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Fabrication of Differential Unit Locking System

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***Abstract*: When a working vehicle travels on an inclined ground or on an unleveled ground, slipping cause a difference in revolution between right and left wheel impairing straight running of the vehicle. It is therefore conventional practice to equip a working vehicle such as a lawn mower or a garden tractor which needs to be run in a straight manner with a differential locking mechanism to forcibly stop the differential revolution of the wheels. If the differential lock remained on during all time, then it may leave scratches on the ground. Hence an automatic differential locking system has to be designed to eliminate the above disadvantage. The proposed mechanism is to lock the differential. By locking the differential, the differential is disengaged from the axle. Thus the power is directly transmitted to the axle and hence to the wheels. This will considerably reduce the power loss in some occasions when unwanted loss is happening due to the transmission, if power from the shaft to the differential and then to the axle and hence to the wheels.**

***Keywords*: A semi-automatic differential lock system, Dog ring, Spike shaft, Same traction, Belt, Shifter.**

1. Introduction

The proposed mechanism is to lock the differential. By locking the differential, the differential is disengaged from the axle. Thus the power is directly transmitted to the axle and hence to the wheels. This will considerably reduce the power loss in some occasions when unwanted loss is happening due to the transmission if power from the shaft to the differential and then to the axle and hence to the wheels. So in mechanism the unwanted power loss in the due course of transmission through the differential is reduced. There are some drawbacks in the existing mechanism and we overcome it in the proposed project. The first is while climbing in steep hills the differential is not really needed as the speed of the vehicle is low. And also there are some transmission loses in the differential. So at this time the unit is locked and the loss is overcome. Then when a heavy truck is struck in a pit or mud it is very difficult to recover the truck as the differential unit cuts the power which is to be transmitted to the wheel struck. So in this project the unit is disengaged and power is directly given to the axle by pneumatic means and so the recovery is made easier. This is even made use in the vehicle to be driven in the dense forests and even in dessert.

Problem Definition: Existing Mechanism -A differential is a device which is used in vehicles over a few decades and when a vehicle is negotiating a turn, the outside wheel travels a greater distance and turns faster than the inside wheel. The differential is the device transmitting the power to each wheel, allows one wheel to turn faster than the other. It splits the engine torque two ways, allowing each output to spin at a different speed. The differential is found on all modern cars and trucks, and also in many all-wheel-drive (full-time four-wheel-drive) vehicles. The solution to the above problem is to have a differential locking system which can be engaged or disengaged either manually or automatically, as per the conditions or a sensor based system can be developed that will sense the difference in speed or stalling of one wheel to lock the differential so that both wheels will have same traction.

2. Components and Description

A. Differential: what's a differential?

When a vehicle is negotiating a corner, the outside wheel has to travel a greater distance than the inside wheel. Therefore, the outside wheel must turn faster than the inside wheel. The differential is the device within the axle assembly which, in addition to transmitting the power to each axle shaft/wheel, allows one wheel to turn at a different speed than the other. A conventional open differential sends equal amounts of torque to both axle shafts (top) because of lost traction; it is sustaining zero engine torque, so zero engine torque is also going to the wheel with traction. Adding a locking differential in this case a No Spin locker (bottom) mechanically links the two shafts so that power will be delivered to both axles in all circumstances.

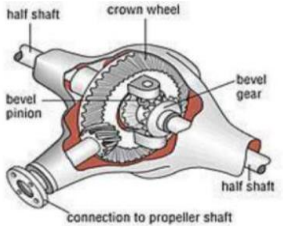


Fig. 1. Differential unit

B. The function of differential

To aim the engine power at the wheels. To act as the final

gear reduction in the vehicle, slowing the rotational speed of the transmission one final time before it hits the wheels. To transmit the power to the wheels while allowing them to rotate at different speeds (This is the one that open differentials. Use two side gears inside the differential case. Each gear is splinted to accept an axle shaft. These side gears are in turn driven by a set of spider gears. The spider gears, also inside the differential case, ride on a shaft which is pinned into the differential case and through which all the power is transmitted. The case is driven by the ring gear which is bolted fast to the case. The conventional differential is fitted as standard equipment on most vehicles. On paved roads this system is very successful, giving predictable handling, even tire wear and requiring very little maintenance. However, in off road situations where traction surfaces vary greatly, this type of differential has a major limitation. When one wheel has greater traction than the other, all the power will be directed to the wheel with the least traction. For example, if one wheel is in the air and the other wheel is still on a hard surface, then all the power will be transferred to the wheel in the air. No power will go to the one on the ground and the vehicle will not move. Limited Slips (LSD's) come in a variety of designs. Most use friction plates, cones and/or gears to reduce slippage between each of the tires. These units have a dual power path from the differential case to the axle shafts. Some power is transmitted through the spider gears to the side gears in the conventional manner. The remainder is transmitted by friction between the differential case and the clutch plates and the side gears. A certain amount of "clutch preload" is built into the unit in a static condition. Then, as load is applied to the differential, the separation forces between the spider gears and the side gears increases this clutch loading. This increase in friction provides for a good positive power flow from the case directly to the side gears. When traction is available to both wheels, the power going to the differential causes the plates to bind tightly together, giving even power to both wheels.

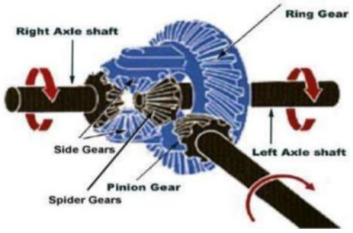


Fig. 2. Working of a differential unit

3. List of Components

Table 1
List of components

Component Name	Sr. No.	Component Name
DC motor	10	LH OP Shaft
Belt	11	RH OP Shaft
Reduction Pulley	12	Guide Bar
differential	13	Crown
Dog Ring	14	Crown Casing
Shifter Links	15	Frame
Shifter	16	Rack

A. Material procurement

Material is procured as per raw material specification and part quantity. Part process planning is done to decide the process of manufacture and appropriate machine for the same.
General Material Used
EN24- Alloy Steel
EN9- Plain Carbon
Steel MS-Mild Steel

4. Deformation and Stress Concentration of Components

Stress analysis is done by using ANSYS software to obtain Equivalent (Von mises) Stress and deformation.

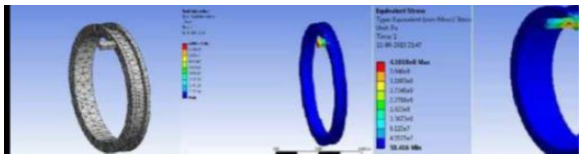
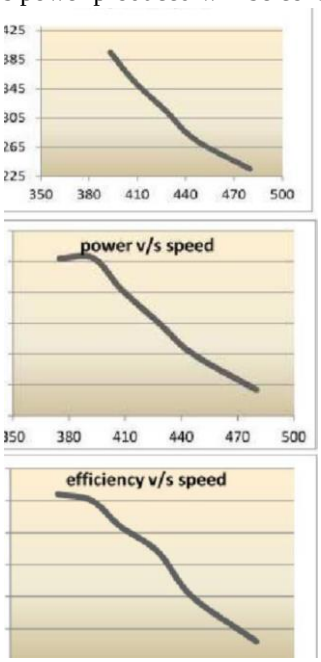


Fig. 2. Meshing, Displacement and Stress Concentration of Dog Ring

- *Torque v/s Speed:* From above diagrams we can reason that with diminishing in speed of yield wheel shaft torque is expanding. Torque and speed are contrarily corresponding. Henceforth the minute closeness sensor sense the lessening in the speed, the locking differential will attempt to give same torque on both wheel shafts.
- *Power v/s Speed:* With expanding speed, control likewise increments up as far as possible then there will be same yield control that power is known as evaluated power. Above plotted diagrams demonstrates diminishing nature as speed is over the evaluated speed.
- *Efficiency v/s Speed:* Graph indicates expanding proficiency up to constrain with speed additionally increment in speed won't impact as power produced will be consistent



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 generates 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. Fabricated view of differential locking system

5. Conclusion

Summary of the work done this project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries. We are proud that we have completed the work with the limited time successfully. The automatic lockable differential is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression project work. In concluding the words of our project, since the locking of the differential is very much useful in reducing a considerable amount of loss due the transmission through the differential and also in recovering the heavy trucks from pits in rainy season this could be a source for the above said solutions.

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