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Application And Working of Electromagnetic Fail Safe Brakes

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ABSTRACT:

Electromagnetic fail-safe brakes are critical safety components used in a diverse range of mechanical systems and industrial applications. This abstract provides an overview of the functioning and applications of Electromagnetic fail-safe brakes, emphasizing their important role in ensuring safety and reliability in machinery. Electromagnetic fail-safe brakes are designed to address the need for controlled and safe cessation of motion in various mechanical systems. These brakes play a vital role in preventing accidents and ensuring operational integrity during power failures or emergencies. Electromagnetic brakes are mainly used in EOT crane brakes to control and hold the position of the crane, mainly the prime location of the brakes is at the shaft of the motor and at the wheels of the crane. Electromagnetic fail safe brakes play a very crucial role in the safety of the crane mechanism. We found out the importance of the Electromagnetic fail safe brake in the heavy industrial usage, As an electrical engineering student we tried to purse the brake and found out that the main mechanism in this brake is related to "Electromagnetic Induction" on this principal the whole brake works, So we have tried to study the mechanism and the working process of the Electromagnetic fail safe brake.

Keywords — Electromagnetic Brake; Fail-Safe System; Industrial Applications; Controlled Stopping; Crane and Hoist Safety.

INTRODUCTION :

In the realm of industrial machinery and mechanical systems, safety and control are paramount. One crucial component that ensures the integrity and reliability of these systems is the electromagnetic fail-safe brake. These brakes, often operating behind the scenes, play an important role in providing a robust and dependable safety mechanism when it matters most – during power failures or critical emergencies. This introduction provides an overview of electromagnetic fail-safe brakes, shedding light on their significance, working principles, and applications. Electromagnetic fail-safe brakes are meticulously engineered devices that combine the principles of electromagnetism and friction to create a fail-safe operation. These brakes are specifically designed to bring machinery to a swift and controlled halt or to securely hold loads in the event of a power outage, equipment malfunction, or other emergency situations. They are an integral part of numerous industrial and commercial applications, ranging from EOT Cranes and Conveyor systems, Heavy Lifting operations, and Holding positions.

Literature Survey

The historical development of electromagnetic fail-safe brakes is a fascinating journey that highlights the evolution of safety and control mechanisms in industrial and mechanical applications. Here's an overview of the historical development of electromagnetic fail-safe brakes.

EARLY ELECTROMAGNETIC BRAKE:- The origins of electromagnetic brakes can be traced back to the late 19th century when electromagnetic technologies were emerging

INDUSTRIAL REVOLUTION AND SAFETY NEEDS:- With the onset of the industrial revolution, the need for enhanced safety in industrial machinery became evident.

INTRODUCTION OF SPRING-APPLIED FAIL-SAFE BRAKES:- One of the critical developments in electromagnetic brakes was the introduction of spring-applied fail-safe brakes

DIVERSE APPLICATIONS:- The mid-20th century witnessed the widespread adoption of electromagnetic fail-safe brakes in various applications.

TECHNOLOGICAL ADVANCEMENTS:- With advances in materials science and design techniques, electromagnetic fail-safe brakes became more reliable and efficient.

INTEGRATION WITH CONTROL SYSTEM:- As industrial automation and control systems evolved, electromagnetic fail-safe brakes were increasingly integrated into these systems

COMPLIANCE WITH SAFETY STANDARDS:- Electromagnetic fail-safe brakes became subject to safety regulations and standards, leading to the development of brakes designed to meet specific safety requirements.

ONGOING RESEARCH AND DEVELOPMENT: - The 21st century has seen ongoing research and development in electromagnetic failsafe brake technology. • focus areas include enhancing energy efficiency, improving environmental resistance, and integrating these brakes with smart systems and industry 4.0 technologies

1. LIST OF COMPONENTS

Mounting Plate, Linear Plate, I Stack Plate, E Stack Plate, Square Hub, Coil, Main Spring, Lock Nut, Manual Release Bolt.

2. Mathematical Equations

Designing an Electromagnetic Fail Safe Brakes invovles various calculations to insure proper operation and safety. While specific formulas may vary based on design parameters and requirements of brake here some fundamental formulas and consideration commonly used in the design process.

- Brake Torque (Tb) Calculation:- The brake torque is the force required to stop or hold the load. It can be calculated using the following formula: Tb = Friction Coefficient (μ) × Normal Force (N).
- Normal Force (N) Calculation:- The normal force represents the force pressing the friction surfaces (e.g., brake disc and liner plate) together. It is typically calculated as: N = Load Weight (W) × g (acceleration due to gravity)
- Magnetic Force (Fm) Calculation:- The electromagnetic coil generates a magnetic force that opposes the brake torque. The magnetic force can be calculated using the formula: Fm = B (magnetic field strength) × A (cross-sectional area) × μ0 (permeability of free space)
- Magnetic Field Strength (B) Calculation:-B is the magnetic field strength created by the coil and is given by: B = (μ0 × μr × N × I) / L .where μ0 is the permeability of free space, μr is the relative permeability of the core material, N is the number of coil turns, I is the current through the coil, and L is the length of the magnetic path
- Coil Current (I) Calculation:- To generate the required magnetic field strength, the current through the coil can be determined using: I = Fm / (μ0 × μr × N × A)
- Response Time (τ) Calculation:- The response time of the brake can be calculated using the time constant formula: τ = L / R. where L is the coil inductance, and R is the coil resistance.
- Thermal Analysis:- The heat generated during brake operation can be estimated using the power dissipation formula: P = I^2 × R. where P is power dissipation, I is the current, and R is the coil resistance. Heat dissipation should be calculated and compared to the brake's heat tolerance
- Spring Force (Fs) Calculation:- The main spring force required to engage the brake can be calculated using Hooke's Law: Fs = k × δ. where k is the spring constant and δ is the spring compression or tension.

Working Principal Behind the Electromagnetic fail safe brake

The working of electromagnetic fail-safe brakes is based on several fundamental principles in the field of electromagnetism, which are governed by the laws of physics and electrical engineering. The primary laws and principles behind the operation of electromagnetic fail-safe brakes include

Faraday's Law of Electromagnetic Induction: This law, formulated by Michael Faraday, states that a change in magnetic flux within a closed loop of wire induces an electromotive force (EMF) or voltage in that wire. In the case of electromagnetic fail-safe brakes, this principle is applied when electrical power is supplied to the coil, generating a magnetic field that attracts the armature and disengages the brake

Ampere's Circuital Law: This law, established by André-Marie Ampère, describes the relationship between a closed loop's current and the magnetic field it produces. The coil within the fail-safe brake applies Ampère's law as it carries an electric current, generating a magnetic field around the coil that attracts the armature.

Magnetic Forces: The fundamental principles of magnetism, as described by the laws of electromagnetism, govern the interaction of magnetic forces in the electromagnetic fail-safe brake. When the coil is energised, it produces a magnetic field that exerts an attractive force on the armature, pulling it away from the friction surface and disengaging the brake.

Newton's Laws of Motion: Isaac Newton's laws of motion are fundamental in understanding how the electromagnetic brake brings a moving load to a stop. The force applied by the magnetic field, along with the friction between the armature
and the liner plate, results in a deceleration or stopping force, ultimately obeying Newton's laws.

Electrical Circuit Laws: The operation of the electromagnetic fail-safe brake depends on the principles of electrical circuits, including Ohm's Law (which relates voltage, current, and resistance) and Kirchhoff's Laws (which govern the conservation of current and voltage in closed loops)

Normal Operational Condition Of The Brake:- The normal operational condition of an electromagnetic fail-safe brake is when the brake is functioning as intended during regular operation. In this state, the brake remains disengaged when power is supplied to the electromagnetic coil, allowing the load or machinery to move freely.

Model Size	Technical Data		Dimensions					
	Torque in Kgm	VA mm	D mm	B mm	L mm	T mm	J(max) mm	Sq.hub

DAT-150XH	2.20	80	150	80	144	10	24	1 ½”x1 ½”

Table. 1 Model Specification

Model Size	Coil Data		
DAT-150XH	No. of Turns	Coil Gauge mm	Coil Ampere amp
	1150	35	0.72

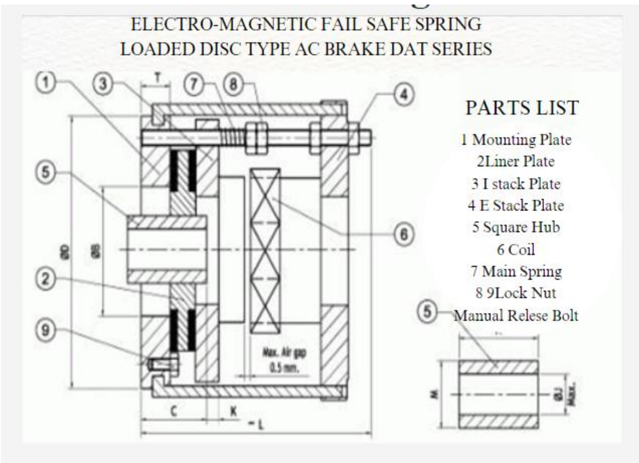

Fig. 1 Auto Cad 2D Diagram

Application Of Electromagnetic Fail Safe Brake

EOT Crane Brakes:- EOT (Electric Overhead Traveling) cranes, also known as bridge cranes or overhead cranes. Here are the key applications of electromagnetic fail-safe brakes in EOT cranes.

- Hoisting Mechanism: The hoisting mechanism in an EOT crane is responsible for lifting and lowering loads. Fail-safe brakes are often used to control the motion of the hoist, ensuring that it stops quickly and securely when required. In the event of a power failure or when the operator releases the hoisting control, the fail-safe brake engages to prevent the load from dropping.
- Traveling Mechanism: EOT cranes move along tracks or runways, and electromagnetic fail-safe brakes are used to control the motion of the crane along these tracks. They ensure that the crane comes to a complete stop when the control is released or in the event of a power loss, preventing unwanted crane movement.
- Trolley Mechanism: The trolley mechanism allows the crane to move horizontally along the bridge. Fail-safe brakes are applied to the trolley to control its movement. When the operator stops the trolley or in the event of an emergency, the brake ensures the trolley remains stationary.
- Emergency Stop: Electromagnetic fail-safe brakes are crucial for the emergency stop function in EOT cranes. In case of an emergency or a safety hazard, a single action can engage the fail-safe brakes on multiple crane mechanisms, bringing the entire crane to an immediate stop.
- Load Holding: When a load is suspended from the crane's hook, the fail-safe brake helps hold the load securely in place, preventing any undesired load movement during material handling operations or when the crane is stationary.
- Precise Load Positioning: Fail-safe brakes help achieve precise load positioning during material handling operations, contributing to the overall efficiency and safety of EOT crane operations.

CONCLUSIONS

Electromagnetic fail-safe brakes have established themselves as essential safety components in a wide range of industrial and mechanical applications. They offer numerous advantages, including enhanced safety, precise control, and load-holding capabilities. These brakes are designed to automatically engage in the event of a power failure or emergency, providing an additional layer of security to protect both personnel and

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