An Experimental Investigation to Design and Fabricate Gearless Transmission System for Power Transmission between Shafts

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***Abstract*— In current scenario Industries are in need to eliminate the gear transmission which requires high level of maintenance so in order, effective gearless power transmission arrangement is used for skew shafts to transmit power. In Gearless transmission system in order to transmit power odd numbers of pin or links are used which represents the shaft diameter in centers of any two lines. Increase in number of links and pins will give a smooth motion but it will not be cost effective and also it will not advisable due to strength of shaft. In Shaft both ends are drilled according to the size of Pins or links that are to be fixed may be permanent or temporary in which motion is to be transferred. The dimensions and angle of the pins or links are drilled accurately and precisely. In our experimental setup skew shafts are used in order to change the angle between shafts during the rotary motion or intermittent motion with own axis in rotational motion. In our experiment the result of gearless transmission is very effective and smooth arrangement with minimum power loss.**

Index Terms— skew shaft, Gearless Transmission, revolute pair, sliding pair, hyperboloids.

I. INTRODUCTION

Manufacturing of gears become very complex where skew shafts for power transmission for with the help of either crossed helical gear or worm gear or hypoid gears in a machine. Standardization of gears leads to an effective power transmission because power loss in gears are limited due to sliding motion and the shaft orientations is very limited and the system works in better response and accurate.

So in order to eliminate these loses and to transmit the power between skew shafts and to reduce power loses, introduced a gearless power transmission system that leads to reduction of cost & results in time and space. The mechanism proposes an interesting fact which makes the system to allow the motion changing in the orientation of shafts.

While the research works focused on getting a solution for skew shaft power transmission, It has been noticed that gearless transmission can be used for both skew shafts and intersecting shafts during the analysis of mechanism.

The transmission of gearless mechanism gets the output through internal combustion engines in order to the drive wheels. Anyhow such IC Engines had to be operated in starting, slower travel and stopping the transmission in high rotational speed. The transmission reduces the higher engine speed with increasing torque in the process to the slower wheel speed. Transmissions which can also be used on pedal type bicycles and fixed machines where different torques and rotational speeds are adapted.

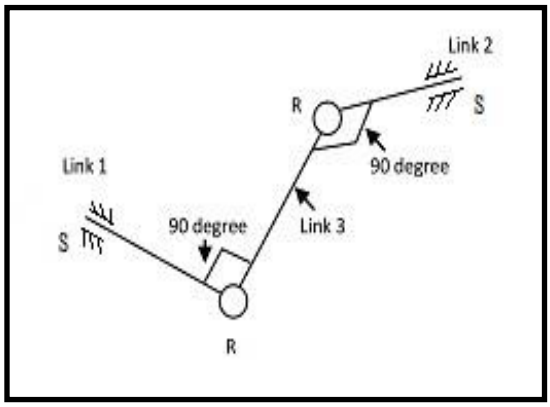

Fig. 1. SRRS Link in space

II. LITERATURE REVIEW

A. Skew Shaft

The term “shaft”, that is widely used, is manufactured with standards which have a specification to all elements of part and which are used in wide applications. Shaft is made up of cylindrical shapes. Term Skew refers to non-intersecting and non-parallel power transmission these are known as skew shafts.

B. Crossed helical gears

A helical gear provides better advantage over spur gears. The leading edges do not have parallel teeth to rotation among axis but they are properly ser at an angle. Tooth shape is to be helix, Since the gear is curved. Helical gears can be used for operations like parallel and crossed orientations. Skew refers to non-intersecting and non-parallel power transmission these are known as skew shafts, sometimes known as "skew gears". For a 'crossed' or 'skew' gear configuration, the gears must be designed to have normal pitch and the same pressure angle. At the same time, helix angle and handedness can be of different ratio. Two skew shafts with helix angle between two respective handedness and two respective shafts may be defined as,

$E = \beta_1 + \beta_2$ for gears of the same handedness.

$E = \beta_1 - \beta_2$ for gears of opposite handedness.

C. Worm Gears

A worm drive is a gear setup arrangement in which a worm in a form of a screw that meshes with a worm gear also called as worm wheel that appears alike spur gear that is used for transmitting power. The term worm gear has a use that is used to drive the worm linkage that is connected with the shaft. Worm gear has an additional feature that in drive the speed can be reduced and can transmit the higher torque where the linkage power is transmitted.

Worm gears linkage has three types, In that first type is typically called as non-throated worm gears. These gear setup which don't have a groove, or throat, and machined around the circumference area of either the worm or worm wheel. The second type is called as single-throated worm gears, where the worm wheel is throated. The third and final type is double-throated worm gears that have both gears throated. This type of gearing will render support even during highest loading. An enveloping (hourglass) worm is a setup of one or more teeth which increases in diameter and shape from its middle portion which tends toward both ends that is called as Double-enveloping worm gearing setup which comprises enveloping worms that are mated with fully enveloping worm gears. It is also known as globoid worm gearing.

D. Hypoid gears

Hypoid gears resemble spiral bevel gears only difference is that except the shaft axis does not intersect each other. The pitch surfaces are in conical shape but, to mate with the offset shaft, are also looks alike hyperboloids of revolution. Hypoid gears are gears that are designed in order to transmit the power at an angle of 90 degrees in order to transmit power in shaft. According to the offset angle of the shaft that is required that contacts between hypoid gear teeth which results in smooth and spiral bevel gear teeth gears. This setup have a meshing teeth along with sliding action which requires more viscosity like gear oils and grease between the mating tooth faces, these are generally designed for special type of HP oils followed by the number that denotes the viscosity of the oil that is to be used.

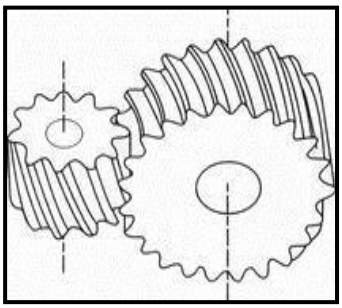

Fig. 2. Crossed Helical Gears

Hypoid gears with a single set with higher feasible system can be designed with fewer teeth's of a spiral bevel pinion, that may result In the gear ration as 60:1 ratio where transmitting become smoother. These types of gear setup is most commonly used in driving differentials of mechanical systems where normally straight cut bevel gears that are used in axles of motor vehicles.

III. COMPONENTS OF THE MODEL AND OPERATION

1) Motor
2) Support frame
3) Shaft
4) Ball bearing
5) Nut and bolt

A. Motor

An electric motor is generally used to convert electrical energy into mechanical energy. The reverse of this process can be achieved (i.e. the conversion of mechanical energy into electrical energy) by help of an electric generator.

B. Support frame

Support Frame is in build with Frame Motor to move larger structures like airships, flying and other moving machines and even to very smaller structures. They can also be used in creating large structure such as bridges. It is also noted that joining to a block which is blocked by another block may leads the motor unable to move them.

C. Shaft

A shaft is a circular in cross section element which is usually used in rotating machine operations that is used to transmit the power from one end to another in an effective manner or even to transfer power from a machine to another machine. The various components such as gears, pulleys and other components are mounted on it for effective transmission of power.

D. Ball Bearing

A ball bearing is a rolling type of bearing which uses small balls made up of steel in order separate the bearing races. The purpose of a ball bearing is to support the radial and axial load at even higher torque also to reduce rotational friction that happens between bearing races.

Power transmission is easily possible as the small balls carry the load within the two bearing races. In almost applications one race is fixed with shaft or hub and other is connected with small balls. As one of the bearing races rotates in shaft it may causes the balls to rotate as well. Because the balls which are rolling they have a much lower coefficient of friction than if two flat surfaces with lubrication were sliding against each other.

E. Nut and Bolt

A nut is a type of fastener containing a standard threaded hole. Nuts are almost always used in order to mate opposite pair bolt to fasten joining of parts together. The two partners are always kept together in a pair of combination with their threads' friction, a slight stretch in the bolt, and compression of the mated parts. In applications with rotation and vibration

there is a chance for loosening of nuts, in order to avoid such situations nylon inserts and other adhesives are used.

IV. WORKING PRINCIPLE

A. View of the Planes

Mechanism and movement of gearless transmission is shown in 3D in order to easy understanding of the complete setup which is shown in below Fig.3.

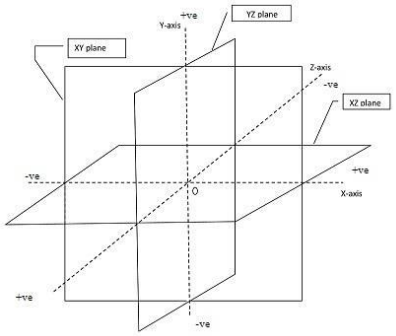

Fig. 3. View of the planes

B. View of the Shafts

Arrangement of shafts for ease understanding is proposed in below figures. It shows the schematic representation of Skew and angle of shafts properly arranged in below figure 4(a) front view 4(b) side view

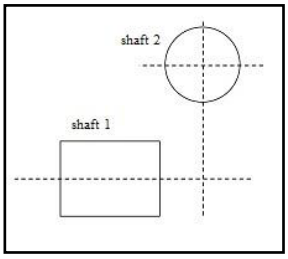

Fig. 4(a). Front View

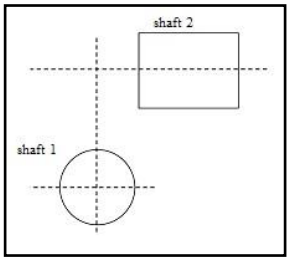

Fig. 4(b). Side View

C. Views of setup

Arrangement of gearless transmission setup and its views are shown in order to show the arrangement of its linkages and shafts. Different views of the setups are shown in below Figure 5 (a) Front view. 5 (b) Side view

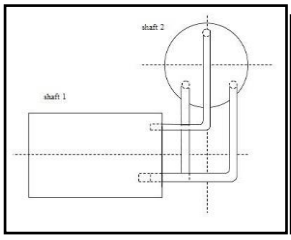

Fig. 5(a). Front View

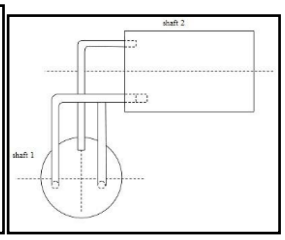

Fig. 5(b). Side View

D. Views of the Pins

In below figures 6. (a) 6. Front view (b) Side view, it is clear that how pins used for linkages is used. These pins are used in gearless transmission process for transmitting the power when there will be no change in arrangement of shafts during motion and power transmits state.

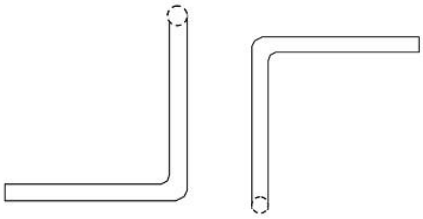

Fig. 6(a). Front View Fig. 6(b). Side View

E. Type of SRRS Links Used

The below Figures types of linkages are used for connecting skew shafts which provides flexibility in motion. Figures 7(a) SRRS link type 1. 7(b) SRRS link type 2. These types will clearly explain the transmission of power. SRRS Link type 1 and SRRS Link type 2 will play a vital role in upcoming discussion remember these linkage types that are used for power transmission state. These linkages will be a key factor for transmitting power from one shaft to other with equitant torque and speed.

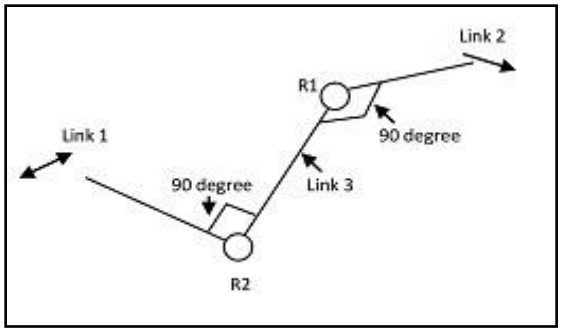

Fig. 7(a). SRRS Link type 1

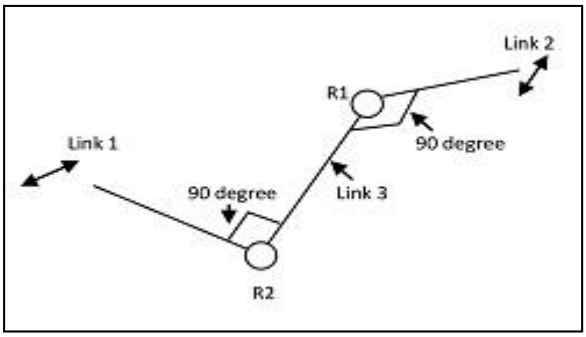

Fig. 7(b). SRRS Link type 2

V. ARRANGEMENT OF PINS IN SHAFT

Arrangement of pins is followed in order to connect the shafts with holes of the skew. These are arranged in odd order where such pins are arranged like 3, 5, 7, etc. and the diameter and angle of shafts are represented by centers of any two pin holes that should be equal for smooth power

TABLE I
PINS AND ANGLE OF SHAFTS

No. of pins	Angle between consecutive hole(degree)	Is value of angle with any integral equal to 180 degree	Value of integral
2(even)	180	Yes	1
3(odd)	120	No	No integral
4(even)	90	Yes	2
5(odd)	72	No	No integral
6(even)	60	Yes	3
7(odd)	51.43	No	No integral
8(even)	45	Yes	4
9(odd)	40	No	No integral

transmissions even at higher shaft speed and torque. Value that is multiplied with any integer should not be equal to 180 degree can be used.

Let the Value of angle = x degree

Then n*x ≠ 180 degree. Then n is an integral value.

The angle of pins should not be 180 degree, at that point the line will lie on same angle. During this point linkages and pins are overlapping each other which may affect the power transmission. So, same angle lying on same line should be avoided.

The below table.1 represents why the pin number should be odd and angle between consecutives should be equal. Relationship between consecutive angles and value of integers are studied using below Table-1.

Only odd number of pins can be used in setup. That can be clearly seen from table.1, where there must be integral, which multiplication of angles gives the values of 180 degree. So even number of pins cannot be used for power transmission only odd number of pin can be engaged.

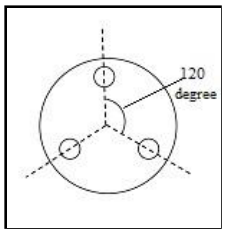

Fig. 8. View of Shaft with Holes

A. Analysis of Mechanism

Front view of the system is used to forecast the setup of mechanism. Though the above views clearly forecasts and established in minds, for convenience front view is shown below Fig.9.

Where the starting instant shaft 1 which starts rotation with 3 pins in the anticlockwise direction which is used to transmit power between shafts to other end of pin where shaft 2 due to the rotation in same direction that of shaft 1. After completion of 120 degree rotation after that pin 1 comes at the place of pin 2 & pin 3 comes at the place of pin 2 & pin 1 comes at the place of pin 3 viceversa by sliding in shaft and which may be self adjusting. Ever rotation of 120 degrees motion may be repeated in successive position in order to exchange the pins of 120 degree in successive order as discussed before.

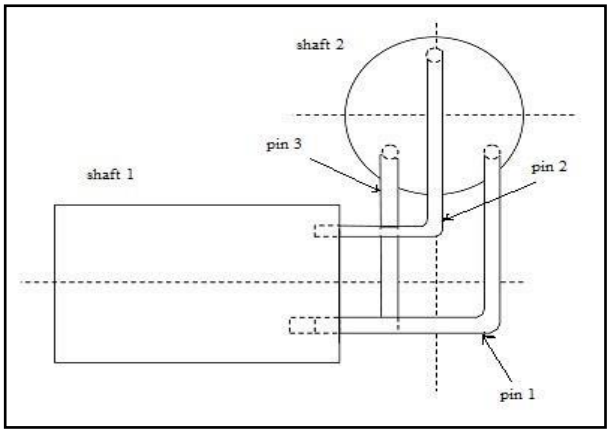

Fig. 9. Setup Front View

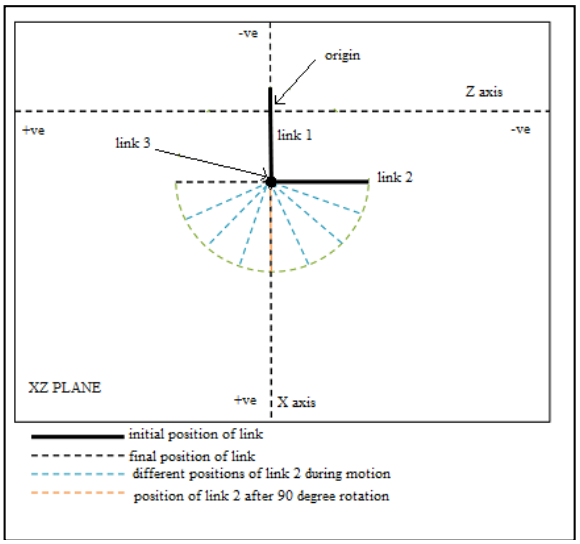

Fig. 10. Movement of Link 2 of Link Type 1 in XZ Plane

Working with pins – pins that are used in the setup for power transmission where there may be no chance for pin position change during the rotation motion where high speed transmission is required.

Working with links- links are used in the power transmission arrangement where change of pins and flexible motion is required during changes in motion or during intermittent motion.

1) Working with link type 1 shows the motion of shaft 2 that is moved in xy plane from starting position to final position which is shown in Fig.10.

2) Working with link type 2 shows the motion of shaft 2 that is moved in YZ Plane from the initial position to final position as indicated in section E and also in below Fig.11.

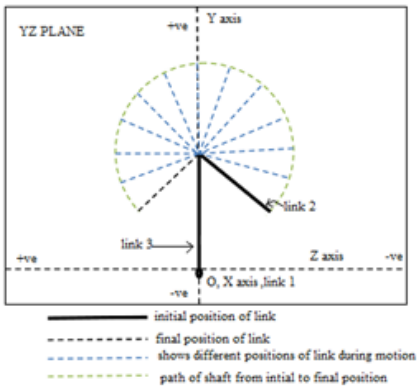

Fig. 11. Movement of Link 2 of Link Type 2 in YZ Plane

VI. GEAR LESS TRANSMISSION SYSTEM COMPARISON WITH EXISTING SOLUTIONS

1. Gearless transmissions may be installed for shafts of any diameter which may be standard or non standard which covers of all dimensions and length. It is not possible with a geared transmission as it requires a complex system of manufacturing of gears and standardization plays a wide role there, where dimensions like diameter are of standards.
2. This arrangement with pins can be used for power transmission with higher loads and speed which cannot be achieved through worm gear and crossed helical gears.
3. As there is no standard specifications used in any component, reduction of machine size can be achieved and large space saving can be achieved easily without the shafts dimensions limit.
4. Low Repairing cost on failure of any single component in entire setup.
5. Very low setup cost.
6. Installation setup time is very limited.
7. Easy manufacturing of links and pins when it is compared with manufacturing of crossed helical and worm gear.
8. Very less skill is required for setup.

Fig. 12. Design and Fabricated Gearless Transmission Setup

VII. APPLICATIONS

Applications of gearless transmission with skew shafts are used in power transmissions with low power torque and with same driver and driven shaft speed is required. In order to transmit power effective and smooth skew shafts are used. These are used in watches, railways, and smaller setups with low power torque. With minimum power loss an effective power transmission can be achieved in less amount of space and where the cross helical gears and other elements cannot be used in similar applications.

VIII. CONCLUSION

Experimental setup working setup is observed and continuously monitored and this may be used for any set of diameters and for any angle. Skew shaft can transfer power only in its axis and shaft with rotational motion only for equal R.P.M of driver and driven shaft. It is also observed that operation is smooth and reliable, employing the links and type of pin that is used for connecting the revolute pair with skew shaft. In our experimental setup skew shafts are used in order to change the angle between shafts during the rotary motion or intermittent motion with own axis in rotational motion. In our experiment the result of gearless transmission is very effective and smooth arrangement with minimum power loss.

REFERENCES

[1] A. Kumar and S. Das, “An arrangement for power transmission between co-axial shafts of different diameter”, International journal of engineering research and technology, ISSN:2278-0181, vol. 4, (2015) January.
[2] Faraday, Michael (1822). "On Some New Electro-MagneticalMotion, and on the Theory of Magnetism". Quarterly Journal of Science, Literature and the Arts. Royal Institution of Great Britain. XII: 74–96 (§IX). Retrieved 12 February 2013.
[3] Tom McInally, The Sixth Scottish University. The Scots Colleges Abroad: 1575 to 1799 (Brill, Leiden, 2012) p. 115
[4] "The Development of the Electric Motor,". Early Electric Motors. Spark Museum.
[5] Prof. A. Kumar and S. Das, “An arrangement for power transmission between co-axial shafts of different diameter”, International Journal of Engineering Research and Technology (IJERT), ISSN: 2278-0181, Volume 2, Issue 2, March 2013, Page .no: 338-347.
[6] Prof. B. Naveen Bardiya, T. karthik, L Bhaskara Rao “Analysis and Simulation of Gearless Transmission Mechanism", International Journal Of Core Engineering & Management (IJCEM) ,Volume 1, Issue 6, September 2014, Page.no: 136-142.
[7] Prof. Mahantesh Tanodi, “Gearless power transmissionoffset parallel shaft coupling", International Journal of engineering Research and Technology (IJERT), volume 3, Issue 3, March 2014, Page.no.129-132.
[8] Franke A, Greiner J, Gösele A, Kiesel J, Sperber R,Stenkert J, Wagner B, Weiss P (2004) Triebstrang andGetriebe (Powertrain and Transmission).ATZ/MTZSonderausgabe 10/2004: Die neue Mercedes-Benz A-Klasse: 150–159
[9] Grad K (2005) Development Trends for Tractor Power trains. 3rd AVL International CommercialPowertrain Conference, 20th–21st April 2005, Graz,Austria.
[10] Greiner J, Dörr C, Nauerz H, Graeve M (2004) The new „7GTRONIC“ of Mercedes- Benz. InnovativeTransmission Technology for Better Driving Performance,Comfort and Fuel Economy. SAE 2004-01-0649
[11] Greiner J, Indlekofer G, Nauerz H, Dorfschmid J, GödeckeT, Dörr C (2003) Das neue Automatikgetriebe 7GTRONICvon Mercedes-Benz (The New AutomaticTransmission 7G-TRONIC of Mercedes-Benz). ATZAutomobiltechnische Zeitung 105, Nr. 10: 920–930
[12] Hata H, Kamiya M, Nagamatsu S (2005) Development ofa New Hybrid Transmission for FWD Sports UtilityVehicle. Toyota Technical Review Vol. 54 No. 1. ToyotaMotor Corporation, Aichi (Japan), ISSN 0916-7501
[13] Hoffmann C, Würfel A (2002) Dreiwellengetriebe – Diekurze Art, Sechsganggetriebe zu bauen (Three-ShaftTransmissions – The Short Way to Build 6-Speed-Transmissions). ATZ Automobiltechnische Zeitschrift104, Nr. 12: 1090–1099.