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Gearless Power Transmission-Offset Parallel Shaft Coupling

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Abstract— **The Gearless transmission for parallel shafts is a device for transmitting motions between the Parallel shafts. The synthesis of this mechanism would reveals that it comprises number of pins would be in between 3 to 8, if more the pins smoother the operation. These pins rotate inside hollow cylinders thus formatting a rotary pair. The Z-pins (or Z-links) are free to rotate in the holes, which are drilled parallel to the axis of shafts. The angle for which the pins are bent to must precisely the same for each one, and the holes in the shafts must be accurately drilled, both radially and tangentially. All parts of this coupler move when the shafts rotate. This is a very smooth-acting device, and the minimal power loss. It can be run at nearly any speed, even at high speed, and is very quiet. It is fascinating to watch in action, with the pins rotating in holes as it rotates. Unlike universal joints, there is no performance loss by increasing shaft offset.**

Keywords— Gearless transmission, Parallel shafts, Z-pins, Rotary pair, universal joints, Oldham's Coupling

I. INTRODUCTION

Mechanisms that transfer rotary motion from an input shaft to an output shaft normally require gear lobes, Oldham's couplings, associated with each shaft end, consequently, include the disadvantages associated with the use of gears and couplings in general. Such disadvantages include small contact ratio and impact load in gears and there is a substantial amount of energy loss due to friction in Oldham's coupling. Accordingly, there is a need for an improved mechanism for transmitting rotary motion between two parallel(but offset) shafts all without the employment of gears or the reliance upon friction to transfer rotational movement from the input shaft to the output shaft. The present invention satisfies the aforenoted needs by providing a gearless transmission that operates using the mechanism of rotary and kinematic chain principle.

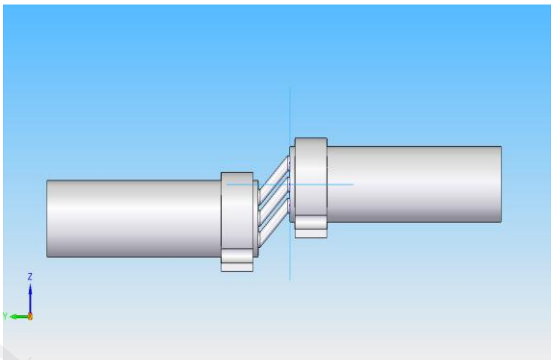

Fig.1.1 Offset parallel shaft coupling

This paper is part of a study investigating the Gearless power transmission for parallel shafts. Gearless Transmission which is compact and portable equipment, which is skillful and is having something practice in the transmitting power between parallel shafts without any gears being used. This type of coupling would be used to transmit a drive between parallel, but offset shafts. It is, in fact, a link version of the multi slider coupling, but would be able to cope with a much greater offset, particularly under load. Couplings offer large shaft misalignment capabilities and constant angular velocity. The acting forces within the coupling can be precisely calculated, assuring a sound coupling design which is especially important for heavy-duty applications.

II. LITERATURE REVIEW

Oldham's coupling: A coupling for parallel shafts slightly out of line consisting of a disk on the end of each shaft and an intermediate disk having two mutually perpendicular feathers on opposite sides that engage slots in the respective shaft disks [3].

Gearless Power Transmission: The gearless transmission is a device for transmitting motions at any fixed angle between the driving and driven shaft. The synthesis of this mechanism would reveal that it comprises of a number of pins would be between 3 to 8, the more the pins, the smoother the operation. These pins slide inside hollow cylinder thus forming sliding pair [1].

An elbow engine is a piston-based engine typically fed by steam or compressed air to drive a flywheel and/or mechanical load. It is based on a mechanism known as a Hobson's coupling. Although not commonly used today for practical purposes, it is still built by hobbyists for its uniqueness [3].

Schmidt couplings enable a variable parallel offset between two shafts. They are adaptable to wide variations in radial displacement while running under load. Invented in the early 1960s by Richard Schmidt, and added to the Zero-Max line of flexible shaft couplings in 1984, Schmidt couplings were originally developed under commission from NASA for use in propulsion systems for rockets in zero-gravity environments [2][4].

Automatic gearless power transmission: This invention consists in the combination with a driving and driven shaft, having a common axis of eccentrics fixed to the driving shaft and eccentric straps connecting said eccentrics with transverse pins which pins have free radial motion in guide ways of the transmission case, and acting, in conjunction with springs as the load varies, to vary the speed [5].

III. COMPONENTS OF THE MODEL AND OPERATION

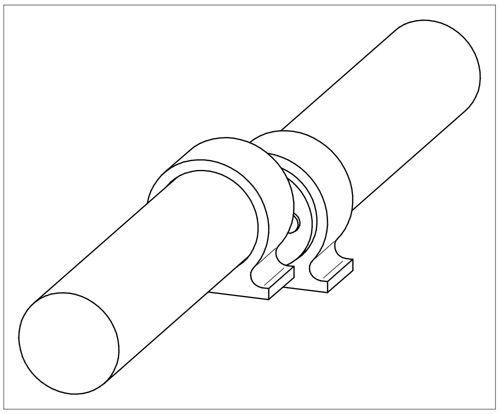

Fig. 3.1 Isometric view of Coupling

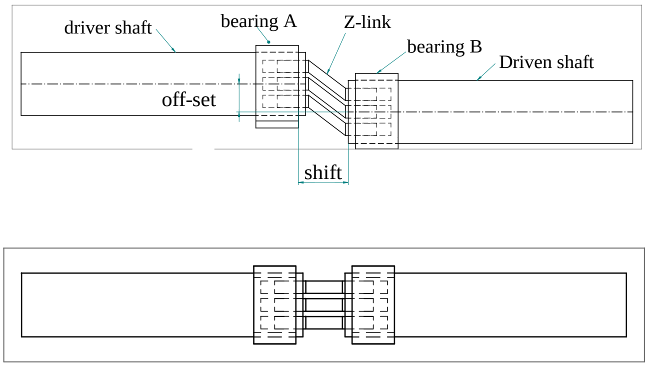

Fig. 3.1 Orthographic views of Coupling

This model consists of two parallel shafts (driver and driven) which are supported in the bearings A and B respectively. At the end of each shaft, uniform sized, equally spaced holes are drilled axially, in diametrically opposite directions as shown in the Fig. The same number of Z-pins is made to insert in these holes such that if the shaft rotates through one revolution, Z-pins also rotate through one complete rotation. Z-pin is a device which acts as an intermediate link between the driver and driven shafts. The two shafts are coupled in such a way that if one shaft rotates, the other shaft also rotates at the same speed. The driver shaft forms the first turning pair with the intermediate link (Z-pin) and the same intermediate link forms another turning pair with the driven shaft. When the driving shaft is rotated, the hub A causes the Z-pin to rotate at the same angle through which the respective hole has rotated, and it further rotates the hub B at the same angle and thus the shaft B rotates. This coupling guarantees a completely true angle of rotation at all times. Our design uses a unique arrangement of Shafts and links—two shafts rotating in unison, interconnected in series by three or more rotating Z-links. Both shafts rotate with equal velocity. The pushing and pulling forces of this coupling alternate and overlap in a sinusoidal pattern, resulting in zero net external forces. Additionally, the constant-velocity relationship between input and output shafts connected by this coupling is not affected by changes in radial displacement, preserving balance in the system.

IV. POSSIBLE ARRANGEMENTS OF Z-PINS

In general we can select two types of arrangements of Z-pins. The possible types of Z-pins arrangement are:

a. Elbow type Z-pin b. Inclined type Z-pin

A. *Elbow type Z-pin*

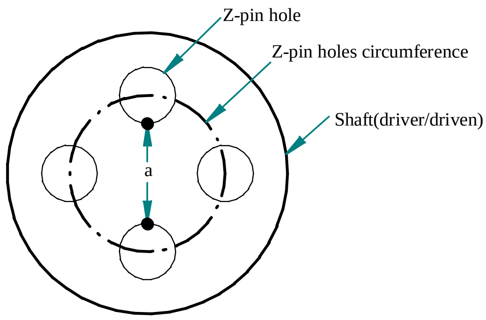

Fig.4.11 Side view of the Shaft (driver/ driven)

For the Elbow type Z-pin the following conditions must be satisfied.

- Shift >Diameter of Z-link
- Offset < a
- Where a = distance between the innermost points of the opposite holes(as shown in Fig.4.11)

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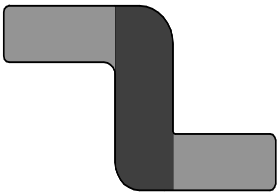


Fig.4.12 Elbow type Z-pin

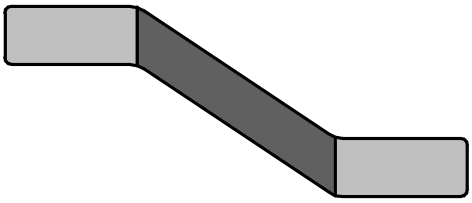


Fig.4.21 Inclined type Z-pin

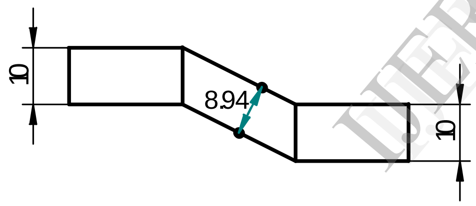
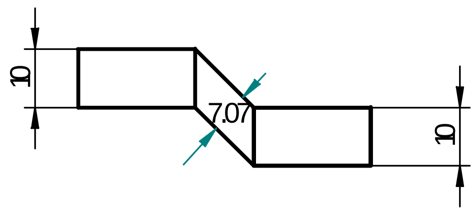
B. Inclined type Z-pin

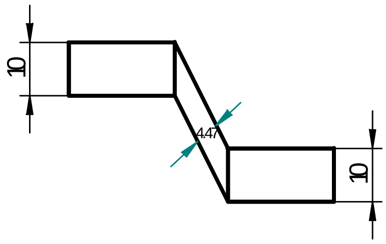
For the Inclined type Z-pin the following conditions must be satisfied.

- Shift ≥ Offset

C. Geometric Analysis of Inclined Z-pin

The following analysis is important by taking various proportions of Offset and Shift of the coupling.

Cases	Off-set to Shift ratios	Figure	Conclusions	Overall Conclusion
Case 1	1:2		Reduction in 10.6% size of the connector	By the geometric configuration it is analyzed that the size of the Z-link connector decreases, as the off-set to shift ratio increases. And hence the strength of the connector comes down. Hence it is advisable to maintain smaller offset to shift ratio for the rigid and stronger Z-link connector.
Case 2	1:1		Reduction in 29.3% size of the connector	

Case 3	2:1		Reduction in 55.3% size of the connector	

V. ADVANTAGES

- By providing a solution to large radial displacement between shafts, the invention of the offset parallel shaft coupling opened up new possibilities in transmission design.
- Owing to the fact that couplings maintain constant transmission ratios between input and output shafts, while the shafts undergo radial shifts in their relative positions, power transmission unit can be built with fewer gears and pulleys.
- This coupling enables a variable parallel offset between two shafts. They provide constant speed velocity with extremely low backlash, and their compact designs provide large floor space savings.
- Wide range of parallel shaft displacement without side loads.
- Backlash-free shaft securement and torque transmission
- High torsional rigidity
- Eliminates radial vibration.
- No effect on performance by increasing shaft displacement in axial direction.
- This coupling allows for the precise transmission of torque and constant angular velocity between shafts with relatively large parallel misalignments
- Extremely advantageous cost/performance ratio compared to any other couplings due to the ingeniously simple construction
- Time-saving installation due to simple and fast shaft securement
- Minimal mass moment of inertia
- Safe torque transmission even at high speeds

VI. APPLICATIONS

These couplings are especially good for roll applications, such as paper processing or converting. Typical applications which benefit from the high accuracy provided by Couplings are feeders, embossers, compactors, printing presses and many others. We have designed these Couplings for parallel shaft displacement from a minimum of 1 to 500 mm and torque capacities from 5.4 to 80000 Nm.

VII. CONCLUSIONS

Based on experimental observations and modeling analysis, the possible geometries are plotted & results are critically discussed. It can be concluded from the results that the proposed conceptual design can be applied for the transmission of power between two parallel shafts having proper shift and off-set by employing different geometries of Z-pins.

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