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Design and fabrication of frictionless electromagnetic braking system

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ABSTRACT

Brakes could be the crucial parts in most of the moving system that are generally used to slow down or stop the motion of the any moving system. Braking system uses the friction force to transform the kinetic energy of a moving part into heat by the use of the brake pads. Frequently using of these type of friction braking leads to rise in temperature of brake pads, these leads to effecting the effectiveness of the braking system. By overcoming these effects we use electromagnetic braking .In this project, we used eddy current braking in vehicle to stop the vehicle by non-contracting type. This braking system is friction-less, it has an advantages over the ordinary braking system in the performance and maintenance.

Index words: Eddy Current Braking System, Eddy Current, Magnetic Field, Brakes, and Frictionless.

INTRODUCTION

In the operation of any machine the primary safety system is the braking system. As brake is an essential parts of car innovation, there are developments in brakes as well .The mainly utilized brakes in cars are drum and disk brakes. In green technology, which focused on the importance of environment conservation, a move to a new braking system is needed. The primary basic designs of the braking system involve the conversion of kinetic energy to heat energy by the use of friction. This is accomplished by friction between two rubbing surfaces may be in disk brake and drum brake. These brakes pose several problems i.e. more wear, complex and slow actuation, lack of fail-safe features, increased fuel consumption. To solve these problems, a contactless magnetic brake has been used to reduce or overcome the friction effect. This concept includes a metals disc which will conduct eddy currents generated by magnets. Electromagnetic braking is an imaginative innovation and further more frames the premise of developing innovation. Electromagnetic brake is as new idea.

This brake is wear-free, low-sensitive to temperature compare to friction brakes, it has fast and simple actuation, and has a reduced sensitivity to wheel lock. This is carry out by the generation of braking torque by a magnetic field across a moving conductor which creates a perpendicular magnetic field by induced eddy currents. Contactless brakes can be applied to any machinery like automobiles, locomotives, roller coasters, machine tools, elevators, etc. Eddy current braking has a lot of advantages compared to conventional braking system such as friction free; there should be no wear and tear in brakes.

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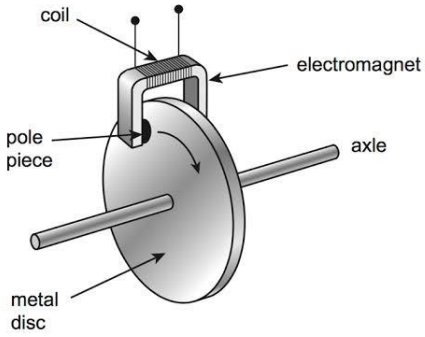

Fig. 1 Experimental setup of electromagnet and disc

LITERATURE SURVEY

Girishdalvi et al studied the operating system of any machinery the most important primary safety system is a braking system. This brake is wear-free and less-sensitive to temperature than friction brakes, it has fast and simple actuation and long lifetime. By using this braking system it is more reliable , quick in response and maintenance free. From theoretical calculations and experimented braking time values, a maximum reduction in braking time 23.97% is found and max air gap limit of 3 mm is obtained beyond with electromagnetic brakes are found to be ineffective [1].

Parth Patel et al, has carried an setup on frictionless braking system using eddy current system. A noncontact braking is works on the principle of magnetic drag force. Electromagnetic braking means applying brakes using electronic and magnetic power [2].

Yogesh Kumar Yadav et al, has studied the developed of the experiments on Electromagnetic braking system. Electromagnetic brake have very numerous preference over frictional braking system. This type of brake expands the life of the brake and increase the reliability .These brakes can be utilised as a part of wet condition, so there is no utilization of against slipping instruments [3].

R. Wilson et al, has studied the one of the most critical requirements for safety in vehicles is the availability of reliable braking system [4].

Der-Ming Ma et al, has studied 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 [5].

EDDY CURRENT

Eddy current brake could be work on the basis of Faraday's law of electromagnetic induction. According to this law, whenever a current carrying conductor cuts the magnetic lines of force,an emf is induced in the conductor, the magnitude of eddy current is proportional to the strength of the field of the magnet and the speed of the conductor.

If the conductor is the disk, there could be circulatory current (eddy current in the disc).According to the Lenz's law, the direction of the current is in the oppose the cause that is act on the movement of the disk.

ELECTROMAGNETS

Electromagnets are DC type which is to be powered by battery. Electromagnets are selected instead of permanent magnet as electrical actuation which is faster than mechanical actuation with lower losses. Magnetic field can be generated at the time when it is needed only.When a current was passed through the coil, the iron became magnetized and attracted other pieces of iron;

when the current was stopped, it lost magnetization. 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 wire wound into a coil. A current through the wire creates a magnetic field which is concentrated in the hole in the centre of the coil. The wire turns are often wound around a magnetic core made from a ferromagnetic or ferrimagnetic material such as iron; the magnetic core concentrates the magnetic flux and makes a more powerful magnet.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 current to maintain the magnetic field.

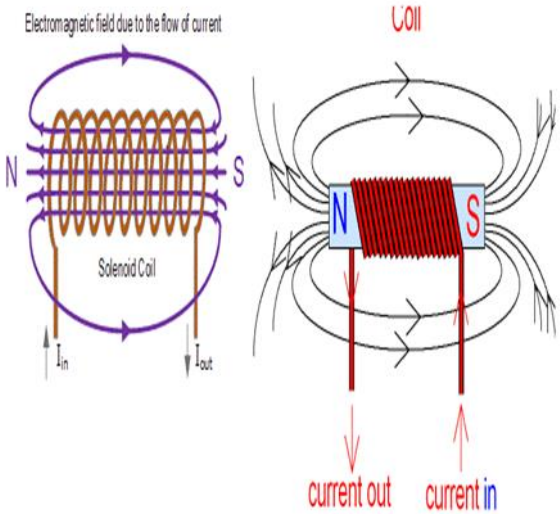

Fig. 2 Electromagnet principle

CIRCULAR DISC

We have to choose the circular disc for our project would be an iron disc. Iron is the best material compared to copper and zinc to be use as the disc for eddy current braking using electromagnetic induction. Iron reacts better and faster compared to the other two materials. Besides that, increasing the current induced will increase the drag force that been produced and will slow down the motion better.This can be seen when the current increase, the speed of the disc rotation has been reduced. Also iron disc does not get attracted in a magnetic field but Eddy current generation due to electromagnetic induction is high. As the thickness of disc increases the generation of eddy current increase.

Iron is the best material to be used as rotating element in eddy current braking. Iron disc of thickness 20 mm and the diameter of 200mm could be used as an disc for electromagnetic braking.

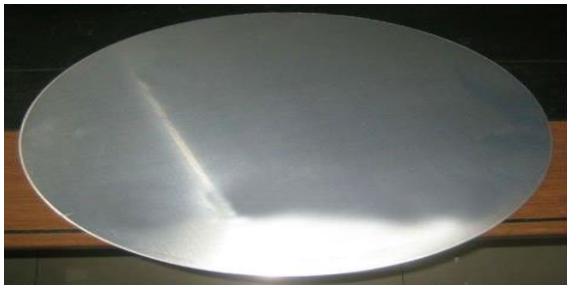

Fig. 3 Circular disc

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. The two main types of AC motors are induction motors and synchronous motors. The induction motor (or asynchronous motor) always relies on a small difference in speed between the stator rotating magnetic field and the rotor shaft speed called slip to induce rotor current in the rotor AC winding. As a result, the induction motor cannot produce torque near synchronous speed where induction (or slip) is irrelevant or ceases to exist. In contrast, the synchronous motor does not rely on slip-induction for operation and uses either permanent magnets, salient poles (having projecting magnetic poles), or an independently excited rotor winding. The synchronous motor produces its rated torque at exactly synchronous speed.

EXPERIMENTAL SETUP

The experimental setup consists of circular disc, electromagnet, AC motor, battery, shaft. The circular disc dimension is 20mm of thickness and 200mm of diameter of an circular disc. The electromagnet is used in this project is two. Each consists of 200 turns of copper wire wounded over the iron rod. AC motor is used to run the circular disc, it can able to run upto 1500-2000rpm. The wheel and disc is attached to the shaft. The shaft is supported by the bearing at the two end of the shaft. The bearing is placed at the frame at the respective place. By the use of motor, the wheel and the disc is rotate at an required speed. The motor is placed at the frame parallel to the disc and wheel. The two electromagnet is placed at an 2mm of air gap between the circular disc and the electromagnet. The electromagnet is energized by the use of an battery. If we want to increase the efficiency of the electromagnet, we have to increase the voltage applied to the electromagnet based on the speed of the circular disc rotate. Electromagnet is energized only at the time of brakes are applied.

WORKING PRINCIPLE

The frictionless braking system uses the principle of eddy current phenomenon. The eddy current method is based on the principle of generating circular electrical currents in a conductive material. This can be achieved by the use of a coil connected to an alternating current generator driving an alternating magnetic field. The current flow induced by this primary field within the conductive material will itself produce a magnetic field in opposition to the primary field according to lenz's law. The working principle of the electromagnetic brake is based on Right hand thumb rule. If a piece of copper wire was wound, around the nail and then connected to a battery, it would create an electromagnet. The magnetic field that is generated in the wire, from the current, is known as the "right hand thumb rule". The wheel and disc is run by using the motor by pressing the acceleration paddle. Then the wheel and disc is rotate at the certain RPM based on the motor capacity. If we want to applied the brake release the acceleration paddle and applied the brake paddle. At the time of brake is applied the current and voltage is supplied to the electromagnet by the use of the battery. Then the electromagnet is energized and emits the magnetic flux , the circular disc is rotate at the air gap of 2mm near to the electromagnet. When the electromagnet emits magnetic flux , it tends to stop or slow down the speed of the circular disc. So the speed of the moving vehicle is reduced.

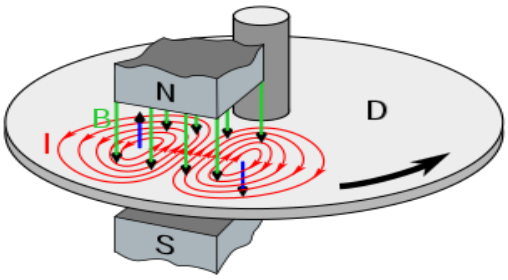

Fig. 4 Working principle of eddy current brake

RESULTS AND DISCUSSIONS

Eddy current braking system is successfully implemented and tested. This braking system can be incorporated along with the conventional braking system as eddy current embedded conventional braking system. Eddy current braking can be successfully used as an auxiliary brake. This is particularly useful to heavy and long distance vehicle. In the cases of heavy vehicles the normal brakes get heated up and become less efficient on continuous usage. In the case of eddy current braking system can be used efficiently. Also eddy current braking is used as a safety brake in automobiles. Eddy current braking also find application on the high speed vehicle as braking force is proportional to the speed of the vehicle.

CONCLUSIONS

Eddy current braking produce effective braking with low wear and tear. The maintenance cost of this braking system is very low. Eddy current braking is a non-contact breaking system and hence there is no friction and low wear and tear. Thus debris produced in braking is very low and hence is ecofriendly. Eddy current braking is a cleaner way of braking. Wheel skidding is avoided as the wheel does not get locked. It works on electricity and consumes very small amount of power for a tiny time period. It only consumes small space therefore installation is easy. Due to non-contact between the disc and the electromagnet it does not emits heat, so the life time of the brake is high. In conclusion, that frictionless electromagnet brake is more effective, eco-friendly when compare to the ordinary braking system.

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