Electromagnetic Braking system

[1]Purohit Harish Laljibhai ,[2]Thakor Divyang Javansinh ,[3]Vankar Dipak Dahyabhai ,[4]Prajapati Jaimin Rameshbhai

Studying Bachelor of engineering in Mechanical Engineering
At
Samarth Group of colleges Himatnagar
Gujarat, India

ABSTRACT

A non-contact method, using magnetic drag force principle, was proposed to design the braking systems to improve the shortcomings of the conventional braking systems. The extensive literature detailing all aspects of the magnetic braking is briefly reviewed, however little of this refers specifically to upright magnetic braking system, which is useful for industries. One of the major issues to design upright magnetic system is to find out the magnetic flux. The changing magnetic flux induces eddy currents in the conductor. These currents dissipate energy in the conductor and generate drag force to slow down the motion. Therefore, a finite element model is developed to analyze the phenomena of magnetic flux density when air gap and materials of track are varied. The verification shows the predicted magnetic flux is within acceptable range with the measured value. The results will facilitate the design of magnetic braking systems.

Keyword: - *Friction, Heat, Conventional Braking, and Electromagnetic braking etc….*

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1. Introduction

Equipment in addition to the regular friction brakes on heavy vehicles. We outline the general principles of regular brakes and several alternative retardation techniques in this section. The working principle and characteristics of electromagnetic brakes are then highlighted. In this project we are trying to make a braking system. Which can be applicable in two wheeler at Electromagnetic brakes have been used as supplementary retardation high speed and low maintenance cost. Here we are using an electromagnetic coil and a plunger. There is an electromagnetic effect which moves the plunger in the braking direction.

When electricity is applied to the field, it creates an internal magnetic flux. That flux is then transferred into a hysteresis disk passing through the field. The hysteresis disk is attached to the brake shaft. A magnetic drag on the hysteresis disk allows for a constant drag, or eventual stoppage of the output shaft.

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 trolleys, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. Both electromagnetic brakes and eddy current brakes use electromagnetic force but electromagnetic brakes ultimately depend on friction and eddy current brakes use magnetic force directly.

1.1 Theory and main concept

The idea of using an electromagnet as a brake has been mainly used in large vehicles and machines. There are several main types, most of which rely on using magnetism to move a mechanical part or parts. The mechanical part can then be used to produce friction with a moving part, thereby reducing speed. However, this process is rather inefficient. Electromagnets can also be used to make frictionless brakes which is what we are interested in. Further, we are interested in reducing the rotation of a bicycle wheel and hence, angular velocity. Thus, the desired brake involves dissipating rotational energy. In theory, if a magnetic field is induced in a rotating disc, it will produce eddy currents within the disc. These currents will then oppose the rotation of the disc by dissipating kinetic energy in the form of heat (causing the temperature of the disc to increase).

To me, this concept did not seem intuitive, so I decided to test it. The magnetic field is usually generated by an electromagnet. Hence, I was interested in knowing if an electromagnet could really affect the rotation of the wheel. Also, I wanted to determine whether increasing the voltage running through the electromagnet would cause a larger retarding force. The latter test may seem obvious, but I felt it was necessary to validate the concept experimentally before making any conclusions.

1.2 Principle of electromagnet Brake system

The principle of braking in road vehicles involves the conversion of kinetic energy into thermal energy (heat). When stepping on the brakes, the driver commands a stopping force several times as powerful as the force that puts the car in motion and dissipates the associated kinetic energy as heat. 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. Brakes may be applied for a prolonged periods of time in some applications such as a heavy vehicle descending a long gradient at high speed. Brakes have to have the mechanism to keep the heat absorption capability for prolonged periods of time.

2. Design and practical work

Theoretically, Model is divided into three main units (1) Base unit (2) Driving unit and (3) Braking unit. Base unit consist of a angle to base of our model, driving unit consist of a electrical motor, power control and bearing. Braking unit consists of a electromagnet

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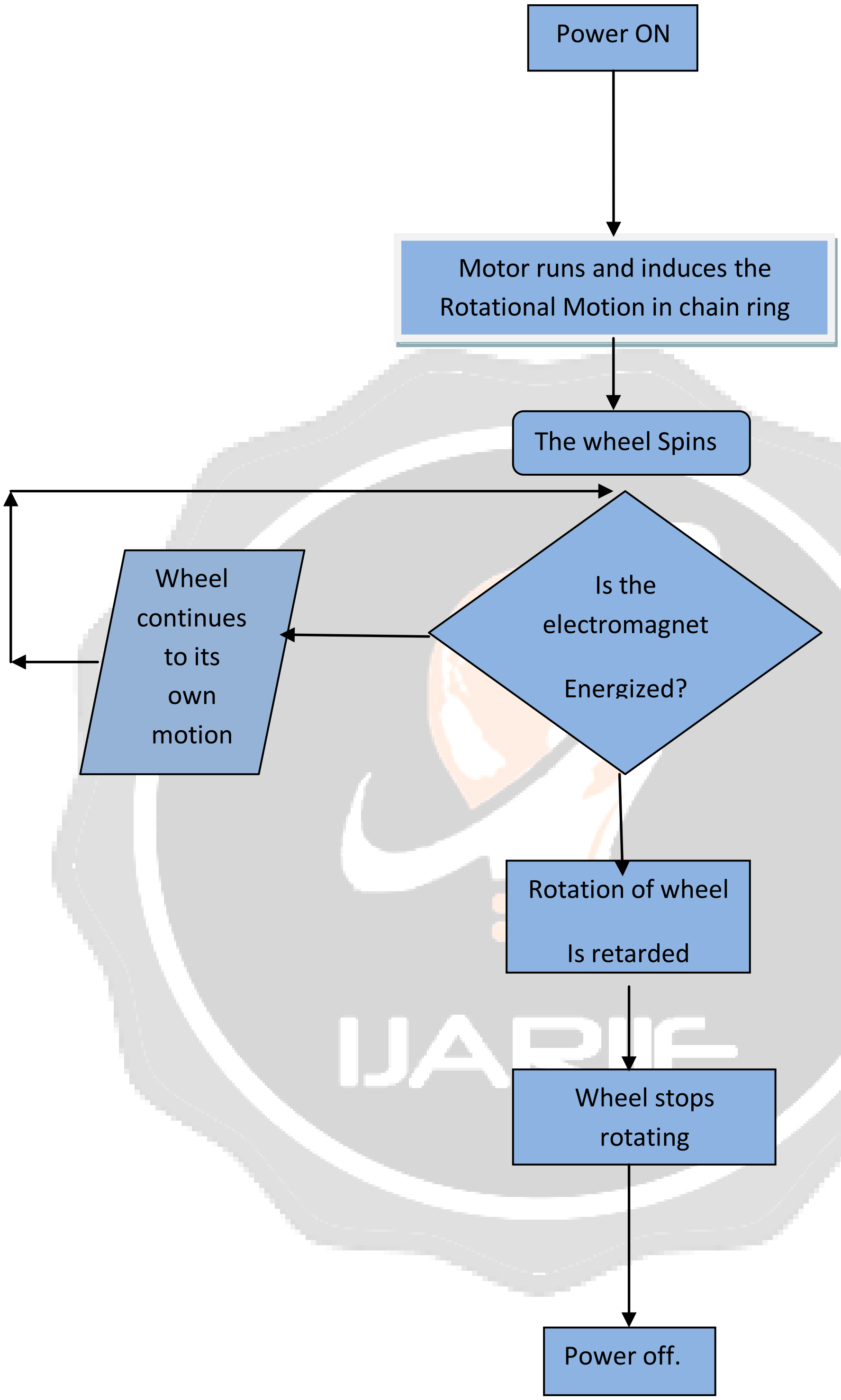

Chart -1: Flow Chart

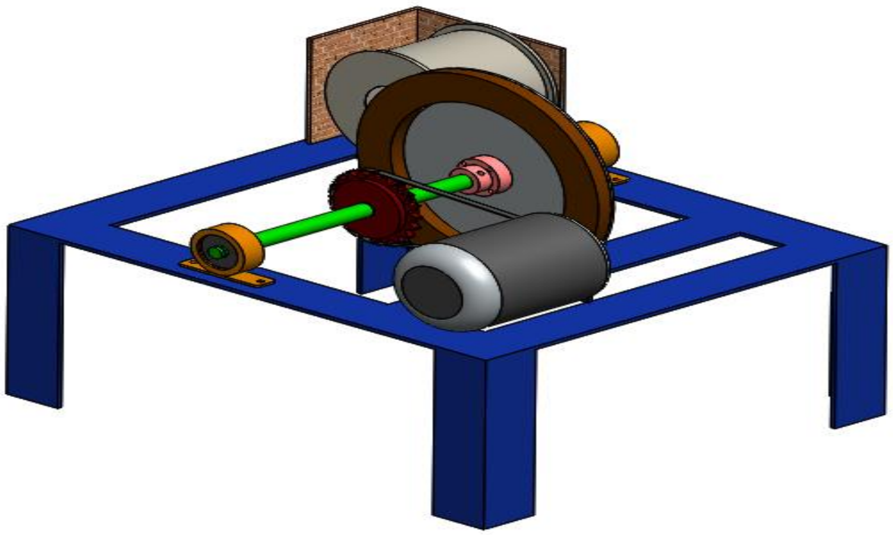

Fig -1: Isometric View (Solidworks)

2.1 Material Selection

Material selection process is depending on application of where the brake is used. Generally plate is mostly used in aluminum because it is very efficient to produce eddy current in plate. We should buy a most effective copper plate but it is costly and not applicable for all buyers.

Table -1: Specification of parts

Title	Electromagnet	AC motor	Round Plate	battery
Specification	36 gauge magnet wire	5-12 V	180 mm	12 volt

2.2 Construction

The construction of the electromagnetic braking system is very simple. The parts needed for the construction are electro magnets, rheostat, sensors and magnetic insulator. A cylindrical ring shaped electro magnet with winding is placed parallel to rotating wheel disc/ rotor. The electro magnet is fixed, like as stator and coils are wounded along the electromagnet. These coils are connected with electrical circuit containing one rheostat which is connected with brake pedal. And the rheostat is used to control the electric current flowing in the coils which are wounded on the electro magnet and a magnetic insulator is used to focus and control the magnetic flux. And also it is used to prevent the magnetization of other parts like axle and it act as a support frame for the electromagnet. The sensors used to indicate the disconnection in the whole circuit. If there is any error it gives an alert, so we can avoid accident. Working principle: At the initial stage the brake pedal and rheostat are in rest. When we apply the brake through the brake pedal, the rheostat allows the current to flow through the circuit and this current energies the electromagnet. The amount of current flow is controlled by the rheostat. Depending on the current flow different amount of magnetic flux can be obtained. By this varying magnetic flux, different mode of brakes can be obtained. For example, if we want to suddenly stop the vehicle then press the brake pedal fully, then the rheostat allos maximum current which is enough to stop the vehicle. Similarly we can reduce the speed of the vehicle by applying the brake gradually.

Parts of Electromagnet Braking system

- AC Motor
- Disc

- Frame
- Electromagnet
- Chain
- Shaft
- Bearing
- Sprocket

3. Installation

Electromagnetic brakes work in a relatively cool condition and satisfy all the energy requirements of braking at high speeds, completely without the use of friction. Due to its specific installation location (transmission line of rigid vehicles), electromagnetic brakes have better heat dissipation capability to avoid problems that friction brakes face as we mentioned before. Typically, electromagnetic brakes have been mounted in the transmission line of vehicles, The propeller shaft is divided and fitted with a sliding universal joint and is connected to the coupling flange on the brake. The brake is fitted into the chassis of the vehicle by means of anti-vibration mounting. 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. Any air flow movement within the chassis of the vehicle is found to have a relatively insignificant effect on the air flow around tire areas and hence on the temperature of both front and rear discs. So the application of the retarder does not affect the temperature of the regular brakes. In that way, the retarders help to extend the life span of the regular brakes and keep the regular brakes cool for emergency situation

There are in existence several types of electromagnetic retarder. In particular, there are electromagnetic retarders of the axial type and electromagnetic retarders of the Focal type. An electromagnetic retarder of the axial type is designed to be placed on a transmission shaft between a rear axle and a gearbox of the vehicle. In that case, the transmission shaft is in two parts, for mounting between those of the retarder. An electromagnetic retarder of the Focal type is designed to be placed directly on a transmission shaft on the output side of the gearbox or on the axle of the vehicle. The axle of a vehicle drives at least one road wheel, which road wheel drives at least one wheel of the same vehicle.

3.1 Electromagnet

Various types of electromagnet are available in market, some of basic electromagnet are described below:

(1) **Single Disc electromagnetic brakes**:

Technical Features:

- Technical Features Torque: 3NM to 500NM
- Single Plate Dry Type
- High Operating Reliability / frequency
- Simple Construction
- Unique pre-stressed spring
- Raw material to DIN standards
- Special friction material

(2) Multi disc electromagnetic brakes

Technical Features:

- **Coil Voltage**: 24 V
- **Torque**: 3 N-m to 3600 N-m
- Compact design
- Electromagnetic brakes are provided
- With or without outer carrier, jaw and driver
- With inner & outer multiple discs.

(3) Spring type

When no electricity is applied to the brake, a spring pushes against a pressure plate, squeezing the friction disk between the inner pressure plate and the outer cover plate. This frictional clamping force is transferred to the hub, which is mounted to a shaft.

(4) Permanente magnet Type

A permanent magnet holding brake looks very similar to a standard power applied electromagnetic brake. Instead of squeezing a friction disk, via springs, it uses permanent magnets to attract a single face armature. When the brake is engaged, the permanent magnets create magnetic lines of flux, which can turn attract the armature to the brake housing. To disengage the brake, power is applied to the coil which sets up an alternate magnetic field that cancels out the magnetic flux of the permanent magnets.

Both power off brakes are considered to be engaged when no power is applied to them. They are typically required to hold or to stop alone in the event of a loss of power or when power is not available in a machine circuit. Permanent magnet brakes have a very high torque for their size, but also require a constant current control to offset the permanent magnetic field. Spring applied brakes do not require a constant current control, they can use a simple rectifier, but are larger in diameter or would need stacked friction disks to increase the torque.

(5) Power off Brake

Power off brakes stop or hold a load when electrical power is either accidentally lost or intentionally disconnected. In the past, some companies have referred to these as "fail safe" brakes. These brakes are typically used on or near an electric motor. Typical applications include robotics, holding brakes for Z axis ball screws and servo motor brakes. Brakes are available in multiple voltages and can have either standard backlash or zero backlash hubs. Multiple disks can also be used to increase brake torque, without increasing brake diameter. There are 2 main types of holding brakes. The first is spring applied brakes. The second is permanent magnet brakes.

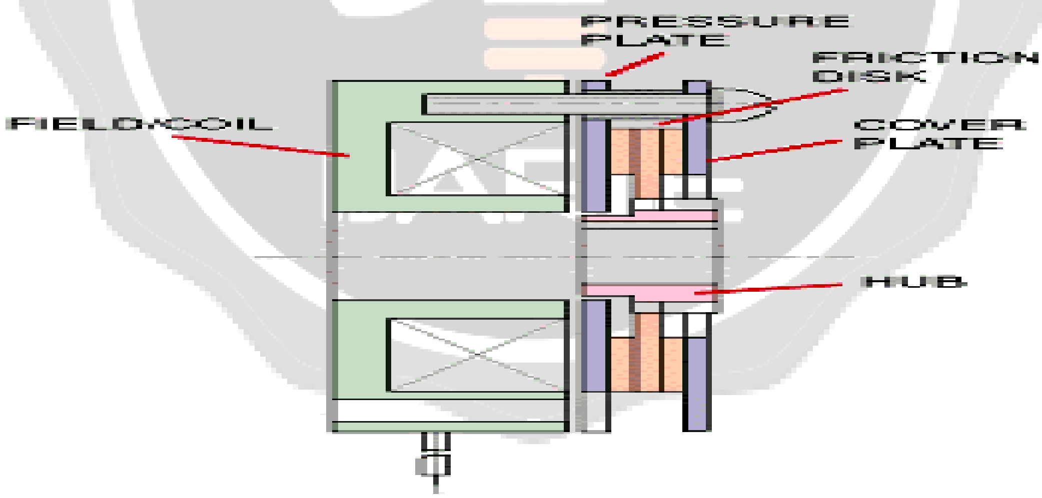

Fig -2: Power off Brake

4. CONCLUSIONS

As we discussed about the limitations of drum brakes, hydraulic brakes and pneumatic brakes electromagnetic brake is a better and reliable solution. Electromagnetic brake control system is an electric switching system which gives it superior controllability. The installation of an electromagnetic brake is not very difficult.

From the foregoing, it is apparent that the electromagnetic brake is an attractive complement to the safe braking of heavy vehicles. Good results with current design, a larger budget would improve performance.

5. ACKNOWLEDGEMENT

It gives us a great sense of pleasure to present the report of the BE project undertaken during BE final year. We owe special debt of gratitude of lecturer selection grade **Mr. Lalitbhai Patel** Department of Mechanical Engineering, Samarth College of Engineering and Technology, Himmatnagar for his constant support and guidance throughout the course of our work. We also take the opportunity to acknowledge the contribution of Mr. Sanket Gandhi, Head of Department of Mechanical Engineering.

I wish to express my heartiest regards to my parents for their guidance and moral support.

My sincere thanks to **Asst. Prof. Lalitbhai D. Patel,** and entire staff of Mechanical Department. Last but not the least, my sincere thanks to all of my friends who have patiently extended all sorts of help and motivate for accomplishing the undertaking.

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BIOGRAPHIES

	Purohit Harish Laljihai Studying at Samarth group colleges Himatnagar, Gujarat India
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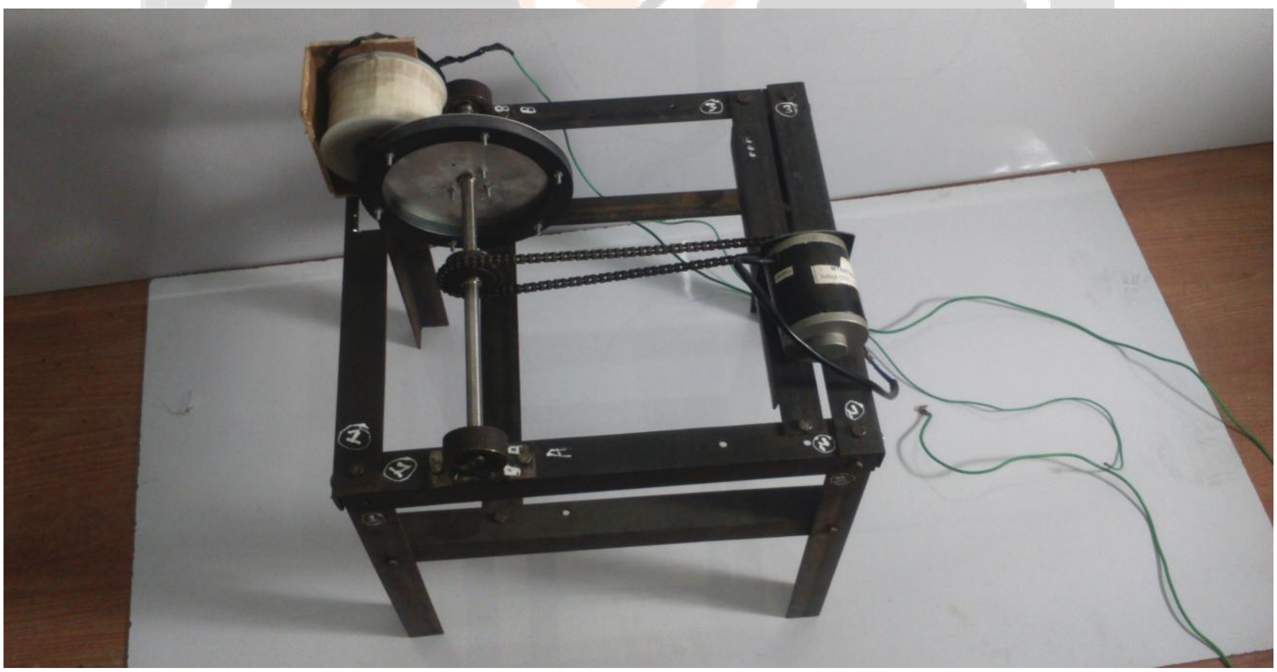

Fig. 3 Working Model Of Electromagnet Brake