A Study of Various types of the Braking System

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ABSTRACT: In recent years, the automobile industry has seen huge developments and most of them are particularly focused towards improving the safety of not only the individuals sitting inside the vehicle but also the ones who are within a certain range of the vehicle. There are safety systems which are being continuously developed and tested such as the AEBS (Automatic Emergency Braking System) which, as the name suggests, applies the brakes automatically thereby reducing the casualties. The systems which are currently being used are the Traction control (TC), Brake Assist (BA), Anti-Lock Braking System (ABS) and the Electronic Stability Control (ESC). These systems help the driver to have better control over their car. With the help of this paper, we aim to review the current braking systems and explore their advantages and disadvantages.

KEYWORDS: Brakes, Braking, Electric, Regenerative Braking System (RBS), Vehicle.

INTRODUCTION

Regenerative braking system are a form of kinetic energy recovery system that converts the kinetic energy of a moving item into potential or stored energy in order to slow down the vehicle and improve fuel economy. Kinetic energy recovery systems are another name for these systems. RBSs use a variety of energy conversion techniques, including as springs, flywheels, electromagnetics, and hydraulics. An electromagnetic-flywheel hybrid RBS has also been developed recently[1]. Each type of RBS uses a distinct technique of energy conversion and storage, resulting in variable efficiency and applications. An automobile, often known as a car or a motor car, is a four-wheeled vehicle that is designed primarily for passenger transportation and is powered by an internal combustion engine that runs on volatile fuel. Decelerating in a moving vehicle involves applying brakes, usually by depressing the pedal, to slow or halt the vehicle's progress. The braking distance is the delay between when the brakes are applied and when the vehicle comes to a complete stop[2].

1.1.Classification of Braking System:

Braking system are defined on following basic:

- On Power Source Basis
- On Frictional Contact Basis
- On Application Basis
- On Brake Force Distribution Basis

1.1.1. On Power Source Basis:

There are six different types of power supplies that bring the pedal power applied by the motorist to the brake pedal for final brakes or drum discs in order to decelerate or stop the vehicle, show in Figure 1.

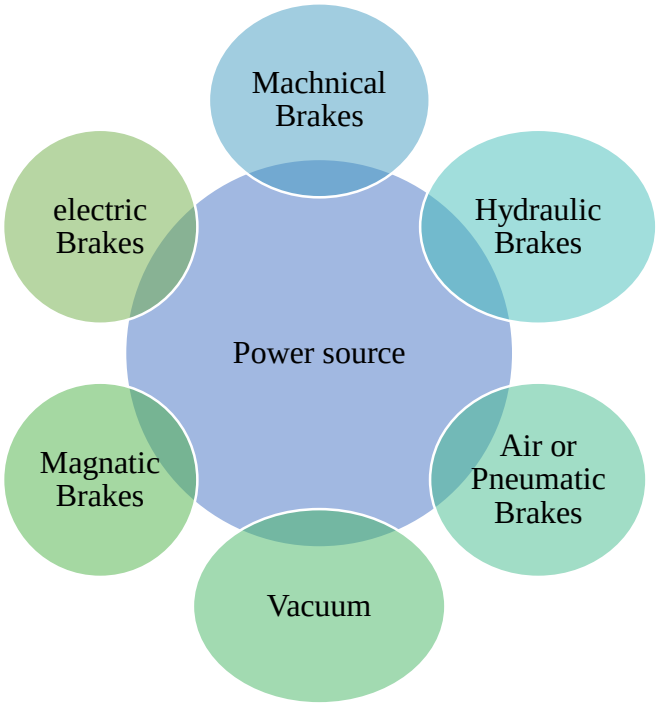

Figure 1: Illustrated Diagram showing the types of power suppliers.

1.1.1.1.Mechanical Brakes:

The brake applied force by the driver on the pedal is moved to the final brakes disc or drum rotor via a range of mechanical connections such as cylindrical rods, springs fulcrums, and so on to slow and stop the automobile in this type of braking system.

Figure 2: The Brake Applied Load by the Operator on the Pedal Shifted to the Final Brakes Disc or Drum Rotor is known as a mechanical drum brake[3]**.**

1.1.1.2.Hydraulic Brakes:

As illustrated in Figure 3, the braking force exerted by the driver on the pedal is first converted to hydraulic pressure from the master cylinders, and then transmitted from the master cylinders to the final brake disc or drum rotors through brake lines.

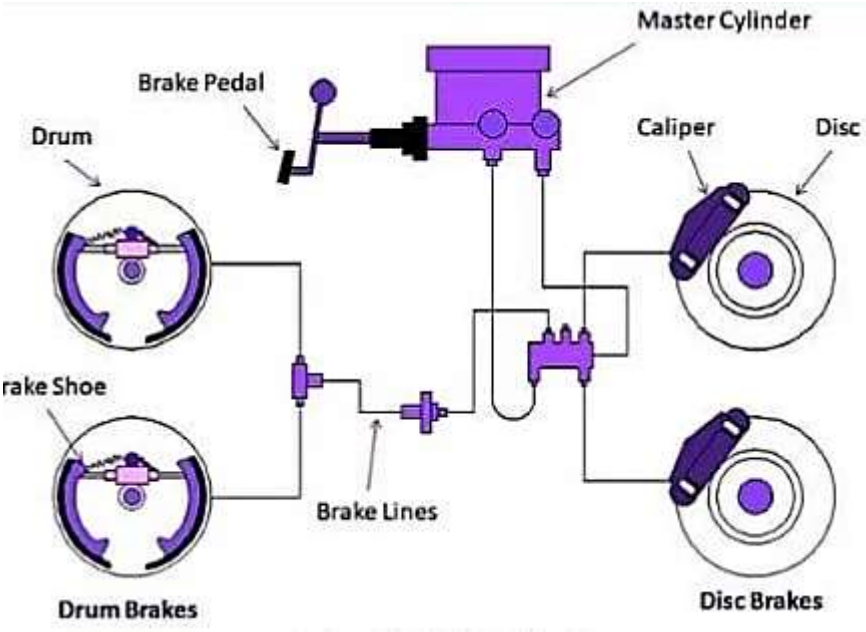

Figure. 3: Hydraulic brakes work by converting the driver's braking force on the pedal into hydraulic pressure from the master cylinders[4]**.**

1.1.1.3.Air or Pneumatic Brakes:

Valves and compressors in that system transmit the brake pedal power from the pedal to the final disc or drum rotor. Air brakes are widely used in large vehicles such as buses and trucks since hydraulic brakes cannot transfer high braking force over longer distances and pneumatic brakes offer higher stopping power than hydraulic brakes.

1.1.1.4.Vacuum Brakes:

In this type of braking system, the pressure inside the brake line causes the brake pad to shift, stopping or speeding up the automobile. Figure 4 depicts the main cylinder, exhauster, valves and brake pads, disc rotor or drum, as well as other important components of a vacuum braking system.

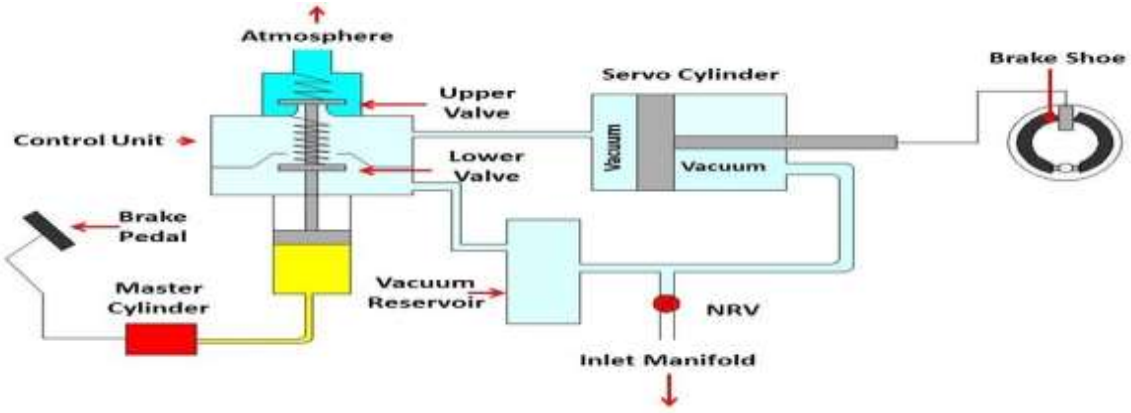

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Figure 4: Vacuum Brakes are those that have a vacuum inside the brake lines that causes the brake pads to shift, stopping or speeding up the vehicle[5] **.**

1.1.1.5.Magnetic Brakes:

The magnetic field created by permanent magnets is used in the braking system to force the car to brake. This is based on the notion that when we drive a magnet through a cooper tube, an eddy current is created, and the magnetic field created by the eddy currents provides brakes, as shown in Figure 5[6].

Figure 5: The magnetic field produced by permanent magnets is used in the braking system to cause the vehicle to brake.

1.1.1.6.Electrical Brakes:

This is a form of braking used in electric cars that uses electric motors to generate brakes, and is further divided into three types:

- Plugging Brakes**:**
- Dynamic or Rheostat Braking
- Regenerative Braking**:**

1.2.*On Frictional Contact Basis:*

There are 2 types of frictional contact in orders to deaccelerate or stops vehicle given below:

1.2.1. Drum Brake or the Internal Expand Brake
1.2.2. Disc Brake or the External Contract Brake

1.3.Internal Expand Brake or Drum Brakes:

They are braking systems in which the disc rotor is connected to the wheel hub in such a way that it spins with the wheel rather than a drum component, and the rotor is clamped between the calliper, which is permanently stuck with the car upright, and the knuckle.

1.3.1. Disc Brakes or the External Contract Brake:

They are braking systems in which, instead of drum construction, a rotor attached to the wheel hub is clamped between callipers, which are permanently attached to the car's knuckles or the upright, and spins with the wheel, The calliper houses the brake shoes' housing and actuation mechanism.

1.4.*On Application Basis:*

There are 2 types of application based brakes which are given below:

1.4.1. Foot or Service Brakes
1.4.2. Parking or Hand Brake

1.5. Service Brake or Foot Brakes:

The brake form with which the brakes are applied is further increased by the pedal force given by the driver and sent to the braking drum or disc either via mechanical connections or by hydraulic pressure, which in turn activates braking, as shown in Figure 6.

Figure 6: The Brake Form is a Foot Brake in which the Driver uses his foot to push the Brake Pedal mounted within the Cockpit or at the Foot of the Vehicle.

1.6.Hand Brake or Parking Brake:

AS they are impartial of main services brake, the hand brake is sometimes known as emergency brakes. Hand brakes are made up of hand operated brakes lever that is attached to brake disc or drum rotor via a metal cord.

1.7. Single Acting Brakes:

As indicated in Figure the brake forces are communicated by a single actuation mechanism to either pairs of wheels or a single wheel (mechanical linkages or master cylinder).

1.8.Dual Acting Brakes:

This is a braking system that employs a dual actuation mechanism to apply brake pressure to both of the vehicle's wheels. For both sides of the piston, double working cylinders alternate a pressurised fluid cycle, creating extend and retract forces to move the piston rod, allowing for better control.

1.9.The Regenerative Braking System's Basic Concept:

A RBS is used to power all-electric vehicles. This gadget has an electrically powered engine. The engine acts as a generator and battery charger when the brakes are applied. Frictional heat energy has been transformed to usable braking energy.

2. Various Type of the RBS:

In an electric system which is powered only by means of electric motor the system consists of an electric motor which acts both as generator and motor .The main components of this system.

- Motor or Generator
- Engine
- Electronic controls system
- Batteries

By integrating electrical and hydraulic features, the Hydrostatics Regenerative Braking system improves vehicle fuel economy. Ford Motor Company and Eaton Corporation are constructing a new RBS. It's known as HPA, or Hydraulic Power Assist,

2.1.Nitinol Spring Regenerative Brakes:

how K.E is stored as Potential energy (PE) in the spring when it breaks. When the system needs acceleration, stored P.E is returned to the wheels to push them, as seen in Figure 7.

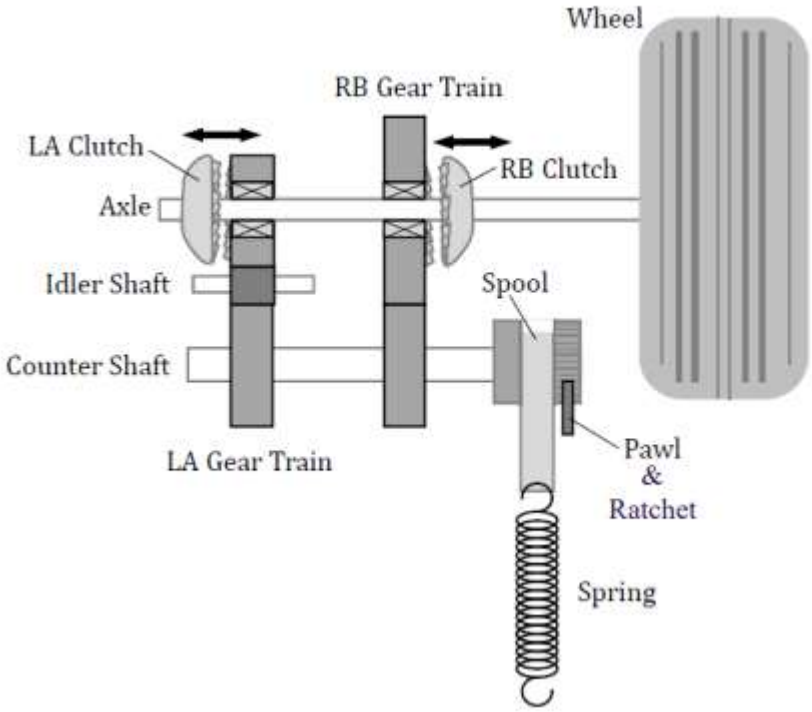

Figure 7: Hydraulic Regenerative Brakes in which while Braking K.E is Stored in the form of P.E in the spring.

2.2.Indian Scenario of RBS in Electrical Vehicles:

Electric and hybrid automobiles such as the Tesla Roadster, Mahindra E20, and Toyota Prius, among others, use regenerative braking. Technology that transforms kinetic energy from automobiles into chemical energy stored in the battery. As a consequence, when the brakes are applied, the normally lost energy is employed to replenish the batteries. Electric vehicles (EVs) are a relatively new vehicle type that has lately entered the Indian market. Electric motors are used to propel these vehicles, which are powered by rechargeable battery packs. During braking, the electric motor that drives the car's wheels plays an essential role[7].

The power generated is used to recharge the car's storage batteries. This gadget will greatly increase the fuel economy of automobiles. Consumers are concerned about growing gasoline prices and environmental challenges in today's society. The goal of this technique is to save energy while lowering carbon emissions. It increases the range of electric cars and makes them more useful in everyday situations. The Kinetic Energy Recovery System in Formula One vehicles offers an instant power boost that is extremely useful for overtaking manoeuvres. BHEL, which is run by the government, has created ground-breaking technologies. Through its in-house R&D centre, the PSU has created India's first electric locomotive with regenerative braking. The locomotive had recently left the organization's Jhansi facility. The idea for the energy-efficient regeneration system originated from the Railway Ministry, and it was implemented by BHEL utilising a 5,000 horsepower WAG-7 electric locomotive. The approach is intended to be an improvement to locomotives' current dynamic braking system[8].

LITERATURE REVIEW

Xiaohong Nian et al. studied about regenerative braking can help electric vehicles save energy while also extending their operating range (EVs). This study presents a novel regenerative braking system (RBS). The RBS is designed for brushless dc (BLDC) motors and focuses on braking force distribution as well as BLDC motor management. The novel approach outperforms existing alternatives in terms of real-world implementation, robustness, and efficiency. The simulation results are then presented in this article by examining the battery state of charge, braking force, and dc bus current in the MATLAB as well as Simulink

environments. The simulation findings indicate that with fuzzy logic and PID control, EVs may achieve regenerative braking and extend their driving range while maintaining braking quality. Finally, the feasibility of the suggested approach for actual application is confirmed[9].

Hao Pan et al. studied about A novel regenerative braking control technique based on braking intention is presented for distributed electric cars with in-wheel motors. First, a regenerative braking system design concept is given. For regenerative braking and hydraulic braking, four in-wheel motors as well as an Electro-Hydraulic Braking (EHB) system are used. Then, using the Hidden Markov Model technique, self-learning libraries for braking intention identification are taught and verified by a driver-in-loop. The interval between motor maximum regenerative braking and the coefficient of regenerative braking are described by the coefficient of regenerative braking. Finally, the results of the co-simulation demonstrate that the suggested method may not only greatly enhance energy recovery capabilities, but also offer coordinated management of regenerative and hydraulic braking, which is highly consistent with the driver's braking intention[10].

DISCUSSION

This paper discusses the automobile industry has seen huge developments and most of them are particularly focused towards improving the safety of not only the individuals sitting inside the vehicle but also the ones who are within a certain range of the vehicle. There are safety systems which are being continuously developed and tested such as the AEBS (Automatic Emergency Braking System) which, as the name suggests, applies the brakes automatically thereby reducing the casualties. Electrical vehicles have a number of advantages over non-electric vehicles, one of which is the braking system. When a driver applies the brakes in a non-electrical vehicle, the energy is completely lost in the form of kinetic energy due to friction loss between the vehicle's wheels and the road, but in an electric vehicle, this energy is stored in the form of electrical energy in a battery, which is then used to charge the battery, which is then used to drive the vehicle. i-MiEV evaluates the proposed approach on dynamo systems and finds that it boosts regeneration energy by 18%. As a result, boosting regenerative energy will improve the efficiency of an engine in future cars with regenerative braking systems.

CONCLUSION

The Intelligent Braking system, if implemented may prevent numerous accidents and could save individual human lives and property. Implementation of such a complex system are frequently made obligatory much as wearing of seat belts in order that accidents are often avoided to some degree. Our Intelligent braking system offers a look into the long run of automobile safety, and the manner much more sophisticated these separate systems are frequently for preventing accidents and safeguarding car passengers when they are combined into one system. The long haul of automobile safety is beyond simply creating new technology; it's changing the attitude to safety. Intelligent Braking System method marks a significant change from the conventional approach to safety, yet it's essential to obtaining the enormous advantages. The RBS in automobiles achieves the objective of recouping some of the energy lost while braking. The RBS is designed to recover some of the battery charges that have been squandered. In the braking system of the car. Friction brakes transfer energy dissipated into the environment into heat, which is used to rotate the generator rotor and transform spinning mechanical energy of the wheels into useable battery charges. There are a variety of cars that use RBS, and these cars store kinetic energy that is lost due to frictional loss between the wheel and the road, increasing the efficiency of an engine by storing energy in the form of electrical energy in the battery, or there are many companies that can use this type of RBS in the future to increase the efficiency of an engine.

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