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# Gearless Power Transmission- L Pin Coupling

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***Abstract*—The Gearless transmission for intersecting shafts is a device for transmitting motions between the intersecting shafts with angular misalignment. The synthesis of this mechanism would reveals that it comprises number of L-pins would be in between 3 or more, if more the L-pins smoother the operation. These L- pins rotate as well as slide inside hollow cylinders thus formatting a rotary and sliding pair. The L-pins (or L-links) are free to rotate and slide in the holes, which are drilled parallel to the axis of shafts. The angle for which the L-pins are bent to must precisely the same for each one, and the holes in the shafts must be accurately drilled, both radially and axially. 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 L- pins rotating and sliding in holes as it rotates. Unlike Bevel and Worm gear there is no unequal distribution of forces.**

***Index Terms*—Gearless transmission, intersecting shafts, L-pins, rotary pair, sliding pair, universal joints, Oldham's Coupling, Worm gear**

## I. INTRODUCTION

Mechanisms that transfer rotary motion from an input shaft to an output shaft normally require gear lobes, 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 coupling. Accordingly, there is a need for an improved mechanism for transmitting rotary motion between two intersecting (but angular 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, sliding and kinematic chain principle. This paper is part of a study investigating the Gearless power transmission for intersecting shafts.

Gearless Transmission which is compact and portable equipment, which is skillful and is having something practice in the transmitting power between intersecting shafts without any gears being used. This type of coupling would be used to transmit a drive between intersecting, but angular offset shafts. Couplings offer large shaft misalignment capabilities and constant angular velocity combined with smoother operation. The acting forces within the coupling can be precisely calculated, assuring a sound coupling design which is especially important for heavy-duty applications.

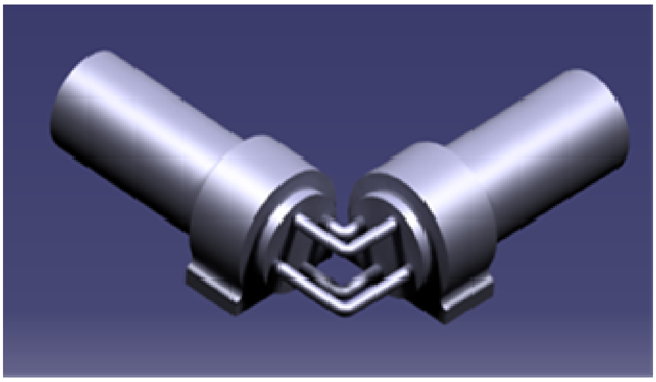

Fig.1 L-Pin Coupling (Isometric view)

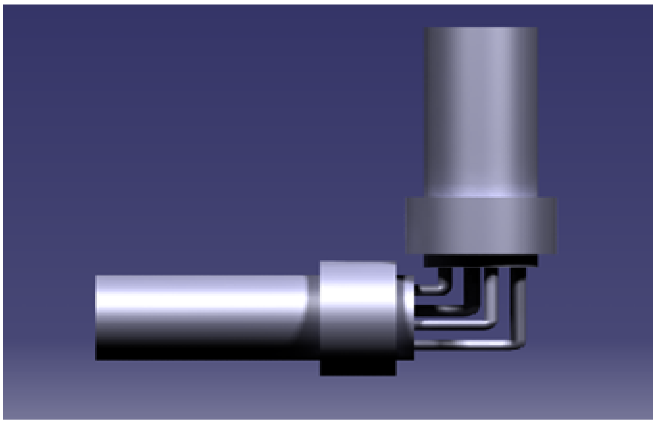

Fig.2 L-Pin Coupling (Top view)

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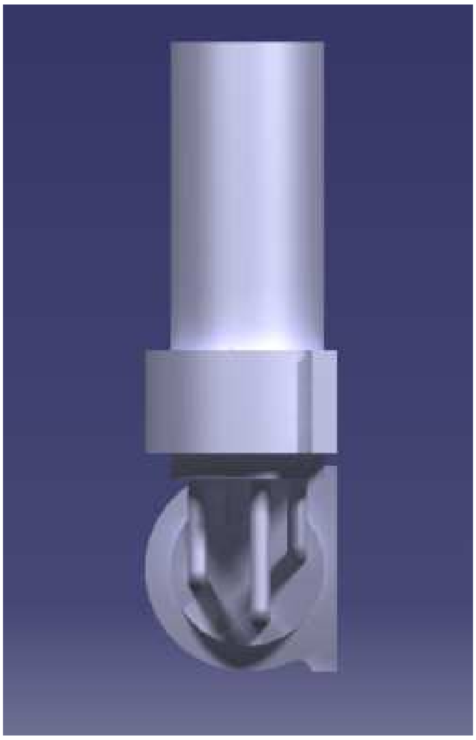

Fig.3 L-Pin Coupling (Side view)

## 2. LITERATURE REVIEW

*Bevel Gears* are the gears where the axes of the two shafts intersect and the tooth bearing faces of the gears themselves are conically shape. Most often bevel gears are mounted on shafts which are $90^0$ apart. The main drawback of bevel gear is that of one wheel of such gear is designed to work with its complementary wheel and no other. And must be precisely mounted. [1][2].

*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 [4].

*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 [6].

*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 [3][5].

*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].

## 3. COMPONENTS OF THE MODEL AND OPERATION

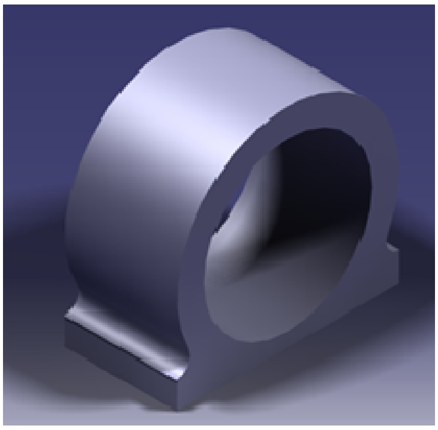

Fig.4 Bearing

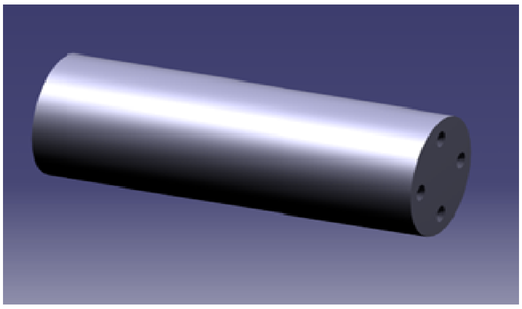

Fig.5 Shaft with End holes

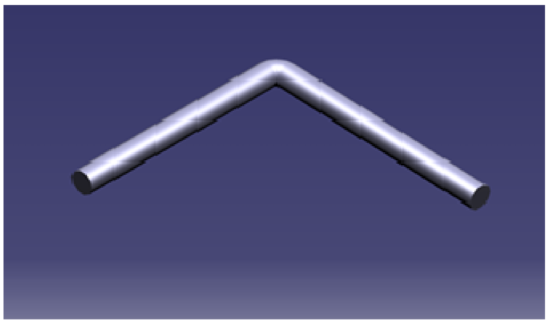

Fig.6 L-Pin

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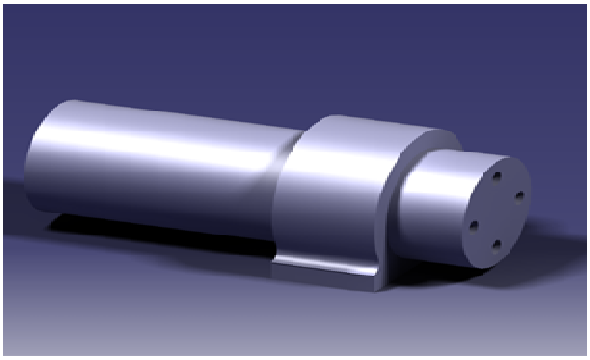

Fig.7 Shaft with Bearing

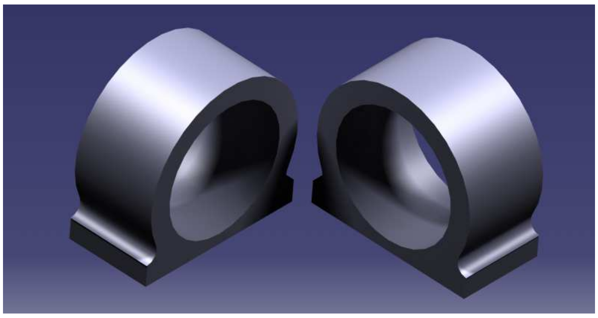

Fig.8 Bearing Positioning

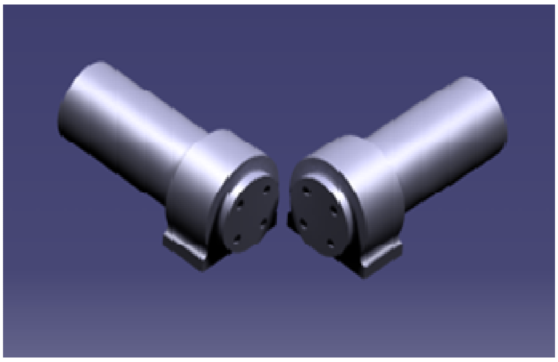

Fig.9 Shaft and Bearing Positioning

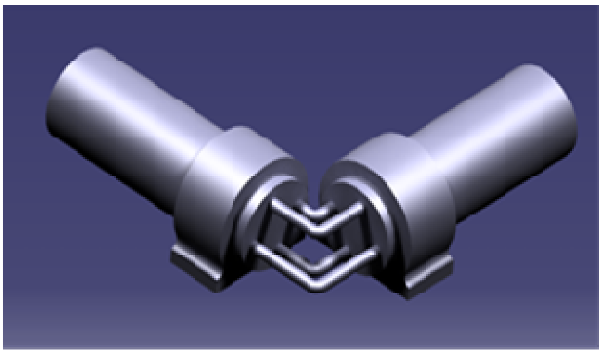

Fig.10 Final Assembly of L-Pin Coupling

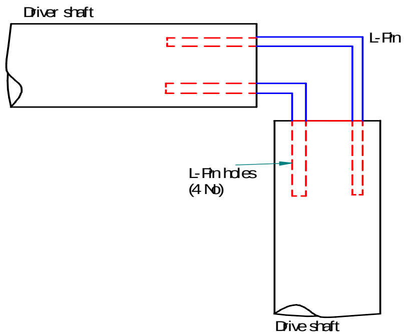


Fig. 11 Orthographic views of L-Pin Coupling

This model consists of two Intersecting 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 L-pins is made to insert in these holes such that if the shaft rotates through one revolution, L-pins also rotate through one complete rotation. L-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 and sliding pair with the intermediate link (L-pin) and the same intermediate link forms another turning and sliding pair with the driven shaft. When the driving shaft is rotated, the hub A causes the L-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 L-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.

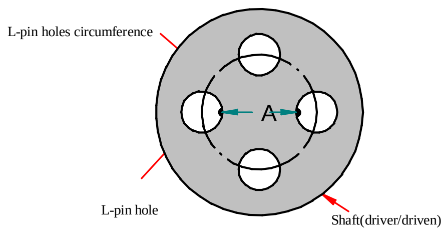


Fig.12 Side view of the Shaft (driver/ driven)

Where A = distance between the innermost points of the opposite holes

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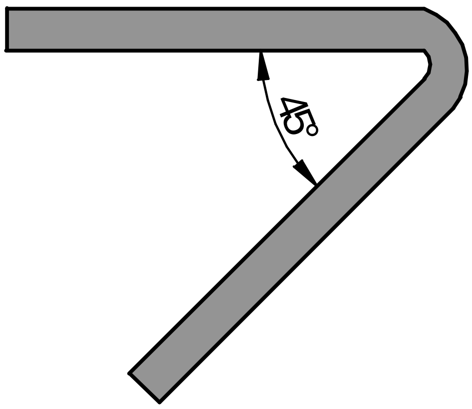
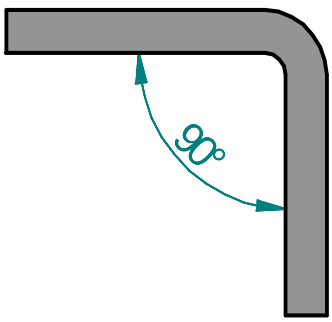
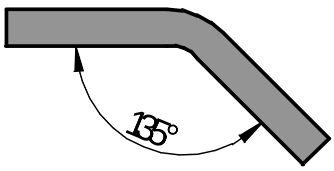
**4. Geometric Analysis of L-pin**

The following analysis is important by taking various misalignments between the two shafts of the coupling.

| **Cases** | **Bent Angle** | **Figure** | **Features** | **Overall Conclusion** |
|---|---|---|---|---|
| Case 1 | Less than 90° |   | • The length of the L-Pin increases.<br>• Size of the coupling increases | |
| Case 2 | Equal to 90° |   | • The length of the L-Pin decreases as compared to case 1.<br>• Size of the coupling decreases as compared to case 1. | By the geometric configuration, it is analyzed that the length of the L-link connector decreases, as the angular misalignment decreases. And hence the compactness of the coupling increases as the angular misalignment decreases. |
| Case 3 | More than 90° |   | • The length of the L-Pin decreases as compared to case 2.<br>• Size of the coupling decreases as compared to case 2. | |

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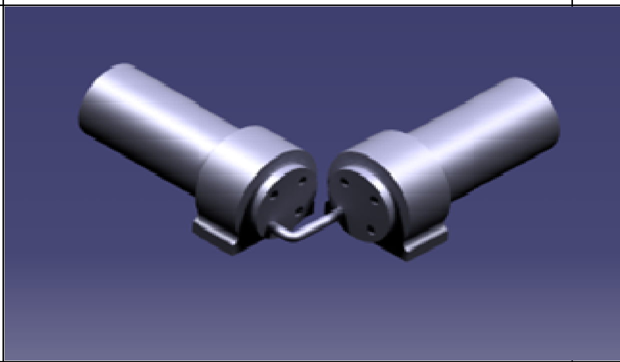
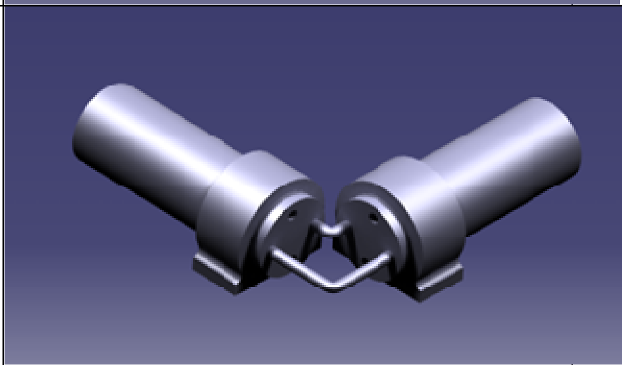
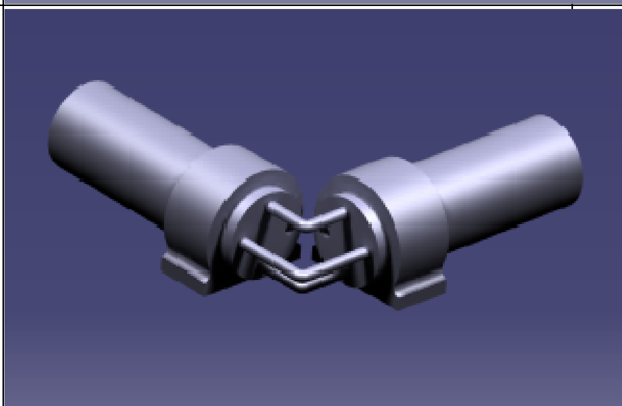
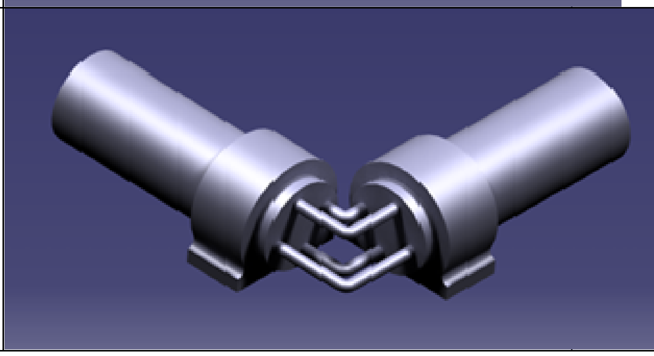
### 5. Analysis for Optimum number of L-pin

The following analysis of CATIA® shows the minimum number of L-Pin connectors required for smoother and continuous transmission of power between two shafts.

| Cases | No of L-Pins | Figure | Features | Overall Conclusion |
|---|---|---|---|---|
| Case 1 | 1 |  | Drastic change in the lirection of forces. Unequal distribution of forces leading to mbalance. t is not possible to ransmit the power rom one shaft to nother continuously. | By CATIA® analysis, it is found that minimum number of L-Pins required are 3, for continuous transmission of power between the two shafts and smoothness of operation depends upon the number of pins i.e. more the number of pins, more smoother the operation. |
| Case 2 | 2 |  | Drastic change in the direction of forces. Unequal distribution of forces leading to imbalance. It is not possible to transmit the power from one shaft to another continuously. | |
| Case 3 | 3 |  | Forces are equally distributed. It is possible to transmit the power from one shaft to another continuously. | |
| Case 4 | 4 |  | rces are equally stributed. is possible to ansmit the power om one shaft to other ntinuously. noother the eration | |

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## 6. ADVANTAGES

- By providing a solution to large axial displacement between shafts, the invention of the L-pin Intersecting shaft coupling opened up new possibilities in transmission design.
- This coupling enables a variable angular misalignment between two shafts. They provide constant speed velocity with extremely low backlash, and their compact designs provide large floor space savings.
- Wide range of Intersecting shafts 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 angular 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

## 7. APPLICATIONS

These couplings are especially good for Door shutter applications, 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.

## 8. CONCLUSION

Based on experimental observations and CATIA® 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 Intersecting shafts having proper angular misalignment by employing different geometries of L-pins and it is found that minimum number of L-Pins required are 3, for continuous smooth power transmission.

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