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Anti-Roll Back Mechanisms: a Review

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***Abstract*— The purpose of the paper is to analyze and review the already developed anti-roll back mechanisms for vehicles and other mechanisms of the same kind, to find the shortcomings of each of them, which hindered its general use in the vehicles, and to propose a mechanism overcoming all those shortcomings. Anti-roll Back Mechanisms or Unidirectional Motion Mechanisms are the mechanisms which may be added to the conventional gear box of a vehicle, to provide the remedy for the issue of descending of the vehicle under the influence of self-weight, faced while starting a vehicle to move uphill. Technically, this mechanism encounters the issue free motion of the shafts of the gearbox as the vehicle tries to roll downhill, 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. Such mechanisms restrict one or the other shaft(s) of the gearbox to rotate opposite under the influence of wheels, thereby restricting vehicle to roll back in opposite direction.**
***Keywords*— Anti-rollback, unidirectional motion mechanism, starting uphill motion, descends and rollback.**

I. INTRODUCTION

These mechanisms give a solution for the general issue of descending or rolling back of the vehicle, while starting motion uphill in forward or reverse direction in various ways. The issue is encountered by employing the devices like freewheel, roller clutch or ratchet-pawl mechanism in different-different manners and locations within the gearbox. The issue is discussed here considering uphill motion in forward direction. Uphill motion in the reverse direction also has the similar issue.

II. GENERAL ISSUE

Referring to figure 1, when a person drives uphill in forward direction on an inclined path / hilly terrain, when he tries to commence the motion, here comes the issue of managing three pedals / foot-levers using two feet. Initially, the person keeps on pressing the brake pedal using right foot in order to prevent the backward motion due to self-weight of vehicle on inclination and presses clutch pedal using left foot to shift the gears, further, he fixes any of the forward gear, say the lower most – 1st gear, now the clutch pedal is to be slowly released and the engine is to be accelerated by pressing the accelerator pedal to start motion simultaneously. At this instant, the left foot of the person is busy with guiding the clutch pedal. As the person tries to press the accelerator pedal, he removes right foot from the brake pedal. The moment he releases the brake pedal, the vehicle descends backward under the influence of self-weight due to inclination, which is undesired and may cause accidents. To overcome this issue, generally, people use to take the help of the hand-brake and drives without fully or partially releasing the hand-brake, which is not the exact remedy for the problem.

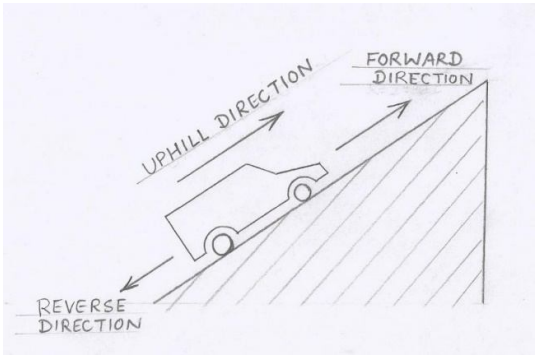


Fig. 1 Uphill motion in forward direction

Referring to figure 2, a similar problem is faced when a person drives uphill in reverse direction on an inclined path / hilly terrain. When he tries to commence the motion, initially, the person keeps on pressing the brake pedal in order to restrict the

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forward motion due to self-weight of vehicle on inclination, further, he fixes reverse gear, now the clutch pedal is to be slowly released and the engine is to be accelerated by pressing the accelerator pedal to start reverse direction motion. Similar to the issue discussed for forward uphill motion, the moment he releases the brake pedal, the vehicle descends forward under the influence of self-weight due to inclination, which is undesired and may cause accidents.

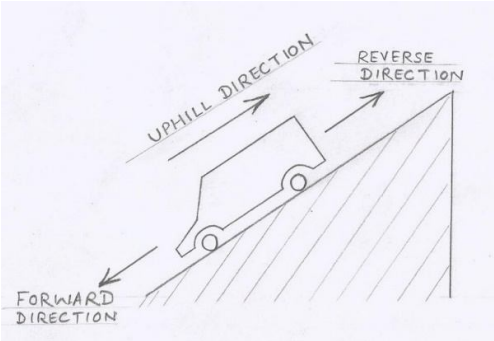


Fig. 2 Uphill motion in reverse direction

III. TECHNICAL EXPLANATION FOR THE ISSUE

Referring to the figure 3, we classified the vehicle into three parts:

A. Engine (piston, cylinder, crank, etc.)
B. Clutch
C. Gearbox

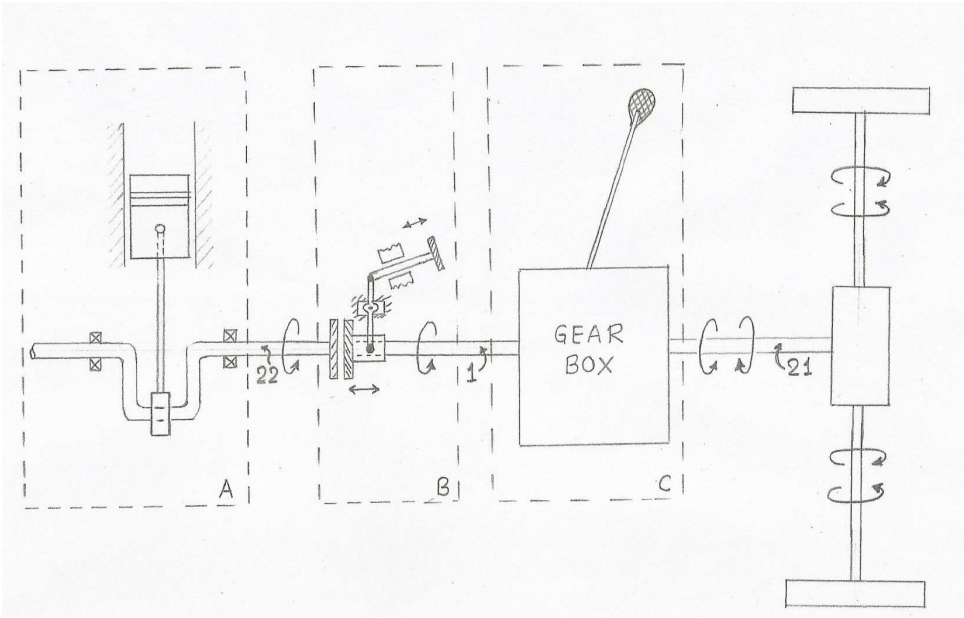


Fig. 3 Sections of a vehicle

As per given diagram, we assumed that the engine always gives motion in counter-clockwise direction, considering from the right side view. Shaft (22) transfers the motion from the engine (section A) to the clutch (section B). Shaft (1) transfers the motion from the clutch (section B) to gearbox (section C). When the vehicle comes into motion, the engine drive shaft (22) and shaft (1) in counter-clockwise direction and accordingly shafts rotate in the gearbox. Further, this motion comes to shaft (21) in clockwise and counter-clockwise directions depending upon the clutch dog engagement with different gears, finally, motion transfers motion to the wheels.

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Referring to the figure 4, taking the example of a constant mesh 3 speed gearbox, when engine drives the vehicle, shaft (1) is always meant to rotate in counter-clockwise direction, thereby due to the meshing of gear (7) and (8), the countershaft (9) is always meant to rotate in clockwise direction. Further, depending upon the engagement of the clutch dogs (18) and (19), shaft (21) rotates in clockwise and counterclockwise directions.

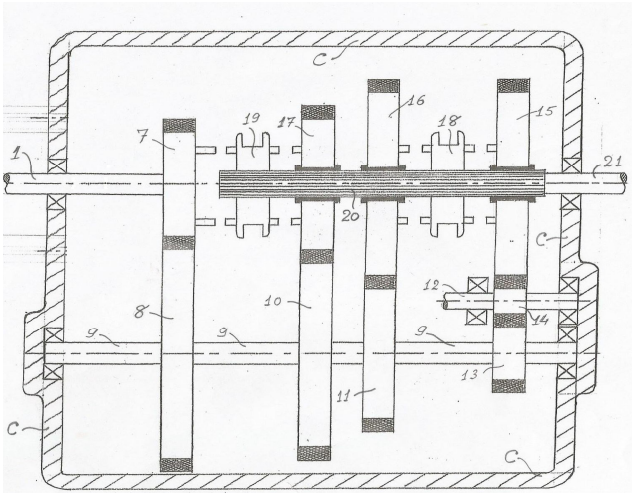


Fig. 4 Conventional Gearbox

For discussing the problem, let us consider the case when vehicle tends to start uphill motion in forward direction. Let us consider that we fixed the gearbox to lowest forward gear, i.e., clutch dog (18) is engaged with gear 16. Now, as the countershaft (9) rotates in clockwise direction, the gear (11) rotates in clockwise direction and gear (16) moves in counter-clockwise direction, thereby rotating splined shaft (21) in counter-clockwise direction. Now, while moving uphill in the forward direction, at the instant when the driver releases the brake pedal to accelerate the engines. Before the driver accelerate, let the clutch to engage and let the engine to drive the whole system, in the meantime, the gearbox remains idle from the engine, due to which all gears and shafts of the gearbox rotate in opposite directions, from the direction they are actually meant to rotate. This is due to the influence of the wheels moving in opposite of the desired motion due to self-weight of vehicle on inclination. What happens there is that, under the action of the wheels, the shaft (21) rotates in clockwise direction, rotating the countershaft (9) in counter-clockwise direction and finally all elements in the opposite direction. Similar things happen when the vehicle tries to move uphill and backward direction. Thus, we may conclude that the technical reason behind the problem is that the gearbox remains idle in that meantime of shifting the foot from brake pedal to accelerator pedal.

IV. ALREADY DEVELOPED MECHANISMS - LITERATURE REVIEW

Heretofore, a lot of work is done to encounter or prevent this issue of rolling back of vehicles. Different scientist and researchers gave different remedies. Significant among them are: “No-Roll Back Device”, the mechanism invented in 1934, it was developed by installing a device like ball type freewheel or roller-clutch on the shaft which gets connected to the propeller shaft, which extends to the differential [1]. Shortcomings:

A. The device works in one direction only. It will not restrict the rolling back when the vehicle moves uphill in reverse direction.
B. For driving the vehicle in reverse direction, it requires manual deactivation of the device.
C. To change the direction of motion, every time it requires activation or deactivation of the device manually.

“No-Roll Back Brake for Automobile”, the mechanism invented in 1938, it was developed by installing a “cramping” member normally entirely free and out of the engagement with the operating devices while the driving shaft is in the rotation, but instantly operable on a reverse movement such as is imparted to the shaft when the vehicle would tend to back down a hill or a grade when the clutch is released or when stalled [2].

Shortcomings:

D. Once this mechanism came into action for stopping the roll back, it stops the propeller shaft, extending from the gear box to

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differential box, like brake shoe action in the brake drum. To release the propeller shaft for motion further, it requires a lever to be guided manually.

E. This mechanism requires its deactivation manually, to allow reverse direction motion of the vehicle.

F. Once this mechanism got deactivated for reverse direction motion, it needs to be re-activated manually, i.e., it requires manual assurance to get it re-activate again.

G. It does not work while the vehicle is moving uphill in reverse direction.

"No-Roll Back Mechanism", the mechanism invented in 1939, it was developed by installing the devices like freewheel, ratchet-pawl or roller clutch on the driven (output) shaft of sliding mesh gearbox, to restrict its rotation in one direction only [4]. This mechanism was made in such a way that it deactivates when the reverse gear is applied.

Shortcomings:

H. It does not work while the vehicle is moving uphill in reverse direction.

I. Once this mechanism got deactivated, it does not get re-activate, unless the top gear is applied, i.e., it requires manual assurance to get it re-activate again.

J. This mechanism cannot be installed in the constant mesh gearbox.

"Anti-Roll Back Device for Motor Vehicles", the mechanism invented in 1993, it was developed by installing two additional gears on the lobs on a plate. One of them meshes with clutch dog of lower most gear (1st gear) and other meshes with the intermediate gear of reverse gear, for restricting their motion in one desired direction only [3]. The gear, which is installed separately comprises of freewheel / roller clutch within it. The mechanism is installed on an additional shaft.

Shortcomings:

K. It does not work with all the gears. Its application is limited to the lowest gear and the reverse gear.

L. An additional sliding mesh mechanism will be involved.

M. Additional shafts and lobs are required.

"Hill Holder Control Apparatus for Vehicle", the mechanism invented in 2003, it was developed by employing an additional clutch within the gearbox termed as secondary clutch [3]. An additional couple of gears is kept always meshed up between the countershaft and the driven splined shaft of a constant mesh gearbox. This additional gear rotates under the guidance of secondary clutch, which is operated by an electronic controller, sensors and controlling the hydraulic pressure of the actuators.

Shortcomings:

N. It employs electronic controller, sensors and actuators, which makes it less reliable in comparison to mechanical mechanisms.

O. Expensive.

P. The secondary clutch releases the additional gear after a predetermined time frame decided by the electronic circuit, i.e., it deactivates after a stipulated time.

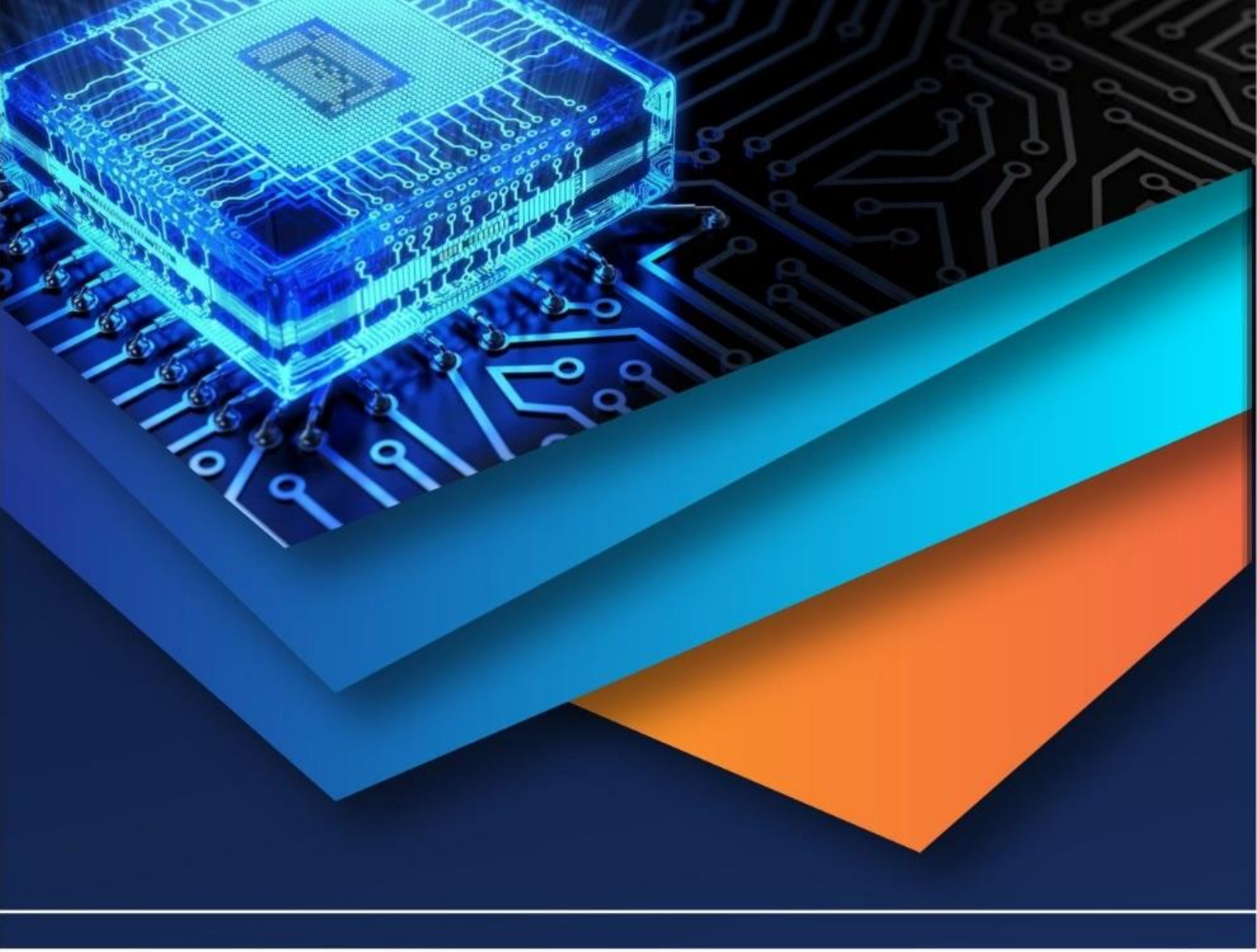
V. CONCLUSION

The outcome of the analysis so far is that the said issue comes into the picture, in the meantime of shifting foot from brake pedal to accelerator pedal when the clutch is pressed (disengaged), due to gearbox being idle from the engine side and it's all elements (shafts and gears) rotate in a direction under the influence of wheels, which is opposite to the direction they are supposed to rotate when driven by the engine. It concludes that the opposite direction rotation of the gearbox elements is to be restricted in such a way that required agenda gets fulfilled, ensuring the removal of the shortcomings of the already invented mechanisms. This may be achieved employing a device like roller-clutch, freewheel or ratchet pawl mechanism one shaft of the gearbox, which rotates in the same direction for both forward and reverse motion of the vehicle, so that its rotation is restricted to one direction only.

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