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Design & Fabrication of Electromagnetic Braking System

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Abstract

An engineer is always focused towards challenges of bringing ideas and concepts to life. Therefore, sophisticated machines and modern techniques have to be constantly developed and implemented for economical manufacturing of automobile products. At the same time, we should take care that there has been no compromise made with quality and accuracy. In the age of automobile automation& artificial intelligence machine become an integral part of human being. By the use of automation machine prove itself that it gives high reliability, safety & comfort. In competition market everyone wants to make their machine multipurpose. The engineer is constantly conformed to the challenges of bringing ideas and design into reality. New machines and techniques are being developed continuously to safe & reliable operation various automobile products at cheaper rates and high quality.

So we are going to make a machine for Electromagnetic braking systemand make it reliable, safe & accurate braking operations used as alternate to conventional braking system. It is simple to maintain easy to operate. Hence we tried our hands on "Electromagnetic braking system.

Keyword- *EBS.*

I.INTRODUCTION

A brake is a device which inhibits motion. Its opposite component is a clutch. Mostcommonly brakes use friction to convert kinetic energy 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.Magnetic brakes working on the principle of the forceinteraction between a pair of permanent magnets are nowadays commonly used in numerous industrial applications as a cheap alternative to the classical brake systems. Due to their simple design they are often used, for example, as dampers. The aim of this paper is to present the simplest kind of such a damper, derive its complete mathematical model, determine its characteristics and verify some theoretical results experimentally.

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 because of the current flowing across the coil and causes armature to get attracted towards the coil. 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.

II PROBLEM STATEMENT

The statement of project is "Design & fabrication of Electromagnetic braking system" for the braking application in automobile as per requirements for braking performance. The braking is the major operation performed in automobile used to control & reduced the speed of a vehicle and to perform most rigid operation in automobile safety. the accuracy of braking is increasesby using automation in system, so we are trying to do a work on new system in Electromagnetic braking system.

III OBJECTIVES

1) To reduce the braking effort.

2) To maintain the accuracy in braking system.

3) To develop automation unit for braking so that, it can easily be adopted in today's automated vehicle.

4) This type of system work practically at low cost, low maintenance, low capital investment in less space.

5) To performed the most rigid operation with high speed braking.

6)

IV PRINCIPLE OF Electromagnet

An electromagnet is type of magnet in which the magnetic field is produced by a flow of electric current. The magnetic fields disappear when the current ceases. The wire produces loops of magnetic field lines around it. Imagine turning a screw so that it moves into a piece of wood. You have to turn it clockwise and it will move forward in analogy, the current represents the movement of screw and resulting field line direction is the direction of turning. If a wire is wound into a coil, then the field lines add up in such a way as to produce a set of field lines surround the coil in a similar way to those that surrounds a permanent bar magnet.

If further a piece of soft iron is placed inside the coil, the magnetic domain in the iron align with the field lines and they themselves serve as many little bar magnets in the iron, creating a strong bar magnet as long as the current is switch on.

Electromagnet

A soft-iron core that is magnetized by passing a current through a coil of wire wound on the core. Electromagnets are used to lift heavy masses of magnetic material and to attract movable magnetic parts of electric devices, such as solenoids, relays, and clutches.

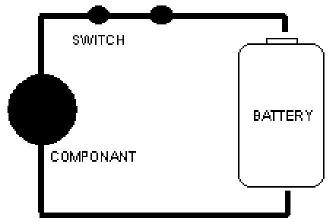
The difference between cores of an electromagnet and a permanent magnet is in the retentively of the material used. Permanent magnets, initially magnetized by placing them in a coil through which current is passed, are made of retentive (magnetically "hard") materials which maintain the magnetic properties for a long period of time after being removed from the coil. Electromagnets are meant to be devices in which the magnetism in the cores can be turned on or off. Therefore, the core material is no retentive (magnetically "soft") material which maintains the magnetic properties only while current flows in the coil. All magnetic materials have some selectivity, called residual magnetism; the difference is one of degree. See also Magnetization.

In an engineering sense the word electromagnet does not refer to the electromagnetic forces incidentally set up in all devices in which an electric current exists, but only to those devices in which the current is primarily designed to produce this force, as in solenoids, relay coils, electromagnetic brakes and clutches, and in attractive and lifting or holding magnets and magnetic chucks.

Electromagnets may be divided into two classes: traction magnets, in which the pull is to be exerted over a distance and work is done by reducing the air gap; and lifting or holding magnets, in which the material is initially placed in contact with the magnet. Examples of the latter type are magnetic chucks and circular lifting magnets. For examples of the first type. See also Brake; Clutch; Relay; Solenoid (electricity)

The basic idea behind an electromagnet is extremely simple. By running electric current through a wire, you can create a magnetic field.The C.G.S unit is the Maxwell's a measure for the magnetic flux while in M.K.S. system the unit measure is called the Weber.

By using this simple principle, one can create all sorts of things including motors, solenoids, read/write heads for hard disk tape drives so on. In this article, we will see exactly how electromagnet works. We will also have to try several experiments with electromagnets that we create our self. An electromagnet is a "temporary magnet" - - the magnetic field only exits when electric current following



An electromagnet starts with a battery (or some other source of power) and a wire. What a battery produces is electrons.

If we look at a battery, say at a normal D-cell from a flashlight, you can see that three are two ends. One marked plus (+) and the other marked

Minus (-) Electrons collect at the negative end of the battery, and, if you let them, they will gladly flow to the positive end. The way you "let them" flow is with a wire. If we attach a wire directly between the positive and negative terminals of a D-cell three things will happen.

1] Electrons will flow form the negative side of the battery to the positive side as fast as they can.

2] A small magnetic field is generated in the wire. It is this small magnetic field that is the basis of an electromagnet.

V.PRINCIPLE OF BRAKING 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 generatinghigh torque and absorbing energy at extremely high rates for short periods of time. Brakes may be broadly described as using friction, pumping, or electromagnetic. One brake may use several principles: for example, a pump may pass fluid through an orifice to create friction**.**

VI CALCULATION OF ELECTROMAGNETIC FORCE

Computing the force on ferromagnetic_materials is, in general, quite complex. This is due to fringing field lines and complex geometries. It can be simulated using finite element analysis. However, it is possible to estimate the maximum force under specific conditions. If the magnetic field is confined within a high permeability material, such as certain steel alloys, the maximum force is given by:

$$F = \frac{B^2 A}{2\mu_o}$$

Where:

F is the force in Newton.

B is the magnetic field in teslas.

A is the area of the pole faces in square meters.

μ_o is the permeability of free space.

In the case of free space (air),

$$\mu_o = 4\pi \cdot 10^{-7}\,\mathrm{H} \cdot \mathrm{m}^{-1},$$

In a closed magnetic circuit:

$$B = \frac{\mu N I}{L}$$

Where:

N is the number of turns of wire around the electromagnet.

*I*is the current in amperes.

L is the length of the magnetic circuit.

Based on the above formulas we design electromagnet for our prototype model considering:

No. of turns on electromagnet (N) =800, (24 gauge wire)

Current & Voltage supplied (I/V) = 7amp/230volts.

Length of electromagnet (L) =25 mm.

So, using

$$B = \frac{\mu N I}{L}$$ (L is in meters)

B= 0.2814 wb/m^2

Also force on the piston is given by

$$F = \frac{B^2 A}{2\mu_o}$$

A is the area of electro magnet having diameters,

External diameter d_1=25 mm,

Internal diameter d_2=40 mm.

Hence area, A=3.14/4(d_1^2-d_2^2) 10^{-3}=7.657 X $10^{-4}m^2$

Putting the values in above equation we get,

Force (F)=24.126 Newton. (For each Electromagnet)

Total braking Force (F)=4 X 24.126

= 96.504 Newton.

MOTOR SELECTION

Thus selecting a motor of the following specifications

Single phase AC motor

Power = 1/15hp=50 watt

Speed= 0-8600 rpm (variable)

Motor is a Single phase AC motor, Power 50 watt; Speed is continuously variable from 0 to 8600 rpm. The speed of motor is variator by means of an electronic speed variator. Motor is a commulator motor i.e., the current to motor is supplied to motor by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed variator; thereby the speed is also is changes. Motor is foot mounted and is bolted to the motor base plate welded to the base frame of the indexer table.

Motor Torque

$$P = \frac{2 \Pi N T}{60}$$

$$T = \frac{60 \times 50}{2 \Pi \times 8600}$$

T = 0.055 N-m

Note: All Calculations are taking at full speed of motor.

Power is transmitted from the motor shaft to the input wire brush bundle shaft by means of an open belt drive,

Motor pulley diameter = 30 mm

IP _ wire brush bundle shaft pulley diameter = 60 mm

Reduction ratio = 2

IP shaft speed = 60/2 = 30 rpm

Torque at IP rear shaft = 2 x 0.055= 0.11 Nm

Speed of IP _ wire brush bundle shaft pulley = 8600/2 =4300rpm

DESIGN OF OPEN BELT DRIVE

Motor pulley diameter d = 30 mm

IP _ shaft pulley diameter D = 60 mm

Reduction ratio = 2

Coefficient of friction = 0.23

Center distance c= 380mm

Let,

t = Thickness of belt= 5 mm

b= Width of belt=6mm

Velocity of belt is given by;

$$V=\frac{\Pi\ (d+t)\ n}{60\ X\ 1000}$$

$$V=\frac{\Pi\ (30+5)\ x\ 8600}{60\ X\ 1000}$$

V=15.76 m/s Linear velocity of open belt drive

To find out tension in the belt is;

$P= \frac{(F1-F2)\ V}{1000}$

$50\ X\ 10^{-3} = \frac{(F1-F2)\ X\ 15.76}{1000}$

$F1 - F2 = 3.172$ N --------- (1)

Center distance between two pullies of motor &pullies of wire brush bundle C=380mm.

$\alpha = \sin^{-1}\frac{D-d}{2\ C}$

$\alpha = \sin^{-1}\frac{(60-30)}{2\ X\ 380}$

$\alpha = 2.2622^{0}$ (In Degrees)

$\alpha = 2.2622\ X\ (\Pi /180)$

$\alpha = 0.03948^{c}$ (In Radians)

θ = Angle of lap of belt.

$\theta = \Pi - 2\ \alpha$

$= \Pi - [2\ X\ 0.03948]$

$\theta = 3.06^{c}$ (In Radians)

$\theta = 175.4759^{O}$ (In Degrees)

Now,

$\frac{F1}{F2} = e^{\mu\theta}$

$= e^{0.23\ x\ 3.06}$

$\frac{F1}{F2} = 2.0214$ ----------------- (2)

F1= 2.0214 F2 ------------------ (3)

Put Eq. (3) in Eq. (1)

F1- F2 = 3.172

F2 = 3.1055 N

Put in Eq. (3)

F1 = 6.2775 N

Mass of belt per unit length is given by;

$m = \frac{\rho\ x\ b\ x\ t\ x\ 1}{10^{6}}$

ρ= density of belt material = 950 kg/m^3

$$m = \frac{950 \, x \, 6 \, x \, 5 \, x \, 1}{10^6}$$

m= 0.0285 kg/m

Centrifugal force in belt is given by,

$Fc = mV^2$

$=0.0285 \text{ X } (15.76)^2$

Fc = 7.078 N

VI I. ADVANTAGES

1. This machine can be used for any shape of trip size.
2. This machine has compact size.
3. This machine is easy to handle.
4. Cost of machining is low.
5. Skilled person are not required.
6. Production rate can be easily changes by changing motor speed
7. Maintenance cost is less.
8. Easy to assemble and disassemble.
9. Initial investment & maintenance is low.

VIII. SAILENT FEATURES

1. Problems of drum distortion at widely varying temperatures. Which is common for friction-brake drums toexceed 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 negligible/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 retardercaused by the motion of the vehicle

CONCLUSION

It gives us immense pleasure to have completed our project Semi Automatic Defoiling Machine as per project analysis and time estimate that is in 5 months.

Our project Semi Automatic Defoiling Machine was designed on experimental basic and so adopted and chooses all channels that assure quality. After the successful completion of the complete model it is now for sure that the model can will be employed on large scale with machine increase in cost of around Rs.11000/- of semi Automatic Defoiling Machine. The present that we have developed is capable of overcoming all the drawbacks of previous and in addition will provide extra utilities such as better space utilization, remote placement of semi Automatic Defoiling Machine, added luxury, etc. Another noticeable aspect is that the maintenance is the least. The lubrication of joint is eliminated.

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