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Design and Development of Brake Release System for Elevator

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Abstract - *The elevator brake is an important part to carry out the safe working of the elevator. The brake is the frequently use part of the elevator. This paper has discussed about designing and developing an electrically operated brake release system during maintenance and emergency. The manual-operated braking system can be hazardous in case of a power failure and mechanical failure. But the proposed system is external battery powered and automatically works using Arduino base programming. This system preferably suited for MRL gearless traction elevator. The control and maintaining of this system are easy and more economical than any other system. Efforts required to operate this system are more convenient than the mechanically operated system. It eliminates risk factors for passengers as well as workers.*

Key Words: *Elevator, Traction drive, Gearless MRL, Brake motor, Brake release system, Arduino, Power failure*

1. INTRODUCTION

[1] Nowadays due to Modernization, the use of elevators has increase rapidly for the ease of vertical transportation, especially in modern high-rise buildings. Almost every residential as well as industrial area has installed elevators for every day's works. It brings convenience to us and improves working efficiency and living standards. It is a combination of various machine parts and mechanisms. With often use, it is also required to do maintenance of the elevators.

1.1 Elevators parts and mechanisms

[2] The elevator is electromechanical machine. It consists of parts such as brake motor - motor combine with solenoid brake together act as a prime mover, gearbox - to increase or decrease speed of the travelling cabin, ropes - the main connecting links between prime mover and travelling cabin, governor - to limit the excess speed of travelling cabin, car (cabin) - the part where passengers enter and travel to desired floor, doors - to keep the passengers safe while travelling through it, various sensors - to send the receive signals to control panel, and control panel -to control and command all the electro mechanically operated parts Etc.

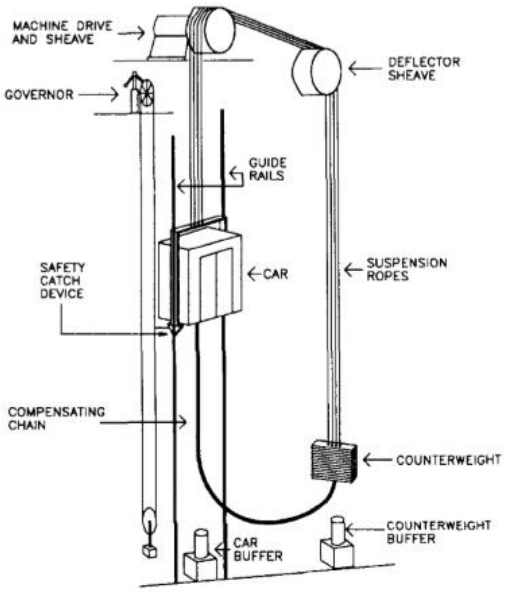

Fig 1: Elevator and its terminology [3]

Also it involves mechanisms such as lifting mechanism - upward and downward movement of cabin, speed governing mechanism -limit/control the over speed of cabin, door mechanism - opening and closing of the door and brake releasing mechanism - stop and release the cabin while travelling etc. For erecting the lift we have to consider lot of design parameters right from formation of pit to actual installation of the elevator.

1.2 Brakes for gearless MRL

[4] The brakes system is an integral and a very important part of the elevator system. Its function is not only to stop the cabin to the desired floor but to also operate during any emergency. If there is any mechanical failure or an electrical failure, the brakes should be capable of stopping the cabin at the right moment in order to avoid any serious accidents. There are various types of elevators in used like electric, hydraulic, pneumatic etc. For high height and normal speed gearless electrical traction drives are more efficient. In gearless, gearbox is eliminated and wheel (pulley) is directly attached to the electric motor. [5] Traction drive use ropes that pass over a pulley and lift the cabin by using an electric motor placed on the top of the hoist-way. A counterweight is used to offset the weight of the cabin (and passengers) so that the work to be done

by the electric motor is reduced. The electric brake motor attached to wheel and other components like control panel, ARD, over speed governor mounted over the top head of hoist way in a separate room called machine room. This room is not favorable if building height is too large. In that case Machine Room Less (MRL) drive is used.

Fig.2.Solenoid Brake for Gearless MRL

It better utilizes hoist-way space. But during maintenance of MRL, it is unsafe for worker to stand in the hoist-way over a cabin to do a required maintenance. In gearless MRL traction drive, electric motor is directly coupled with the disc type brakes. The disc brakes are operated by using solenoid signal.

2. Failures in Brake system

[6] In elevators, brakes play a major role of safety. If there are any mechanical or electrical failure brakes are responsible for the safety of the occupants as well as workers. If in any case, brakes fail to perform their function the control over the cabin will be lost.

The elevator brakes are majorly electromagnetic brakes which work on the excitation of electromagnetic coil. [7] The failure occurs due to continuous wear of the brake plunger and the magnetic ring. This is due to abnormal rotation of brake lever. Other failures are sudden power cut, failure of actuation of solenoid or braking of elevator rope causing it to free fall. [8] These accidents have resulted into 90 percent of deaths and 60 percent of serious injuries. Hence, safety of both occupants and the workers are a priority.

3. Brake Release System

In an old elevator & some modern system consists of manual braking. Manual breaking has some concerns about safety and maintenance. [9] Manual brakes Are not fully proof that they can fail by inadequate torque, seizing of the brake mechanism & break down any mechanical component from the system, which leads to accidents & breakdown. For maintenance Purposes it is risky for workers that if the elevator gets breakdown or power failure happens then the car gets trapped in any position in the hoist way then the workers had to work in a dangerous position to sort the problem. [10] Some permanent magnet machines have a disk system & some have a brake connected to the shaft of the motor. It is not feasible to develop a mechanical wire system to fully proof for the rescue operation. So, controller incorporated electrical systems are used. For overcoming this problematic situation nowadays automatic rescue device is used for power supply in rescue operations.

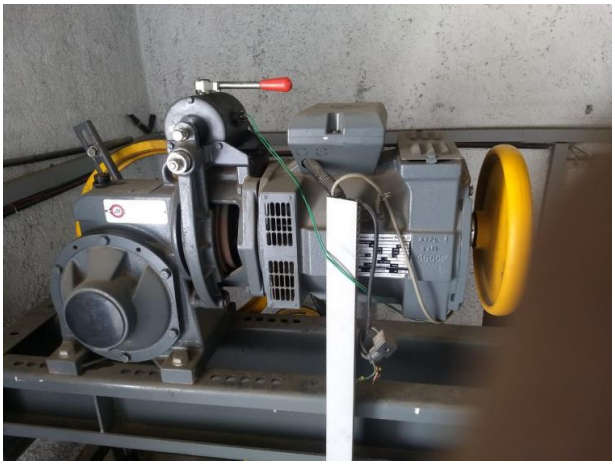

Fig .3. Manual Braking System at Site Visit

But the ARD has some drawbacks that it can use for a very short time. If the battery gets discharged the system gets useless until the battery is again Charged.it operates the whole control unit so it consumes a lot of battery & the battery of ARD is taking a long time to charge. Automatic rescue device is expensive too. [11]

4. Design and Development of System

[13] In this chapter, we Are going to develop Arduino controlled electrically operated brake system. First, we are going to develop a mathematical model from considering the mass pulley system. Assume pulley to be massless we have solved the situation taking into consideration various conditions. This mathematical model is used to build the logic for the program that is to put in aurdino. Based on this, aurdino program for our circuit is developed. The circuit is divided into two parts, the right side specifically and the left side.

The right side circuit shows the brake operation in normal conditions where the power supply is uninterrupted. 3 Phase supply is given to the main control panel and the solenoid coil is energized. The brakes then are operated according to the response in either direction. The left side circuit shows Power-failure mode operation. In the braking system, the 3 main components we have considered are, firstly is the Primary battery (48V approx.) for heavy operations like the movement of the lift, solenoid energizing, and brake application. The second is

the secondary battery (9V approx.) for charging Arduino and accessorial parts. The third is the Arduino Uno circuit which is analogous to the control panel in the right side circuit.

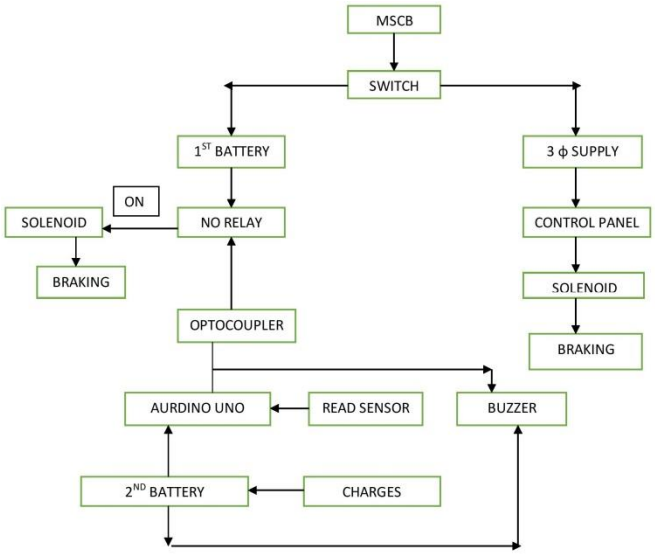

Fig .4. Process Flowchart

This circuit is responsible for giving the required feedback obtained by the sensors, timer delay, and buzzer and is thereafter is used to control the operation of the solenoid and the brakes regulation respectively.

[12] Under no-power condition brake spring keep the brake liner pressed against the cooling fan. These prevent rotor shaft rotation, because, the fan is keyed to it. When power is switched on, the brake coil gets energized through the rectifier unit. It instantly attracts the armature disc by overcoming the spring force. This action results in releasing of the fan allowing the rotor to rotate freely.

When the power fails or when it is switched off, the brake coil gets de-energized. This results in the springs pressing the brake liner against the cooling fan, i.e. returning the armature disc to its original position. This causes almost instantaneous braking of the rotor to fail-safe condition is thus ensured.

[13] In an elevator, brakes are disc brakes. These are electromagnetic brakes whithatve a spring assembly whithaterates from the solenoid. When the solenoid is de-energized, the disc brake is gripped by its arms by the compression springs, which producing the braking torque. Brake linings made with a high coefficient of the friction material and also decrease wear.

5. CONCLUSIONS

In this paper, manual braking mechanism and its failures were studied .In situations like mechanical or electrical failure, the brakes are supposed to actuate and safely take the occupants to desired floor. The manual braking had drawbacks which lead to retrofit the same elevator with newer technology of automatic brake release. The design has minimum components because of which it is space and cost effective. The complexity involved in implementing the circuit is less and can be retrofitted into any existing elevator without even need for replacing the whole elevator system by the newer elevator system.

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