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DESIGN AND FABRICATION OF ELECTROMAGNETIC BRAKING SYSTEM

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ABSTRACT

This system is designed as a "frictionless" system and although it is not completely frictionless it eliminates the need for standard hydraulic brake pads and rotors which wear and fail due to friction and material loss. This could save the consumer time and money in maintenance. This project aims to create a electromagnetic braking system model capable of applying brakes without any friction loss and without losing the energy supplied. It uses a two electromagnets which runs by the supply of power from the circuit. Also, there is a wheel which is attached to the motor so when the power the supplied, by the help of motor the wheel rotates. Then a fan is attached near electromagnets to cool the electromagnets from excessive heating. A metal bar is in the vicinity of the electromagnets and wheel so when the electromagnets produces eddy currents which stops the rotating wheel or rotor. This model helps in a way to be a used a retardation equipment in vehicles

Keywords: Electromagnetic brakes, negative power, alternative retardation equipment, friction brakes, brake linings.

1. INTRODUCTION

Electromagnetic brakes (also called electro-mechanical brakes or em brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). the original name was "electro-mechanical brakes" but over the years the name changed to "electromagnetic brakes", referring to their actuation method. since becoming popular in the mid-20th century especially in trains and trams, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. electromagnetic brakes are the brakes working on the electric power & magnetic power. they work on the principle of electromagnetism. these brakes are an excellent replacement on the convectional brakes due to their many advantages. the reason for implementing this brake in automobiles is to reduce wear in brakes as it frictionless. electromagnetic brakes are of today's automobiles. the working principle of this system is that when the magnetic flux passes through and perpendicular to the rotating wheel the eddy current flows opposite to the rotating wheel/rotor direction. this eddy current tries to stop the rotating wheel or rotor. this results in the rotating wheel or rotor comes to rest/ neutral. the use of electromagnetic brakes has been found to be a highly competitive alternative to other retardation equipment due to their ability to develop a negative power that is twice the maximum power output of a typical engine and three times the braking power of an exhaust brake. By using electromagnetic brakes as supplementary retardation equipment, friction brakes can be used less frequently, leading to longer-lasting brake linings and avoiding potential brake fade problems.

2. LITERATURE REVIEW

Analytical modeling of eddy current brakes with the application of time varying magnetic fields" by Kerem Karakoca,Afzal Sulemana, Edward J. Parka, Eddy current brakes have a number of potential advantages, i.e. contactless operation, faster response, reduced number of components and easy implementation of various controllers. "Improved braking torque generation capacity of an eddy current brake with time varying magnetic fields: A numerical study" by Kerem Karakoc a,n, Edward J. Park a,b, Afzal Suleman Eddy current brakes (ECB) are electrically controlled and non-contact actuators used as assistive brakes in vehicles. ECBs exhibit insufficient generated braking torque at low speeds. "An investigation on braking systems used in railway vehicles." By Mustafa Günay a, Mehmet Erdi Korkmaz The high safety and comfort expectations under varying conditions have required the development of brake systems in railway vehicles. The main factors affecting the performance and function of the brake system are braking force, mass and speed of the vehicles, stopping or braking distance, railway condition and environmental factors. "Brake Performance Analysis of ABS for Eddy Current and Electro hydraulic Hybrid Brake System " by Ren He,1 Xuejun Liu,1,2 and Cunxiang Liu2 This paper introduces an eddy current and electro-hydraulic hybrid brake system to solve problems such as wear, thermal failure, and slow response of traditional vehicle brake system. "An Analysis Of Permanent Magnet Eddy Current Braking System" by Shivashankar. R, Dr. G. V. Naveen Prakash The developed brake is wear-free, less-sensitive to temperature than friction brakes, has fast and simple actuation, and has a reduced sensitivity to wheel lock.

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3. METHODOLOGY

Eddy current brake works according to Faraday's law of electromagnetic induction. According to this law, whenever a conductor cuts magnetic lines of forces, an electromagnetic field (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. Essentially the eddy current brake consists of two parts, a stationary magnetic field system and a solid rotating part, which is a copper 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.

3.1 Working Operation

Essentially an eddy current brake consists of two members, a stationary magnetic field system and a solid rotary member, generally of mild steel, which is sometimes referred to as the secondary because the eddy currents are induced in it. Two members are 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 east steel laminations and fixed to the state of frames by means of screw or bolts. Copper and aluminum is used for winding material the arrangement is shown in fig. 1.This system consists of two parts.

1. Stator
2. Rotor

When the vehicle is moving, the rotor disc of eddy current brake which is coupled to the wheels of the vehicle rotates, in close proximity to stationary 14 magnetic poles. When we want to brake the vehicle, a control switch is put on which is placed on the steering column in a position for easy operation. When the control switch is operated, current flows from a battery to the field winding, thus energizing the magnet. Then 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. A flow of current always means there is a magnetic field as well. Due 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 "drag" or the braking effect, and thus the disc stops rotation. The wheels of the 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

4. DESIGN MODELLING

4.1 Components

Motor: Voltage = 12V, Current = 5Amp, Speed = 60 RPM

$P = 2*\pi*N*T/60$

Shaft: Material of shaft = M.S.

Use Torsional Rigidity for finding diameter of shaft.

Bearing: Deep groove ball bearing having dimensions as d = 20mm, D = 52mm. Bearing Designation = 6304

Chain: Select standard chain used in cycle as Chain -06, Pitch - 9.525mm

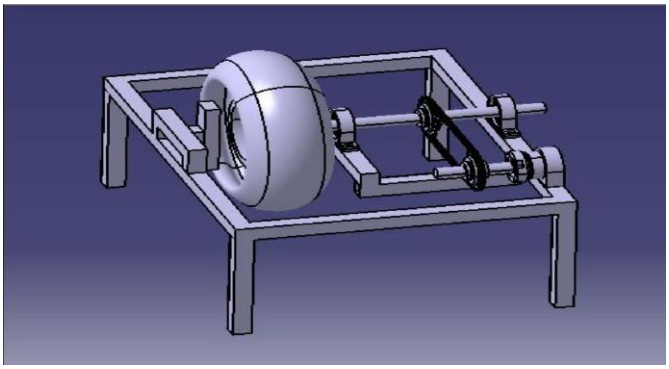

Figure 1. CATIA Model

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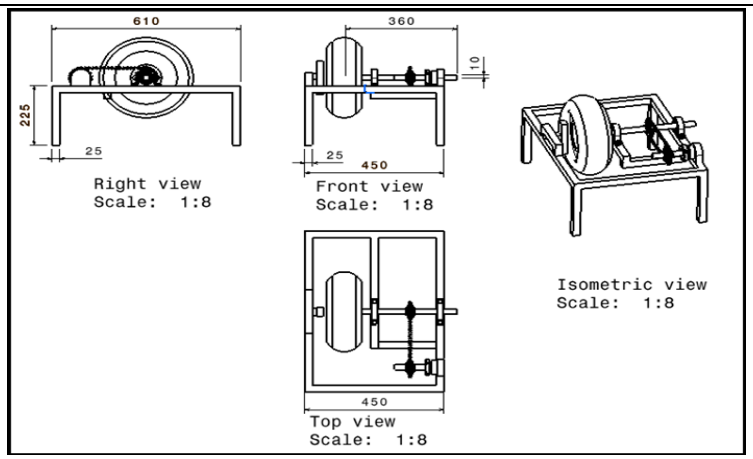

Figure 2. Assembly

5. ADVANTAGES, DISADANTAGES AND APPLICATIONS

5.1 Advantages

- It uses electromagnetic force and not mechanical friction
- Non-mechanical (no moving parts, no friction)
- Fully resettable
- Can be activated at will via electrical signal
- Low maintenance
- 6. Operates at any rotational speed
- 7. Light weight

5.2 Disadvantages

- Braking force diminishes as speed diminishes with no ability to hold the load in position at stands till.
- That could be considered to be a safety issue, but it really means that friction braking may need to be used as well.
- Eddy-current brakes can only be used where the infrastructure has been modified to accept them.

5.3 Applications

- 1. It is used as a stopping mechanism in trains.
- 2. It is also used in the smooth breaking and functioning of roller coasters and such fast moving machines.

6. CONCLUSION

This Paper presents the performance of an electromagnetic braking system which includes various components with its cost effectiveness and efficient methodologies to utilize the supplied energy. With the application of the effective and strong electromagnet we can have greater efficient braking system.

7. REFERENCES

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