International Journal of Mechanical Engineering and Robotics Research

ISSN 2278 – 0149 www.ijmerr.com
Vol. 3, No. 4, October 2014

Research Paper

MECHANICALLY VARIABLE STEERING RATIO GEAR BOX

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All vehicles today have a fixed or set steering ratio for their steering mechanism depending upon the type and purpose of the vehicle.Steering ratio is the amount of rotation given to steering wheel for a unit degree rotation of road tires. But the performance of this system does not change with changing road and dynamic condition of vehicle. Hence there is a need to vary the steering ratio of vehicle depending upon the conditions in which it is being driven. For instance we require low steering ratio (12:1 to 7:1) during parking and low speed cornering condition whereas we require moderate steering ratio (18:1 to 24:1) at high speed to maintain dynamic stability of the vehicle. Using this steering gear box the driver can manually change the steering ratio of its vehicle to adjust to the condition. The following article focuses on production and use of this gear box on a typical vehicle.

Keywords: Variable steering ratio, Continuous meshing gear box, Active steering, Manually operated gear shifting catcher

INTRODUCTION

Steering is a system that is used in most type of transport to control the movement of the vehicle. Steering mechanism is the vehicle movement control system that includes few main components which are the steering wheel, the steering column, the steering rack and the vehicle wheels.

The gear box is placed in the steering shaft for this case in between steering wheel and pinion of rack.

The main objective of the gear box is to change the steering ratio of the vehicle between two settings one for higher ratio and one for lower.

For case study the high steering ratio is taken as 22:1 and low steering ratio is take as 16.5:1.

CONSTRUCTION

The gear box is a continuous meshing type gear box having three set of gears in continuous meshing at all times. However

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the torque is supplied through two sets only at a given time. It consists of steering shaft coming from steering wheel, a secondary shaft and a pinion shaft connecting to pinion as shown in Figure 1 (without catcher). It also consists of a catcher which engages the required set of gears as shown in Figure 2.

Figure 1: Gear Box Without Catcher

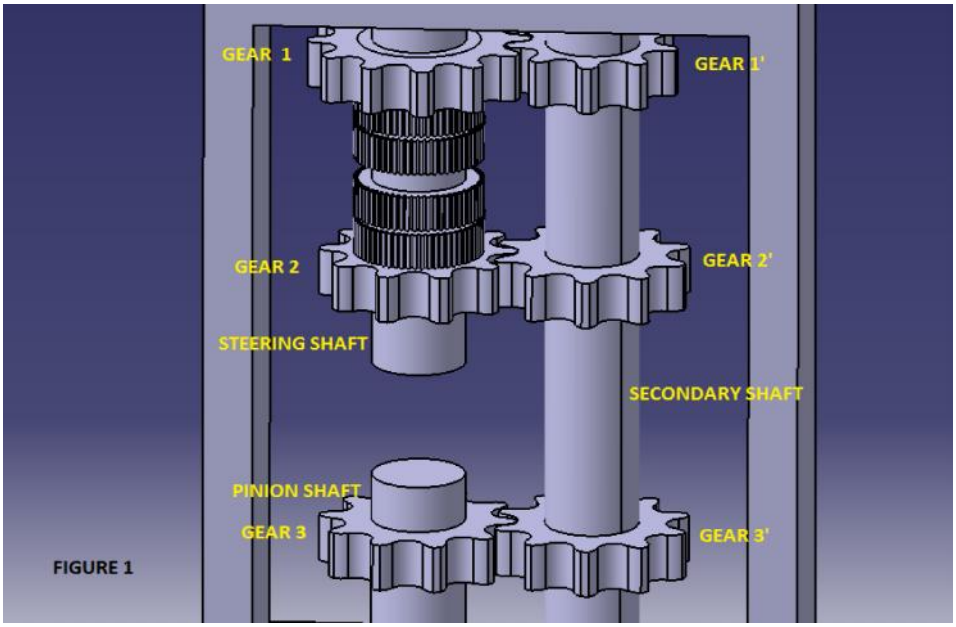

Figure 2: Gear Box with Catcher and Lever

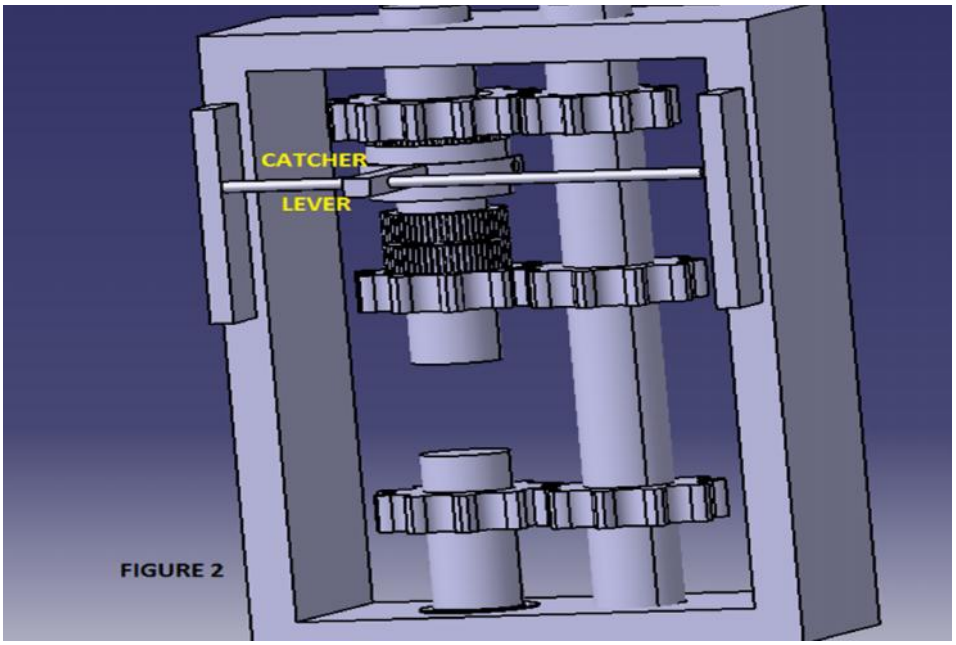

Table 1: Gears Specification

Gear	Bore	Pitch Diameter	No of Teeth	Thickness	Specifications
1	25 mm	40 mm	12	20 mm	Free from steering shaft through needle bearing. SPLINES
1'	18 mm	30 mm	9	20 mm	Fixed on secondary shaft
2	25 mm	35 mm	10	20 mm	Free from steering shaft through needle bearing. SPLINES
2'	18 mm	35 mm	10	20 mm	Fixed on secondary shaft
3	25 mm	35 mm	10	20 mm	Fixed on pinion shaft
3'	18 mm	35 mm	10	20 mm	Fixed on secondary shaft

The specification of gears is mentioned in Table 1.

ASSEMBLY AND WORKING

The assembled view of the gear box is shown in Figure 2.

Gear 1 and Gear 1'; Gear 2 and Gear 2'; Gear 3 and Gear 3' are in continuous meshing with each other. Gear 1 and Gear 2 are free from steering shaft through needle bearings. Catcher engages the splines of these free gears with the steering shaft splines on lower and upper setting of lever respectively.

When lever of catcher is on lower setting. Torque transmission follows following path:

Steering shaft – gear 1 – gear 1' – secondary shaft – gear 3' – gear 3 – pinion shaft.

Hence total rotation of steering shaft is lesser than that of pinion shaft (due to gear 1 – gear 1'). Hence the steering ratio is lowered or decreased.

Similarly, when lever of catcher is on upper settingtorque transmission follows following path:

Steering shaft – gear 2 – gear 2' – secondary shaft – gear 3' – gear 3 – pinion shaft.

Hence total rotation of steering shaft is equal to that of pinion shaft (due to gear 2 – gear 2'). Hence the steering ratio remains same.

CALCULATIONS INVOLVED

Gear ratio for 1 – 1' = T1/T1' = N1/N1' = D1'/D1 = 4/3 = 1.33

Steering ratio obtained = 16.5:1

Gear ratio for 2-2' = T2/T2' = N2/N2' = D2'/D2 = 1

Steering ratio obtained = 22:1

GEAR RATIO FOR 3 – 3' = 1

ADVANTAGES

1. Variable steering ratio can be easily achieved without customizing rack or using heavy mechanisms.
2. The mechanism give similar results as active steering but the overall cost of gearbox is much lower and mechanism used is much simpler.
3. Shifting of ratio is driver controlled and easily possible during running as well.
4. The gearbox can be designed to obtain any gear ratio and thus any steering ratio depending upon vehicle and conditions.

RESULTS AND DISCUSSION

The steering ratio of the given vehicle can be manually changed between:

16.5:1 (upper configuration of catcher)

22:1 (lower configuration of catcher)

The steering ratio can be changed according to the need of vehicle.

CONCLUSION

Thus we see that the basic advantage of active steering, i.e., variable steering ratio can easily be obtained using this gear box.

The applications of the gear box have a wide range for various vehicles but this system is much less inexpensive as compared to the high end expensive vehicle's active steering. Thus it can be used for normal commercial vehicles available in market today at a low cost.

REFERENCES

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