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Automatic Engagement and Disengagement of Handbrake System Using Pneumatic system

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Abstract: ***One of the most important safety features in an automobile is brake. A typical automobile consists of two types of brakes, one for retarding the speed of vehicle while it is in motion and other is to hold the vehicle in its place when standing still or parked. The latter is mostly important when the vehicle is parked on slope. It is important to disengage the handbrake before starting the vehicle from rest position. Due to operator errors the conventional handbrake system remained engaged even when the vehicle was moving due to manual operation of the hand lever through which the handbrake is operated. This led the brakes to become ineffective and eventually they failed to serve their purpose. To overcome all the limitation of the conventional system we proposed the new automatic handbrake engagement and release system. This system uses electro-pneumatically operated components using solenoid and pneumatic circuits. This system operates depending on the positions of the key. When the ignition switch is turned on the handbrake disengages and engages when the ignition is turned off.***
Keywords: Handbrake, Automatic Handbrake, Vehicle Safety

I. INTRODUCTION

In cars the hand brake is a latching brake usually used to keep the car stationary. Automobiles e-brakes usually consist of a cable directly connected to a brake mechanism on one end and to some type of mechanism that can be actuated by the driver on the other end the mechanisms is often a hand –operated lever, on the floor on either side of the driver, a pull handle located below and near the steering wheel column, or a pedal located far apart from the other pedals. Although sometimes known as an emergency brake, using it in any emergency where the footbrake is still operational is likely to badly upset the brake balance of the car vat increase the likelihood of loss of control of a vehicle for example by initiating the rear – wheel skid. Additionally, the stopping force provided using the hand brake of or in addition to the footbrake is usually small and would not significantly aid in stopping the vehicle, again because it usually operates on rear wheel while braking .The emergency brake is instead intended for use in case of mechanical failure, where the regular footbrake is inoperable or compromised, hopefully with opportunity to apply the brake in a controlled manner to bring the vehicle to a safe.

Brakes are one of the most important safety systems in a motor vehicle. The main functions of brakes system are to decelerate the vehicle, to maintain the vehicle's speed during downhill operation and finally to park the vehicle stationary either on a flat or slope road condition. The first two functions are related to the service brakes, while the last function is referred to the secondary or parking brakes. Conventional parking brake actuation involves the human interference. Without pulling or pushing the lever, the parking brake will not work. Also, sometimes due to negligence or in emergency conditions, we humans often forget to apply parking brakes. This may lead to rolling of vehicle in case of slopes and collision with other vehicles in parking area. Constant enhancements in active safety and improvements with respect to the reliability and comfort of operation mean that mechanical handbrakes are increasingly being replaced by new other systems and this giving birth to new ideas of parking brake techniques.

II. LITERATURE REVIEW

A traditional handbrake is very simple by pulling the lever up; you are pulling two cables which run to each of the rear brakes. By adding tension to these cables, this in turn causes the pads (or 'shoes' for cars with drum brakes) to squeeze against the discs (or drums) to hold the rear wheels firmly in place. Some cars with disc brakes have separate handbrake drum-brake shoes or even a separate disc-brake calliper for the handbrake. Later electronic parking brake replaces this mechanical system with an electrical one. By pressing the switch, motors on each brake calliper squeeze the pads into the disc.

III. PROBLEM STATEMENT

In automobile, Handbrake (Parking brake) is the system used for safety. Conventional system works by operating handbrake lever

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manually. In this system, it is observed due to manual errors the brakes remain engaged when vehicle is moving. This condition causes safety hazards which may cause damage the system components.

IV. METHODOLOGY

A. *Analytical Method*

In Analytical method design of various components and their related calculations required are calculated and carried out as follows. Design of various components or parts of new designed parking brake system, which includes Design of pneumatic cylinder. As per required condition, the complete system should be fitted in a one frame and it should compact & feasible in size, the whole system should be fitted in compact box.

After completing the analysis of components we used to create the parts for assembly by using Creo software.

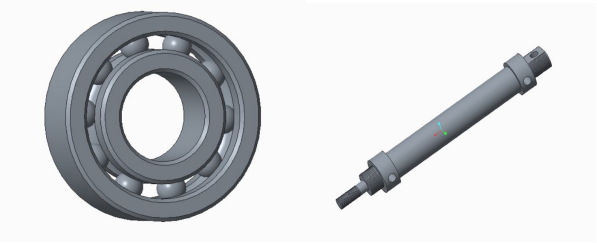

Fig.1 Bearing Fig.2 Cylinder

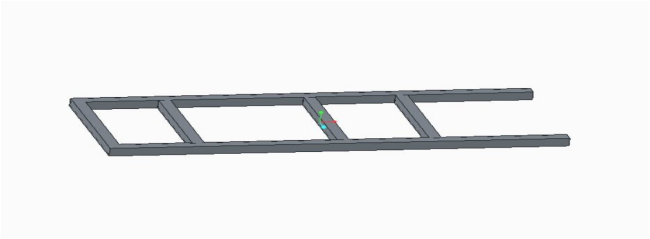

Fig.3 Frame

V. DESIGN PARAMETERS

A. The frame which will hold the whole system.
B. Shaft used to drive the wheels connected with frame using bearings.
C. Bearings which will support the shaft ends and support and hold the frame.
D. Disc is the main braking element in the system.
E. Cylinder Clamps is used to support the cylinder mechanism.
F. Cylinder which is the main actuating component which allows the brake to engage or disengage.

VI. DESIGN CALCULATIONS

A. *Force Calculation Analysing foot brake*

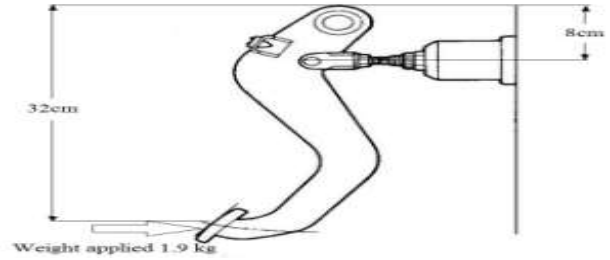

Fig. Dimensions and force applied

By lever principal

Volume 5 Issue VI, June 2017
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F×8=32 × 1.9
F= 60.8/ 8
F = 7.6 kg
F= 74.556 N.

B. Hand brake calculations

Now for hand lever, we can assume that the pull force applied on lever during applying hand brake is approximately 30N

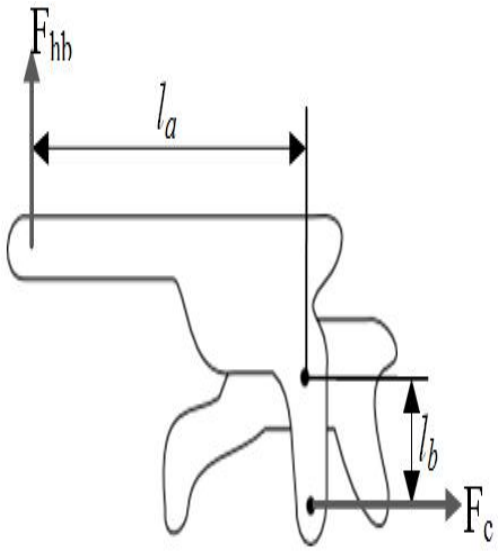

Fig. Hand lever mechanism

By considering F= 74.556 N From above calculations we will calculate F_{hb}.
Considering dimensions of Hand lever
l_a= 25 cm,
l_b= 8 cm,
F_c= 93.75 N,
In case of handbrake, generally 60% of Handbrake we use while braking instead of total brake so force required for handbrake is 60% of total Force.
0.6 x 74.55 = 44.75 N
Now for automatic hand break system, we have to choose an actuator which produce nearby 45N of force.
But for our calculation and safety, we are assuming that the braking force required is 100N.

C. Pneumatic cylinder calculations Assuming maximum pressure 2 N/mm2

By using trial and error method Calculate diameter of piston rod

1) Calculate pressure to check feasibility of actuator

$P=F/A = 100/ ((3.14/4)x7^2$

$P= 2.598$ N/mm^2

2) $P=F/A = 100/((3.14/4)x8^2$

$P= 1.989$ N/mm^2

Hence Actuator with 8mm rod diameter is selected.
From the manufacturer catalogue
AIR CYLINDERS Double Acting - Ø32 - 100 mm
As per ISO 15552 / VDMA 24562 standards

Volume 5 Issue VI, June 2017
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VII. MATERIAL USED

Table. 1. Bill of Materials and Process Selected

Part Name	Material Used & Process Selected
Frame	Mild Steel, Arc Welding
Cylinder	AIR CYLINDERS Double Acting - Ø32 - 100 mm As per ISO 15552 / VDMA 24562 standards
Bearing	Ball Bearing
Shaft	Mild Steel

WHEEL	GEAR	IGNITION	HANDBRAKE
REST	NEUTRAL	OFF	ENGAGE
RUNNING	ON GEAR (ANY)	ON	DISENGAGE
REST	ON GEAR OR NEUTRAL	ON	ENGAGE

Cylinder Clamp	Mild Steel
Disc	Stainless Steel
Wheels	Rubber

VIII. CONSTRUCTION & WORKING

A. Working Principle

Parking brakes have a ratchet locking mechanism that will keep them engaged until a release button is pressed. On vehicles with automatic transmissions, this is usually used in concert with a parking pawl in the transmission.

Hand brakes are also used to assist in hill starts on vehicles with manual transmissions. Use of the handbrake frees both feet for use on the accelerator and clutch pedals, allowing the car to move off without rolling back at all handbrake system it is required to engage brake when the car is parked or stopped on hill road. At this time, the engine is OFF and the driver may be out of the car. So we will produce our system in such a way that the input to system is given by ignition key position. As when the ignition switch is turned OFF (i.e. car is parked), brake must engage and when the ignition switch is turned on (i.e. car is moving), brake must disengage. This system works electro-pneumatically by using solenoid valve and pneumatic system circuit.

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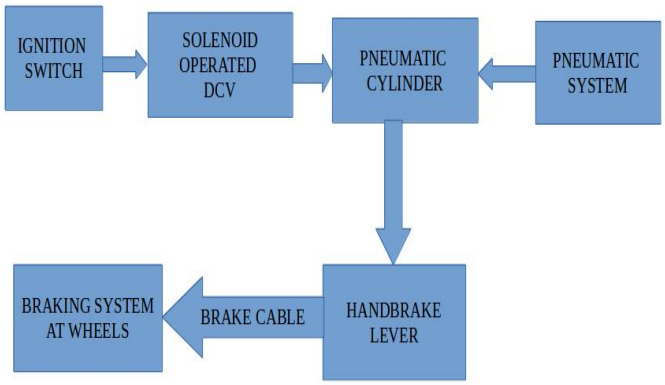
B. Working

The conventional handbrake system is a manually operated and uses a hand lever and cables for its operation. At the time of engagement the hand lever is pulled upwards creating tension on the cable eventually creating the braking force required for locking the wheels. Disengagement requires releasing of the pawl from the ratchet which is accomplished by pressing the button incorporated on the hand lever. This conventional construction of the handbrake system cannot be automated and requires manual actuation only. Thus the system we have designed eliminates the use of pawl and ratchet mechanism and thus making it possible to completely automate the working of the handbrake system. We made use of electro-pneumatically operated components and sensors which automatically engages and releases the handbrake in various predefined conditions. Various sensors are placed in the system at different places which sense the current position of the vehicle Eg. When the wheels are in motion, when they are not in motion etc. and depending on this feedback is sent to the arduino controller which decides whether to actuate the pneumatic cylinder which in turn engages or disengages the parking brakes.



C. Braking conditions

1) When the vehicle is at the rest and the ignition is kept off in neutral gear the handbrake will stay engaged that is vehicle's wheels will be locked.

2) When the vehicle is moving in a certain with ignition on the handbrake will be disengaged and wheels will be free to move.

3) When the vehicle is at the rest for certain period with ignition on, irrespective of gear position the handbrake will stay engaged.

IX. ADVANTAGES

A. The cost of this system is much lower than the similar systems used in high end cars which use electronic controllers which are way more expensive than this system.

B. If a driver is not confident on climbing a hill in stop and go conditions then he may use the system and find it very easy to park as well as start ascending on the hill.

C. Use of various sensors like proximity sensors make it is very easy to operate and modify the system. Increasing number of sensors in various different places can help and improve this system by engaging the handbrake and disengaging it in different conditions.

D. Number of sensors used can be reduced to reduce cost and the engaging and disengaging may be done for minimum conditions.

E. Manual interaction regarding the handbrake is completely reduced causing almost no error in operation of the handbrake.

F. Very fast engagement and disengagement as possible and there is no lag in operation of the handbrake.

X. DISADVANTAGES

A. In case of failure of Pneumatic system the whole hand brake system would fail.

B. Pneumatic system needs compressor which will consume power thus reducing the efficiency of the car overall

C. For manual override of the handbrake brake system buttons need to be provided which will increase the overall cost of the system

D. It is difficult to retrofit it to a current existing car model.

E. Use of sensors means the load created on the battery will be more.

F. In case of leakage in the pneumatic cylinder the handbrake mate disengage and the vehicle me start moving if it is parked on slope.

XI. CONCLUSION

Thus the use of conventional hand brake system can be eliminated using this system and the error occurring due to operator can be eliminated completely. It can clearly be seen that this system is completely fool proof and we may use this system in automobiles even in the lower price range as this system is not extremely expensive. This can even allow using the system in high end cars instead of the expensive electronically controlled system they use for automatic parking brakes to reduce the overall cost of the vehicle. Use of Pneumatic system allows fast engagement and disengagement of the handbrake and it makes the vehicles safer. By using the system we have reduced the manual load on the operator and eliminated the error that operator me induce while operating the system.

XII. FUTURE SCOPE

A. It can be used automate overall braking system in an automobile.
B. It can be developed to use in case of failure of main Braking System of the vehicle. That is if the foot brake fails this system may take over to retard the vehicle to safe speed and ultimately stopping it.
C. It can be developed to operate these brakes remotely using a remote key or a smartphone
D. This system can be useful in driverless cars.

XIII. ACKNOWLEDGEMENT

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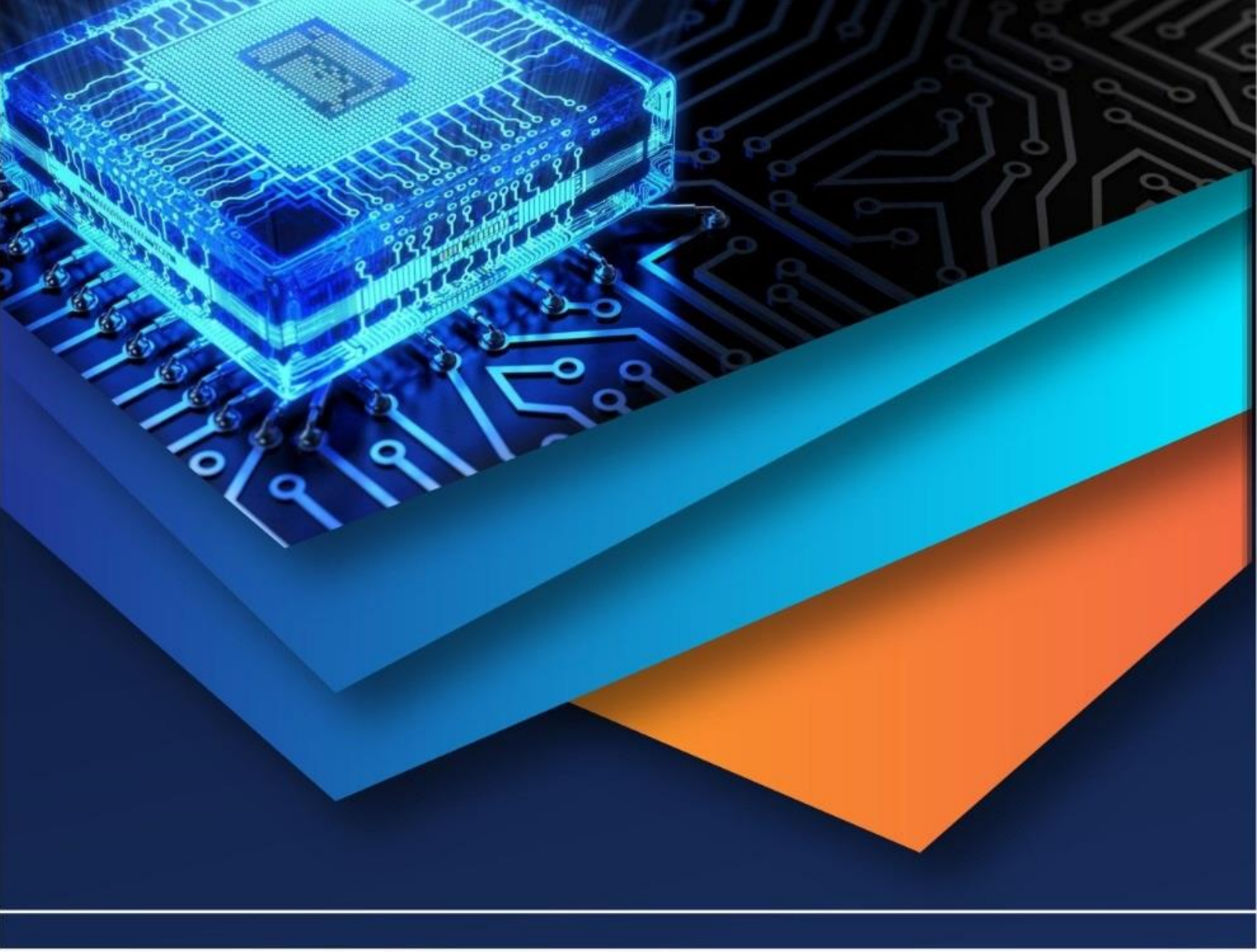

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