Design of Back stopper Mechanism for Automobiles

Sneha.H.Dhoria#1, B.Sandeep#2, G.Narendra Santosh Kumar#3, M.Srivatsava#4

#1,2 Assistant Professor, Department of Mechanical Engineering, R.V.R& JC College of Engineering, Guntur, India

#3,4 Asst. Professor, Department of Mechanical Engineering, Guru Nanak Institutions Technical Campus, Hyderabad, India

Abstract - A Good automobile must possess all safety and comfort aspects independent of driver's skill. There are often many situations where vehicles lose control over an inclination and rolls backwards. This problem is more predominant in countries like India where we can observe the road transport at hilly areas, slanted roads, etc. According to a survey, every 3 out of 10 drivers face this problem. It needs good driving skills to overcome this problem. This paper aims at designing a back stopper Mechanism to overcome the problem of rolling back of vehicle on inclined roads without the use of any special driving skills. Technically, this mechanism encounters the issue free motion of the shafts of the gearbox as the vehicle tries to roll down hill, when the clutch is pressed (disengaged) for the moments in which driver shifts his foot from the brake pedal to accelerator pedal to accelerate the engine. Back stopper mechanism allows the rotation of drive shaft in only forward direction, thereby restricting vehicle to roll back in opposite direction. Parts were designed in Catia v5 r20 and analysis was done using Ansys workbench.

Keywords: Automobiles, Back stopper, Catia, Ansys workbench

1. INTRODUCTION

For conventional vehicles moving on uphill is a risky one in India, particularly with a full payload. The vehicle risks rolling back if the driver lets go the clutch with not enough power on the gas. In high-end commercial vehicles though, technologies like the Electronic Braking Systems (EBS) helps pull away the vehicle from a standstill on steep gradients with no risk of rolling back. Back Stopper Mechanism give a solution for the general issue of descending or rolling back of the vehicle, while starting motion uphill in forward direction. The issue is encountered by employing the devices like freewheel, roller clutch, springs, Dog clutch, etc. The issue is discussed here considering uphill motion in forward direction. Uphill motion in the reverse direction also has the similar issue.

2. PROBLEM DESCRIPTION:

In the hill station, the most common problem to the drivers is to park their cars in the slope and to start up the car. While waiting in the traffic, the cars have to move on step by step very slowly, this situation is a difficult one for the drivers to make their car not to roll back in the slope. The driver has to control clutch, brake, and accelerator while changing the gear all by himself in a short span of time. Failure of any one of these leads to hit any vehicle behind. So the mechanism has to be developed to stop the vehicle from rolling back and it should not stop the vehicle in accelerating forwards. This function can be achieved by back stopper mechanism.

PURPOSE AND GOALS

The purpose of the paper was to design a “back stopper” device that prevents the vehicle from rolling backwards and at the same time allowing it to reverse when needed. The goal is to provide a safer and comfortable ride for the driver on inclined roads with low cost and easy maintenance.
which ‘hill start’ system can get inputs and accordingly controls output valves through which brake can be applied and released.

However it is difficult and expensive to implement these systems in conventional vehicles which are equipped with basic brake system and mechanical engine with manual transmission due to many limitations such as lack of electronic control units, sensors.

3. COMPONENTS

I. Trapped roller bearing:

Trapped roller bearings often used on inclined conveyers, head shaft drives to prevent run back at the event of power failure, these are also used in roller coasters. Trapped roller bearing consists of a cylindrical outer race, an inner race with ramps and individually sprung rollers. The springs will ensure that the rollers will be held in contact with the outer race and inner race ramp, making torque transmission instantaneous. It is a type of bearing which permits only one type of rotation of the shaft either clock wise or counter clock wise. When bearing is rotating in clock wise direction the rollers of the bearing will rotate freely but when the direction of the bearing is reversed then it locks the rotation and it can resist the shaft from rotating.

The trapped rollers freewheel can be used in 3 applications they are

1. Overrunning
2. Backstopping
3. Indexing

II. Springs:

Springs are generally used for engaging and disengaging using force of compression or tension. In back stopper device springs were used to disengage and engage the moving Dog clutch with the fixed Dog clutch to achieve the purpose of backstopping.

III. Cables:

Cables were used to control the movement of Dog clutch which ensures the functions of engage and disengage the moving Dog clutch with the fixed Dog clutch. It was one of the major component for actuation mechanism. This can also be done using linkage mechanism.

IV. Rollers

Rollers were used in the housing to slide the Dog clutch freely without any obstruction. Since the rolling friction is less than the sliding friction rollers were preferred for getting sliding motion. Rollers were placed in between the surfaces of moving Dog clutch and housing.

V. Housing

Housing plays an important role by restricting the rotation of the moving Dog clutch. Housing also serves as a guide ways for the movement of sliding Dog clutch to engage with the fixed Dog clutch. The housing is bolted to the hub or gearbox.

The main functions of the housing are:

- Act as guide ways for the movement of Dog clutch
- To restrict the rotation of the sliding Dog clutch thereby constraining the shaft to rotate only in one direction.

VI. Dog clutch

A Dog clutch is a type of clutch that couples two rotating shafts or other rotating components by interference not by friction. The two parts of the clutch were designed such that one will push the other, causing both to rotate at the same speed and will never slip. This back stopper consists of two types of Dog clutches

(i) Fixed Dog clutch which is fixed on the shaft.

(ii) Sliding Dog clutch which slides in the housing.

4. COMPONENT ASSEMBLY

In the back stopper mechanism the housing is fixed, sliding Dog clutch is made to slide inside the housing with the help of balls of ball bearings. Sprag clutch is press fitted inside the fixed Dog clutch. The fixed Dog clutch engages with sliding plate on the shaft to prevent the reverse movement.
ACTUATION MECHANISM

The actuation mechanism uses springs, cables and lever to work this out. The basic principle used by the actuating mechanism is compression force in the spring. The fixed Dog clutch along with the trapped roller bearing is keyed to the shaft using a mechanical key. Initially the sliding Dog clutch is held back tightly with the help of lever against the compressive spring forces acting on the sliding Dog clutch.

The actuation mechanism on vehicle can be of any type according to the drivers comfort. It can be made to work along with the gear shifter rod with some minor modifications or it can have a separate lever. The mechanism is designed to engage only when the vehicle is running in first gear since in almost 99.9% of the cases the vehicle rolls back during the start of the vehicle and also it can be actuated to engage in every gear and disengage in the reverse gear.

At the time of engagement as soon as the lever is released to engage the Dog clutch, the sliding Dog clutch is pushed forward by the compressive spring forces and is forced to engage with the fixed Dog clutch. As sliding Dog clutch is restricted to rotate in the housing the shaft rotates in only one direction thereby restricting the backward motion.

When the lever is held tightly and kept back in its position there is no restriction to the motion of the shaft. It can rotate forward or backward. The fixed Dog clutch rotates along with the shaft in any direction.
The back stopper mechanism is designed in Catia v5 r20. The back stopper mechanism is analyzed in Ansys workbench 14.5. The various results of analysis obtained are tabulated as shown below.

<table>
<thead>
<tr>
<th>Result</th>
<th>Stainless Steel</th>
<th>Cast Iron</th>
<th>Aluminum alloy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Deformation (mm)</td>
<td>0.153</td>
<td>0.312</td>
<td>0.489</td>
</tr>
<tr>
<td>Von-Misses stresses (Pa*e+9)</td>
<td>1.375</td>
<td>1.406</td>
<td>1.325</td>
</tr>
</tbody>
</table>

Therefore it is concluded that the use of Stainless steel or Cast Iron is best suited for the design of back stopper mechanism.

6. CONCLUSION

The back stopper mechanism was designed in Catia v5 r20, analyzed in Ansys workbench and prototype was tested successfully. This mechanism showed promising signs for its implementation in conventional vehicles having manual transmission providing safer and comfortable ride for the drivers by preventing the vehicle from rolling backwards at the same time allowing it to reverse when needed.
Advantages of back stopper:
1. Economical:
   The components of back stopper mechanism like Trapped roller bearing, springs, Dog clutch are very economical compare to it’s counter parts in electrical systems.
2. Easy to maintain:
   The back stopper mechanism requires less maintenance, the only maintenance includes lubrication of bearings, tightening of cables.
3. No need of ECU’s and sensors:
   The installation of back stopper mechanism doesn’t need any electrical sensors and E.C.U.

7. REFERENCES