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A Survey of Different Braking System Types

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ABSTRACT: ***The automotive industry has undergone significant changes recently, and the majority of them are especially geared towards enhancing the safety of everyone nearby the car as well as those who are seated inside. Safety measures are continually evaluated and modified, such as the AEBS (Automatic Emergency Braking System), which, as its name implies, automatically applies the brakes to reduce casualties. Traction control (TC), brake assistance (BA), the Anti-Lock Braking System (ABS), and electronic stability control are the systems that are now in use (ESC). These devices assist the driver in maintaining better control of their vehicle. With the aid of this research, we hope to examine the benefits and drawbacks of the present braking systems.***

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

INTRODUCTION

Regenerative braking systems are a type of kinetic energy recovery device that use stored or potential energy to slow down moving objects in order to increase fuel efficiency. These systems are also known as kinetic energy recovery systems. RBSs employ a range of energy conversion methods, including as electromagnetics, hydraulics, flywheels, and springs. Recently, an electromagnetic-flywheel hybrid RBS was also created[1]. Each type of RBS employs a unique method of energy conversion and storage, resulting in a range of applications and efficiencies. An automobile, also referred to as a car or a motor car, is a four-wheeled vehicle with an internal combustion engine that uses flammable gasoline and is primarily intended for passenger transportation. Deceleration is the process of slowing or stopping a moving vehicle by applying brakes, typically by depressing the pedal. The time it takes a vehicle to stop completely after using the brakes is known as the braking distance. [2].

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

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.

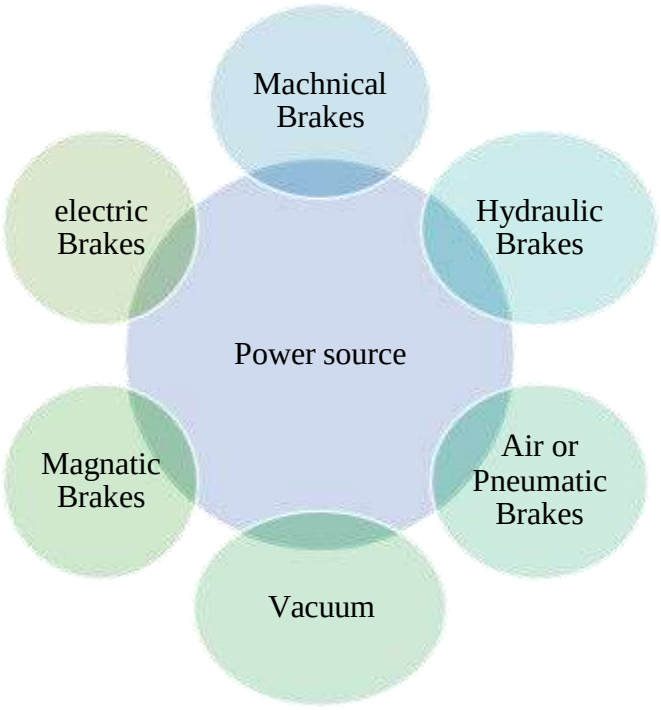

Figure 1: Illustrated Diagram showing the types of power suppliers.

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]**.**

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.

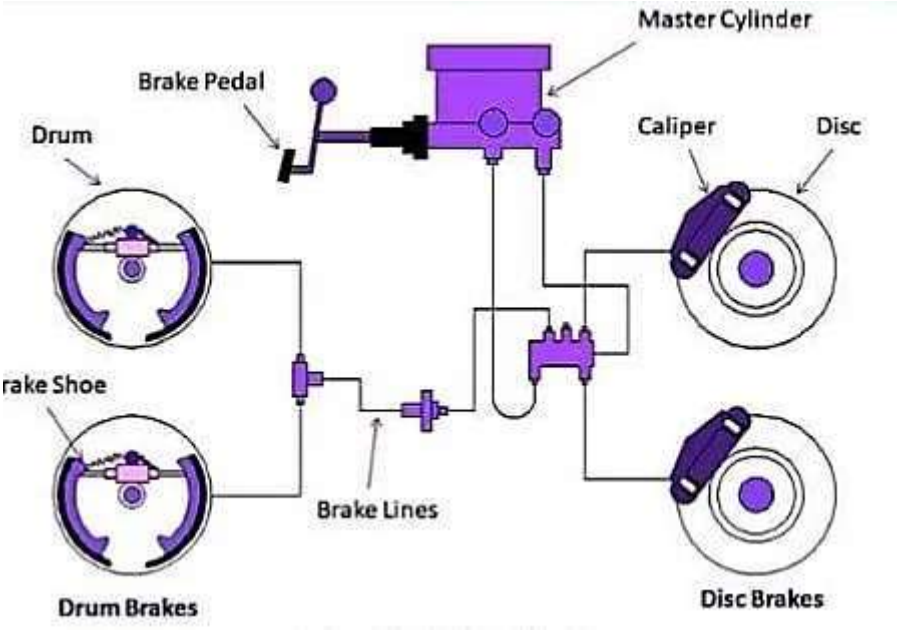

Figure. 3: Hydraulic brakes work by converting the driver's braking force on the pedal into hydraulic pressure from the master cylinders[4]**.**

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.

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.

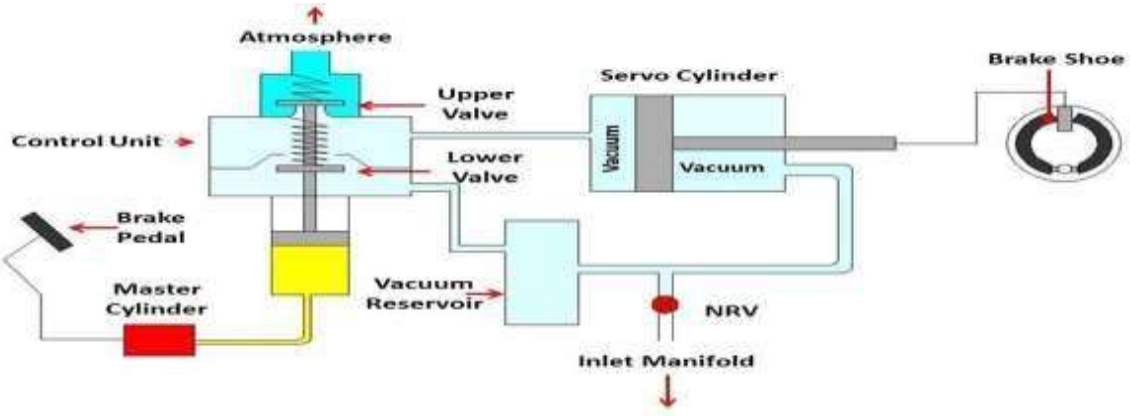

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Figure 4: Vacuum Brakes are those that have a vacuum inside the brake lines that causes the brake pads to shift, stopping or speeding up the vehicle[5] **.**

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.

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**:**

On Frictional Contact Basis:

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

Drum Brake or the Internal Expand Brake
Disc Brake or the External Contract Brake

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.

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.

On Application Basis:

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

Foot or Service Brakes
Parking or Hand Brake

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.

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.

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).

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.

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,

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.

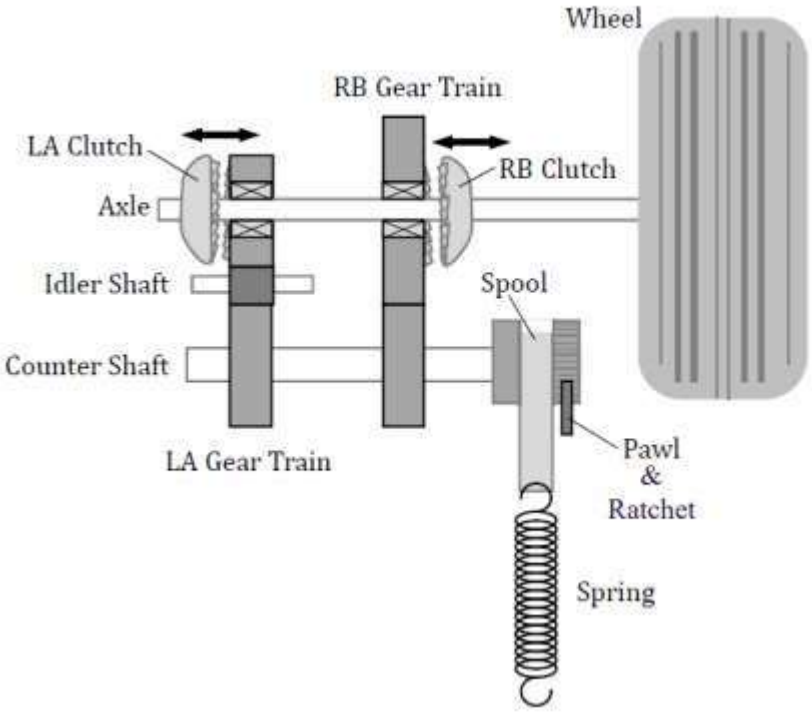

Figure 7: Hydraulic Regenerative Brakes in which while Braking K.E is Stored in the form of P.E in the spring.

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

If the intelligent braking system is used, many incidents could be avoided, saving both individual lives and property. Implementing such a sophisticated system is usually made mandatory, much like wearing seat belts, in order to somewhat prevent accidents. Our intelligent braking system provides a glimpse into the future of automotive safety and shows how much more effective these different systems are at averting collisions and protecting passengers when they are integrated into a single system. The long-term solution to auto safety goes beyond just developing new technology; it involves altering people's attitudes towards safety. Although the Intelligent Braking System method represents a substantial departure from the standard safety strategy, it is necessary to reap the benefits in order to maximise them. The RBS in cars succeeds in its goal of recovering some of the energy lost while braking. A portion of the wasted battery charges will be recovered by the RBS. in the vehicle's braking system. In order to turn the generator rotor and convert the spinning mechanical energy of the wheels into usable battery charges, friction brakes convert energy lost to the environment into heat.. The efficiency of an engine can be increased by storing energy in the form of electrical energy in the battery or by using this type of RBS in the future by a number of companies. A variety of cars use RBS, and these cars store kinetic energy that is lost due to frictional loss between the wheel and the road.

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