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DESIGN AND LOAD ANALYSIS OF AND OPTIMIZATION OF COMPOUND EPICYCLICGEAR TRAINS

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Abstract

Higher torque capacity, reduced weight, compact size, and enhanced planetary design efficiency are some of the benefits of epicycle gear trains.Technology that reduces transmission speeds via the use of planetary gears is small, powerful, and innovative. The study focuses on the structural analysis of planetary gear trains with three stages of coupling. The efficiency and power flow directions, as well as the speed ratio and torques, of connected planetary gear trains may be quickly and easily determined using this methodology. Efficiency in three stages found.Analysis is performed in ANSYS and 3D modeling is done in CATIA.

INTRODUCTION

One or more planet gears encircle a sun gear in a planetary or epicyclic gear train, as described in the introduction. In order to obtain a high reduction ratio in a compact and powerful package, epicyclical gearing systems are often used. The planetary gear train's unequal load-sharing capabilities are studied. These gear trains are the backbone of any mechanical power transmission system and see heavy use in transmission applications. Identifying the reasons and optimizing for optimal performance is crucial because of the critical function they play in all industrial fields; a failure of the gear train results in a whole system failure. Greater torque capacity, reduced weight, compact size, and enhanced planetary design efficiency are some of the benefits of epicyclic gear trains. People may mistakenly believe it is weaker than a standard gearbox due to its 60% less weight and 50% smaller size. As a result, to keep the gear train from experiencing undue stress, the loads must be kept to a minimum.

EPICYCLIC GEAR TRAIN:

at the other's core. The two gears are connected at their centers by a carrier, which spins to revolve the planet gear around the sun gear. The planets and the sun are connected with gears that allow their pitch rings to move smoothly. A point on the planet gear's pitch circle follows an epicycloid curve. Here, we simplify things by saying that the sun gear is stationary and that the planetary gears revolve around it. It is possible to construct an epicycle gear train so that the planet gear rolls inside the pitch circle of a stationary outer gear ring, also known as an annular gear.

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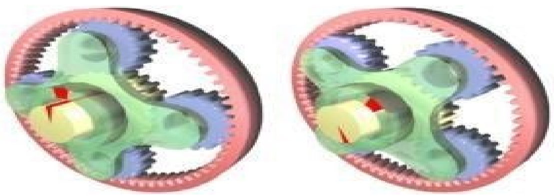
Here, a hypocycloid is the shape that a point on the planet's pitch circle traces. A planetary gear train is an epicycle gear train that incorporates a planet that engages a sun gear and a ring gear. Here, it is common practice to drive the sun gear while fixing the ring gear.

Fig: epicycle gear

Advantages Of An Epicyclic Gear:



- Envelope size (smaller than parallel shaft for samepower)
- Low weight
- Lower Pitch Line Velocity for comparable parallelshaft unit
- Coaxial Shafts (in line system) resulting in more compact installation
- low cost for entire train layout One of the most important considerations for an epicyclical gear is to assure uniform load distribution among the planets. This is made possible in a 3 or more planet arrangement.

DISADVANTAGES:

Include high bearing loads, constant lubrication requirements, inaccessibility, and design complexity. The efficiency loss in a planetary gear trains 3% per stage. The load in a planetary gear
train is shared among multiple planets; therefore torque capability is greatly increased.

LITERATURE SURVEY

In the 2nd century AD treatise Almagest, Ptolemy used rotating deferent and epicycles that form epicyclic gear trains to predict the motions of the planets. Accurate predictions of the movement of the Sun, Moon and the five planets, Mercury, Venus, Mars, Jupiter and Saturn, across the sky assumed thateach followed a trajectory traced by a point on the planet gear of an epicyclic gear train. This curve is called an epitrochoid. Epicyclic gearing was used in the Antikythera Mechanism, circa 80 BCE, toadjust the displayed position of the moon for its elasticity, and even for the precession of the ellipticity. Two facing gears were rotated around slightly different centers, and one drove the other not with meshed teeth but with a pin inserted into a slot on the second. As the slot drove the second gear, the radius of driving would change, thus invoking a speeding up and slowing down of the driven gear in each revolution.The sun and planet gear converted the vertical motion of a beam, driven by a steam engine, into circular motion using a 'planet', a cogwheel fixed at the end of the connecting rod (connected to the beam) of the engine. With the motion of the beam, this revolved around, and turned, the 'sun', a second rotating cog fixed to the drive shaft, thus generating rotary motion. An interesting feature of this arrangement, when compared to that of a simple crank, is that when both sun and planet have the samenumber of teeth, the drive shaft completes two revolutions for each double stroke of the beam instead of one. The planet gear is fixed to the connecting rod and thus does not rotate around its own axis.Epicyclic gear stages provide high load capacity and compactness to gear drives. There is a wide variety of different combinations of planetary gear arrangements. For simple, epicyclic planetary stages when the ring gear is stationary, the practical

gear ratio range varies from 3:1 to 9:1. For similar epicyclic planetary stages with compound planet gears, the practical gear ratio range varies from 8:1 to 30:1. Using differential planetary gear arrangementsit is possible to achieve gear ratios of several- hundred-to-one in one-stage-drive with commonplanet gears, and several thousand- to-one in one- stage drive with compound planet gears. A special two stage planetary arrangement may utilize a gear ratio of over one-hundred-thousand-toone.

INTRODUCTION TO CAD

Computer-aided design (CAD) is the use of computersystems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term CADD (for Computer Aided Design and Drafting) is also used.

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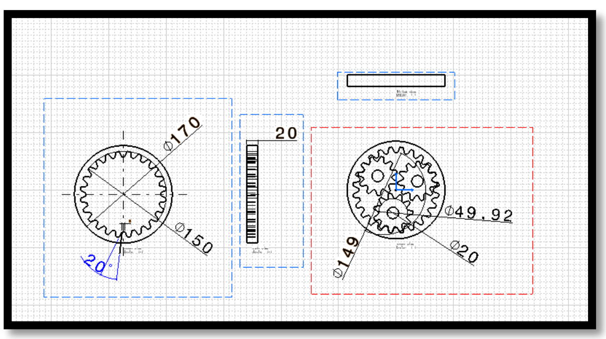
Its use in designing electronic systems is known as electronic design automation, or EDA. In mechanical design it is known as mechanical design automation (MDA) or computer-aided drafting (CAD), which includes the process of creating a technical drawing with the use of computer software.

INTRODUCTION TO CATIA

CATIA (an acronym of computer aided three-dimensional interactive application) is a multi-platform software suite for computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE), PLM and 3D, developed by the French company Dassault Systems.

CATIA started as an in-house development in 1977 by French aircraft manufacturer Avions Marcel Dassault, at that time customer of the CADAM software to develop Dassault's Mirage fighter jet. It was later adopted by the aerospace, automotive, shipbuilding, and other industries.

Epicyclical gear assembly model



INTRODUCTION TO FEA

Finite element analysis is a method of solving, usually approximately, certain problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in some mathematical form, is available. As such, it is a numerical rather than an analytical method. Methods of this type are needed because analytical methods cannot cope with the real, complicated problems that are met with in engineering. For example, engineering strength of materials or the mathematical theory of elasticity can be used to calculate analytically the stresses and strains in a bent beam, but neither will be successful in finding out what is happening in part of a car suspension system during cornering.

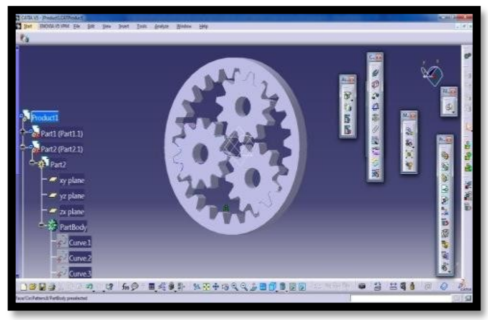
STATIC ANALYSIS OF EPICYCLICAL GEAR TRAINS

Imported model

RESULTS

TABLE STATIC

ANALYSIS



Material	Deformation	Stress(pa)	Strain
Cast iron	0.001619	3.699	$3.3629e^{-5}$ [
Steel	0.0009789	4.0887	$2.0245e^{-5}$]

Material	**Cast-iron**	**Steel**
Frequency1 (hz)	699.21	[900 is
Deformation	9.5594	9.1532 el

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Frequency2	702	901.06 2
Deformation	8.8625	8.4973 [
Frequency 3	900.17	1159.9 Ma
Deformation	7.0869	6.7883

Modal analysis

In summary,

Technology that reduces transmission speeds via the use of planetary gears is small, powerful, and innovative. The study focuses on the structural analysis of planetary gear trains with three stages of coupling. The efficiency and power flow directions, as well as the speed ratio and torques, of connected planetary gear trains may be quickly and easily determined using this methodology. Efficiency in three stages found. ANSYS is used for analysis, whereas CATIA is used for 3D modeling.The static analysis shows that when the rotational velocity rises, the stress values also rise. When it comes to stress values, cast iron is lower and steel is higher.Compared to steel, cast iron exhibits higher deformation values in the modal analysis.It follows that epicyclical gear trains are best constructed from cast iron.

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