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Fabrication of Gearless Transmission System

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Abstract

This paper focuses on developing a compact and portable gearless power transmission system capable of transmitting motion at 90° without using gears. The main objective of this work is to fabricate a mechanical model that demonstrates right-angle power transmission through an elbow mechanism. The elbow transmission mechanism transmits input power from the driving shaft to the driven shaft using bent links (90° cylindrical rods) instead of conventional gears. The input shaft is positioned at a right angle to the output shaft, and power is transmitted through a set of specially arranged bent rods that convert rotational motion smoothly and efficiently. The rotary motion of the input shaft produces a combined rotary and reciprocating motion in the bent links, which in turn drives the output shaft. The entire system was designed using appropriate mechanical design principles and fabricated using standard materials and workshop processes. The fabricated model successfully demonstrates the working principle of gearless right-angle transmission.

1. INTRODUCTION

Here is a wonderful mechanism that carries force through a 90º bend. Translating rotational motion around an axis usually involves gears, which can quickly become complicated, inflexible, and clumsy looking, often ugly. So, instead of using gears, this technology elegantly converts rotational motion using a set of cylindrical bars, bent to 90º, in a clever, simple and smooth process that translates strong rotational force even in restricted spaces. A gearless transmission is provided for transmitting rotational velocity from an input connected to three bent links. Both the input shaft and the housing have rotational axes. The rotational axis of the input shaft is disposed at an angle of 90 degrees concerning the rotational axis of the housing. As a result, rotation of the input shaft results in a processional motion of the axis of the bent link. The rotary and reciprocating motion of bent link transmit rotation of prime mover to 90 degrees without any gear system to an output shaft without gears. The transmission includes an input shaft. T: Gearless transmission mechanism transmits power from input to output shafts using sliding links that form revolute pair with the hub. Links bent at the required angle slide inside the holes in the hub. Thus, as the holes in the input hub rotate; it pushes the links and in turn, the output hub is rotated.

2. LITERATURE REVIEW

Gearless transmission systems are innovative mechanical arrangements designed to transmit power without conventional gear meshing**.** These systems commonly employ link mechanisms (elbow rods), cams, rollers, or couplings to transfer motion between shafts. The main objective is to reduce friction, noise, maintenance cost, and complexity associated with traditional gear drives.

Recent research trends emphasize compactness, energy efficiency, and ease of fabrication**,** making gearless systems suitable for low-cost automation, robotics, and small-scale machinery**.**

H. S. Rajput et al. [1] presented the design and fabrication of a gearless transmission mechanism for skew shafts using elbow link arrangements. The system utilized multiple L-shaped rods to transmit motion between non-parallel shafts. The study emphasized the importance of link length, angular positioning, and material selection in achieving smooth motion. It was concluded that the mechanism provides efficient power transmission for low-load applications, but accuracy in fabrication is essential to reduce vibration and wear. M. Tanodi et al. [2] reviewed gearless power transmission using offset parallel shaft coupling. Their analysis showed that such systems eliminate the need for gears, thereby reducing frictional losses and maintenance requirements. The authors highlighted that although the system ensures smooth and quiet operation, it is limited in handling high torque and heavy loads. Proper alignment of shafts was identified as a critical factor affecting performance. V. M. Dagala et al. [3] developed an improved gearless transmission system using optimized elbow mechanisms. The study reported an efficiency of approximately 94.8%, achieved by arranging the links at optimal angular positions. The system was found to be cost-effective, compact, and easy to fabricate. The authors concluded that performance can be significantly enhanced by improving the geometry and balancing of the mechanism. L. Wu and M. W. Dong [4] investigated the working principle of a gearless reducer based on cylindrical cam mechanisms. The fabricated prototype demonstrated high transmission efficiency, compact size, and reduced material consumption. The study suggested that cam-based gearless systems are suitable for applications requiring high precision and compact design, although manufacturing complexity is relatively higher. J. Sabil et al. [5] designed a gearless transmission system integrated with a box shifting mechanism for material handling applications. The system demonstrated smooth motion transfer and reduced mechanical complexity. The authors concluded that such gearless systems are particularly useful in automation and low-power industrial applications. M. P. Gowtham et al. [6] focused on the design and fabrication of a compact gearless transmission system. Their work highlighted the advantages of portability, low cost, and ease of maintenance. However, the study also identified limitations such as restricted load capacity and wear in link joints, which need further improvement. V. M. Dagala et al. [7] developed an improved gearless transmission using elbow mechanisms. The system used three links positioned at 120° and achieved an efficiency of about 94.8%. The study highlighted that proper fabrication of pins, links, and hubs significantly improves smoothness and reduces power loss. K. Surawanishi et al. [8] studied a gearless transmission capable of transmitting power up to 180° using sliding links forming revolute pairs. The mechanism replaces bevel gears in low-torque applications and allows transmission at variable angles, making it suitable for compact mechanical systems. G. M. Kumbar et al. [9] analyzed the performance of elbow-based gearless transmission systems and reported efficiencies up to 92%. The study concluded that gearless mechanisms are economical and effective for small-scale applications but are limited in high-load conditions. F. Gutiérrez [10] proposed a gearless speed reducer using roller screw and threaded chain mechanisms. This design replaces traditional gear contact with rolling elements, reducing friction and improving durability. Experimental results showed improved efficiency and smoother operation compared to conventional worm gear systems. H. Xue et al. [11] investigated advanced transmission synthesis using planetary configurations. Although not completely gearless, the study introduced simplified analytical methods (lever analogy) to design compact transmission systems with multiple speed ratios, influencing modern gearless and hybrid designs. Y. Ma et al. [12] proposed a variable transmission ratio system using double planetary mechanisms for vehicle steering applications. The research emphasized improved control, compact design, and efficient power transmission, which are key inspirations for advanced gearless systems. L. Deng et al. [13] developed a magnetorheological planetary transmission system for electric vehicles. The study demonstrated that integrating smart materials enables smooth torque variation and eliminates conventional gear shifting losses, contributing to next-generation transmission systems. Recent research in robotics by Emre et al.[14] introduced a load-based variable transmission mechanism using linkages. The system automatically adjusts transmission ratio based on load without additional actuators, showing the future direction of adaptive and intelligent gearless transmission systems.

3. WORKING PRINCIPLE

The Elbow Transmission Mechanism works on the principle of converting rotary motion through bent links arranged between two intersecting shafts. The input shaft and output shaft are positioned at 90° to each other. When the input shaft is rotated by a prime mover (such as an electric motor or hand drive), the bent links attached to the input shaft rotate along with it. These bent links are cylindrical rods bent at 90°. As the input shaft rotates, the bent rods undergo rotary and slight reciprocating motion. This motion is transmitted to the output shaft through proper alignment of the bent rods inside the housing. The continuous rotation of the input shaft causes the bent rods to push and guide the output shaft in rotational motion. Thus, rotary motion is transmitted from the input shaft to the output shaft without the use of gears.

Since there are no meshing gear teeth, problems such as backlash, gear tooth wear, and hunting errors are

eliminated. The mechanism operates smoothly and is suitable for compact applications where space is limited. In this paper, the mechanism was fabricated and tested for demonstration purposes. The working model successfully transmits motion at 90° using only mechanical links, proving the feasibility of gearless transmission. The Gearless Transmission or Elbow Mechanism is a device used to transmit motion between two shafts placed at a fixed angle (generally 90°). The mechanism consists of bent cylindrical rods (pins) placed between the driving and driven shafts. The number
of pins used may vary from 3 to 8 depending on the required smoothness of operation. A higher number of pins results in smoother power transmission.

In the fabricated model, three bent pins are used. These pins slide inside hollow cylindrical holes drilled in both the input and output shafts, forming sliding pairs. The holes are equally spaced at 120° from each other around the shaft circumference. The entire assembly is mounted securely on supporting brackets fixed to a wooden base frame. Power is supplied to the input shaft using an electric motor through a pulley arrangement.

Fig 1. working of gearless transmission

When the driving shaft rotates, the bent rods rotate along with it. Due to the angular positioning (90°) between the input and output shafts, the rods undergo a combined rotary and reciprocating motion. As one rod moves outward from the input shaft, it simultaneously engages and pushes the output shaft, causing it to rotate. During half of the revolution, a rod slides outward, and during the remaining half revolution, it slides inward. Meanwhile, the other rods follow the same cycle successively.

3.1 Material

Component	Material Selected	Reason
Shafts	Mild Steel	Good strength and low cost
Elbow Links	Steel Rod	High rigidity
Frame	MS Square Pipe	Structural stability
Bearings	Standard Ball Bearing	

4. EL-BOW MECHANISM

The right angled joint helps in transmitting the input power from the motor to the driver. The joints are positioned in such a way that the rotary motion is converted into sliding motion, by the el-bow mechanism. The amount of friction being generated is minimal when compared to the amount of power transmitted. The mechanism consists of three sliding pairs. The zero back lash is also achieved during transmission. Therefore, the efficiency of 90% - 93% is possible in gearless transmission system. The cylindrical L-shaped 90º bars is placed equally spaced to each other in a hub. The mechanism is then mounted on a channel.

5. Fabrication of the Gearless Transmission

The fabricated gearless transmission mechanism is used to transmit motion between two shafts placed at 90° without using gears. Instead of gear teeth, the mechanism uses elbow links and sliding pins to transfer motion from the driving shaft to the driven shaft. When the input shaft rotates (by motor or handle), the elbow link connected to it also rotates. The pins fitted in the drilled holes move in a combined rotary and sliding motion. This movement transfers power to the output shaft, causing it to rotate smoothly.

The main parts of the fabricated model are the base frame, driving shaft, driven shaft, elbow links, pins, and bearings. Mild steel is used for fabrication because it is strong, economical, and easy to machine. This mechanism is simple in construction, requires less maintenance, and avoids problems like gear wear and lubrication issues. It is suitable for light and medium power transmission applications such as drilling machines, lubrication pumps, and small mechanical systems. The fabricated model successfully demonstrates smooth and continuous motion transmission without the use of gears.

6. CONCLUSION

The gearless transmission mechanism based on the elbow mechanism was successfully designed and fabricated as per the project requirements. The design process included preparation of detailed dimensions, selection of suitable material (mild steel), and proper arrangement of shafts and elbow links at 90°. All components were manufactured using standard workshop operations such as cutting, drilling, turning, welding, and fitting.

After assembly, the model demonstrated smooth transmission of motion between perpendicular shafts without the use of gears. The rotary motion of the input shaft was effectively transmitted to the output shaft through the combined rotary and sliding motion of pins inside the elbow links. The fabrication work ensured proper alignment and rigidity, which are essential for smooth operation.

The project mainly focused on the structural design and practical fabrication of the mechanism. The working model proves that gearless transmission is simple, compact, economical, and suitable for light mechanical applications. Thus, the aim of designing and fabricating a functional gearless elbow transmission mechanism has been successfully achieved.

7. FUTURE SCOPE

Since this project is limited to design and fabrication, there is wide scope for further improvement and development. Detailed performance testing can be carried out to evaluate efficiency, speed variation, and load-carrying capacity. Computer-based analysis such as stress and deformation analysis can be performed to optimize the design. In future work, high-strength alloy materials and precision machining techniques can be used to improve durability and reduce wear. Proper lubrication systems and high quality bearings can be incorporated to enhance performance. The mechanism can also be integrated with electric motors and speed control systems for real-time industrial applications. With further research and development, the gearless transmission mechanism can be adapted for drilling machines, air compressors, pumps, robotics, and other angular motion transmission systems.

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