IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A STUDY ON PLANETRY GEAR SYSTEM

Rishab Raj[1], Nazim Afzal[2], Hritik Kumar[3], Sourav Chowrasiya[4], Koushik Gope[5]

[12345]School of Mechanical Engineering, Lovely Professional University, Phagwara, Punjab

Abstract

This article summarizes different types of planetary gear system. It is a multi-stages complex set of one sun gear and three planetary spur gears and one inner diameter gear. For any power transmission, spur gear and helical gears are the widely used gears in automobile industry. Research on this topic has increased drastically over few decades. A good amount of research has already been done on this topic till date that explain its challenges and shortcomings. This paper gives a brief review of research done by various researchers and their findings are cited below which shows their working and applications.

Keywords: - Gear, spur gear, engine, power, speed, motion, gearbox, torque, epicycle

Introduction

A planetary gear system is a collection of gear teeth that assist transfer power from one shaft to another. It aids in the discussion of output torque. It sits between the crank shaft and the moving wheel. It's frequently used in the car sector, as well as in energy transfer for CNC lathe, forklifts, and heavy machinery. This gear assists in separating the engine from the drive axle as well as lowering engine performance in the ratio of 4:1 in passenger cars and a bigger ratio in large vehicles such as tankers and buses. But besides that, they're also useful for operating wheels at different velocities. Due to the stretching of the pavement cushion, it delivers the relative displacement between motor and the driving axles. The output shaft, cushion shaft, lay shaft, gear, dog gearboxes, sprocket livers, and constant mesh device are all part of this system. This is separated into two parts, one for manual gearbox and the other for drive system. Because manual gearboxes are less economical than clutch transmissions, they are normally found in vehicles and buses, whereas automated transmissions are found in automatic lift systems. The epicycle gearbox, commonly known as a planetary gear set, is a form of autonomous transmission gearbox used during high torque transfer and velocity control. Automatic transmission systems also employ this gear arrangement Spur gear, helical gear, or bevel gear can also be used in epicycle mechanical devices. A basic drive shaft consists of one sun gear, planet gear, ring gear, planet carrier,

and break. A compound gear train includes among one sun gear, planet gear, ring gear, planet carrier, and break. The Epicycle gearbox's operating concept is related to the fact that any of the solar gear, planetary gears, or annular gear could well be fixed to get the needed power or velocity output. As a result of any of the foregoing, gear ratios vary from heavy loads to high speed. Spur gear, helical gear, or bevel gear can also be used in epicycle mechanical devices. A basic drive shaft consists of one sun gear, planet gear, ring gear, planet carrier, and break. A compound gear train includes among one sun gear, planet gear, ring gear, planet carrier, and break. The Epicycle gearbox's operating concept is related to the fact that any of the planetary gears, or annular gear could well be fixed to get the needed power or velocity output. As a result of any of the foregoing, gear ratios vary from heavy loads to high speed. These gears are extremely compact and versatile.

Review of Literature:

Following are some of the research findings from various researchers:

Chaudhari et al. [1] did a comprehensive study of planetary gear box and have also studied about the load analysis optimization. From their review they concluded that all the parts of epicyclic gear box are working under safe limits and for the failure criteria they have used the Von Mises stress analysis.

Tongjie Li et al. [2] mentioned that the transnational traits of planetary outfit trains with torsional climate, time- varying entrapping stiffness, and a couple of outfit reactions, and primarily grounded on their estimate which concludes that the planetary tools set has two coinciding periodic route ways with long- term balance with the unique set of parameters; i.e. one is P-4 periodic stir, and the different is P-8 periodic stir

Yongliang Yuan et al. [3] described about the Automatic pin machine which are common in mechanical and electronic industries and it has been used primarily for automatic assembly of pinhole parts. From their review they concluded that planetary gear train is established by analysing the pin machine's working mechanism and the dynamic properties of various operating situations are examined.

James Yang et al. [4] described about the special planetary equipment trains over resemblant shaft tools trains and additionally they've written about including demand of planetary equipment trains for excessive velocity and low vibration and low noise. In their evaluation they discussed the dynamic model of planetary gear system and solution were shown in terms of mesh phasing, load sharing and other parameters.

Ali Tatar et al. [5] discussed in his paper how gearbox parameters effect the dynamic behavior of a planetary geared rotor system with numerical simulations and experiments and also emphasizing the importance of a planetary gearbox installation in terms of vibration and coupled rotor dynamic challenges. From their review they concluded that to accurately predict the dynamics of a geared rotor system, both the planetary gearbox and the shafts must be considered.

Zhixin Fan et al. [6] discussed a rigid-flexible coupled dynamic system of planetary tools transmission based totally on the shell and Timoshenko beam propositions and taking into consideration the inflexibility of the interior ring equipment and the solar shaft and from their assessment they concluded that the stiffness will increase with thickness, the load-sharing coefficient decreases hastily and Misalignment of one of the planet pins and a number transmission mistakes negatively affect the load-sharing coefficient.

Zengbao Zhu et al. [7] discusses in their work the contemporary nonlinear dynamic equation for differential planetary equipment trains. It consists of multi backlash and mesh stiffness modifications over time. From their overview they concluded the use of a differential planetary equipment with multi backlash and time-varying mesh stiffness with which a tensional nonlinear dynamic equation has been developed.

Hongwu Li et al [8] concluded in their paper that the planetary equipment machine was once mentioned as one of the most vital components of several industrial transmission structures and the ring tools is typically elastically connected to the gearbox. Based on their review, they proposed an MBD mannequin for a planetary tools machine with an elastic ring tools assist to make clear what impact the radial aid stiffness of the ring tools has on the vibration of the device.

Oliver Climescu et al [9] presented experimental results of the efficiency determination of a planetary gear system. From their review they concluded to find out the mechanical characteristics of the generator and the turbine, both are tested on experimental rigs.

Ajay Narayankutty et al [10] discussed that the primary advantages of planetary gears over parallel axis gears are significant, weight and space savings. These benefits stem from the fact that the use of multiple planets allows the load to be transmitted through multiple tooth contacts, and the co-axial arrangement of input and output shafts allows for a more compact layout. From review they concluded that the differential planetary gear can offer high reduction ratios, but it will also work for low torque applications.

Adam Marcaine et al [11] mentioned about the graphical approach for identifying all transmission element rotational speeds, as nicely as torque, energy flow, strength losses, and efficiency of any PGT. From their evaluation they concluded that for the use of graphical technique a sketcher workbench any modern-day CAD machine can be used. This affords an interactive way of working.

R. G. Parker, and S. M. Vijayakar et al [12] shows in their work shows the dynamic response of planetary gears in helicopters over a vary of working speeds and torques. In tools dynamics, a finite factor method is used that lets in for a specific illustration of the geometry and contact forces that are vital in the analysis. From their evaluation they concluded that it is in particular convenient to deal with matrixes of planetary gears due to the fact they are dealt with naturally, and dynamic mesh forces can't be precise a priori.

Chao Xun et al [13] describes how Split- necklace transmission structures are used for high- energy mechanical transmission operations to preserve cargo on every component inside secure limits. Despite its comparable aspects such as excessive electricity viscosity, excessive transmission rate, low bearing load, and concise-

ness, planetary tools trains (PGTs) are amongst the most famous split-neck transmission systems. They concluded from their assessment that a easy discrete mannequin is used to look into the load sharing throughout the planet meshes of PGTs with many kind errors.

Cheon-Jae Bahk and Robert G. Parker et al [14] discussed that at some stage in tools gyration, planetary gears are parametrically excited by way of fluxes in mesh stiffness that alternate as the variety of outfit enamel dyads in contact adaptations and also when the resonance occurs, the vibration reasons the enamel to separate, main to results similar as vault marvels and subharmonic resonances. Grounded on their review, they concluded that this paper analyses the nonlinearity of a parametrically agitated planetary gear.

Suresh et al [15] described the influence of planetary gears over others when determining gearbox discount ratios, minimal and most savings per planetary equipment pair. From their work they concluded that manufacturing blunders in planetary gears and how these mistakes affect dynamic response have excessive torque density, lightweight, low inertia and can be grease lubricated for existence and the automation additionally carried.

CONCLUSION

The result of planetary gear box proves to be effective and furnishing stability in mechanical system. Various researchers have done a lot of work in this system and they concluded that planetary gear system has have a wide range of applications especially in automotive sector. Compared to conventional gearboxes, it produces lower noise. Additionally, this type of gear system decreases weight compared to other gearboxes but they are delicate to repair compared to conventional gear boxes, so professional repairs are needed to minimize injuries. These attributes of planetary gear units will continue to be applied in various products like toys, machines, and automated systems, in the future.

References

[1] Shailesh Chaudhari, Jayveer shah and Tarun Garg, “Design, Analysis and Optimization of Planetary Gearbox: A Review”, IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 10, 2014 | ISSN (online): 2321-0613

[2] Tongjie Li and Rupeng Zh, “ Global Analysis of a Planetary Gear Train”, Hindawi Publishing Corporation Shock and Vibration ,Volume 2014, Article ID 930350

[3] Yongliang Yua, “Dynamic Analysis of Planetary Gear Train Based Adams”, Matec Web of Conferences, Volume 175, (2018) 2018 International Forum on Construction, Aviation and Environmental Engineering-Internet of Things (IFCAE-IOT 2018), doi.org 10.1051 matecconf 201817503051

[4] Jianming Yang, Liming Dai, “Survey of dynamics of planetary gear trains”, Int. J. Materials and Structural Integrity, Vol. 1, No. 4, 2008.

[5] Tatar, A., Schwingshackl, C.W. and Friswel, "Effect of planetary gearboxes on the dynamics of rotating systems", researchgate.net publication 339817230, Doi: 10.25560/80800, Thesis for: PhD Advisor: Christoph W. Schwingshackl

[6] Zhixin Fan, Caichao Zhu and Chaosheng Song, " Dynamic Analysis of Planetary Gear Transmission System Considering the Flexibility of Internal Ring Gear", Iranian Journal of Science and Technology, Transactions of Mechanical Engineering (IF1.596),doi: 10.1007/s40997-019-00290-3, Pub Date: 2019-03-22

[7] Zengbao Zhu, Longchao Cheng, Rui Xu, and Rupeng Zhu, "Impacts of Backlash on Nonlinear Dynamic Characteristic of Encased Differential Planetary Gear Train", Shock and Vibration, Volume 2019, Article id-9347925, doi:10.1155/2019/9347925

[8] Hongwu Li1, Jing Liu, Jinlei Ma and Yimin Shao, "Effect of the radial support stiffness of the ring gear on the vibrations for a planetary gear system", Journal of Low Frequency Noise, Vibration and Active Control, Volume: 39 issue: 4, doi:-10.11772F1461348419844642

[9] Oliver Climescu, Codruta Jaliu, Radu Saulescu, " On the Efficiency of a Planetary Speed Increaser Usable in Small Hydros", researchgate.net publication 299703878, VL - 13, do - 10.1007/978-94-007-6558-0-18, PY - 2013/01/01

[10] Ajay Narayankutty, Vitthal Udyognagar, "A Review of Design and Analysis of a 3-Stage Planetary Gearbox", Ijariie-Issn (O)-2395-4396, Vol-2 Issue-3, 2016,

[11] Adam Marcaine, Mariusz Sobolak and Piotr Połowniak, "Graphical method for the analysis of planetary gear trains", Alexandria Engineering Journal, vol-61, issue-5, doi-10.1016/j.aej.2021.09.036

[12] R. G. Parker, V. Agashe, and S. M. Vijayakar , "Dynamic response of a planetary gear system Using a finite element/contact mechanics model", Journal of Mechanical Design, Transactions of the ASME, vol. 122, no. 3, pp. 304–310, 2000.

[13] Chao Xun and He Dai, "Dynamic Load Sharing Behaviours of Planetary Gear Trains and Parameter Study through Perturbation Analysis", Shock and Vibration, Hindawi, Volume 2021, Article ID 8832908, 24 pages,doi-10.1155/2021/8832908

[14] Cheon-Jae Bahk and Robert-Parker, "Analytical Solution for the Nonlinear Dynamics of Planetary Gears", Journal-of-Computational and Nonlinear-Dynamics, Volume 6, Issue 2 April 2011, doi:10.1115/1.4002392, April 2011

[15] P. Suresh, "A Paper on Planetary Gear Train", Journal of Emerging Technologies and Innovative Research (JETIR), June 2019, Volume 6, Issue 6