

Mechanical Power Transmission Without Gears Using Six Elbow Links

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Abstract -Efficient power transmission with minimal energy loss is a key factor in determining the overall performance of any mechanical system. Conventional machines commonly use gear mechanisms to transfer motion from input to output shafts. However, gear-based transmission systems often experience significant power losses due to friction, wear, noise, and maintenance requirements. To overcome these limitations, this study presents an alternative gearless power transmission mechanism designed for right-angle motion transfer. The proposed system replaces conventional bevel gears with a set of 90° elbow rods to transmit rotary motion efficiently. The mechanism consists of six elbow rods arranged radially at 60° intervals around a central axis.

Keywords: Elbows, Housings, Power transmission, Design stresses.

1. INTRODUCTION

The gearless mechanism is a type of link mechanism based on a sliding pair, commonly referred to as an Elbow Mechanism. This mechanism is particularly useful for transmitting motion between intersecting shafts, especially at right angles. It provides an alternative method for power transmission without the use of conventional gears. In automobiles, bevel gears are widely used in differential systems to allow the inner and outer wheels to rotate at different speeds while negotiating curves. However, gear systems are associated with frictional losses, wear, noise, and reduced efficiency due to continuous contact between mating gear teeth. The proposed elbow mechanism can be effectively applied in situations where power needs to be transmitted at right angles or around corners. The transmission is achieved using a set of elbow rods connected between input and output housings, enabling smooth and continuous motion transfer. In many practical cases, the efficiency of traditional gear drives may not exceed 55%. Even in modern gear systems made from materials such as polypropylene and epoxy

to reduce friction, efficiency is often limited to around 40–45%, especially in small-scale applications.

In contrast, the elbow mechanism transmits input power to the output shaft through a series of links arranged to transfer angular forces directly. The links absorb the input motion and transfer the right-angle drive to the output assembly with minimal frictional interaction. Since the mechanism reduces direct tooth contact and sliding friction, it offers improved mechanical efficiency. It is estimated that the gearless elbow transmission system can achieve an efficiency of approximately 90–92%, making it a promising alternative to conventional gear-based transmission systems.

2. LITERATURE REVIEW

AtishLahuPatil et al [1] explained and did the gearless elbow mechanism setup with three elbow rods with obtuse angle of 120° for transmission of power in the wood cutting machine.

Navneet Bardiya et al [2] calculated and simulated the stresses acting on the mechanism and the reaction forces acting on the points of the joints using analysis software.

Jagushte G. S et al [3] estimated the design stress of the shaft and housing of the transmission setup for proper and smooth working of the shaft by selecting the desired factor of safety.

R. Somraj et al [4] explained and designed the conceptual multiple views of this transmission systems with three elbow rods.

Amit Kumar and Mukesh Kumar [5] have designed the link mechanism from the input shaft to output shaft to achieve perfect rolling and sliding pair of the mechanism

MahanteshTanodi et al [6] used the oldham's coupling method to transmit the power instead of gears.

3. WORKING :

The Gearless transmission or El-bow mechanism is an apparatus for transmitting power at any desired angle between the driving and driven shaft. The creation of this mechanism would reveal that it contains of a number of links would be between 3 to 8 the more the links the smoother the operation. These links slide inside the housing thus to form a sliding and rolling pair. This mechanism has 3 such sliding pairs. These cylinders are placed in a Hollow pipe and are fastened at 60° to each other. This experimental setup is mounted on wooden table. Power is supplied by an electric motor. The operation of the mechanism is explained by the experimental setup given in the fig.6. An unused form of transmission of power on shaft located at an angle. Motion is transmitted from driving to the driven shaft through the rods which are bent to fit in to the 90° between the shafts. These rods are located at in the holes equally spaced around a circle and they are free to slide in & out as the shafts revolve. This type of drive is particularly appropriate where quite operation at high speed is vital but only recommended for high duty. The operation of this transmission will seem by the action of one rod during a single revolution. If the driving shaft is revolving in clockwise the driven shaft will rotate counter clockwise. As input shaft turns through half revolution elbow rods shown in the inner and most effective driving position slides out of both input and output shafts. The first half revolution and elbow rods then will be at the top then during the remaining half slide in wards until it again reaches to inner most position in the meanwhile the other rods have of sequence distributed through the same cycle of movements all rods are consecutively sliding inwards and outwards. Though this transmission is an old one many mechanics are doubtful about its operation, however it is not only feasible but has proved satisfactory for various applications when the drive is for shafts which are ceaselessly located at given angle.

The elbow mechanism with right angle setup, in the same way the setup may be flexible for different angle in between any angle (0° - 90°). It is important to have the holes for a given rod located accurately in the same holes must be equally spaced in radial and circumferential directions, be parallel to each rod should be bent to at angle at which the shaft are to be located. If the holes drilled in the ends of the shafts have "blind" or closed ends, there ought to be a small vent at the bottom of each rod hole for the escape of air compressed by the pumping action of the rods. These holes are useful for oiling to avoid blind holes shafts may have enlarged port

or shoulder. This transmission situated centrally and in line with the axis of each shaft and on condition that with a circular groove at each rod or a cross pin to permit rotation of the shaft about the rod simply active as a retaining device for shipping and handling purposed. As mentioned in first chapter that we are showing two applications of this mechanism at a time. 1) As a wood cutting machine the cutter is attached on the output shaft. 2) The wood cutter is attached at the end of the output shaft, when the power is given to input shaft automatically it transfers to the cutter directly. The speed is adjusted by means of pulley (i.e. rpm). The cutters will also start to rotate along with the shaft the because of cutter is 250mm. the through slot introduces in the table for free rotation of cutter edges in table. The speed is adjusted by means of pulley (i.e. rpm). The cutters will also start to rotate along with the shaft. 3) air compressor or air pump - the compressor or and pump also introduced in our project when the links inside the drilled holes are reciprocates as well as revolves along the axis of cylinder it gives the compressor effect. Among the six links when first pin goes at inner dead center it sucks the air then it start to move at outer dead center by revolving, it compresses the air against seal and cylinder head disc and does simultaneously by six links and we can get continue discharge of air the quantity. 4) Mechanical seal is defined as a devise which seals by virtue of axial contact pressure between two relatively flat surfaces in a plane right angle to the axis of the shaft. The seal used in EL-BOW m/c compressor is stationary type. It is place between cylinder and cylinder head.

4. ANALYSIS OF THE MECHANISM

Figures 7 and 8 illustrate the detailed views and arrangement of the gearless elbow transmission setup. The front view is primarily used to understand and analyze the working of the mechanism. When Shaft-1 (input shaft) begins to rotate in the anticlockwise direction, all six elbow links connected to it move simultaneously. As rotation starts, a reaction force is developed at the contact surface between the pin and the shaft. This force is transmitted through the link to the opposite end, where it acts on Shaft-2 (output shaft). As a result, Shaft-2 begins rotating in the same direction as Shaft-1. After every 60° rotation of the input shaft, the links change their positions cyclically: Pin 1 moves to the position of Pin 2 Pin 2 shifts to the position of Pin 3 Pin 3 shifts to the next position This sequence continues for

all six links. The links continuously slide within the shaft slots and automatically adjust themselves during rotation. This positional interchange takes place after each 60° rotation, ensuring continuous and smooth transmission of motion. The process repeats uniformly, allowing uninterrupted right-angle power transmission without the use of GEARS.

5. ADVANTAGES

1. Low friction helps in better and more efficient power transmission. Problems like backlash and gear tooth damage do not occur because no gears are used. 2. The mechanism can work for both right-angle shafts and parallel offset shafts. 3. It has a simple design and is easy to manufacture. 4. The speed ratio can be controlled by changing the shaft speed and the angle of the elbow rods.

6. APPLICATIONS

This elbow mechanism is already used in very rare cases not in regular some of the applications are listed below

1. The elbow mechanism was first used in the London tower clock in the year 1685
2. This mechanism is also used for a multiple spindle drilling operation simultaneously.
3. It is also used for angular drilling in between 0 to 90° position.
4. In C.N.C. lathe machines this mechanism is used to lubricate the machine while machining at the end of lubrication pump.
5. In electronic devices and computers this mechanism is used to transmit the power from the device to air blowers.
8. In submarine ships this mechanism is used in periscopes

7. CONCLUSION

Elbow transmission mechanism is possible in almost for short lengths and also it is suitable for medium length by increasing the housing diameter. The setup indicates that by increasing the elbow a rod in account increases the smoothness of the transmission. The absence of friction ultimately raises the efficiency of the mechanism. In this paper the mechanism illustrated experimentally and proved with prototype. This mechanism may give the possibility of different angle transmission in between 0° – 90° (acute angle) at any point of angle.

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