.25

Final speed × reduction ratio = speed on the second shaft.

61.33334 × 2.25 = 140 Rpm

We know that the first shaft speed = the motor speed = 75 rpm

To gain 140 rpm at the second shaft a 1.95 increasing ratio were needed must increase the first, so the following set were designed.

First the module and the number of teeth were assumed to be:

Module = 1.25

Number of teeth= 27 teeth

D = 34 mm

b = 4*3.14*1.25= 15.70 mm, taken = 16 mm

Material C1020(K) used.

Tension stress = 455 Mpa

σd = $Tensionstress \div Safteyfactor$ = 455÷ 2 = 227.5 Mpa

Lewis static check:

$Fs = \sigma d * b * m * y$

Y=0.348

Fs = 227.5 × 16 × 1.25 × 0.348 = 1583.4 N

$Ft = P/v$

P = 130 watt

V = $(2\pi \times N \times D) \div (60 \times 2) = (2\pi \times 60 \times 34) \div (60 \times 2)$ = 0.13 m/s

Ft = 130/0.13 = 1000 N

Fs/Ft=1.58 $(safe)$

Lewis dynamic check:

$Fw = K * Q * b * d$

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K=1.807 Mpa

Q = (2×$Reductionratio$) ÷ (1+$Reductionratio$) = 4÷ 3 = 1.333

Fw = 1.807 × 1.322 × 16 × 34 = 1299.53 N

$Fd = CV*Ft$

CV = (6+V) ÷ 6

CV = 1.022

Fd = 1.022 × 1000 = 1022 N

Fw/Fd = 1.27 ($safe$)

FABRICATION

Components:

Bottle car jack: We used the bottle car jack because of the following reasons:

1- It's extremely versatile,

2- Compatible,

3-Small in size,

4- Safe and reliable,

5- Good in performance,

6- And it's very good at heavy duties.

Gears:

Two gears were made to give the rotating movement of the car jack, they are made of steel. The pinion has 52 teeth and it was fitted on the motor shaft and used as a driver, and the gear has 27 teeth and it was fitted on the car jack. A steel shaft were taken 50 mm diameter and 200 mm length.

After cutting the shaft into two pieces for the two gears, the pieces were taken to the lathe machine to acquire the needed diameters for every piece

After acquiring the right diameters for the two pieces they were taken to the milling to make the gears using module of 1.25 mm/tooth

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Base and side members:

A steel plate within 150 mm width, 300 mm length and 5 mm thickness were used as a base for the car jack .Two steel plates within 130 mm length, 40 mm width and 5 mm thickness were used as side members to hold the base and the motor together.

CONSLUSIONS

Considering all available car jacks in the market, this prototype can be improved by a few modifications on the features and design. The objectives are to design a car jack that is safe, reliable and able to raise and lower the level, to develop a car jack that is powered by internal car power and automated with buttons system. Although this car jack was designby using higher torque it is able to lift more loads up to 950 kilograms.

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