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Development of Vehicle Locking Mechanism Using Electromagnetic Brakes

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ABSTRACT: Electromagnetic brakes have attracted substantial attention in aircraft systems during the last few decades as a helpful actuator to limit the movement of a mechanical system. Thus, the electromagnetic braking system was created to enhance stopping power, service life, and maintenance costs. This may be accomplished by employing permanent magnets rather than moving elements. Permanent magnets can generate more power than ordinary electromagnets at a significantly cheaper cost. Furthermore, the field emission feature of the magnet allows for a decrease in the number of metal powders or steel needed in the rotors, which reduces cost and weight even further. During actuation circumstances, a basic nonlinear magnetics model is used to analyze magnetic field changes across the brake. A novel electromagnetic brake operating principle is presented, which might be more energy-efficient and dependable than traditional solenoid-based brakes to reduce the accidents and save the life of peoples.

KEYWORDS: Electromagnetic Brakes, Magnets, Motor, Rotor, Speed, Vehicles.

1. INTRODUCTION

The automobile sector is growing at a breakneck pace. Inventions in technology have made it possible to compete in this market. Additionally, when creating any type of car, automotive industry firms now strive for an environmentally responsible approach. As a result, automakers are now vying for customers by producing vehicles with a variety of qualities, including excellent engine performance, safety, dependability, current design, and speed. As a complement to the standard friction brakes, the electromagnetic brake has found extensive use in such big vehicles. Friction brakes, which are standard equipment on all motorized vehicles, and electromagnetic discs are the two primary techniques of turning heat into kinetic energy in road vehicles [1], [2].

One is the frictional resistance provided either by wheels, which only causes heat to be generated when braking and requires no power input and refer to this as “frictional braking”. The second technique uses electromagnetic induction, which transforms kinetic energy into electricity that may be stored by a battery or an electromagnetic capacitor and released as electrical current when the brakes are applied once again. The term “electromagnetic braking” (EMB) or “electromagnetic retardation” refers to this technique. A contactless brake like the Eddy Current Braking System could be a solution to this problem. Additionally, it is ecologically friendly, can lessen vibration and brake pad wear [3]–[5]

These benefits thus offer us optimism for additional research and the development of a green tech braking system. Eddy currents are created in a conductor when it passes over a stationary magnet. The speed is slowed down by the drag force created by these currents. Induced magnetic fields are

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also produced by the eddy current safety system during deceleration and acceleration and these fields interact with moving conductors to provide braking force. A magnet that is powered by this braking mechanism attracts the metal disc as it is being braked as shown in Figure 1. A braking system is an installation between the rear hub as well as the brake system, or calliper. It has the form of a disc [6], [7]

Figure 1: Represents the Different Types of Electromagnetic Brakes Used In Various Applications [Source: Ultramotion]

This part slows the wheels' rotational speed. Vehicles having mechanical brakes, such as tractors, motorbikes, trucks, and cars, employ brake discs. A powerful magnetic field is produced by the product's high self-induction coils and magnet core. An electromotive force is created when the current is turned ON and passes through the wire. Internal magnetism and the magnetic field created by the current are attracted to one another, creating a second force through which the permanent magnets rotates. The magnetic field vanishes and the rotating of the core stops when the current is turned OFF or stops flowing [8]–[10].

The EMB is an example of such a control strategy. A rear iron framework and an integrated permanent magnet operate jointly as an energy storage device in a new and efficient flipping EMB configuration that increases the platform's energy efficiency. The latch-type valves and brakes have received a lot of attention in speed control devices. The latch-type valves and brakes have received a lot of attention in speed control devices. The current arrangement, on the other hand, differs from them, which lowers the complexity of the hardware and magnet assembly. Contrary to typical magnetic brakes, there are no intricate structures surrounding the rotor. Experiments on manufactured hardware have been used to carry out and validate nonlinear electromagnetic analysis.

2. DISCUSSION

The battery supplies the charge to the electromagnetic coils whenever applying the brakes is necessary. This is one of the main parts of EMB system. Inside the stator is a coil as well as spiral wire that is often made of copper. The coils generate an electromagnetic field when the battery's

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current passes to them. To slow down or halt the spinning of the armature, friction material is fastened to the stator. The armature is attached on the armature hub using splines and is constructed of ferromagnetic material. Splines allow the Armature to smoothly glide on the Armature Hub, and the Plate Spring also connects the Armature to the Armature Hub. On one side of the armature, there is a friction surface. When the electromagnetic field is turned off, the plate spring aids the armature in returning to its starting position. Armature hub with splines for mounting the armature. A key joint is used to attach the output shaft to the armature hub.

The complex assemblies known as electromagnetic brakes offer tremendous torque, quick response times, and the option of smooth, backlash-free operation. Therefore, all electromagnetic brakes could carry out some or all of the essential tasks listed below, regardless of their particular designs and characteristics:

- Stopping a loads
- Decelerating a loads
- Static holdings

The sorts of application for which the electromagnetic brake is most appropriate will depend on its particular design and engagement strategy. For instance, while tooth brakes are great for stationary or holding-only applications, they are not appropriate for tasks requiring dynamic engagement due to their positive locking nature. On the other side, friction disc-based electromagnetic brake technologies offer the regulated, progressive deceleration needed to support dynamic contact or stopping. Below is a more thorough examination of several EWB designs and associated engagement processes.

In order to drive the armature plate onto the friction disc after the power is switched off and electromagnetic field has gone, spring-engaged friction brakes use spring pressure. The friction disc is compressed as a result, and the torque that is transmitted allows the brakes to stop or hold attached weights in the lack of power. Applications that call for an emergency stop feature in the case of a power outage frequently employ spring-engaged power-off brakes. Other typical applications are depicted in Figure 2.

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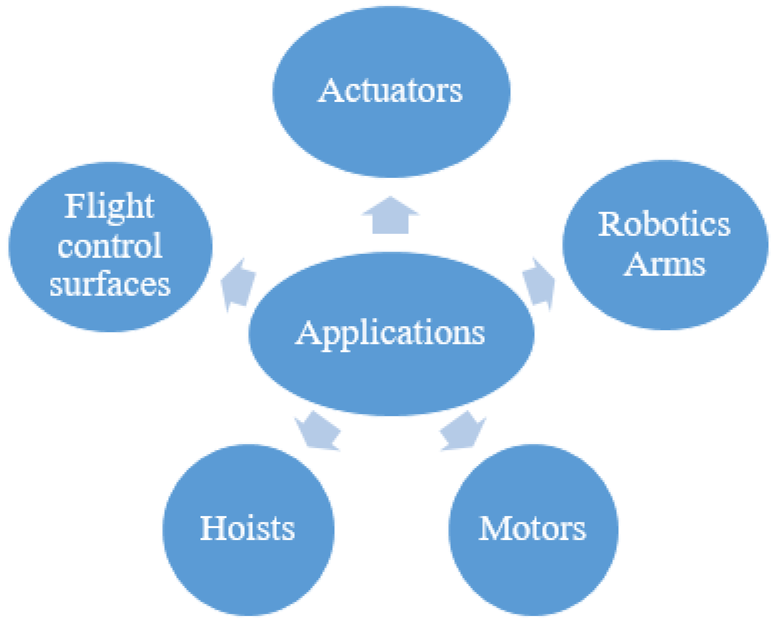

Figure 2: Illustrates the Applications of Electromagnetic Braking System.

Interlocking tooth between both the armature as well as output plate improve the brake's torque capacity and holding qualities in magnetically engaged power-on tooth brakes. These power-on brakes start working when the coil receives current. The armature may bypass the release spring, slide into the outlet plate's splines, and interact with the magnet body because the current creates a strong magnetic attraction. The connected weight can be halted or held when the teeth come into contact. Power-on brakes create a magnetic field that is strong and frictional, which provides the force required to stop circular motion. The following applications call for this kind of braking action:

- Elevation actuators
- Valve actuators
- Positioning systems
- Doors

Compared to other braking options, electromagnetic brakes provide a number of advantages. In mechanical braking systems, the amount of friction needed to reduce or halt loads can result in severe long-term wear and tear on the brake's parts. Electromagnetic brakes contribute to a reduction in wear by employing electromagnetic force and well-chosen friction material to give the slowing/stopping action. A tailored electromagnetic brake can offer quick response, exact engagement, and backlash-free operation. Electromagnetic braking systems last longer and need significantly less maintenance since they lessen component wear and increase brake efficiency. When compared to mechanical systems and other options, well-engineered electromagnetic braking systems may be quite effective at dispersing heat.

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When the battery's current source begins to flow to the coil, the coil turns into an electromagnet and generates an electromagnetic field. Due to friction that develops between the rotating armature and the friction materials on the stator as a result of the magnetic field, both the armature and the spinning of the shaft come to a stop. Therefore, Brake is used in this manner. When the coil's current supply is cut off, the electromagnetic field that the coil was producing ends. As a result, the armature's attraction force is reduced as a result of the Electromagnetic field's cessation of development, and the Stressed Spring pushes the armature in the direction of the armature hub. Brake is therefore released in this manner.

Magnetic and electronic power are used to apply the brakes during electromagnetic braking. Here, we apply the electromagnetic concept to brake with reduced friction. Since there is reduced friction, the lifespan and dependability of brakes are likely to rise as a result. Additionally, it requires less oiling and maintenance. This is a future technological advancement that will replace conventional braking methods. The fact that these brakes are frictionless is the fundamental justification for their proposed usage in automobiles. Due to the lack of friction and oiling, maintenance costs are significantly reduced. Additionally, conventional braking systems are susceptible to slippage, but this one ensures that the car will be stopped. Therefore, this technique is a favoured replacement for conventional brakes because it doesn't require friction or lubrication. In comparison to conventional braking systems, it is also considerably smaller in size.

3. CONCLUSION

A design approach utilizing magnetic circuit modelling in combination with finite element computation has also been described, along with a research of electrostatic brakes for use in aircraft. The device's equivalent magnetic circuit is developed and established analytically. The brake is built to all standards and has a higher output torque than the system demands. It works perfectly in a variety of applications. This research examined the reasoning and architecture of the EMB system. To characterize the braking effectiveness simulation outcomes of an EMB systems with varied settings, theoretical formulations were developed. In this research, it has been demonstrated that the unspring mass dynamics and EMB shape, frequency, and amplitude are connected to the braking performance.

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