Development of the Electro-Magnetic Brake

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Abstract

Most of the braking systems utilize friction forces to transform the kinetic energy of a moving body into heat that is dissipated by the braking pads. The overuse of friction-type braking systems causes the temperature of the braking pads to rise, reducing the effectiveness of the system. An Electromagnetic Braking system uses Magnetic force to engage the brake, but the power required for braking is transmitted manually. The disc is connected to a shaft and the electromagnet is mounted on the frame .When electricity is applied to the coil a magnetic field is developed across the armature. The eddy-current is created by the relative motion between a magnet and a metal (or alloy) conductor. The current induces the reverse magnetic field and results in the deceleration of motion. The proposed mechanism implements this phenomenon in developing a braking system. The potential applications of the braking system can be a decelerating system to increase the safety of an elevator or any guided rail transportation system As a result it develops a torque and eventually the vehicle comes to rest. In this project the advantage of using the electromagnetic braking system in automobile is studied. These brakes can be incorporated in heavy vehicles as an auxiliary brake. The electromagnetic brakes can be used in commercial vehicles by controlling the current supplied to produce the magnetic flux. Making some improvements in the brakes it can be used in automobiles in future. . 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.

Keywords: Electromagnetic Braking, Electromagnet, Eddy Current, Magnetic Field, Bearing, Sensor, Proximity Sensor

I. INTRODUCTION

A. Brake

A vehicle brake is used to slow down a vehicle by converting its kinetic energy into heat. Most commonly brakes use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed. For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

- Types of Brake

1) Friction Brake
2) Electromagnetic Brake

B. Friction Brake

- A friction brake is a type of automotive brake that slows or stops a vehicle by converting kinetic energy into heat energy, via friction. The heat energy is then dissipated into the atmosphere. In most systems, the brake acts on the vehicle's wheel hubs, but some vehicles use brakes which act on the axles or transmission.
- Friction brakes may be

1) Drum Type.

2) Disc Type.

C. Drum Brake

A drum brake is a vehicle brake in which the friction is caused by a set of brake shoes that press against the inner surface of a rotating drum. The drum is connected to the rotating roadwheel hub

D. Disc Brake

The disc brake is a device for slowing or stopping the rotation of a road wheel. A brake disc (or rotor in U.S. English), usually made of cast iron or ceramic, is connected to the wheel or the axle. To stop the wheel, friction material in the form of brake pads (mounted in a device called a brake caliper) is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

E. Electromagnetic Brake:

1) Electromagnetic brakes slow an object through electromagnetic induction, which creates resistance and in turn either heat or electricity. Friction brakes apply pressure on two separate objects to slow the vehicle in a controlled manner.
2) In locomotives, a mechanical linkage transmits torque to an electromagnetic braking component.
3) Trams and trains use electromagnetic track brakes where the braking element is pressed by magnetic force to the rail. They are distinguished from mechanical track brakes, where the braking element is mechanically pressed on the rail.
4) Electric motors in industrial and robotic applications also employ electromagnetic brakes.
5) Recent design innovations have led to the application of electromagnetic brakes to aircraft applications. In this application, a combination motor/generator is used first as a motor to spin the tires up to speed prior to touchdown, thus reducing wear on the tires, and then as a generator to provide regenerative braking.

II. LITERATURE REVIEW

Stephen Z. Oldakowski, Bedford, Ohio A magnetic brake provides braking or locking capability and is remotely controlled by electric power. The magnetic brake comprises a rotatable shaft and a brake disc mounted on the shaft. A non-rotating core housing assembly located around the shaft includes a permanent magnet and a bipolar solenoid. A magnetic armature adjacent to the core housing assembly is capable of movement toward the core housing assembly and toward and into engagement with a brake disc to prevent rotation of the shaft. A spring urges the armature away from the core housing assembly and into engagement with the brake disc. The brake does not use any electric power to maintain the brake in the set mode with the rotating shaft fully locked or in the released mode with the rotating shaft fully released. The permanent magnet is of sufficient strength to hold the armature against urging of the spring until an opposite polarity is supplied by the solenoid.

Karl Erny, Holzhausem An elevator drive has a brake device with compression springs to actuate brake levers, and brake linings on a brake drum creating a braking force. A sensor is provided to detect the movement of a brake magnet armature tappet. A bracket is attached to the brake magnet tappet on one end and a distance piece carrying the sensor housing is arranged on the other end. A restoring lug is attached to the existing mechanical indicator. A monitor evaluates the sensor signal and turns off the elevator drive in the event of dangerous operational states via a safety circuit. The system allows the state of the brake device to be monitored. The more the brake linings wear off due to abrasion, the smaller the distance between the armature and the brake magnet housing. If the armature is in contact with the brake magnet housing, the braking ability of the brake linings is completely void.

Hung-Chi Wu, 958-2, Ghung Shan Rd., Tao-Yuan, Taiwan This invention relates to an adjustable magnetic brake and in particular to one including an aluminum fan, a magnetic conducting ring enclosing the aluminum fan, a permanent magnet disposed within the aluminum fan, a fixing seat for keeping the permanent magnet in position, a sliding seat mounted in the fixing seat and provided with a bearing, a housing, bolts provided on one side of the fixing seat and extending out of the housing, a mounting plate connected with the bolts and a wire connected with the mounting plate such that when the wire is pulled outwards, the permanent magnet will be moved outwards.

Jae-Woong Lee, Seoul, Rep. of Korea Disclosed is a magnetic brake system for a vehicle. comprising: a plurality of brake disk solenoids for generating the magnetic force; a plurality of brake pad solenoids for generating the magnetic force; a braking sensor for detecting whether a brake pedal is applied; a wheel speed sensor for detecting wheel speed; a magnetic polarity sensor for detecting magnetic polarity of the brake disk solenoids; and a control unit for controlling the brake pad solenoids using signals from the braking sensor. The wheel speed sensor and the magnetic polarity sensor.

Albert E. Miller, Dayton, Ohio This invention relates to a fishing reel and more particularly to an improved type of reel having a compensated magnetic brake means for preventing backlash or overrunning of the spool. An object of this invention is to provide a reel which is inexpensive to manufacture and which is durable and trouble-free in operation. Still another object of this invention is to provide an improved form of magnetic brake having spring means for modifying the brake action. A further object of this invention is to provide a fishing reel which is smooth in operation and which is readily adjustable to desired degrees of drag or braking effect. Further objects and advantages of the present invention reside in the construction and

combination of parts and in the mode of operation as will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the present invention is clearly shown.

III. METHODOLOGY

A. Electromagnetism:

Electromagnetism is one of the four fundamental interactions in nature. The other three are the strong interaction, the weak interaction and gravitation. Electromagnetism is the force that causes the interaction between electrically charged particles; the areas in which this happens are called electromagnetic fields.

B. Magnetic Effect of Current

The term "Magnetic effect of current" means that "a current flowing in a wire produces a magnetic field around it". The magnetic effect of current was discovered by Oersted in 1820. Oersted found that a wire carrying a current was able to deflect a magnetic needle.

C. Electromagnet:

An electric current can be used for making temporary magnets known as electromagnets. An electromagnet works on the magnetic effect of current. It has been found that if a soft iron rod called core is placed inside a solenoid, then the strength of the magnetic field becomes very large because the iron ore is magnetized by induction.

D. Factors Affecting Strength of an Electromagnet:

The strength of an electromagnet is:

1) Directly proportional to the number of turns in the coil.
2) Directly proportional to the current flowing in the coil.
3) Inversely proportional to the length of air gap between the poles.

In general, an electromagnet is often considered better than a permanent magnet because it can produce very strong magnetic fields and its strength can be controlled by varying the number of turns in its coil or by changing the current flowing through the coil.

E. Eddy Current:

Eddy currents are circular electric currents induced within conductors by a changing magnetic field in the conductor, due to Faraday's law of induction. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field. By Lenz's law, an 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. This effect is employed in eddy current brakes which are used to stop rotating power tools quickly when they are turned off. The current flowing through the resistance of the conductor also dissipates energy as heat in the material.

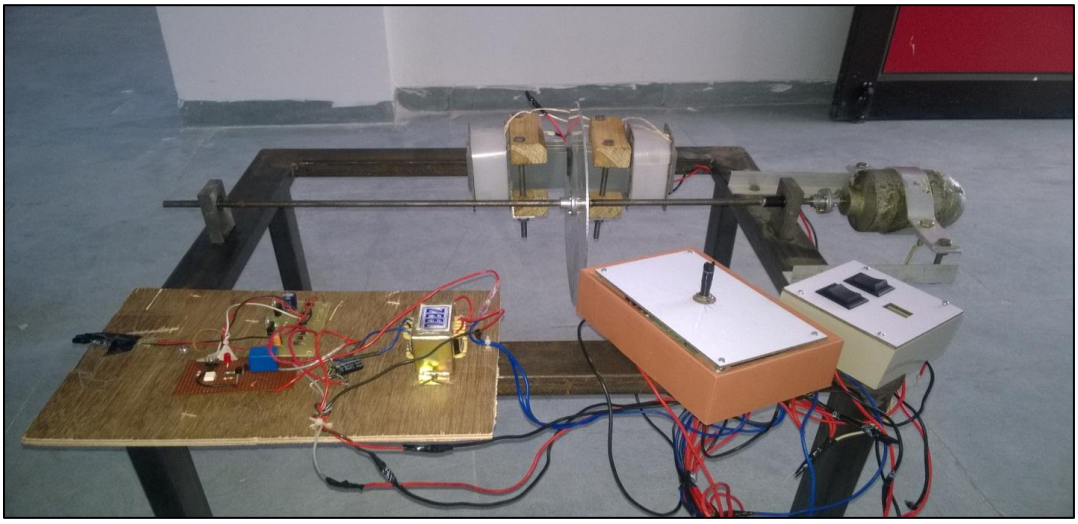

Fig. 1: EDDY Current

IV. PARTS

A. AC Motor:

An AC motor is an electric motor driven by an alternating current (AC). The AC motor 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 producing a second rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings.

Less commonly, linear AC motors operate on similar principles as rotating motors but have their stationary and moving parts arranged in a straight line configuration, producing linear motion instead of rotation.

B. Electromagnet

An electromagnet is a type of magnet in which the magnetic field is produced by an electric current. The magnetic field disappears when the current is turned off. Electromagnets usually consist of a large number of closely spaced turns of wire that create the magnetic field. The wire turns are often wound around a magnetic core made from a ferromagnetic or ferromagnetic material such as iron; the magnetic core concentrates the magnetic flux and makes a more powerful magnet. A simple electromagnet consisting of a coil of insulated wire wrapped around an iron core. The strength of magnetic field generated is proportional to the amount of current.

The main advantage of an electromagnet over a permanent magnet is that the magnetic field can be quickly changed by controlling the amount of electric current in the winding. However, unlike a permanent magnet that needs no power, an electromagnet requires a continuous supply of electrical energy to maintain a magnetic field.

Electromagnets are widely used as components of other electrical devices, such as motors, generators, relays, loudspeakers, hard disks, MRI machines, scientific instruments, and magnetic separation equipment. Electromagnets are also employed in industry for picking up and moving heavy iron objects such as scrap iron and steel.

C. Aluminum Disk

1) The aluminum disk is the make from the aluminum.
2) This disk is mounted on the shaft.
3) And the shaft is connected to the ac motor so that the aluminum disk is rotates as the same speed of the motor.
4) There are the two electro magnets are provided on the two other sides of the disk.
5) So that when the aluminum disk cuts the magnetic field created by the electromagnet it is produce eddy current in it.

D. Metal FRAM

1) The metal frame is the base of the whole equipment.
2) The metal frame is suitable for the withstand the load of the assembly on it so it is design properly.
3) There is the use the metal frame for the support the whole assembly on it.
4) The metal frame is made from the cast irons. The blocks of the cast iron are cut by the cutting machine.
5) Arc Welding is use for the join the cast iron blocks as per the requirement so the frame.

E. Shaft

1) The shaft is the life line of the any equipment.
2) In this project there is the use the 8mm cast iron shaft for the mounting the disk and electric motor.
3) The shaft is attached to the motor and aluminum disk with help of the flange coupling.
4) The shaft is supported on the frame by the bearing and bearing blocks.

F. Bearing (608)

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

The most common standardized ball bearing size is the 608 series. In the 608 series, the ball bearing typically consists of optional closures, inner race, outer race, balls, and ball retainer. It is characterized by an 8mm inner diameter (the bore of the ball bearings), a 22mm outer diameter, and a width of 7mm.

G. Bearing Block

The fundamental application of both types is the same which is to mount bearings safely enabling their outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings are either split type or unsplit type. Split type housings are usually two piece housings where the cap and base can be detached, while certain series are one single piece housings. Various seals are provided to prevent dust and other contaminants from entering the housing. Thus the housing provides a clean environment for the expensive bearings to freely rotate, hence increasing their performance and duty cycle.

Bearing housings are usually made of grey cast iron. However various grades of metals can be used to manufacture the same.

H. Flange Coupling

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation, however there are torque limiting couplings which can slip or disconnect when some torque limit is exceeded.

The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. By careful selection, installation and maintenance of couplings, substantial savings can be made in reduced maintenance costs and downtime.

This coupling has two separate cast iron flanges. Each flange is mounted on the shaft end and keyed to it. The two flanges are coupled together with the help of bolts and nuts. The projected portion of one of the flanges and corresponding recess on the other flange help to bring the shaft into line and to maintain alignment. A flange which is provided with a shroud which shelters the bolts heads and nuts is called protected type flange coupling.

I. Distance Sensor (Proximity Sensor)

A sensor is a transducer whose purpose is to sense some characteristic of its environs. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal. Sensors are used in everyday objects such as touch-sensitive elevator buttons and lamps which dim or brighten by touching the base besides innumerable applications of which most people are never aware.

Types of Sensor:

1) Proximity Sensor
2) Temperature Sensor
3) Pressure Sensor
4) Ultrasonic Sensor
5) The Acceleration Sensor
6) Displacement Sensor
7) Holzer Switch Sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; aninductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance.

The sensors are use for the collect the data of the outside of the equipment and use this data for controlling the equipment. The sensors are use for the automatic operation of the equipment. Proximity type sensors are use for the find the distance. This type sensors are use for the give a signal to operate a equipment and stop in specific condition. The proximity sensors are work on principle of emitting and receiving diode. The sensors are not in action while obstacle are away the sensor. So that the sensors are allows the run motor. When the obstacle is near to the sensor in range that time the sensor are activated. Sensor cutoff the power of motor. And sensor will start a electromagnet for the braking purpose at a time. When the obstacle is move away that time sensors stop the electromagnet and start a power of motor. So that this system is work as automatic braking system.

V. OPERATIONS

A. Turning Of Shaft:

Turning is the machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the workpiece rotates. In this operation reduce the diameter of the shaft. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear

B. Cutting of the Pipe:

Pipe cutting, or pipe profiling, is a mechanized industrial process that removes material from pipe or tube to create a desired profile. Typical profiles include straight cuts, mitres, saddles and midsection holes. These complex cuts are usually required to allow a tight fit between two parts that are to be joined via arc welding.

C. Welding:

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. In this operation, fix the sprocket on the shaft

D. Making of Electromagnet:

Magnetic fields are produced when all the electrons in a metal object are spinning in the same direction, either as a natural phenomenon, in an artificially created magnet , or when they are induced to do so by an electromagnetic field.

Material Required For Making of Electromagnet

1) Iron nail
2) Copper wire
3) Battery or electricity supply
4) Wire strippers
5) Tape

– Wrap the copper wire around the nail, starting at the head of the iron nail.
– Wound copper wire over the nail as per requirement. As we apply more turns of copper wire then magnetic field is higher.
– After wounding current by battery or electricity supply magnetic field is produced.

E. Fix Bearing Supports:

1) Bearing is use for smooth rotation of shaft on which disk is mounted.
2) Bearing fix at both side of disk on support which mount over the frame.
3) When disk start rotational motion, due to bearing support it easy to operate disk.
4) By screwing of bearing support, fix over frame at both side of disk.
5) Due to that starting of disk motion is quick and frictionless.

F. Coupling of Motor Shaft and Disk Shaft:

1) For coupling of motor shaft and disk shaft two clamps are use.
2) Both this clamp has same dimensions and hole for coupling.
3) By nut and bolt this both shaft mount separately on motor shaft and disk shaft.
4) When separate mount of clamp is done then this both clamp coupled together by nut and bolt.

G. Assembly of All Components:

1) At last the assembly of all parts is done on suitable space on frame.
2) Disk is mounting over shaft which in bearing support at both side.
3) Motor shaft and disk shaft is coupled by clamping method.
4) Then after electromagnet are mount at one side of disk but in opposite side.
5) For rotational motion of disk there is 2000 rpm motor mount with clamping.
6) At front side of frame sensor is mount.
7) For proper way for electricity process switch are provide.

VI. RESULT ANALYSIS

There are the result of the project are as shown in table

The reading are taken as the rotation speed of the aluminum disk with the motor and stopping time when the electromagnet are in action and motor power supply cutoff.

The results are as shown in table.

Table – 1

SR NO	*ROTATING SPEED(RPM)*	*STOPING TIME (SEC)*
1	*500*	*1.10*
2	*1000*	*1.40*
3	*1500*	*2.10*

4	*1700*	*2.50*
5	*2000*	*3*

VII. ADVANTAGES AND DISADVANTAGE

A. Advantages:

1) Problems of drum distortion at widely varying temperatures. Which is common for friction-brake drums to exceed 500 °C surface temperatures when subject to heavy braking demands, and at temperatures of this order, a reduction in the coefficient of friction ('brake fade') suddenly occurs.
2) This is reduced significantly in electromagnetic disk brake systems.
3) Potential hazard of tire deterioration and bursts due to friction is eliminated.
4) There is no need to change brake oils regularly.
5) There is no oil leakage
6) 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.
7) The retarders help to extend the life span of the regular brakes and keep the regular brakes cool for emergency situation.
8) The electromagnetic brakes have excellent heat dissipation efficiency owing to the high temperature of the surface of the disc which is being cooled.
9) Due to its special mounting location and heat dissipation mechanism, electromagnetic brakes have better thermal dynamic performance than regular friction brakes.
10) Burnishing is the wearing or mating of opposing surfaces .This is reduced significantly here.
11) In the future, there may be shortage of crude oil; hence by-products such as brake oils will be in much demand. EMBs will overcome this problem.
12) Electromagnetic brake systems will reduce maintenance cost.
13) The problem of brake fluid vaporization and freezing is eliminated.
14) Electric actuation, no fluid.
15) Easier integration with anti-lock, traction, and dynamic stability controls.
16) Easy individual wheel braking control.

B. Disadvantages:

1) Dependence on battery power to energize the brake system drains down the battery much faster.
2) Due to residual magnetism present in electromagnets, the brake shoe takes time to come back to its original position.
3) The installation of an electromagnetic brake is very difficult if there is Not enough space between the gearbox and the rear axle.

VIII. CONCLUSION

Electromagnetic braking system is found to be more reliable as compared to other braking systems. In oil braking system or air braking system even a small leakage may lead to complete failure of brakes. While in electromagnetic braking system as four disc plates, coils and firing circuits are attached individually on each wheel, even any coil fails the brake does not completely fails remaining three coil works properly. And this system needs very little of maintenance. In addition, it is found that electromagnetic brakes make up approximately 80% of all of the power applied brake applications. Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles. The frictions brakes can be used less frequently and therefore practically never reach high temperatures. The brake linings would last considerably longer before requiring maintenance and the potentially "brake fade" problem could be avoided. This enhanced braking system not only helps in effective braking but also helps in avoiding the accidents and reducing the frequency of accidents to a minimum. Furthermore the electromagnetic brakes prevent the danger that can arise from the prolonged use of brake beyond their capability to dissipate heat.

With all the advantages of electromagnetic 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 electromagnetic brakes can be used as an auxiliary braking system along with the friction braking system to avoid overheating and brake failure. ABS usage can be neglected by simply using a micro controlled electromagnetic disk brake system .These find vast applications in heavy vehicles where high heat dissipation is required. In rail coaches it can used in combination of disc brake to bring the trains moving in high speed. When these brakes are combined it increases the life of brake and act like fully loaded brakes. These electromagnetic brakes can be used in wet conditions which eliminate the anti-skidding equipment, and cost of these brake are cheaper than the other types. Hence the braking force produced in this is less than the disc brakes if can be used as a secondary or emergency braking system in the automobiles.

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