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EMERGENCY BRAKING SYSTEM IN AUTOMOBILE USING EDDY CURRENT BRAKING

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***Abstract*— Eddy current brakes are very essential for smooth braking of high speed vehicles. This system is a combination of electro-mechanical concepts. The frequency of accidents is now-a-days increasing due to inefficient braking system. The main aim of the present paper is to ensure efficient braking system in automobiles, a prototype model is fabricated. It is seen that the eddy current brake is an essential complement to the safe braking of heavy vehicles. It aims to minimize the brake failure to avoid the road accidents. Many of the ordinary brakes, which are being used now days stop the vehicle by means of mechanical blocking. This causes skidding and wear and tear of the vehicle. And if the speed of the vehicle is very high, the brake cannot provide that much high braking force and it will cause problems. 'The eddy current brake' is a frictionless method for braking of vehicles. This method eliminates the problem of wear of brake shoes and brake fluid leakage.**

***Keywords:*Accidents, Electromagnetic braking, Eddy current braking system.**

I. INTRODUCTION

A brake is a device which stops motion. Mostly brakes use friction to convert kinetic energy into heat, though other methodof energy conversion may be employed. Brakes may be applied for a long period of time in some heavy vehicles. Brakes must have heat absorption capability for more period of time. Due to inefficient braking system and quick wear of brakes accidents is now-a-days increasing. Hence braking system needs to be enhanced for effective braking. Eddy Current brake is as new revolutionary concept. It is found that eddy current brakes can develop a power which maximum than an ordinary brake and greater than the braking power of an exhaust brake. These performance of eddy current brakes make them much more competitive for alternative retardation equipment compared with other retarders. In this research work, with a view to enhance to the braking system in automobile, a prototype model is created and analysed. It aims to minimize the brake failure to avoid the road accidents. It also reduces the maintenance of braking system. An advantage of this system is that it can be used on any vehicle with minor modifications to the transmission and electrical systems. As it is a frictionless brake, periodic change of braking components is reduced. If Eddy Current brake is employed in automobiles, the braking would be more efficient than the present friction based brake and braking cost in automobiles could be reduced to a larger extend. Also toxic smell caused by friction brakes during vehicle motion can be reduced in heavy vehicles.

II. PRINCIPLE OF BRAKING SYSTEM

The mechanism which is used to slow down the vehicle is known as braking system. In other words, the total system starting from pedal or ever to the brake shoe is known as braking system. The principle of braking in vehicles involves the conversion of kinetic energy into heat. When stepping on the brakes, the driver actuates a stopping force this stops the vehicle from motion. Brakes must be able to arrest the speed of a vehicle in short periods of time regardless how fast the speed is. As a result, the brakes are required to have the ability to generating high torque and absorbing energy at extremely high rates for short periods of time. These drawbacks of ordinary brakes can be overcome by a simple and effective mechanism of braking system 'The eddy current brake'. It is an abrasion-free method for braking of vehicles. It makes use of the opposing tendency of eddy current.

III. TYPES OF BRAKING SYSTEM

A. Drum Brake:

A brake drum is connected to the wheel and also a back plate is mounted on the axle casing. Two bake shies are connected on the back plate. Friction linings called brake linings, are provided on brake shoes. Retarder springs are connected to keep brake shoes away from the drum without applying brakes. The brake shoes are tightly fixed at one end but the force is applied at the other end by a brake actuating mechanism. It forces the brake shoes towards the revolving drum. Therefore, the brake is applied. An adjuster is linked to compensate the wear of friction lining. The relative braking torque obtained at shoes varies with the pedal force according

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to the type of expander. It is already connected or floating to lead or trail the shoes.

B. Disc Brake:

A disc brake is a type of brake that uses a calipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The friction elements are shaped like pads and are squeezed inwards to clamp a rotating disc or wheel.

C. Hydraulic Brakes:

Hydraulic brake system consists of two main components which are master cylinder and wheel cylinder. The master cylinder is attached to the wheel cylinder by tubes on each of four wheels. The system has light liquid pressure which acts as a brake fluid. This brake fluid is a mixture of glycerine and alcohol or castor oil, denatured alcohol and some additives. The liquid pressure supplies hydraulic brakes. The pedal force is transmitted to the brake shoe by definite quantity of liquid passing through a force transmission system.

D. Mechanical Brakes:

The pressure is applied by the foot pedal or hand pull. It is widely used in parking brakes. Brake is applied through cables, cams and linings. The brake shoe is operated be the cam against the revolving brake drum to stop or slow down the motion of the vehicle. The cam is actuated by a mechanical linkage. If the pull is applied, the linkage will be moved by brake shoes for making in contact with the brake drum. The brake lining is connected to brake shoes by rivets. It increases the co-efficient of friction which eliminates the metal contact to prevent wear on metallic shoes.

E. Air Compressed Hydraulic Brakes:

Air compressor receives power from the engine for driving it. Fresh air is admitted into the cylinder first and then compressed. Then the compressed air is sent to the reservoir. Governor controls the air in the reservoir. When the pressure in the reservoir attains 5.3 kg, this governor will not allow the air to go to the tank because additional pressure may cause the bursting of tank. An air bottle Is also connected with the governor.

IV. EXISTING PROBLEMS

A. Brake Fading Effect:

The conventional friction brake can absorb and convert enormous energy, but only if the temperature rise of the friction contact materials is controlled. This high energy conversion therefore demands an appropriate rate of heat dissipation if a reasonable temperature and performance stability are to be maintained.

B. Bleeding:

When any part of hydraulic line is replaced, air will be trapped into the system. Due to compressed air, the effort of brake pedal becomes waste in applying brakes. Unless air from the system is completely removed, the brakes will not function properly. The process of removing air from the brake system is called bleeding.

C. Brake Fluid Leakage:

If your vehicle has worn brake pads or brake shoes, the fluid level in your brake fluid reservoir will be low. But let's say you have relatively new brake pads and you recently topped-off your brake reservoir only to notice a few days later that the fluid level has dropped noticeably. If that's the case, it's a good bet you have a leak somewhere in your brake system -- which means that you likely have bigger brake issues than something as simple as worn brake pads.

D. Other Major Problems:

The brake fluid vaporization and brake fluid freezing though vaporization occurs only in rare cases. Freezing is quite common in colder places like Scandinavian countries and Russia etc…… where the temperature reaches as low as -50°C to−65°C, in such cases there is a need for some anti-freezing agents and increases the complexity and cost of the system.

V. EDDY CURRENT BRAKING

A. Introduction:

"EDDY" the term **w**as developed by Foucault Bae J. S. (2004) found that when the magnetic flux is linked with a metallic conductor changes, induced currents are developed a conductor in the form of closed loops. These currents are known as eddy current. Eddy currents produce an opposing magnetic field to slow down an object such as a conductive rotating disc. These forces are created by inducing a current through the coil when a disc, with conductive properties rotate within the air gap. The magnitude of these forces is dependent on the conductivity of the conductor and the rate the magnetic field changes.

Eddy current brake works based on Faraday's law of electromagnetic induction. According to this law, whenever a conductor cuts magnetic lines of forces, an emf is induced in the conductor, the magnitude of which is proportional to the strength of magnetic field and the speed of the conductor. If the conductor is a disc, there will be circulatory currents i.e. eddy currents in the disc. According to Lenz's law, the direction of the current is in such a way as to oppose the cause, i.e. movement of the disc.

B. Electromagnetic Interaction:

Electromagnetic interaction is one of the four fundamental interactions in nature. The other three are the strong nuclear interaction, the weak nuclear interaction and gravitation. Electromagnetic interaction causes the interaction

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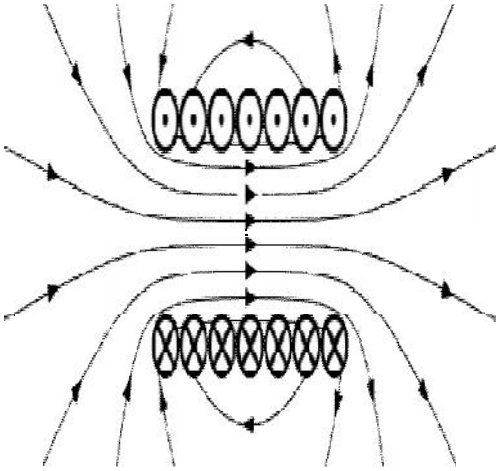
between electrically charged particles the areas in which this happens are called electromagnetic fields



Magnetic Field Lines

C. Eddy Current:

Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field. They can be induced within nearby stationary conductors by a time varying magnetic field created by an electromagnet or transformer, for example, or by relative motion between a magnet and a nearby conductor. The magnitude of the current in a given loop is proportional to the strength of the magnetic field, the area of the loop, andthe rate of change of flux, and inversely proportional to the resistivity of the material. Eddy current creates a magnetic field that opposes the magnetic field that created it, and thus eddy currents react back on the source of the magnetic field. For example, when a magnet is dropped inside an aluminium tube the nearby conductive surface will exert a drag force on a moving magnet that opposes its motion, due to eddy currents induced in the surface by the moving magnetic field. This effect is employed in eddy current brakes which are used to stop rotating power tools quickly when they are turned off.

VI. EDDY CURRENT BRAKE CONSTRUCTION

The eddy current brake consists of two parts, a stationary magnetic field system and a solid rotating part, which include a metal disc. During braking, the metal disc is exposed to a magnetic field from an electromagnet, generating eddy currents in the disc. The magnetic interaction between the applied field and the eddy currents slow down the rotating disc. Thus the wheels of the vehicle also slow down since the wheels are directly coupled to the disc of the eddy current brake, thus producing smooth stopping motion. Generally, the solid rotating part may be made up of mild steel or aluminium disc, the eddy currents are induced in it. Stationary magnetic field system and solid rotating part separated by a short air gap, they're being no contact between the two for the purpose of torque transmission. Consequently, there is no wear as in friction brake. Stator consists of pole core, pole shoe, and field winding. The field winding is wounded on the pole core. Pole core and pole shoes are made of steel laminations and fixed to the frames by means of screw or bolts. Copper is used for winding material the arrangement. This system consists of two parts

VII. COMPONENTS USED

A. Electromagnets
B. Rotating disc
C. Pulleys and belts
D. Frame
E. Shaft
F. A.C Motor

A. Electromagnets:

Electromagnets are made by winding the copper coil over a metal frame this will provide the necessary magnetic field on application of current for braking effect.

Electromagnet

B. Rotating disc:

Rotating disc is the stator on which the eddy current is to be induced. On application of current to the electromagnet it induces eddy current in the disc which opposes the motion of rotating disc. It is made up of non-ferrous metals which are good conductors of magnetic field so that large eddy current can be produced.

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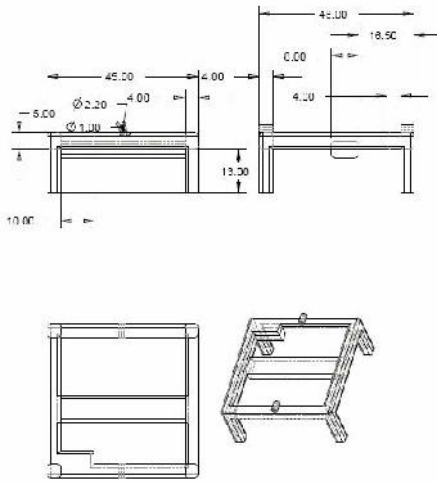
Rotating disc

C. *A.C Motors:*

An AC motor is an electric motor driven by an alternating current. It commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft that is given a torque by the rotating field. Where speed stability is important, some AC motors (such as some past motors) havethe stator on the inside and the rotor on the outside to optimize inertia and cooling.

A.C Motor

D. Frame:



E. Assembled model:

VIII. WORKING OF EDDY CURRENT BRAKE

When the vehicle is moving, the rotor disc of eddy current brake which is coupled to the wheels of the vehicle rotates, which is close to the electromagnet. When in need to brake the vehicle, a control switch is put on which is placed on the handle bar.When the control switch is operated, current flows from a battery to the field winding and energizes the magnet. Now the rotating disc will cut the magnetic field. When the disc cuts the magnetic field, flux changes occur in the disc which is proportional to the strength of the magnetic field. The current will flow back to the zero field areas of the metal plate and thus create a closed current loop like a whirl or eddy.

According to Lenz's law, the magnetic field produced by the eddy currents works against the movement direction. Thus instead of mechanical friction, a magnetic friction is created. In consequence, the disc will experience a braking effect and the disc stops rotation. The wheels of the

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vehicle, which is directly coupled to the disc, also stop rotation. Faster the wheels are spinning, stronger the effect, meaning that as the vehicle slows, the braking force is reduced producing a smooth stopping action.

The control knob can be set at different positions for controlling the excitation current to several set values in order to regulate the magnetic flux and consequently the magnitude of braking force. i.e. if the speed of the vehicle is low, a low braking force is required to stop the vehicle. So the knob is set at the lowest position so that a low current will be supplied to the field winding. Then the magnetic field produced will be of low strength, so that a required low braking force is produced. But when the wheels are not moving, magnetic lines of force are not cut by it, and the brake will not work.

A warning LED is provided on the instrument panel to indicate whether the brake is energized. This provides a safe guard for the driver against leaving the unit energized.When the brake is applied the current magnetizes the poles in stator, which placed next to the rotor. When rotor rotates it will cut magnetic lines and eddy current will set up in the rotor.

The magnetic field of this eddy current produces a breaking force or torque in the opposite direction of rotation disc. This kinetic energy of rotor is converted as heat energy and dissipated from rotating disc to surrounding atmosphere.Current in the field can change by changing the position of the controls switch. Thus we can change the strength of the braking force.

IX. ADVANTAGES

- There is no need to change brake oils regularly.
- There is no oil leakage.
- The practical location of the retarder within the vehicle prevents the direct impingement of air on the retarder caused by the motion of the vehicle.
- The eddy current brakes have excellent heat dissipation efficiency owing to the high temperature of the surface of the disc which is being cooled.
- Due to its special mounting location and heat dissipation mechanism, electromagnetic brakes have better thermal dynamic performance than regular friction brakes.
- Burnishing is the wearing or mating of opposing surfaces. This is reduced significantly here.
- In the future, there may be shortage of crude oil, hence by-products such as brake oils will be in much demand. Eddy current brakes will overcome this problem.
- Eddy current brakes will reduce maintenance cost.
- The problem of brake fluid vaporization and freezing is eliminated.

X. CONCLUSION

We conclude that this method of braking is very suitable at high speed. With all the advantages of eddy current brakes over friction brakes, they have been widely used on heavy vehicles where the ‘brake fading’ problem exists. The same concept is being developed for application on lighter vehicles. The concept designed by us is just a prototype and needs to be developed more because of the above mentioned disadvantages. These eddy current brakes can be used as an auxiliary braking system along with the friction braking system to avoid overheating and brake failure with the friction braking system to avoid overheating and brake failure. ABS usage can be neglected by simply using a micro controlled eddy current brake system. These find vast applications in heavy vehicles where high heat dissipation is required.

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