DESIGN AND FABRICATION OF FNR PLANETARY GEAR BOX

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Epicyclic gear trains are utilized in the design and fabrication of FNR planetary gear box (Forward, Reverse and Neutral). FNR gear boxes are utilized in autos, forklifts, and trucks with automatic transmission to operate the vehicle in three required modes subsequently transmitting power from the engine to wheels. The planet gears in gear train act as idler gears that achieve the required reversal torque with a reduction gear ratio. Planetary gearboxes are worthwhile as the load is divided by three gears at a time and three teeth each in the sun and ring gear. Hence higher torque can be transmitted in a small area with required gear ratio.

***Keywords*:** Epicyclic gear, Planet gear, Torque, Ring gear

1. Introduction

The elliptical gear is standard for providing excellent characteristics like accurate transmission, compact size, and easy equilibrium. Hence elliptical gears have been successfully used in various types of automatic machinery, packaging machines, quick-return mechanisms, flying shears, pumps, flow meters, and a wide array of instruments. The overall gear ratio of a simple planetary gear set can be reliably calculated using the following two equations, representing the sun-planet and planet-annulus interactions respectively:

$$Ns\ \omega s + Np\ \omega p - (Ns + Np)\ \omega c = 0$$

$$Na\ \omega a - Np\ \omega p - (Na - Np)\ \omega c = 0$$

Where,

ωs, ωp, ωc, ωa are the Angular velocity of the Annulus, Sun gear, Planet gears and planet Carrier and Ns, Np, Nc, Na are the Number of teeth of the Annulus, the Sun gear and each Planet gear respectively.

From which we can deduce that,

$$Ns\ \omega s + Na\ \omega a = (Ns + Na)\ \omega c \text{ (or) } -\frac{N_a}{N_s} = \frac{\omega_s - \omega_c}{\omega_a - \omega_c}$$

Considering $\boldsymbol{\omega_a \neq \omega_c}$

Alternatively, if the number of teeth on each gear meets the relationship, Na = Ns + 2Np

The equation can we rewritten as the following,

$$\eta\omega_s + (2+\eta)\omega_a - 2(1+\eta)\omega_c = 0$$

$$\text{Where, } \eta = \frac{N_s}{N_p}$$

These equations are used to analyse the epicyclic gear system including the manual transmission system in which the output is relatively provided by the two input of the system.

2. Literature Review

In the past, elliptical gears have not been widely used in industry because of difficulties in their design and manufacture. To date, little research has been devoted to this topic. Most research has focused on computer-aided design (CAD) and kinematic analysis of elliptical pitch curves [3~6].

Litvin [7, 8] proposed extending tooth evolute curves to form the tooth profile, and derived the tooth evolute of an ellipse. Chang [9] developed a mathematical model of elliptical gears, based on the tooth evolute curve, whose rotation shaft coincides with one of its foci. A computer program for generating the tooth profile of elliptical gears was also developed by Chang.

Dooner [10], Kochev [11] and, recently, Yao and Yan [12] proposed the use of non-circular gears in order to cut back speed fluctuations in rotating shafts or to balance both shaking moments and torque

Fluctuations in planar linkages, whereas Emura and Arakawa extended the utilization of elliptical gears to steering mechanisms [13].

Qin et al. [14] studied the dynamic reliability of wind turbine gear system. Hu et al. [15] established a reliability model for a closed planetary gear system, which considered the effects of load, tooth width and load sharing on the reliability of the gear system. Zhou et al. [16] thought-about reliability based mostly sensitive factors to conduct the reliability analysis for the planetary gear system in shearer mechanism.

3. Design of Gear Box

The design of FNR planetary gear is shown in Fig. 1 below.

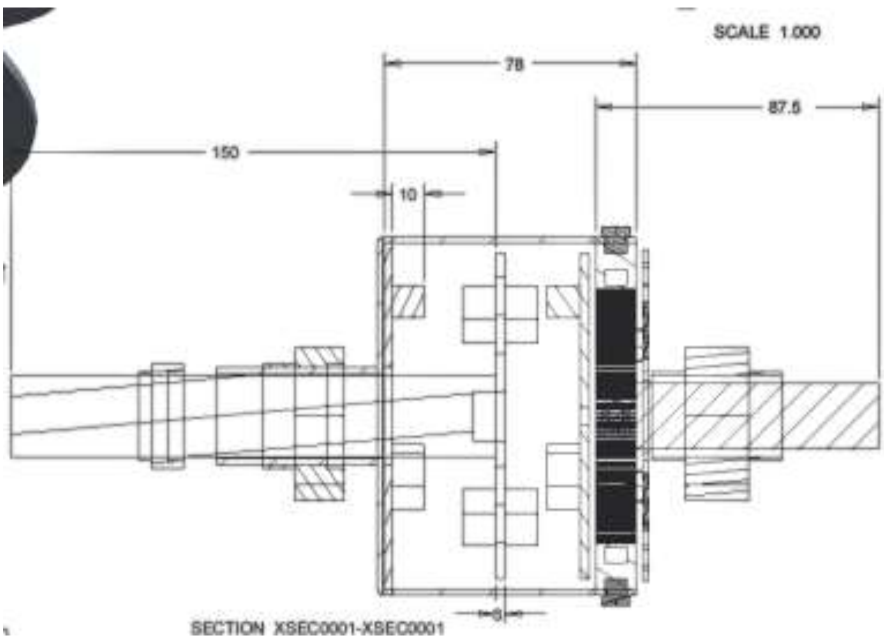

Fig. 1. Design of Gear Box

5.1 Sun Gear

Pitch Diameter = 26 mm

Number of Teeth = 26

Module = 1

Pressure angle = 200

Material = Cast Steel Grade 1

Tensile Strength = 550MP

5.2 Planet Gear

Pitch Diameter = 26 mm

Number of Teeth = 26

Module = 1

Pressure angle = 200

Material = Cast Steel Grade 1

Tensile Strength = 550MPA

5.3 Ring Gear

Pitch Diameter = 78 mm

Number of Teeth = 78

Module = 1

Pressure angle = 200

Material = Cast Steel Grade 1

Tensile Strength = 550MPA

5.4 Input Shaft

Diameter = 25mm

Material = Mild Steel

Shear Strength = 80MPA

Length = 150mm

5.5 Ring Hub

Inner Diameter = 110mm

Outer Diameter = 116mm

Material = Mild Steel

Shear Strength = 80MPA

Length = 150mm

4. Design Considerations

The consideration that is used for the calculating the Gears are given in the table.1 below.

Table.1. Design Considerations

Engine	Honda City 1498 cc
Maximum Power	98.6HP @ 3600RPM
Maximum Torque	200NM @ 1750RPM
Young’s Modulus	250MPA
Poisson’s Ratio	0.3
Yield Strength	550 N/MM2
Service Factor	1.25
Factor of safety	1

5. Assembly of Components

The various components of gear box are modelled in CAD software and are assembled as shown in Fig. 2 below.

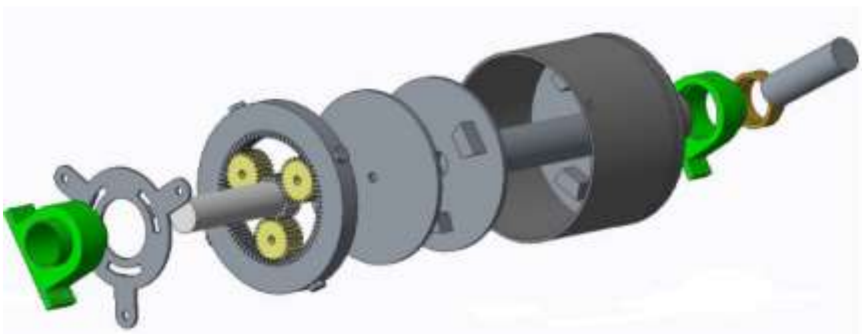

Fig. 2. 3-D Model of Gear box

7. Fabricated Components of Gear Box

The fabrication process is carried out accordingly and the components are shown below.

Fig. 3. Input Shaft

Fig. 4. Output Shaft

Fig. 5. Planetary Gear Set

Fig. 5. Ring Hub

Fig. 6. Output Shaft

8. Fabricated Components of Gear Box

Thus, the design and fabrication of FNR-PLANETARY gear box is complete and it suits its purpose of operating a 98HP engine of HONDA CITY car at the rated rpm and torque of 200NM with the output of 600NM. It is less expensive when compared with other FNR gear boxes available in the market and is highly reliable with compact size and weight.

Fig. 7. Fabricated Gear Box

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