Advances in Motion Control of Rear Wheels of Automobile Differential Using wheel Locking System

Vinod P.Sakhare[1], Ajinkya D.Wadatkar[2], Gaurav B. Lohakare[3], Nikhil G.Narad[4]

[1]Assistant Professor, [2,3,4]UG Students
Department of Mechanical Engineering
Datta Meghe Institute of Engineering Technology and Research
Wardha-442001, Maharashtra State, India

ABSTRACT: **Differential in automobile is a device which transmits power gained by propeller shaft to the wheels. The important use of the differential gear is to allow the drive wheels to turn at different rpm while both receiving power from the engine. An ordinary differential of an automobile transmits equal torque to both the wheel. But if the rpm of one wheel is lowered compared to another wheel then the power of that wheel will be supplied to another wheel and counter wheel will move with twice that of its normal speed. A differential locking system introduced here can be locked or unlocked either by hand or automatically, as per the conditions of the road surface. The sensor based system can be very sensitive and hence signals to system even if there is no requirement for differential locking. Here in this system we will be incorporating manual based differential locking sytem.The dog ring will be engaged manually instead of sensor based system to avoid the actuation of sensor even if it is not required which senses even small variations on road surface which may sometimes cause accidents. The manual engagement of wheel stalls one wheel to lock the differential by sliding a dog ring to get engaged in planetary gear spike shaft so both the wheel have same traction and if the difference in speed of driven and rolling wheel is encountered then the differential is lock.**

Keyword*: *Ordinary differential, Traction, Slip,* Stalls, *Dog ring.

1. INTRODUCTION

1.1Power transmission in conventional differential system:

The conventional differential is used to transmission of difference in speed to both the rear wheels and allows taking a fix turn rotation .The major principal of the differential is to permit each of the driving wheels to rotate at different speed. A vehicles wheels move at different speed, at the time of turning. The conventional differential is design to run both off wheels with same torque while allowing them to rotate at variation in speed. At the time of cornering, the inside wheel needs to travel a smaller distance than the outside wheel so if differential is not use the result is the inside wheel spinning, and this result in difficult handling, damage found. But major problem is that when the vehicle goes in pit condition then one wheel is in stationary condition, the opposite wheel turns at twice its normal speed. This condition create major problem in pit condition, one wheel cannot generate enough traction. And due to loss of traction it will spin and the counter wheel will stay stationary so the vehicle can't able to move. The solution is that we create the "Differential locking system" which can able to solve the above problems. In this system a locking system is provided which means that fixing the spike shaft between the inner gear and in certain condition it locked by the dog ring. This will stop the conventional differential action and give same speed to both the rear wheels. The result is that increase in torque and provide enough traction to move

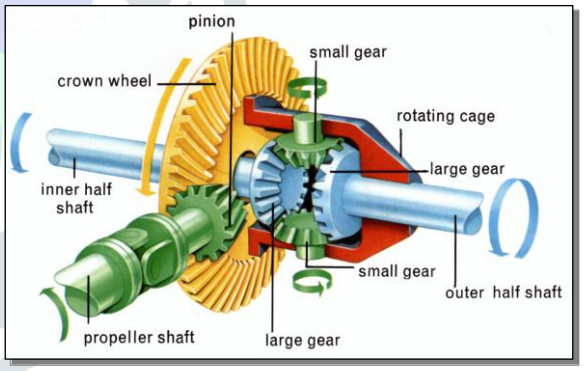


Fig 1.1:- Conventional transmission system

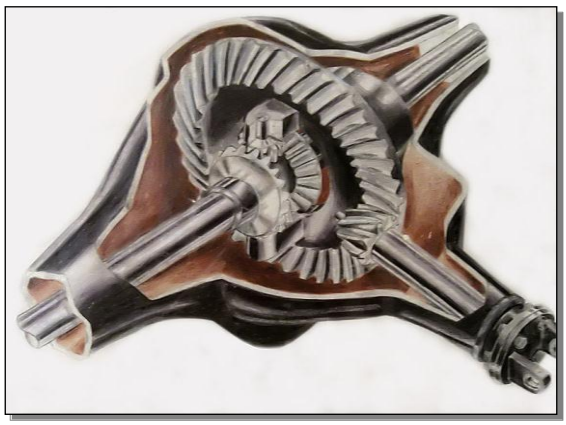


Fig 1.2: Functional description of differential

2. DESIGN METHODOLOGY

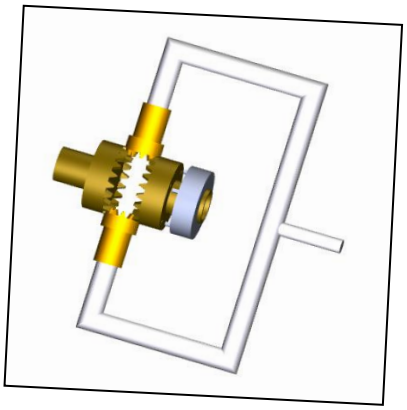


Fig 2.1: Description of model using CAD modeling

1: Parts to be design :(Spike shaft & Dog ring)

1: DESIGN OF SHAFT-

- TO CALCULATE INPUT TORQUE

POWER = $\frac{2 \Pi NT}{60}$

$\Rightarrow$ T = …… N.m

Assuming 100% overload.

$\Rightarrow$ T design = 2 x T

CHECK FOR TORSIONAL SHEAR FAILURE OF SHAFT.

Td = $\Pi/16$ x fs_{act} x d^3

$\Rightarrow$ fs_{act} = ……. N/mm^2

As $fs_{act} < fs_{all}$

$\Rightarrow$ Spike shaft is safe under torsional load

2:*DESIGN OF DOG RING.*

These pins are located at PCD (D_p) = 72 mm Tangential force on each bolt (F_b) = T÷ ((D_p x n)/2)

Shear stress = Shear force ÷Shear area Assuming Pin

$\Rightarrow$ $1.19 \times 10^3 = \frac{1 \times (fs_{act} \times \Pi \times (5)^2)}{4} \times \frac{72}{2}$

As $fs_{act} < fs_{all}$

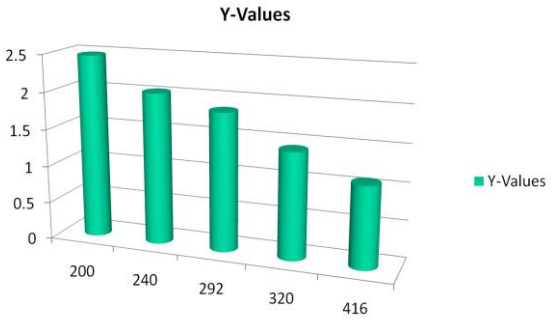
$\Rightarrow$Pins are safe under shear load

Observation Table

Sr No	Speed when unlock (rpm)	Torque when unlock (N.m)	Speed after locking (rpm)	Torque after locking (N.m)
1	200	2.96	108	6.6
2	240	2.47	114	6.02
3	292	2.03	153	3.88
4	320	1.85	156	3.3
5	416	1.09	175	3.9

Table No1: Observation

Torque v/s Speed



Graph no 1: torque v/s speed

As the above graph shows that speed is inversely proportional to the torque as the speed increase torque will ultimately reduce.

3. WORKING OF DIFFERENTIAL LOCKING SYSTEM:

As the vehicles wheel goes in muddy or slippery type of condition then due to loss of traction it will not able to solve this difficulty. In such condition we apply the locking system by manually or sensor based in which dog ring is inserted into the spike shaft and due to locking this spike shaft, The total differential action will stop and give same speed to both the wheel and maximum torque. As it can be operated manually which engaged the system mechanically, the manually operated system gives much better results and high accuracy than the sensor based technique. This system generate high traction to the rear wheel due to this vehicle will overcome the difficulty of slippery type conditions and able to move with high torque.

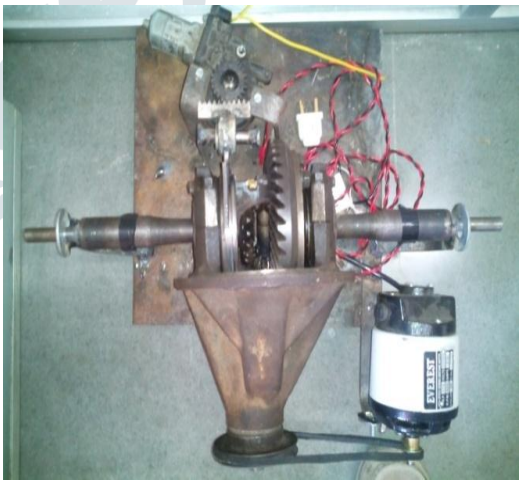


Fig 3.1: fabricated view of differential locking system.

SCOPE:

1. Highly use in defense vehicles.
2. Generate equal traction to both wheel.
3.It will be generate high rpm beyond specific limit.
4 Easily move the vehicle when one wheel is in the slippery or pit condition
5. It will able to avoid the vehicle from the accident.

6. It could be synthesis for the farm tractors, Heavy duty vehicles, trucks etc.
7. Very useful for heavy duty vehicles for generating high torque at necessary conditions.

CONCLUSION:

In this project, we develop the simple mechanism for controlling the power distribution from the engine of the vehicle to the differential in slippery or pit condition of the rear wheel (i.e. the only one wheel)The new develop mechanism, transfer the total power of the engine to the slippery wheel and pull the wheel and provide the equal traction to both wheel. In this way we avoid the accident and controlling the vehicle in slippery condition. We make this system as manually or mechanically operated because in the sensor based technique there may be chance of mis happening(accidents) due to unequal road surface (distance from road surface of the wheels) or error in sensing the speed of vehicle so avoid this we can able to run with manually operated system.

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