FABRICATION OF QUICK LIFTING SCREW JACK USING SPUR GEAR ARRANGEMENT

A Project Submitted by

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Under the supervision of

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DEPARTMENT OF MECHANICAL ENGINEERING

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BONAFIDE CERTIFICATE

Certified that this project report **"FABRICATION OF QUICK LIFTING SCREW JACK USING SPUR GEAR ARRANGEMENT"** is the bonafide work of **"SAMUELSON (UR17ME197)"** who carried out the project work under my supervision during the academic year 2020-2021.

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Submitted for the Full Semester Viva Voce held on ______________

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CONTENTS

CHAPTER 1

ABSTRACT

With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into translatory motion. A screw jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The principle on which it works is similar to that of an inclined plane. The mechanical advantage of a screw jack is the ratio of the load applied to the effort applied. The screw jack is operated by turning a lead screw. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor. In this project, an electric motor will be integrated with the screw jack and the electricity needed for the operation will be taken from the battery of the vehicle and thereby the mechanical advantage will be increased.

CHAPTER 2

INTRODUCTION

Screw type mechanical jacks were very commonly referred in jeeps and trucks at World War II vintage. For ex., the World War II jeeps (Ford GPW and Willys MB) were introduced with the Jack, Screw type, Capacity 1 1/2 ton, Ordnance part number 41-J-66. In that days, the 41-J-66 jack was carried in the jeep's tool box. Screw type jack's preferred continued for small capacity use due to minimum cost of production for raise or lower the load. It had negligible maintenance. The concept of using a screw as a machine was first demonstrated by Archimedes in 200BC with his device used for pumping water. There is also evidence that screws were preferred in the Ancient Roman world. But, In the late 1400s, the Leonardo da Vinci, who first displayed the method of use of a screw jack for lifting the loads. Its design used a threaded worm gear, supported on bearings, which is rotated by the turning of a worm shaft to drive a lifting screw to move the load instantly recognizable as the principle used today. Thomas J. Prather (2009) in this, there was a introduction about vehicle lift system. a drive assembly was mechanically coupled to the piston. the drive assembly was operated in first direction to raise an upper end of the piston with respect to the housing. the drive assembly was operated in a second direction to lower the upper end of the piston with respect to the housing. the drive assembly was coupled to the power supply port which is removable to supply electrical power to the drive assembly. FarhadRazzaghi (2007) in this, electrically powered jack shown for normally raising and lowering of automobile from ground surface. The mechanism may be used in joining with a typical portable car jack, during which the mechanism constitute a power drill, a rod, and a numerous jack adapters. ManojPatil (2014) in this general article, screw jack is to developed to overcome the human effort. it is actually difficult job to operate for pregnant women and old person. changing the tyre is not a pleasant experience. especially women can't apply more force to operate. for that, electric operated car jack is introduced lokhandetarachand (2012) this paper referred to optimise the efficiency of square threaded mechanical screw jack by varying different helix angle.

Motivation for the research

With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into translatory motion. A screw jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The principle on which it works is similar to that of an inclined plane. The mechanical advantage of a screw jack is the ratio of the load applied to the effort applied. The screw jack is operated by turning a lead screw. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor. In this project, an electric motor will be integrated with the screw jack and the electricity needed for the operation will be taken from the battery of the vehicle and thereby the mechanical advantage will be increased

LITERATURE REVIEW

M V Babu Tanneru, Taj

- **Quick Lifting Screw Jack Using Spur Gear Arrangement**

With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into translatory motion. A screw jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The principle on which it works is similar to that of an inclined plane. The mechanical advantage of a screw jack is the ratio of the load applied to the effort applied. The screw jack is operated by turning a lead screw. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor. In this project, an electric motor will be integrated with the screw jack and the electricity needed for the operation will be taken from the battery of the vehicle and thereby the mechanical advantage will be increased.

Modestus Okwu

❖ **Modified Screw Jack for Lifting Operation in Industrial Setting**

With the increasing level of technology, researchers all over the world are working continuously to improve and implement better and robust design of materials at workplace for productivity, efficiency and effectiveness. Detailed design procedure of a quick lifting screw jack is presented in this paper. The design is fundamentally a modification of the conventional scissor jack. The problems associated with the conventional jacks are the ergonomic snags experienced by operators due to prolonged bending or squatting positions during operation. These problems of waist pain and backaches are as a result of continuous turning of the wrench or crank shaft in an uncomfortable position for a long period. These led to the design and modification of quick lifting screw jack with gear arrangements that are safe, reliable and capable of raising or lowering heavy load with little effort. The results showed that the introduction of the crank and gear mechanism would help reduce difficulty in operation, reduce time, increase efficiency and effectively control the difficulties concomitant with Ergonomics - which is an ultimate sensitivity in design process.

Benjamin Ezurike1 , Modestus Okwu

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Ivan Sunit Rout , Dipti Ranjan Patra , Sidhartha Sankar Padhi

- **Design and Fabrication of motorized automated Object lifting jack**

With the increasing levels of technology, the efforts are being put to produce any kind of work that has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into reciprocating motion. An object lifting jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. In this fabricated model, an electric motor will be integrated with the object lifting jack and the electricity needed for the operation will be taken from the d.c battery and thereby the mechanical advantage will be increased.

Asst Prof.Anand A. Kulkarni Avinash V. Roy , Chaitanya Kale , G Praveen Himalay Jakuti

- **DESIGN AND FABRICATION OF AUTOMATED MOTORIZED MECHANICAL JACK**

A jack is a device which is used to raise part of vehicle in order to facilitate vehicle maintenances or breakdown repairs. In normal jack system a mechanical jack is used for lifting the vehicles. The most common form is a car jack, garage jack, floor jack which lifts vehicles so that maintenance can be performed. Jacks are generally used to increase mechanical advantage (lifting the vehicle).Generally jacks undergo buckling when they reach maximum load conditions (as per the tests conducted by consumer affairs). For this reason, we have to develop the system which can use toggle jack which is automatic in operation using electric motor . Vehicle's battery can be used as a source of power for this motor. Our research in this regard reveals the facts that mostly some difficult methods were adopted in lifting the vehicles for reconditioning. This paper attempts to overcome this difficulty and a suitable device is to be designed such that the vehicle can be lifted from the floor without any application of impact force. The operation remains to be an essential part of the system although with changing demands on physical input, the degree of mechanization is increased.

CHAPTER 3

METHODOLOGY

1. Literature reviews
2. Analysis
3. Requirements specification
4. Manufacture
5. Implementation
6. Testing and Investigation
7. Maintenance
8. Conclusion

WORKING PRINCIPLE

- It is required to design a screw jack for supporting the machine parts during their repair and maintenance. It should be a general purpose jack with a load carrying capacity of 50KN and a maximum lifting height of 0.3m. The jack is to be operated by means of a D.C motor.
  - Step II Selection of Materials, The frame of the screw jack has complex shape. It is subjected to compressive stress. Grey cast iron is selected as the material for the frame.
  - Cast iron is cheap and it can be given any complex shape without involving costly machining operations.
  - Cast iron has higher compressive strength compared with steel. Therefore, it is technically and economically advantageous to use cast iron for the frame.
  - The screw is subjected to torsional moment, compressive force and bending moment. From strength consideration, EN8 is selected as material for screw.
  - There is a relative motion between the screw and the nut, which results in friction. The friction causes wear at the contacting surfaces.
  - When the same material is used for these two components, the surfaces of both components get worn out, requiring replacement. This is undesirable.
  - The size and shape of the screw make it costly compared with the nut. The material used for the nut is stainless steel.

CHAPTER 4

MAJOR COMPONENTS

1. DC MOTOR
2. BATTERY
3. TWO WAY SWITCH
4. FRAME
5. SHAFT
6. SPUR GEAR
7. SCREW JACK
8. BEARING
9. METAL STRIP

DC MOTOR

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on theforces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. Different number of stator and armature fields as well as how they are connected provides different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems which adjust the voltage by "chopping" the DC current into on and off cycles which have an effective lower voltage.

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

DC motor calculation

Specification of a DC motor Speed : N = 30 RPM

Voltage : V = 12 Volt

Loading Current : I = 300 MA No Load Current : I = 60 Ma

Power : P = VxI=12x0.3 = 3.6WATT

P = 0.0048HP

Motor Efficiency : E = 36%

Motor Shaft Diameter : D = 6 mm

Good science project does not stop with building a motor. It is very important to measure different electrical and mechanical parameters of your motor and calculate unknown values using the following helpful formulas This formula could be used in many cases. You may calculate the resistance of your motor by measuring the consumed current and applied voltage. For any given resistance (in the motors it is basically the resistance of the coil) this formula explains that the current can be controlled by applied voltage

Electrical power of the motor is defined by the following formula Input power : $P_{in} = I \times V$

Where, I – current, measured in amperes (A) V – applied voltage, measured in volts (V) Motors supposed to do some work and two important values define how powerful the motor is. It is motor speed and torque, the turning force of the motor. Output mechanical power of the motor could be calculated by using the following formula Output power : $P_{out} = T \times \omega$

τ – Torque, measured in Newton meters (Nm). ω – Angular speed, measured in radians per second (rad/s). Calculation of angular speed if we know rotational speed of the motor in rpm Angular speed : $\omega = N \times 2\pi$ 60 (3) Where, π – Mathematical constant pi (3.14). 60 – Number of seconds in a minute. Efficiency of the motor is calculated as mechanical output power divided by electrical input power: Efficiency:E = Pout Pin (4) Therefore, $P_{out} = P_{in} \times E$

After substituting equation no 1 & 2 in equation no 4, we get

$T \times \omega = I \times V \times E$

$T \times N \times 2\pi$

60

$= I \times V \times E$

Connect the motor to the load. Using the motor from generator kit is the best way to do it. Why do you need to connect the motor to the load? Well, if there is no load there is no torque.

Measure current, voltage and rpm. Now you can calculate the torque for this load at this speed assuming that you know efficiency of the motor.

Motor torque changes with the speed. At no load, you have maximum speed and zero torque. Load adds mechanical resistance. The motor starts to consume more current to overcome this resistance and the speed decreases. If you increase the load at some point motor stops (this is called stall).

4.1.2 Torque of the Motor

The formula for calculating torque will be

Torque : $T = (I \times V \times E \times 60) / (N \times 2\pi)$

Speed : $N = 30$ RPM

Voltage : $V = 12$ Volt

Loading Current : $I = 300$ mA

Torque : $T = (0.3 \times 12 \times 0.36 \times 60)/30 \times 2\pi$

$T = 0.412$ Nm Torque

: $T = 4.2$ Kgcm

BATTERY

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cations. One halfcell includes electrolyte and the electrode to which anions migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cations migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, reduction occurs to cations at the cathode, while oxidation occurs to anions at the anode. The electrodes do not touch each other but they are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half cells allows ions to flow, but prevents mixing of the electrolytes. Each half cell has an electromotive force determined by its ability to drive electric current from the interior to the exterior of the cell. The net EMF of the cell is the difference between the EMF of its half-cells, as first recognized by Volta. Therefore, if the electrodes have EMF and, then the net EMF is in other words, the net EMF is the difference between the reduction potentials of the half-reactions.

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cations (positively charged ions) migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, reduction (addition of electrons) occurs to cations at the cathode, while oxidation (removal of electrons) occurs to anions at the anode.

The electrodes do not touch each other but are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half cells allows ions to flow, but prevents mixing of the electrolytes. Each half cell has an electromotive force (or emf), determined by its ability to drive electric current from the interior to the exterior of the cell. The net emf of the cell is the difference between the emf of its half-cells, as first recognized by Volta. Therefore, if the electrodes have emf and, then the net emf is in other words, the net emf is the difference between the reduction potentials of the half-reactions.

SPUR GEAR

A gear or cogwheel is a rotating machine part having cut like teeth, or cogs, which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape.[1] Two or more meshing gears, working in a sequence, are called a gear train or a transmission. A gear can mesh with a linear toothed part, called a rack, producing translation instead of rotation.

The gears in a transmission are analogous to the wheels in a crossed, belt pulley system. An advantage of gears is that the teeth of a gear prevent slippage.

When two gears mesh, if one gear is bigger than the other, a mechanical advantage is produced, with the rotational speeds, and the torques, of the two gears differing in proportion to their diameters.

In transmissions with multiple gear ratios—such as bicycles, motorcycles, and cars—the term "gear" as in "first gear" refers to a gear ratio rather than an actual physical gear. The term describes similar devices, even when the gear ratio is continuous rather than discrete, or when the device does not actually contain gears, as in a continuously variable transmission

Two meshing gears transmitting rotational motion. Note that the smaller gear is rotating faster. Since the larger gear is rotating less quickly, its torque is proportionally greater. One subtlety of this particular arrangement is that the linear speed at the pitch diameter is the same on both gears.

DRIVE MECHANISUM

The definite ratio that teeth give gears provides an advantage over other drives (such as traction drives and V-belts) in precision machines such as watches that depend upon an exact velocity ratio. In cases where driver and follower are proximal, gears also have an advantage over other drives in the reduced number of parts required. The downside is that gears are more expensive to manufacture and their lubrication requirements may impose a higher operating cost per hour.

SPECIFICATIONS

Design of gears:

No of teeth in drive gear (z_1) = 20

No of teeth in driven gear (z_2) = 60

Speed (N_1) = 60 Rpm

Speed Ratio,

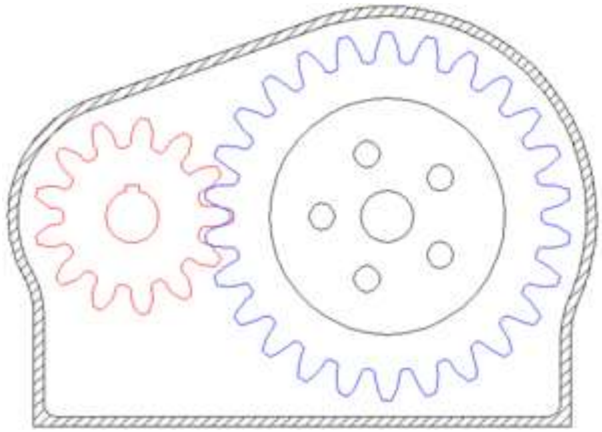
$$i = \frac{N_1}{N_2} = \frac{Z_2}{Z_1} = \frac{60}{N_2} = \frac{20}{68}$$

N_2 = 206 Rpm

$N_2 \approx$ 206 Rpm

Gear ration = $\frac{\text{Driven gear teeth}}{\text{Drive gear teeth}}$

Gear ratio = $\frac{60}{20}$ = 3:1

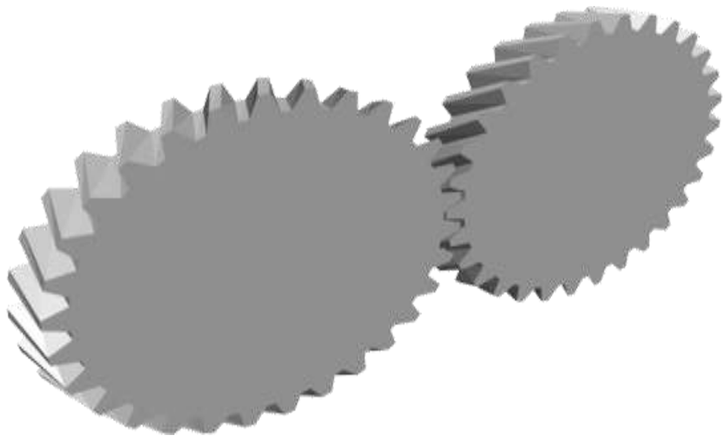


SPUR GEAR

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with teeth projecting radially. Though the teeth are not straight-sided (but usually of special form to achieve a constant drive ratio, mainly involute but less commonly cycloidal), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears mesh together correctly only if fitted to parallel shafts. No axial thrust is created by the tooth loads. Spur gears are excellent at moderate speeds but tend to be noisy at high speeds

HELICAL GEAR

Helical or "dry fixed" gears offer a refinement over spur gears. The leading edges of the teeth are not parallel to the axis of rotation, but are set at an angle. Since the gear is curved, this angling makes the tooth shape a segment of a helix. Helical gears can be meshed in parallel or crossedorientations. The former refers to when the shafts are parallel to each other; this is the most common orientation. In the latter, the shafts are non-parallel, and in this configuration the gears are sometimes known as "skew gears".



The angled teeth engage more gradually than do spur gear teeth, causing them to run more smoothly and quietly. With parallel helical gears, each pair of teeth first make contact at a single point at one side of the gear wheel; a moving curve of contact then grows gradually across the tooth face to a maximum, then recedes until the teeth break contact at a single point on the opposite side. In spur gears, teeth suddenly meet at a line contact across their entire width, causing stress and noise. Spur gears make a characteristic whine at high speeds. For this reason spur gears are used in low-speed applications and in situations where noise control is not a problem, and helical gears are used in high-speed applications, large power transmission, or where noise abatement is important. The speed is considered high when the pitch line velocity exceeds 25 m/s.

A disadvantage of helical gears is a resultant thrust along the axis of the gear, which must be accommodated by appropriate thrust bearings, and a greater degree of sliding frictionbetween the meshing teeth, often addressed with additives in the lubricant.

SCREW GEAR

For a "crossed" or "skew" configuration, the gears must have the same pressure angle and normal pitch; however, the helix angle and handedness can be different. The relationship between the two shafts is actually defined by the helix angle(s) of the two shafts and the handedness, as defined:

for gears of the same handedness,

for gears of opposite handedness,

is the helix angle for the gear. The crossed configuration is less mechanically sound because there is only a point contact between the gears, whereas in the parallel configuration there is a line contact.

Quite commonly, helical gears are used with the helix angle of one having the negative of the helix angle of the other; such a pair might also be referred to as having a right-handed helix and a left-handed helix of equal angles. The two equal but opposite angles add to zero: the angle between shafts is zero—that is, the shafts are parallel. Where the sum or the difference (as described in the equations above) is not zero, the shafts are crossed. For shafts crossed at right angles, the helix angles are of the same hand because they must add to 90 degrees.

DOUBLE HELICAL

Double helical gears overcome the problem of axial thrust presented by single helical gears by using a double set of teeth, slanted in opposite directions. A double helical gear can be thought of as two mirrored helical gears mounted closely together on a common axle. This arrangement cancels out the net axial thrust, since each half of the gear thrusts in the opposite direction, resulting in a net axial force of zero.

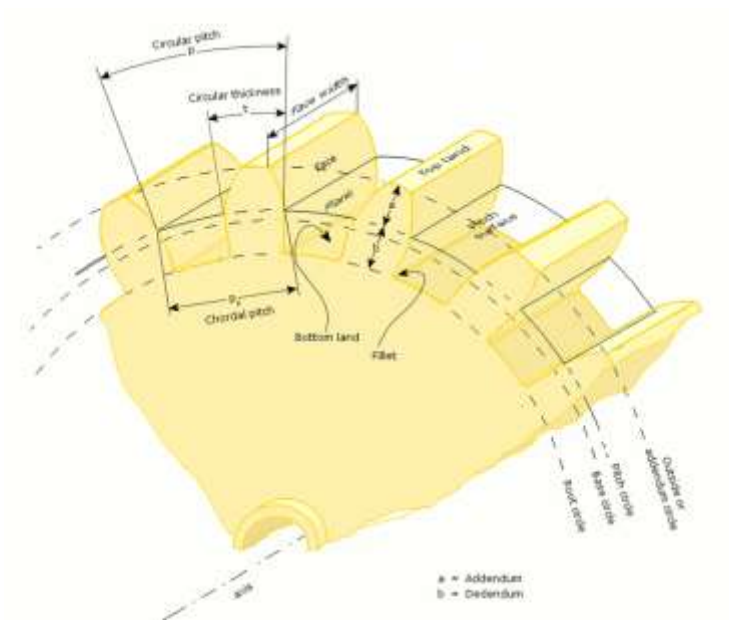
This arrangement can also remove the need for thrust bearings. However, double helical gears are more difficult to manufacture due to their more complicated shape.

Herringbone gears are a special type of helical gears. They do not have a groove in the middle like some other double helical gears do; the two mirrored helical gears are joined together so that their form a V shape. This can also be applied to bevel gears, as in the final drive of the Citroën Type A.

For both possible rotational directions, there exist two possible arrangements for the oppositely-oriented helical gears or gear faces. One arrangement is called stable, and the other unstable. In a stable arrangement, the helical gear faces are oriented so that each axial force is directed toward the center of the gear. In an unstable arrangement, both axial forces are directed away from the center of the gear. In either arrangement, the total (or net) axial force on each gear is zero when the gears are aligned correctly. If the gears become misaligned in the axial direction, the unstable arrangement generates a net force that may lead to disassembly of the gear train, while the stable arrangement generates a net corrective force. If the direction of rotation is reversed, the direction of the axial thrusts is also reversed, so a stable configuration becomes unstable, and conversely.

Stable double helical gears can be directly interchanged with spur gears without any need for different bearings.

GEAR NOMENCLATURE



Rotational frequency, n

Measured in rotation over time, such as revolutions per minute (RPM or rpm).

Angular frequency, ω

Measured in radians/second. 1 RPM = 2π rad/minute = $\pi/30$ rad/second.

Number of teeth, N

How many teeth a gear has, an integer. In the case of worms, it is the number of thread starts that the worm has.

Gear, wheel

The larger of two interacting gears or a gear on its own.

Pinion

The smaller of two interacting gears.

Path of contact

Path followed by the point of contact between two meshing gear teeth.

Line of action, pressure line

Line along which the force between two meshing gear teeth is directed. It has the same direction as the force vector. In general, the line of action changes from moment to moment during the period of engagement of a pair of teeth. For involute gears, however, the tooth-to-tooth force is always directed along the same line—that is, the line of action is constant. This implies that for involute gears the path of contact is also a straight line, coincident with the line of action—as is indeed the case.

Axis

Axis of revolution of the gear; center line of the shaft.

Pitch point

Point where the line of action crosses a line joining the two gear axes.

Pitch circle, pitch line

Circle centered on and perpendicular to the axis, and passing through the pitch point. A predefined diametral position on the gear where the circular tooth thickness, pressure angle and helix angles are defined.

Pitch diameter, d

A predefined diametral position on the gear where the circular tooth thickness, pressure angle and helix angles are defined. The standard pitch diameter is a basic dimension and cannot be measured, but is a location where other measurements are made. Its value is based on the number of teeth, the normal module (or normal diametral pitch), and the helix angle. It is calculated as:

in metric units or in imperial units.

Module or modulus, m

Since it is impractical to calculate circular pitch with irrational numbers, mechanical engineers usually use a scaling factor that replaces it with a regular value instead. This is known as the module or modulus of the wheel and is simply defined as

where m is the module and p the circular pitch. The units of module are customarily millimeters; an English Module is sometimes used with the units of inches. When the diametral pitch, DP, is in English units,

in conventional metric units.

The distance between the two axis becomes

where a is the axis distance, z_1 and z_2 are the number of cogs (teeth) for each of the two wheels (gears). These numbers (or at least one of them) is often chosen among primesto create an even contact between every cog of both wheels, and thereby avoid unnecessary wear and damage. An even uniform gear wear is achieved by ensuring the tooth counts of the two gears meshing together are relatively prime to each other; this occurs when the greatest common divisor (GCD) of each gear tooth count equals 1, e.g. GCD(16,25)=1; if a 1:1 gear ratio is desired a relatively prime gear may be inserted in between the two gears; this maintains the 1:1 ratio but reverses the gear direction; a second relatively prime gear could also be inserted to restore the original rotational direction while maintaining uniform wear with all 4 gears in this case. Mechanical engineers, at least in continental Europe, usually use the module instead of circular pitch. The module, just like the circular pitch, can be used for all types of cogs, not just evolvent based straight cogs.

Operating pitch diameters

Diameters determined from the number of teeth and the center distance at which gears operate. Example for pinion:

Pitch surface

In cylindrical gears, cylinder formed by projecting a pitch circle in the axial direction. More generally, the surface formed by the sum of all the pitch circles as one moves along the axis. For bevel gears it is a cone.

Angle of action

Angle with vertex at the gear center, one leg on the point where mating teeth first make contact, the other leg on the point where they disengage.

Arc of action

Segment of a pitch circle subtended by the angle of action.

Pressure angle,

The complement of the angle between the direction that the teeth exert force on each other, and the line joining the centers of the two gears. For involute gears, the teeth always exert force along the line of action, which, for involute gears, is a straight line; and thus, for involute gears, the pressure angle is constant.

TWO WAY SWITCH

Type: reverse and forward condition.

Power supply: AC or DC.

A Two Way light switch is a simple single pole "changeover" switch with three terminals. These are typically labelled COM, L1, and L2 (Some may label the L1 and L2 positions as "1 Way" and "2 Way").

In one switch position the COM terminal is connected to L1. In the other switch position it changes over so that COM is connected to L2. The design is a "break before make" type, such that the connection to the first terminal is disconnected before the connection to the new one is made.

multiway switching is the interconnection of two or more electrical switches to control an electrical load (often, but not always, lighting) from more than one location. For example, this allows lighting in a hallway, stairwell or large room to be controlled from multiple locations. While a "normal" light switch needs to be only a single pole, single throw (SPST) switch, multiway switching requires the use of switches that have one or more additional contacts and two or more wires must be run between the switches. When the load is controlled from only two points, single pole, double throw (SPDT) switches are used. Double pole, double throw (DPDT) switches allow control from three or more locations.

In alternative designs, low-voltage relay or electronic controls can be used to switch electrical loads, sometimes without the extra power wires.

- A minimum of two "3-way" (SPDT - single pole, double throw) switches are needed in a multiway switch setup. (In North America each 3-way switch has a single dark-colored "common" terminal, and two gold-colored "traveler" terminals.)

- If more than two switches are used, all additional switches need to be "4-way" (DPDT - double pole, double throw). (In North America each 4-way switch has four gold-colored traveler terminals.)
- On a 4-way switch, the traveler terminals are typically paired up on each side of the switch. In other words, one side of the switch will be used for the two 'incoming' wires, and the other side of the switch is for the two 'outgoing' wires. It is important that you establish if this is in fact the case with the particular switches you will use. Once you have confirmed, for example, that terminals are paired on each side, it does not matter which side you use for 'incoming' versus 'outgoing'. It also does not matter which of the two terminals on one side of the switch receives which of the two incoming traveler wires, or which of the two 'outgoing' wires.
- The switches are connected in a continuous linear series, with the two 3-way switches connected one-at-each-end of the series, and with any optional 4-way switches connected in between the 3-way switches. These switches deal strictly with the 'hot' conductors of the circuit. The neutral is not involved with the switches.
- The hot from the 'mains' will travel "unswitched" to the 'common' terminal of one of the two 3-way switches, and, typically, whatever switch is furthest from the 'load' is designated for this.
- The neutral from the 'mains' will travel "unswitched" to the 'load'.
- Typically, the switch closest to the load will be designated as the other 3-way switch. This 3-way switch's 'common' terminal is for the conductor that travels

to, and connects to, the hot terminal of the load. For example, this wire would travel to the box for a light, and be connected to the light's hot wire, and not the light's neutral wire.

- Safety Note: It is important that the wire that travels from the 3-way switch's common terminal, to the box for the load, be connected to the hot side of the load, and NOT to the neutral side of the load.

The danger of not following that rule is perhaps best illustrated by considering, as an example, a light with a screw-in bulb. If you were to make the error of connecting the 'hot' from the 3-way switch's common terminal to the neutral wire of the light (or the light's neutral terminal), you will in fact have connected the 'hot' to the fixture's 'shell' (the threaded metal outer shell that the bulb screws into). Then, whenever the power is 'on' at the fixture, the shell is energized. If you then ever go to change the bulb without first being sure the power is off at the fixture, you will be at a greater risk of being shocked versus if you had not wired the 3-way hot to the load neutral. That is because now you will get 'shocked' if you touch the shell while changing the bulb if the fixture is powered, whereas if you had connected the hot from the 3-way switch to the light fixture's hot side, and if the power were on at the fixture when you change the bulb, the only way you could get shocked is by touching the small bare terminal that is all the way inside at the base of the shell.

If you have two wires coming out from the load that are the same color, or in other words, if you do not know which wire or terminal is hot versus neutral, you should determine which is which. For example, if you have two black wires, you can use a continuity tester to determine which one of the two wires is electrically continuous with one of the 'shells' for the bulbs, and is, therefore, the neutral wire.

- A 2-conductor cable (not including an extra third conductor for the 'safety ground') is all that is needed from the "mains" to one of the boxes. One conductor is for the "Hot" from the 'mains' (the service panel, or subpanel), and the other wire is for the "Neutral" from the mains.
- The 2-conductors from the mains can enter your multiway setup at any of the switch boxes, or even at the box for the load. The box closest to the mains is typically the one that receives the two conductors from the 'mains'.
- A 2-conductor cable (not including an extra third conductor for the 'safety ground') is all that is needed between the box at the load, and the 3-way switch closest to the load.
- Regardless of which box first receives the hot and neutral from the mains, the "hot" must travel unswitched, from there, to the 'common' terminal of the 3-way switch that is opposite-the-load in the multiway switch-series.
- Similarly, regardless of which box first receives the "neutral" from the 'mains', the "neutral" must continue 'unswitched' to the load's box and the load's "neutral" connection.
- A 3-conductor cable (not including an extra fourth conductor for the 'safety ground') is needed to connect all the switch boxes in a single line, starting from one 3-way switch, then to each multiway switch, and then terminating at the other 3-way switch.
- One pair of the three conductors is used to connect the 'traveler' terminals of one switch to the next switch in the series. These will be the 'hot' wires, and

whenever the circuit is energized, one of these two wires, of the pair, will be 'energized'. If two of the three conductors are the same color, then use those for this 'hot' duty. For example, if you have two black conductors, and a white one, then use the black conductors as the 'hot' traveler wires for the traveler terminals. In any case, if one of the wires is white, save it for the next paragraph, and do not use it as one of the 'hot' travelers.

- The remaining "third-conductor" will pass through all of the boxes *unswitched*. And, depending upon which box receives the two conductors from the 'mains', this third conductor might be hot, or it might be neutral.
- The third-conductor will be used as an unswitched 'hot' conductor between the box receiving the mains hot, and the box for the 3-way switch furthest from the load.
- The third-conductor will be used as an unswitched neutral conductor between the box receiving the mains neutral, the box at the load.
- Please Note: In the USA, any time a white conductor is used for 'current-carrying' (that is, when it is not being used strictly for the "neutral" between the load and the 'mains'), it must be permanently re-identified at its terminations (and wherever visible) with a color other than white, gray, or green. [NFPA 70A 200.7 (C)(2) {and (1) for coloring}]

That NFPA regulation will be applicable, in the example above, when the third conductor is white, and if the hot and neutral from the mains enters the system at a box other than the box at the 3-way switch furthest from the load. In other words, the white conductor will be a 'current carrying' conductor between the mains 'entry point' and the 3-way switch opposite the load, and must be permanently identified as non-white.

SCRW JACK

Screw jack is used in applications where linear motion is required. Lifting of any load, pushing or pulling of mechanical equipment, adjusting of tight clearances of mechanical parts can be done by screw jacks.

Mechanical capacity of screw jacks is between 5kN and 2000kN. Jack screws can be used as linear motors, linear actuators, or mechanical lifts depending on type of motion. Main components of screw jacks are; trapezoidal lifting screw, worm screw, worm gear and gear housing. Worm screw is rotated manually or by motor. Worm gear is rotated by worm screw. The lifting screw moves through the rotating worm gear. The linear motion speed of lifting screw depends on thread size and rotation ratio of worm gears.

In some models of jack screws, the lifting screw does not move up and down. It only rotates around its axis. A lifting nut (also known as travelling nut) moves along the screw. The lifting nut of jack screw is made of bronze to decrease friction.

Multiple threaded power screws are used in certain applications where higher travelling speed is required. They are also called multiple start screws such as double-start or triple start screws.

These screws have two or more threads cut side by side, around the rod. Multiple-start trapezoidal threads are designated by letters “Try” followed by the nominal diameter and lead, separated by sign “x” and in brackets the letter “P” followed by the pitch expressed in millimeters. For example, A screw jack is a portable device consisting of a screw mechanism used to raise or lower the load. The principle on which the screw jack works is similar to that of an inclined plane. There’re mainly two types of jacks-hydraulic and mechanical.

The load, Mechanical jacks can be either hand operated or power driven. Jacks are used frequently in raising cars so that a tire can be changed.

A screw jack is commonly used with cars but is also used in many other ways, including industrial machinery and even airplanes. They can be short, tall, fat, or thin depending on the amount of pressure they will bounder and the space that they need to fit into

The jack is made out of various types of metal; butte screw itself is generally made out of lead. While screw jacks are designed purposely for raising and lowering loads, they are not ideal foreside loads, although some can withstand side loads depending on the diameter and size of the lifting screw. Shock loads should also be avoided or minimized. Some screw jacks are built within-backlash.

SHAFT

Specifications

Shaft diameter: 12mm

Material: mild steel

Length:26 inch

Shaft

Shaft is a common and important machine element. It is a rotating member, in general, has a circular cross-section and is used to transmit power. The shaft may be hollow or solid. The shaft is supported on bearings and it rotates a set of gears or pulleys for the purpose of power transmission. The shaft is generally acted upon by bending moment, torsion and axial force. Design of shaft primarily involves in determining stresses at critical point in the shaft that is arising due to aforementioned loading. Other two similar forms of a shaft are axle and spindle. Axle is a non-rotating member used for supporting rotating wheels etc. and do not transmit any torque. Spindle is simply defined as a short shaft. However, design method remains the same for axle and spindle as that for a shaft. 8.1.2 Standard sizes of Shafts Typical sizes of solid shaft that are available in the market are, Up to 25 mm 0.5 mm increments 25 to 50 mm 1.0 mm increments 50 to 100 mm 2.0 mm increments 100 to 200 mm 5.0 mm increments 8.1.3 Material for Shafts The ferrous, non-ferrous materials and non metals are used as shaft material depending on the application. Some of the common ferrous materials used for shaft are discussed below. Hot-rolled plain carbon steel. These materials are least expensive.

Since it is hot rolled, scaling is always present on the surface and machining is required to make the surface smooth.

Since it is cold drawn it has got its inherent characteristics of smooth bright finish. Amount of machining therefore is minimal. Better yield strength is also obtained. This is widely used for general purpose transmission shaft.

Alloy steels

Alloy steel as one can understand is a mixture of various elements with the parent steel to improve certain physical properties. To retain the total advantage of alloying materials one requires heat treatment of the machine components after it has been manufactured. Nickel, chromium and vanadium are some of the common alloying materials. However, alloy steel is expensive. These materials are used for relatively severe service conditions. When the situation demands great strength then alloy steels are used. They have fewer tendencies to crack, warp or distort in heat treatment. Residual stresses are also less compared to CS (Carbon Steel). In certain cases the shaft needs to be wear resistant, and then more attention has to be paid to make the surface of the shaft to be wear resistant. The common types of surface hardening methods are,

Hardening of surface

Case hardening and carburizing

Cyaniding and nitriding

Design considerations for shaft

For the design of shaft following two methods are adopted, Design based on Strength In this method, design is carried out so that stress at any location of the shaft should not exceed the material yield stress. However, no consideration for shaft deflection and shaft twist is included. Design based on Stiffness Basic idea of design in such case depends on the allowable deflection and twist of the shaft.

Design based on Strength

The stress at any point on the shaft depends on the nature of load acting on it. The stresses which may be present are as follows.

Basic stress equations:

Bending stress

$$\sigma_b = \frac{32M}{\pi d_0^3(1-k^4)}$$

Where,

M: Bending moment at the point of interest

do: Outer diameter of the shaft

k: Ratio of inner to outer diameters of the shaft (k = 0 for a solid shaft because inner diameter is zero)

Axial Stress

$$\sigma_a = \frac{4\alpha F}{\pi d_0^2(1-k^2)}$$

Where,

F: Axial force (tensile or compressive)

α: Column-action factor(= 1.0 for tensile load)

The term α has been introduced in the equation. This is known as column action factor. What is a column action factor? This arises due the phenomenon of buckling of long slender members which are acted upon by axial compressive loads.

Here, α is defined as,

$$\alpha = \frac{1}{1-0.0044(L/K)} \quad \text{for } L/K < 115$$

$$\alpha = \frac{\sigma_{yc}}{\pi^2 nE}\left(\frac{L}{K}\right)^2 \quad \text{for } L/K > 115$$

Where,

n = 1.0 for hinged end

n = 2.25 for fixed end

n = 1.6 for ends partly restrained, as in bearing

K = least radius of gyration,

L = shaft length

σyc = yield stress in compression

Stress due to torsion

$$\tau_{xy} = \frac{16T}{\pi d_0^3 (1 - k^4)}$$

Where,

T : Torque on the shaft

xy τ : Shear stress due to torsion

Combined Bending and Axial stress

Both bending and axial stresses are normal stresses, hence the net normal stress is given by,

$$\sigma_x = [\frac{32M}{\pi d_0^3 (1 - k^4)} \pm \frac{4\alpha F}{\pi d_0^2 (1 - k^2)}]$$

The net normal stress can be either positive or negative. Normally, shear stress due to torsion is only considered in a shaft and shear stress due to load on the shaft is neglected.

Maximum shear stress theory

Design of the shaft mostly uses maximum shear stress theory. It states that a machine member fails when the maximum shear stress at a point exceeds the maximum allowable shear stress for the shaft material. Therefore,

$$\tau_{max} = \tau_{allowable} = \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2}$$

Substituting the values of σx and τxy in the above equation, the final form is,

$$\tau_{allowable} = \frac{16}{\pi d_0^3(1-k^4)}\sqrt{\left\{M + \frac{\alpha F d_0(1+k^2)}{8}\right\}^2 + T^2}$$

Therefore, the shaft diameter can be calculated in terms of external loads and material properties. However, the above equation is further standardized for steel shafting in terms of allowable design stress and load factors in ASME design code for shaft.

Specifications

Shaft diameter: 12mm

Inner Diameter: 10mm

Material: mild steel

METAL STRIP

Specifications

Length: 50cm

Width: 5cm

Thickness: 4mm

Metal strip is narrow, thin stock that is usually 3/16 in. (4.76 mm) or less in thickness and under 24 in. (609.6 mm) in width. Metal strips are formed to precise thicknesses and/or width requirements.

How Metal Strip is made?

Metal strip can be designed and manipulated through a large number of processes which are grouped into categories. They are joining and assembly processes, deformation processes, material removal processes, heat treating processes, and finishing processes.

Joining and assembly processes include welding, soldering, brazing, fastening, and other processes that connect parts permanently or semi-permanently to form a new entity.

Deformation processes include bending, curling, punching, rolling, deep drawing, and ironing. They use plastic deformation, where deformation is induced by external compressive forces exceeding the yield stress of the material. Hot rolling and cold rolling are the most common processes for preparing metal strips.

Material removal processes remove extra material from the workpiece in order to achieve the desired shape. They include machining operations, abrasive machining, and nontraditional processes utilizing lasers and electron beams.

Heat treating processes include annealing, quenching, tempering, aging, homogenizing, solution treating, and precipitation hardening. Heat treating modifies the strength, ductility, hardness, machinability, and formability of the metal stock

Finishing processes engineer the structure of the surface to produce the desired surface finish, texture, corrosion resistance, and fatigue resistance of metal shapes. Polishing, burnishing, peening, galvanizing, painting, oiling, waxing, lubricating, plating, and coating are types of finishing processes.

Selection Criteria

Selection of metal strip is usually based first on a design's required size and dimensions, and then on either material types or grades as certain design specifications or application constraints require. Substitute materials can be selected and qualified based on the required material properties. Laboratory, performance, or field testing is used to verify performance in some cases.

BALL BEARING

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least three races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

SPECIFICATION

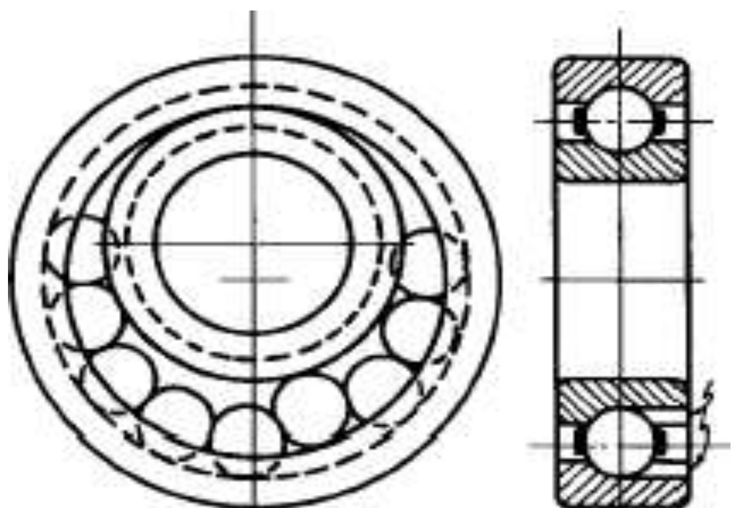
INNER DIA :12mm

OUTER DIA : 37mm

HISTORY

Although bearings had been developed since ancient times, the first modern recorded patent on ball bearings was awarded to Philip Vaughan, a Welsh inventor and ironmaster who created the first design for a ball bearing in Carmarthen in 1794. His was the first modern ball-bearing design, with the ball running along a groove in the axle assembly.

Jules Suriray, a Parisian bicycle mechanic, designed the first radial style ball bearing in 1869, which was then fitted to the winning bicycle ridden by James Moore in the world's first bicycle road race, Paris-Rouen, in November 1869.



DESIGN

ANGULAR CONTACT

An angular contact ball bearing uses axially asymmetric races. An axial load passes in a straight line through the bearing, whereas a radial load takes an oblique path that acts to separate the races axially. So the angle of contact on the inner race is the same as that on the outer race. Angular contact bearings better support combined loads (loading in both the radial and axial directions) and the contact angle of the bearing should be matched to the relative proportions of each. The larger the contact angle (typically in the range 10 to 45 degrees), the higher the axial load supported, but the lower the radial load. In high speed applications, such as turbines, jet engines, and dentistry equipment, the centrifugal forces generated by the balls changes the contact angle at the inner and outer race. Ceramics such as silicon nitride are now regularly used in such applications due to their low density (40% of steel). These materials significantly reduce centrifugal force and function well in high temperature environments. They also tend to wear in a similar way to bearing steel—rather than cracking or shattering like glass or porcelain.

Most bicycles use angular-contact bearings in the headsets because the forces on these bearings are in both the radial and axial direction.

AXIAL

An axial or thrust ball bearing uses side-by-side races. An axial load is transmitted directly through the bearing, while a radial load is poorly supported and tends to separate the races,so that a larger radial load is likely to damage the bearing.

DEEP-GROOVE

In a deep-groove radial bearing, the race dimensions are close to the dimensions of the balls that run in it. Deep-groove bearings support higher loads than a shallower groove. Like angular contact bearings, deep-groove bearings support both radial and axial loads, but without a choice of contact angle to allow choice of relative proportion of these load capacities.

PRELOADED PAIRS

The above basic types of bearings are typically applied in a method of preloaded pairs, where two individual bearings are rigidly fastened along a rotating shaft to face each other. This improves the axial runout by taking up (preloading) the necessary slight clearance between the bearing balls and races. Pairing also provides an advantage of evenly distributing the loads, nearly doubling the total load capacity compared to a single bearing. Angular contact bearings are almost always used in opposing pairs: the asymmetric design of each bearing supports axial loads in only one direction, so an opposed pair is required if the application demands support both directions. The preloading force must be designed and assembled carefully, because it deducts from the axial force capacity of the bearings, and can damage bearings if applied excessively. The pairing mechanism may simply face the bearings together directly, or separate them with a shim, bushing, or shaft feature

CONSRUCTIVE TYPE

CONRAD

The Conrad-style ball bearing is named after its inventor, Robert Conrad, who was awarded British patent 12,206 in 1903 and U.S. patent 822,723 in 1906. These bearings are assembled by placing the inner ring into an eccentric position relative to the outer ring, with the two rings in contact at one point, resulting in a large gap opposite the point of contact. The balls are inserted through the gap and then evenly distributed around the bearing assembly, causing the rings to become concentric. Assembly is completed by fitting a cage to the balls to maintain their positions relative to each other. Without the cage, the balls would eventually drift out of position during operation, causing the bearing to fail. The cage carries no load and serves only to maintain ball position.

Conrad bearings have the advantage that they are able to withstand both radial and axial loads, but have the disadvantage of lower load capacity due to the limited number of balls that can be loaded into the bearing assembly. Probably the most familiar industrial ball bearing is the deep-groove Conrad style. The bearing is used in most of the mechanical industries.

SLOT-FILL

In a slot-fill radial bearing, the inner and outer races are notched on one face so that when the notches are aligned, balls can be slipped in the resulting slot to assemble the bearing. A slot-fill bearing has the advantage that more balls can be assembled (even allowing a full complement design), resulting in a higher radial load capacity than a Conrad bearing of the same dimensions and material type. However, a slot-fill bearing cannot carry a significant axial load, and the slots cause a discontinuity in the races that can have a small but adverse effect on strength.

RELIEVED RACE

Relieved race ball bearings are 'relieved' as the name suggests by basically have either the OD of the inner ring reduced on one side, or the ID of the outer ring increased on one side. This allows a greater number of balls to be assembled into either the inner or outer race, and then press fit over the relief. Sometimes the outer ring will be heated to facilitate assembly. Like the slot-fill construction, relieved race construction allows a greater number of balls than Conrad construction, up to and including full complement, and the extra ball count gives extra load capacity. However, a relieved race bearing can only support significant axial loads in one direction ('away from' the relieved race).

FRACTURED RACE

Another way of fitting more balls into a radial ball bearing is by radially 'fracturing' (slicing) one of the rings all the way through, loading the balls in, re-assembling the fractured portion, and then using a pair of steel bands to hold the fractured ring sections together in alignment. Again, this allows more balls, including full ball complement, however unlike with either slot fill or relieved race constructions, it can support significant axial loading in either direction.

ROWS

There are two row designs: single-row bearings and double-row bearings. Most ball bearings are a single-row design, which means there is one row of bearing balls. This design works with radial and thrust loads.

A double-row design has two rows of bearing balls. Their disadvantage is they need better alignment than single-row bearings.

FLANGED

Bearings with a flange on the outer ring simplify axial location. The housing for such bearings can consist of a through-hole of uniform diameter, but the entry face of the housing (which may be either the outer or inner face) must be machined truly normal to the hole axis. However such flanges are very expensive to manufacture. A more cost effective arrangement of the bearing outer ring, with similar benefits, is a snap ring groove at either or both ends of the outside diameter. The snap ring assumes the function of a flange.

CAGED

Cages are typically used to secure the balls in a Conrad-style ball bearing. In other construction types they may decrease the number of balls depending on the specific cage shape, and thus reduce the load capacity. Without cages the tangential position is stabilized by sliding of two convex surfaces on each other. With a cage the tangential position is stabilized by a sliding of a convex surface in a matched concave surface, which avoids dents in the balls and has lower friction. Caged roller bearings were invented by John Harrison in the mid-18th century as part of his work on chronographs.

HYBRID BALL BEARINGS USING CERAMIC BALLS

Ceramic bearing balls can weigh up to 40% less than steel ones, depending on size and material. This reduces centrifugal loading and skidding, so hybrid ceramic bearings can operate 20% to 40% faster than conventional bearings. This means that the outer race groove exerts less force inward against the ball as the bearing spins. This reduction in force reduces the friction and rolling resistance.

The lighter balls allow the bearing to spin faster, and uses less energy to maintain its speed.

The ceramic balls are typically harder than the race. Due to wear, with time they will form a groove in the race. This is preferable to the balls wearing which would leave them with possible flat spots significantly harming performance.

While ceramic hybrid bearings use ceramic balls in place of steel ones, they are constructed with steel inner and outer rings; hence the hybrid designation. While the ceramic material itself is stronger than steel, it is also stiffer, which results in increased stresses on the rings, and hence decreased load capacity. Ceramic balls are electrically insulating, which can prevent 'arcing' failures if current should be passed through the bearing. Ceramic balls can also be effective in environments where lubrication may not be available (such as in space applications).

In some settings only a thin coating of ceramic is used over a metal ball bearing.

FULLY CERAMIC BEARINGS

These bearings make use of both ceramic balls and race. These bearings are impervious to corrosion and rarely require lubrication if at all. Due to the stiffness and hardness of the balls and race these bearings are noisy at high speeds. The stiffness of the ceramic makes these bearings brittle and liable to crack under load or impact. Because both ball and race are of similar hardness wear can lead to chipping at high speeds of both the balls and the race this can cause sparking.

SELF-ALIGNING

Self-aligning ball bearings, such as the Wingquist bearing shown in the picture, are constructed with the inner ring and ball assembly contained within an outer ring that has a spherical raceway. This construction allows the bearing to tolerate a small angular misalignment resulting from shaft or housing deflections or improper mounting. The bearing was used mainly in bearing arrangements with very long shafts, such as transmission shafts in textile factories. One drawback of the self-aligning ball bearings is a limited load rating, as the outer raceway has very low osculation (radius is much larger than ball radius). This led to the invention of the spherical roller bearing, which has a similar design, but use rollers instead of balls. Also the spherical roller thrust bearing is an invention that derives from the findings by Wingquist.

OPERATING CONDITION

LIFESPAN

Further information: Rolling-element_bearing § Bearing_failure

The calculated life for a bearing is based on the load it carries and its operating speed. The industry standard usable bearing lifespan is inversely proportional to the bearing load cubed. Nominal maximum load of a bearing, is for a lifespan of 1 million rotations, which at 50 Hz (i.e., 3000 RPM) is a lifespan of 5.5 working hours. 90% of bearings of that type have at least that lifespan, and 50% of bearings have a lifespan at least 5 times as long.

The industry standard life calculation is based upon the work of Lundberg and Palmgren performed in 1947. The formula assumes the life to be limited by metal fatigue and that the life distribution can be described by a Weibull distribution. Many variations of the formula exist that include factors for material properties, lubrication, and loading. Factoring for loading may be viewed as a tacit admission that modern materials demonstrate a different relationship between load and life than Lundberg and Palmgren determined .

FAILURE MODES

If a bearing is not rotating, maximum load is determined by force that causes plastic deformation of elements or raceways. The indentations caused by the elements can concentrate stresses and generate cracks at the components. Maximum load for not or very slowly rotating bearings is called "static" maximum load.

Also if a bearing is not rotating, oscillating forces on the bearing can cause impact damage to the bearing race or the rolling elements, known as brinelling. A second lesser form called false brinelling occurs if the bearing only rotates across a short arc and pushes lubricant out away from the rolling elements.

For a rotating bearing, the dynamic load capacity indicates the load to which the bearing endures 1,000,000 cycles.

If a bearing is rotating, but experiences heavy load that lasts shorter than one revolution, static max load must be used in computations, since the bearing does not rotate during the maximum load.

If a sideways torque is applied to a deep groove radial bearing, an uneven force in the shape of an ellipse is applied on the outer ring by the rolling elements, concentrating in two regions on opposite sides of the outer ring. If the outer ring is not strong enough, or if it is not sufficiently braced by the supporting structure, the outer ring will deform into an oval shape from the sideways torque stress, until the gap is large enough for the rolling elements to escape. The inner ring then pops out and the bearing structurally collapses.

A sideways torque on a radial bearing also applies pressure to the cage that holds the rolling elements at equal distances, due to the rolling elements trying to all slide together at the location of highest sideways torque. If the cage collapses or breaks apart, the rolling elements group together, the inner ring loses support, and may pop out of the center.

MAXIMUM LOAD

In general, maximum load on a ball bearing is proportional to outer diameter of the bearing times the width of the bearing (where width is measured in direction of axle).[7]

Bearings have static load ratings. These are based on not exceeding a certain amount of plastic deformation in the raceway. These ratings may be exceeded by a large amount for certain applications.

LUBRICATION

For a bearing to operate properly, it needs to be lubricated. In most cases the lubricant is based on elastohydrodynamic effect (by oil or grease) but working at extreme temperatures dry lubricated bearings are also available.

For a bearing to have its nominal lifespan at its nominal maximum load, it must be lubricated with a lubricant (oil or grease) that has at least the minimum dynamic viscosity

For a bearing where average of outer diameter of bearing and diameter of axle hole is 50 mm, and that is rotating at 3000 RPM, recommended dynamic viscosity is 12 mm^2/s.

Note that dynamic viscosity of oil varies strongly with temperature: a temperature increase of 50–70 °C causes the viscosity to decrease by factor 10.

If the viscosity of lubricant is higher than recommended, lifespan of bearing increases, roughly proportional to square root of viscosity. If the viscosity of the lubricant is lower than recommended, the lifespan of the bearing decreases, and by how much depends on which type of oil being used. For oils with EP ('extreme pressure') additives, the lifespan is proportional to the square root of dynamic viscosity, just as it was for too high viscosity, while for ordinary oils lifespan is proportional to the square of the viscosity if a lower-than-recommended viscosity is used.

Lubrication can be done with a grease, which has advantages that grease is normally held within the bearing releasing the lubricant oil as it is compressed by the balls. It provides a protective barrier for the bearing metal from the environment, but has disadvantages that this grease must be replaced periodically, and maximum load of bearing decreases (because if bearing gets too warm, grease melts and runs out of bearing). Time between grease replacements decreases very strongly with diameter of bearing: for a 40 mm bearing, grease should be replaced every 5000 working hours, while for a 100 mm bearing it should be replaced every 500 working hours.

Lubrication can also be done with an oil, which has advantage of higher maximum load, but needs some way to keep oil in bearing, as it normally tends to run out of it. For oil lubrication it is recommended that for applications where oil does not become warmer than 50 °C, oil should be replaced once a year, while for applications where oil does not become warmer than 100 °C, oil should be replaced 4 times per year. For car engines, oil becomes 100 °C but the engine has an oil filter to maintain oil quality; therefore, the oil is usually changed less frequently than the oil in bearings.

DIRECTION OF LOAD

Most bearings are meant for supporting loads perpendicular to axle ("radial loads"). Whether they can also bear axial loads, and if so, how much, depends on the type of bearing. Thrust bearings (commonly found on lazy susans) are specifically designed for axial loads.

For single-row deep-groove ball bearings, SKF's documentation says that maximum axial load is circa 50% of maximum radial load, but it also says that "light" and/or "small" bearings can take axial loads that are 25% of maximum radial load

For single-row edge-contact ball bearings, axial load can be about 2 times max radial load, and for cone-bearings maximum axial load is between 1 and 2 times maximum radial load.

Often Conrad-style ball bearings will exhibit contact ellipse truncation under axial load. That means that either the ID of the outer ring is large enough, or the OD of the inner ring is small enough, so as to reduce the area of contact between the balls and raceway. When this is the case, it can significantly increase the stresses in the bearing, often invalidating general rules of thumb regarding relationships between radial and axial load capacity. With construction types other than Conrad, one can further decrease the outer ring ID and increase the inner ring OD to guard against this.

If both axial and radial loads are present, they can be added vectorially, to result in the total load on bearing, which in combination with nominal maximum load can be used to predict lifespan. However, in order to correctly predict the rating life of ball bearings the ISO/TS 16281 should be used with the help of a calculation software.

AVOIDING UNDESIRABLE AXIAL LOAD

The part of a bearing that rotates (either axle hole or outer circumference) must be fixed, while for a part that does not rotate this is not necessary (so it can be allowed to slide). If a bearing is loaded axially, both sides must be fixed.

If an axle has two bearings, and temperature varies, axle shrinks or expands, therefore it is not admissible for both bearings to be fixed on both their sides, since expansion of axle would exert axial forces that would destroy these bearings. Therefore, at least one of bearings must be able to slide.

A 'freely sliding fit' is one where there is at least a 4 μm clearance, presumably because surface-roughness of a surface made on a lathe is normally between 1.6 and 3.2 μm.

FIT

Bearings can withstand their maximum load only if the mating parts are properly sized. Bearing manufacturers supply tolerances for the fit of the shaft and the housing so that this can be achieved. The material and hardness may also be specified.

Fittings that are not allowed to slip are made to diameters that prevent slipping and consequently the mating surfaces cannot be brought into position without force. For small bearings this is best done with a press because tapping with a hammer damages both bearing and shaft, while for large bearings the necessary forces are so great that there is no alternative to heating one part before fitting, so that thermal expansion allows a temporary sliding fit.[7]

AVOIDING TORSIONAL LOADS

If a shaft is supported by two bearings, and the center-lines of rotation of these bearings are not the same, then large forces are exerted on the bearing that may destroy it. Some very small amount of misalignment is acceptable, and how much depends on type of bearing. For bearings that are specifically made to be 'self-aligning', acceptable misalignment is between 1.5 and 3 degrees of arc. Bearings that are not designed to be self-aligning can accept misalignment of only 2–10 minutes of arc.

APPLICATION

In general, ball bearings are used in most applications that involve moving parts. Some of these applications have specific features and requirements:

- Hard drive bearings used to be highly spherical, and were said to be the best spherical manufactured shapes, but this is no longer true, and more and more are being replaced with fluid bearings.
- German ball bearing factories were often a target of allied aerial bombings during World War II; such was the importance of the ball bearing to the German war industry.[8]

- In horology, the company Jean Lassale designed a watch movement that used ball bearings to reduce the thickness of the movement. Using 0.20 mm balls, the Calibre 1200 was only 1.2 mm thick, which still is the thinnest mechanical watch movement.

- Aerospace bearings are used in many applications on commercial, private and military aircraft including pulleys, gearboxes and jet engine shafts. Materials include M50 tool steel (AMS6491), Carbon chrome steel (AMS6444), the corrosion resistant AMS5930, 440C stainless steel, silicon nitride (ceramic) and titanium carbide-coated 440C.

- A skateboard wheel contains two bearings, which are subject to both axial and radial time-varying loads. Most commonly bearing 608-2Z is used (a deep groove ball bearing from series 60 with 8 mm bore diameter)
- Yo-Yos, there are ball bearings in the center of many new, ranging from beginner to professional or competition grade, Yo-Yos.

- Many fidget spinner toys use multiple ball bearings to add weight, and to allow the toy to spin.

CHAPTER 5

METAL FRAME

The metal frame is generally made of **mild steel** bars for machining, suitable for lightly stressed components including studs, bolts, gears and shafts. It can be case-hardened to improve wear resistance. They are available in bright rounds, squares and flats, and hot rolled rounds

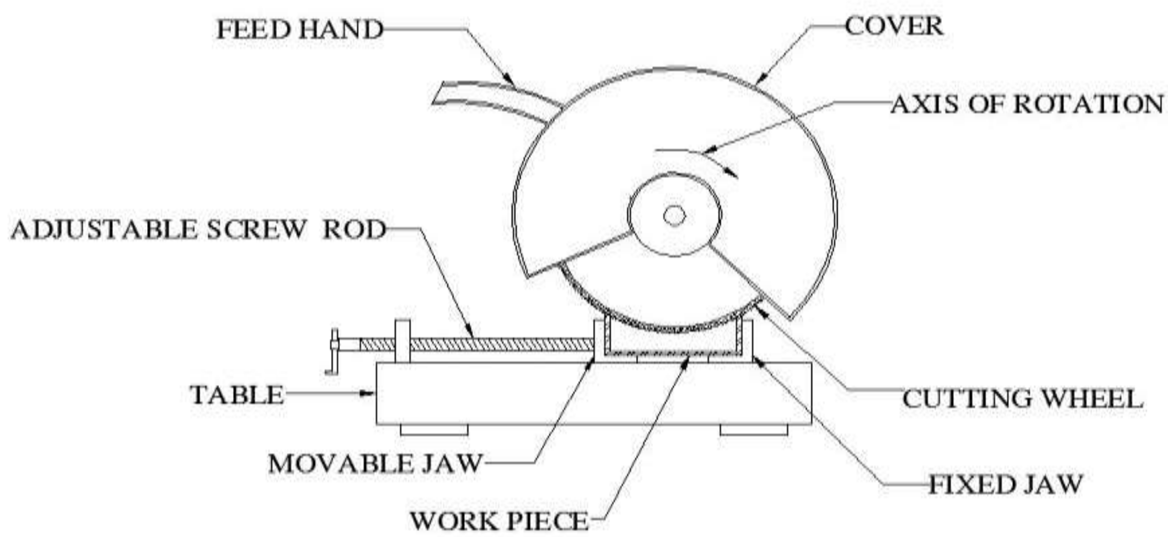
Suitable machining allowances should therefore be added when ordering. It does not contain any additions for enhancing mechanical or machining properties. Bright drawn mild steel is an improved quality material, free of scale, and has been cold worked (drawn or rolled) to size. It is produced to close dimensional tolerances. Straightness and flatness are better than black steel. It is more suitable for repetition precision machining. Bright drawn steel has more consistent hardness, and increased tensile strength. Bright steel can also be obtained in precision turned or ground form if desired.

MANUFACTURING PROCESS

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.

SAWING:

Cold saws are saws that make use of a circular saw blade to cut through various types of metal, including sheet metal. The name of the saw has to do with the action that takes place during the cutting process, which manages to keep both the metal and the blade from becoming too hot. A cold saw is powered with electricity and is usually a stationary type of saw machine rather than a portable type of saw.

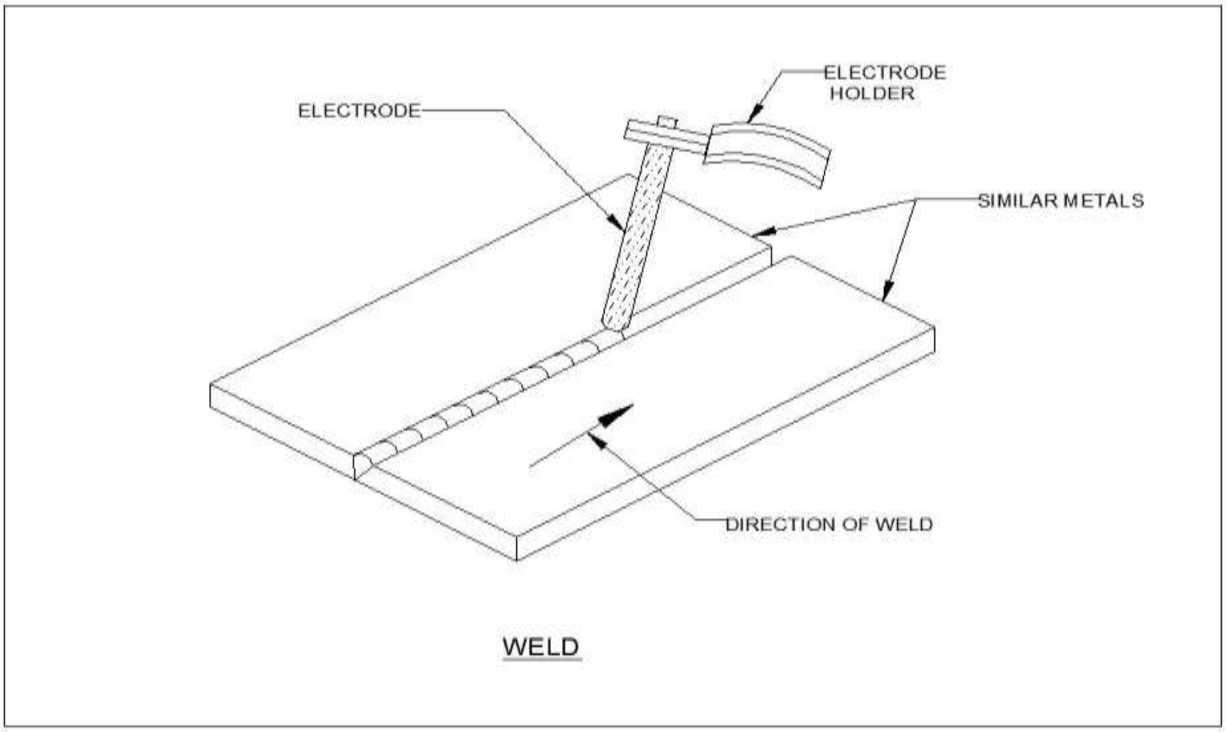


SAWING CUTTING MACHINE

The circular saw blades used with a cold saw are often constructed of high speed steel. Steel blades of this type are resistant to wear even under daily usage. The end result is that it is possible to complete a number of cutting projects before there is a need to replace the blade.High speed steel blades are especially useful when the saws are used for cutting through thicker sections of metal.

WELDING:

Welding is a process for joining similar metals. Welding joins metals by melting and fusing **1,** the base metals being joined and **2,** the filler metal applied. Welding employs pinpointed, localized heat input. Most welding involves ferrous-based metals such as steel and stainless steel. Weld joints are usually stronger than or as strong as the base metals being joined.



Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

OPERATION:

Several welding processes are based on heating with an electric arc, only a few are considered here, starting with the oldest, simple arc welding, also known as shielded metal arc welding (SMAW) or stick welding.

In this process an electrical machine (which may be DC or AC, but nowadays is usually AC) supplies current to an electrode holder which carries an electrode which is normally coated with a mixture of chemicals or flux. An earth cable connects the work piece to the welding machine to provide a return path for the current. The weld is initiated by tapping ('striking') the tip of the electrode against the work piece which initiates an electric arc. The high temperature generated (about 6000^{o}C) almost instantly produces a molten pool and the end of the electrode continuously melts into this pool and forms the joint.

The operator needs to control the gap between the electrode tip and the work piece while moving the electrode along the joint.

DRILLNG:

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips (sward) from the hole as it is drill

CHAPTER 6

ADVANTAGES AND APPLICATIONS

ADVANTAGES

Handling is simple

No Manual power

Easy to Repair.

Replacement of parts are simple

APPLICATION

This using on four wheelers

CHAPTER 7

MATERIAL USED

S.No	DESCIRPTION	QTY	MATERIAL
1	D C MOTOR	1	ELECTRICAL
2	BATTERY	14	ELECTRICAL
3	BEARING		STAINLESS STEEL
4	FRAME	AS PER REWUIRMENT	MILD STEEL
5	SHAFT	AS PER REWUIRMENT	MILD STEEL
6	METAL STRIP	AS PER REWUIRMENT	MILD STEEL
7	SPUR GEAR	1	MILD STEEL
8	TWO WAY SWITCH	1	ELECTRICAL
9	SCREW JACK	1	MILD STEEL
10			

COST ESTIMATION

SL.NO	DISCRIPTION	COST Rs:
1	D C MOTOR	1200
2	BATTERY	1000
3	BEARING	400
4	FRAME	1000
5	SHAFT	300
6	METAL STRIP	200
7	SPUR GEAR	600
8	TWO WAY SWITCH	100
9	SCREW JACK	200
10	TOTAL	5000
11		

LABOUR COST

LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING:

Cost = 1000/-

TOTAL COST

Total cost = Material Cost + Labor cost =

= Rs 5000 + 1000

Total cost for this project = Rs6000

CHAPTER 8

CONCLUSION AND REFERENCE

CONCLUSION

Screw Jacks are the ideal product to push, pull, lift, lower and position loads of anything from a couple of kg to hundreds of tones.

The need has long existed for an improved portable jack for automotive vehicles. It is highly desirable that a jack become available that can be operated alternatively from inside the vehicle or from a location of safety off the road on which the vehicle is located.

Such a jack should desirably be light enough and be compact enough so that it can be stored in an automobile trunk, can be lifted up and carried by most adults to its position of use, and yet be capable of lifting a wheel of a 400-500 kg vehicle off the ground. Further, it should be stable and easily controllable by a switch so that jacking can be done from a position of safety.

It should be easily movable either to a position underneath the axle of the vehicle or some other reinforced support surface designed to be engaged by a jack. Thus, the product has been developed considering all the above requirements. This particular design of the motorized screw jack will prove to be beneficial in lifting and lowering of loads.

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