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REVERSE BRAKING SYSTEM

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ABSTRACT
The Project consist of braking system that constraint the reverse motion of a vehicle. The Ratchet is keyed over the rotating shaft. A push button provided in drivers operating range which control the Pawl's to and Ratchet through the actuator which ultimately stop the reverse motion of vehicle by engaging and disengaging the pawl. The present invention in its various embodiments, aims to address the above drawbacks and requirements, and provide effective systems and methods to prevent a vehicle from reverse movement in a slope.

KEYWORDS- *Rotating Ratchet, Pawl, Live axle.*

1. INTRODUCTION
A vehicle while on an upward slope, experiences a gravitational force towards the reverse side. While the vehicle is stationary and when not subject to an active break mechanism or forward acceleration, it experiences an almost instant pull in the reverse direction and may undergo a downward fall by releasing potential energy. This is thus a common phenomenon which is undesirable while the vehicle is required to stay stationary or move upwards.
This is a common problem faced by all vehicle users and causes considerable inconvenience to them while ensuring the safe mobility of the vehicles. On certain occasions the undesirable reverse movement may even cause accidents and damage to life or property. It further leads to fuel wastage as more fuel combustion will be required to counter the gravitational force action on the vehicle against the direction of the desired motion.
To eliminate this problem, certain anti-reverse mechanisms have been introduced and implemented in vehicle, more particularly in light motor vehicles. However, the said mechanisms are expensive, involve excessive number of components and are dependent on electronic devices and sensors. The present invention in its various embodiments, aims to address the above drawbacks and requirements, and provide effective systems and methods to prevent a vehicle from reverse movement in a slope.The present invention in its various embodiments, aims to address the above drawbacks and requirements, and provide effective systems and methods to prevent a vehicle from reverse movement in a slope.

2. BACKGROUND OF THE INVENTION
The present invention in a preferred embodiment provides systems and methods for preventing a vehicle from reverse movement on a slope. The system comprising of
a) A heavy commercial vehicle.
b) A ratchet and pawl device connected to at least one wheel of the vehicle.
c) A connecting or fastening component which connects the ratchet and pawl device such that the wheel shall rotate only if the ratchet and pawl device rotates.
d) And electronic mechanism i.e. Actuator which will control the movement of the pawl while engaging or disengaging the mechanism when the system may be engaged using an engaging mechanism when reverse motion is undesirable or to be restricted, and may be disengaged when the reverse motion is desirable.

3. COMPONENTS
2.1Electro Mechanical Actuator-
Electro-mechanical actuators are similar to mechanical actuators except that the control knob or handle is replaced with an electric motor. Rotary motion of the motor is converted to linear displacement. There are many designs of modern linear actuators and every company that manufactures them tends to have a proprietary method. The following is a generalized description

of a very simple electro-mechanical linear actuator typically, an electric motor is mechanically connected to rotate a lead screw. A lead screw has a continuous helical thread machined on its circumference running along the length (similar to the thread on a bolt). Threaded onto the lead screw is a lead nut or ball nut with corresponding helical threads. The nut is prevented from rotating with the lead screw (typically the nut interlocks with a non-rotating part of the actuator body). Therefore, when the lead screw is rotated, the nut will be driven along the threads. The direction of motion of the nut depends on the direction of rotation of the lead screw. By connecting linkages to the nut, the motion can be converted to usable linear displacement. Most current actuators are built for high speed, high force, or a compromise between the two. When considering an actuator for a particular application, the most important specifications are typically travel, speed, force, accuracy, and lifetime.

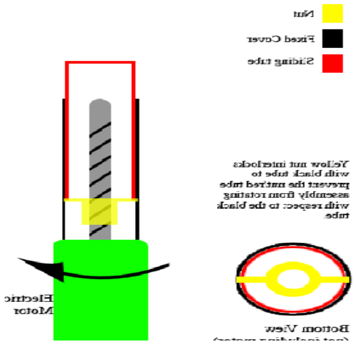

Figure.Actuator

2.2 Ratchet andPawl Gear-

A ratchet consists of a round gear or linear rack with teeth, and a pivoting, spring loaded finger called a *pawl* that engages the teeth. The teeth are uniform but asymmetrical with each tooth having a moderate slope on one edge and a much steeper slope on the other edge. When the teeth are moving in the unrestricted (i.e., forward) direction (see Figure), the pawl easily slides up and over the gently sloped edges of the teeth, with a spring forcing it (often with an audible 'click') into the depression between the teeth as it passes the tip of each tooth. When the teeth move in the opposite (backward) direction, however, the pawl will catch against the steeply sloped edge of the first tooth it encounters, thereby locking it against the tooth and preventing any further motion in that direction.

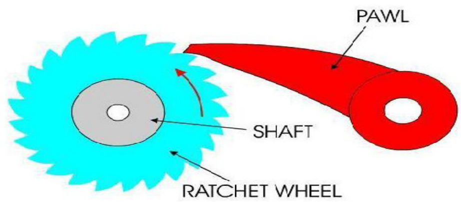

Figure. Ratchet and Pawl

4. WORKING OF REVERSE BRAKING SYSTEM

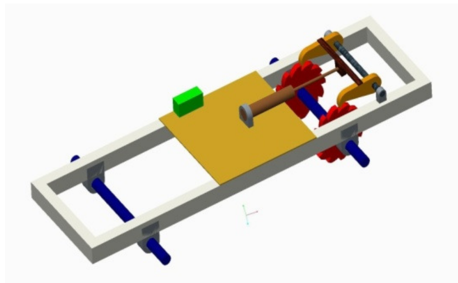

Figure. CAD Diagram for Experimental Setup

The working principal of the mechanism is very simple. It can be easily understood from the above Cad diagram. Mechanism consists of Ratchet and Pawl arrangement which will engage with each other as per the choice of the driver. As seen above the ratchet is simply a gear which has got one side teeth due to which is can transfer the power in unidirectional only. Just above it pawls are mounted which will engage with the ratchet to lock its rotation in any one direction. Ratchet and Pawl will be collectively mounted on the rear axle in such a way that the ratchet will have the drive along with the rear axle. Due to this the pawl will be able to engage with the ratchet when it will be in motion along with the wheels.One push button will be mounted on steering wheel or dashboard which will be operated by the driver on choice. It will have 2 knobs say ON and OFF. The knob will be connected to the power supply and actuators. It will control the operational function of the actuator in contrast with the engaging and disengaging the mechanism. When its knob will be ON that time it will actuate the actuator. The output shaft of the actuator will come outward as it is connected to the common link of the two pawl. Due to this both the pawl will start to move upward i.e. it will not have contact with the ratchet thereby disengaging the mechanism.

5. DESIGN OF MODEL

DESIGN FOR A PROTOTYPE WITH W=150 KG
Actual load acting on Pawl (P):-
Considering maximum weight of Vehicle (W) = 150 kg

$P = W \times 9.81 \times \cos 45$
$= 150 \times 9.81 \times \cos 45$
$P = 1040.508$ N

Considering 2 Ratchet -
Load acting on Single ratchet & pawl pair (P_1):-
$P_1 = P/2$
$= 1040.508/2$
$P_1 = 520.254$ N

Transmitting Torque (T):-
Centre of Gravity (C.G) = 1000/2
= 500 mm
T = Force × Distance (L)
$T = P_1 \times C.G$
$= 520.254 \times 500$
$T = 260.126 \times 10^3$ N-mm

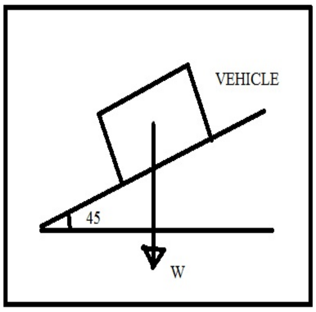

Figure. FBD of Vehicle on Slop

Now, Assuming

- No of teeth (z)= 10 [… For Ratchet type brakes]
- $\Psi(b/m)$ = 1.25 [… From PSG Design Data Book; Pg.No :- 7.85]
- Material, C45 = 600 N/mm^2 [… From PSG Design Data Book; Pg.No :- 1.10]

Bending Stress on Ratchet (σ_b):-
S_{ut} = Ultimate Strength = 600 N/mm^2
F.O.S = 5 [… For High Safety]

$\sigma_b = S_{ut}/F.O.S$
$= 600/5$
$= 120$ N/mm^2

Now,
Calculate Module (m):-
M_t = Transmitted Torque = T = 260.126×10^3 N-mm
Ψ (b/m) = 1.25
z = No of teeth = 10
σ_b = 120 N/mm^2
$m = 2 \times \sqrt[3]{M_t / \{z\Psi(\sigma_b)\}}$
$= 2 \times \sqrt[3]{260.126 \times 10^3 / (10 \times 1.25 \times 120)}$
$= 11.15 \approx 12$

Dimensions for Ratchet:-
Diameter for Ratchet (D) = m × z
= 12 × 10
= 120 mm
Thickness (t) = 37.70 mm
Height (h) = 9 mm
Side Thrust (a) = 12 mm
Nose Radius (r) = 1.5 mm
Face Width (b) = Ψ × m
= 1.25 × 12
= 15 mm
[… From PSG Design Data Book; Pg.No :- 7.86]

Dimensions for Pawl:-
Height (h_1) = 12 mm
Side Thrust (a_1) = 6 mm
Nose Radius (r_1) = 2 mm
[… From PSG Design Data Book; Pg.No :- 7.86]

Check for Failure:-
The pawl is checked for eccentric compression or tension
M_{b1} = Bending Moment for Pawl.
P_f = Peripheral Force
$= 2 M_t / (z \times m)$
e_1 = Eccentricity

$M_{b1} = P \times e_1$

But,
$e_1 = h = 9$ mm
P_f = Peripheral Force
$= 2 M_t / (z \times m)$
$= 2 \times 260.126 \times 10^3 / (10 \times 12)$
$= 4335.43$ N

M_{b1} = Bending Moment on Pawl
$M_{b1} = P \times e_1$
$= 4335.43 \times 9$

$= 39.0189 \times 10^3$ N-mm

$$\sigma_{act} = \frac{6\times Mb1}{bx2} + \frac{P}{x\times b} \leq [\sigma]$$
$$= \frac{6 \times 39.0189\times 103}{15 \times 152} + \frac{4335.43}{15 \times 15}$$

= 88.63 N-mm

Therefore;

$$88.63 \leq 120$$

As σ_{act} is less than σ hence design is safe.

6. Expected Outcomes

1. It will make the new driver feel comfortable during driving on gradient surfaces.
2. Undesirable reverse motion of the vehicle will be hampered.
3. Less chances of accidents.
4. To propose perfect mechanism to Indian market at low cost.

CONCLUSION

It will make the new driver feel comfortable during driving on gradient surfaces. Also undesirable reverse motion of the vehicle will be prevented which will result inless chances of road accidents. This will propose a perfect mechanism to Indian market at low cost. Due to this most of the manufacturers will be in a race to provide such mechanism which will be the first reference of the customer while buying a vehicle.

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