

# Gearless Transmission Mechanism and its Applications

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**ABSTRACT:** Gearless transmission mechanism transmits power from input to output shafts by means of sliding links that form revolute pair with the hub. Links bent at required angle slide inside the holes in the hub. Thus, as the holes in input hub rotate; it pushes the links and in turn output hub is rotated. This mechanism can be used as a replacement for bevel gears in low cost, low torque applications. It can transmit at any angle 0 to 180°. In this paper the mechanism is studied and a possible go-kart transmission layout is fabricated and few future applications are suggested.

**KEYWORDS:** gearless transmission, orbital transmission system, elbow transmission, non-parallel shaft transmission.

## I. INTRODUCTION

Bevel gears are generally used for transmission through non parallel shafts and worm and worm wheel and crossed helical gears are used for transmission through non parallel non intersecting shafts. This gears are costly to manufacture and come in standardized specifications thus limiting the flexibility of its application. [3]

So here we introduce gearless transmission mechanism which can transmit at any angle from 0 to 180°. The mechanism of made of input and output hubs with axial holes drilled along a p.c.d and circular links bent at the angle between two shafts. so for a non-standard angle between shafts; only the angle of the links needs to be changed whereas the whole gear is needed to be redesigned in case of bevel gears. This reduces the cost of this mechanism drastically and also increases its flexibility.

The work in this paper is divided into three parts: -

- Study of gearless transmission mechanism.
- Fabrication and manual analysis of a model using this mechanism which can be used in go-karts.
- Evaluating other fields of application of this mechanism.

## II. RELATED WORK

The mechanism is made of SRRS pair (sliding revolute revolute sliding) sliding pair between the input hub hole and the link; revolute pair between link and input hub; revolute pair between link and output hub; sliding pair between holes in output hub and the link [1]. The rotational motion of input shaft is converted into sliding motion of links which is then converted to rotational motion of the output shaft.

In this paper we have focused on transmission through non parallel shafts only.

View of the Shafts: -Below diagram shows a different view of the shaft arrangement which are skew and angle between them is 90 degrees, which helps us in the understanding of the arrangement of shafts. In below figure [1]

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Vol. 6, Issue 3, March 2017

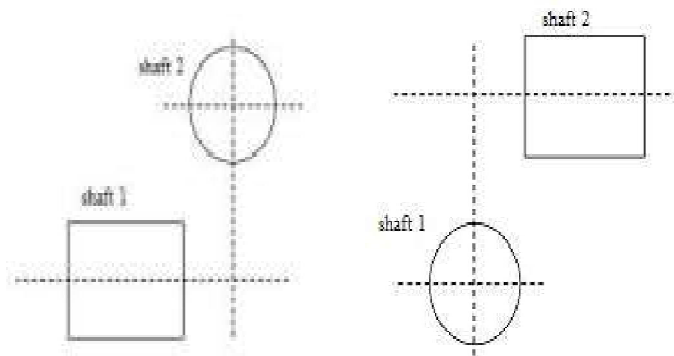


Fig. 1. Shaft layout

Views of Setup: -View of the setup is shown in figure. These view show the arrangement of links and shaft.

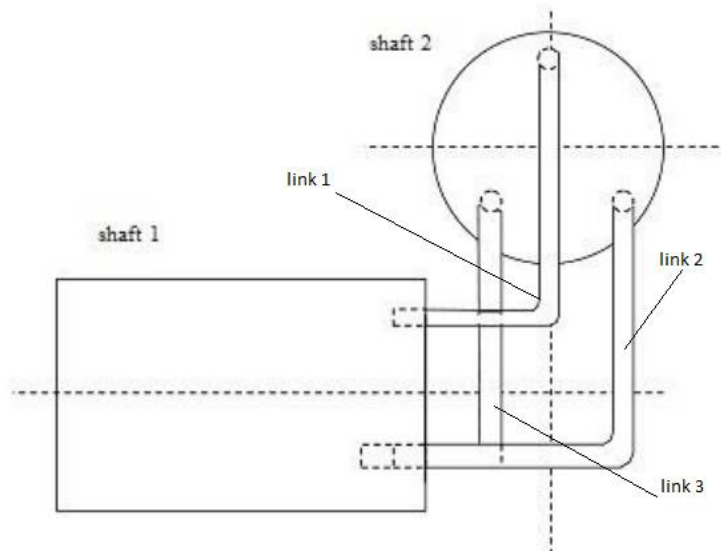


Fig. 2. Setup view

From the above diagram's and views the setup is clearly established in the mind, but as for convenience here we use the front view of the setup for analysing the mechanism of setup. Let at the starting instant shaft 1 starts rotation with 3 pins in anticlockwise direction and a reaction force developed at the pin surface which is in contact with the shaft and this force transferred to the other end of the pin which is in the shaft and applying on the shaft 2 due to which shaft 2 starts rotating in the same direction as shaft 1, after 120 degree rotation pin 1 comes at the place of pin 2 & pin 2 comes at the place of pin 3 & pin 3 comes at the place of pin 1 by sliding in shaft and self-adjusting. This motion repeated for next 120 degrees and further for next 120 degrees and pins are exchanging the position in successive order as discussed before.

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Vol. 6, Issue 3, March 2017

## III. METHODOLOGY

From the study of the mechanism, it was observed that any two pins must not lie on the same diameter. If this happens then the two links motion overlap each other because of this motion is interrupted. To keep the angle between any two pins not equal to  $180^\circ$ ; number of links must be odd and equally spaced along p.c.d.

### Fabrication of mechanism: -

For suggested model for go-kart transmission; two mechanisms are used for each wheel. Both input shafts can be driven by a single motor using a cross belt or by using two separate motors one for each shaft. The rotation direction of both motors needs to be opposite. While observing from front view; the left shaft needs to rotate clockwise and right input shaft needs to rotate anti clockwise for forward motion at the output wheels. If a single motor is used direction of rotation is opposite because of cross belt.

Dimension of various parts of the model were decided on the machinery and material available in the workshop and then a model was prepared in Modelling Software 'CREO PARAMETRIC 3.0 Student Edition M070'.

Shown below is the Top view & 3D view of the model.

- 1- Section 1 is where first gearless transmission system is located
- 2- Section 2 is the position of second mechanism
- 3- Section 3 is the mounting provision for motor. Based on the sense of rotation of motor, motor shaft is coupled with either the first transmission or the second. Motor can be moved left or right in the provided setup to adjust the belt tightness.

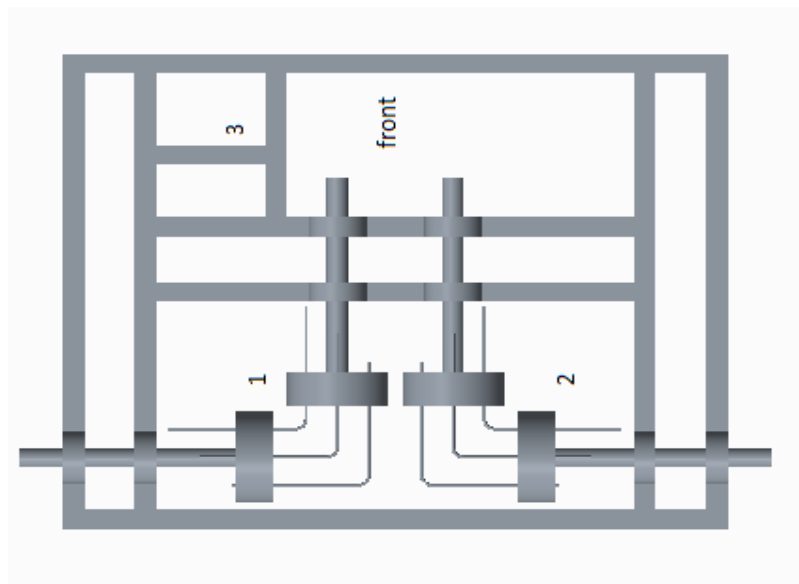


Fig. 3. Top view of model

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Vol. 6, Issue 3, March 2017

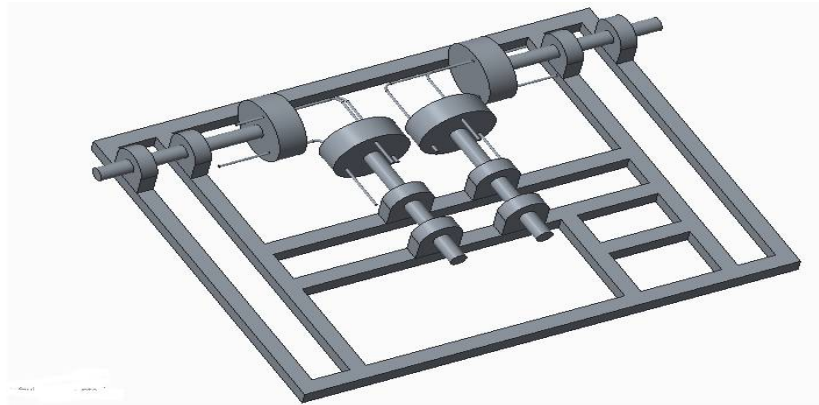


Fig. 4.3D view of model

### Details

Frame: square pipe 40mm\*40mm

- 1050mm \* 2 pipes
- 925mm\*4 pipes
- 750mm \*2 pipes
- 400mm and 200mm

Links: 10mm diameter rods \* 6

Hub: 140mm diameter,50 mm thickness and holes at p.c.d 100mm \*2

Shaft: 25mm diameter 500mm long \*4

Bearings: 25 mm pedestal bearings \*8

### Future applications:

Fabrication of pump and compressor requires very precise machining which was not available to us.so we decided to fabricate above model.

### 1.PUMP

Study of this mechanism also revealed that the output half of the mechanism is similar to axial piston pump. From the inner most point to the outer most point; the link moves outward which reassembles a suction stroke and when moving from outer most point to inner most point it has delivery stroke.

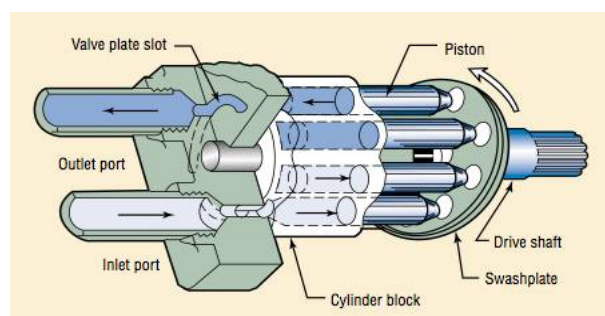


Fig. 5. Axial piston pump [8]

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Vol. 6, Issue 3, March 2017

To convert the mechanism into a pump; only a fixed plate is required to be attached to the output hub. Slots are made on the plate for inlet and outlet.

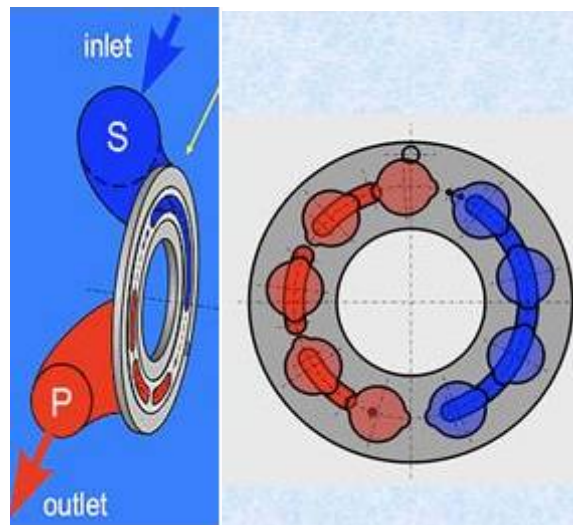


Fig. 6. Inlet outlet plate for pump

### 2. COMPRESSOR

Compressor application is similar to pump; only difference is that instead of a long slot for outlet, a single hole is given at the end of delivery stroke. Using this has benefits of both compressors; high delivery rate of rotary compressors and high compression ratios of piston compressors.

### IV. CALCULATIONS & RESULTS

Considering weight of model along with rider 150kg.

Therefore, weight of model =  $150 * g = 1500 \text{ N}$

Weight on each tyre =  $1500/4 = 375 \text{ N}$

Considering co-efficient of friction between road and tyre = 0.7

Frictional force on each wheel =  $375 * 0.7 = 262.5 \text{ N}$

This is the minimum force required to move the tyre.

Taking 14 inch tyre; radius = 0.1778m

Torque required to move tyre =  $262.5 * 0.1778 = 46.67 \text{ N-m}$

This torque is supplied by three links in the hub;

Torque on each link =  $46.67/3 = 15.55 \text{ N-m}$

Links are on p.c.d 100mm; radius = 0.05m

Tangential force =  $15.55/0.05 = 311.15 \text{ N}$

Diameter of each link = 10mm = 0.01 m

Shear force on link

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$$\begin{aligned} \tau &= \frac{\text{force}}{\text{cross sectional area}} \\ &= \frac{311.15}{3.14 \times 0.25 \times 0.01 \times 0.01} \\ &= 3963694.2675 \text{ N/mm}^2 \\ &= 3.96 \times 10^6 \text{ N/mm}^2 \end{aligned}$$

Taking link material C-45 [7] PSG data book 1.9

$$[\tau] = 45 \text{ N/mm}^2 = 45 \times 10^6 \text{ N/m}^2$$

so the minimum stress induced is within permissible limits

$$\text{For maximum stress } \tau = 45 \times 10^6 \text{ N/m}^2$$

$$[T]_{\max} = \frac{3.14}{16} * \tau * d^3$$

$$[T]_{\max} = 8.835 \text{ N-m}$$

For this torque maximum speed achieved by various power motors is

$$\text{Circumference of the wheel} = 2 * 3.14 * 0.1778 = 1.1171 \text{m}$$

For 1 RPS linear speed is 1.1171m/s

Power (H. P)	Torque (N-m)	Max speed (RPM)
1	8.835	806.72 (54.07 km/hr)
2	8.835	1613.44 (108 km/hr)

Table.1.Results

## V. CONCLUSION

After complete study of the mechanism, we understood that this mechanism is mainly applicable to low cost applications where torque is low to medium. With future development in low friction materials (graphene coating) and stronger composite materials, the efficiency and capacity of this mechanism can be increased. Also if instead of bent links, bolted links or links held by universal joints [2] are used then transmission is possible even when angle changes on the go.

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