INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 2)
Available online at: www.ijariit.com

A research paper on control of an elevator in case of failure of rope holding the inside cage

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ABSTRACT

This paper explains a safety system in the current elevators which would ensure that passengers are safe even if the rope of elevator cage breaks. Elevators are largely used to ease work of human being and reduce the time of traversing up and down a multi-story building. Hence it has become equipment of prime importance. The safety of people in the elevator thus brings us to the idea of developing a low-cost and simple mechanism which can be installed in every elevator ensuring rope breakage safety of the people.

Keywords— *Elevator, Rope, Safety, Brakes, Sensors, Solenoid, Controller, Cage*

1. INTRODUCTION

In the current scenario, the elevator is of great importance in day-to-day life. The increasing modernisation has led to the development of multi-storey buildings. So, elevators are the only source to reach various floors within less time. Therefore, this increasing use gives rise to the safety of people travelling in the elevators. Elevator accidents kill about 30 and injure about 17,000 people each year globally, according to data provided by the 'U.S. Bureau of Labour Statistics and the Consumer Product Safety Commission'. Due to this, it is necessary to develop a system which would make travelling in elevators safe even in critical conditions like fire, rope wreckage, freefall etc.

In our project, we are developing a mechanism which would stop or reduce the free fall velocity of the elevator cage. Sensors are used to sense the speed increase and send a signal to the controller to actuate brakes and reduce the speed of the free fall of the elevator.

2. LITERATURE SURVEY

In [1], the author has introduced PLC in the working of the elevator instead of the use of relays and IC boards. An elevator mentioned here is automated using Programmable Logic Controller. To program a PLC, a ladder logic has been used. The developed ladder logic has been implemented by Ladder diagram programming. By using input signals from operator and sensors, control operations are performed such as moving forward and reverse, door opening and closing etc. According to the signal, PLC will make the drive motor and door motor to work. With this control operations implementation of an elevator can be applied in the real world.

In [2], the paper describes a safety method in an elevator system. The method comprises using speed limits to measure the speed of the elevator and compare with the set value. If the values are greater than the set speed limit, then a brake is applied to bring down the speed. Another two-speed limits are set depending on the position of the elevator and the door zone. Brakes are applied to the measured value is greater than the respective speed limits.

In [3], vibration and noise have been considered in designing a double-shoe brake mechanism. Applying a double shoe brake can lead to damage to the building, lift structure as well as passengers. The author further concluded that the brake mechanism of the

elevator should be designed considering the vibration and noise. For reducing both the noise as well as vibrations, brake pad material should be selected properly considering the necessary damping values.

In [4], a triggering member movable into a stopping position has been introduced in the elevator. This member is adapted to contact the brakes that move vertically relative to the elevator. The actuator controls the position of the triggering member into or out of the stopping position for the contact with the brakes in case of need of brake actuation.

3. MATERIALS AND COMPONENTS

- Base
- Supporting structure
- Car or Cage
- Pulley for motion transmission
- Rope
- Winch arrangement for rope take-up
- Speed sensors
- Brake actuating mechanism
- Springs for actuation and reducing the impact on base

3.1 Base

The entire assembly will be mounted on the base. It will be made of M.S. 4*5 feet. The base supports the structure and act as a vibration absorber.

3.2 Supporting structure

L shaped angles of a certain height will act as a support to allow the cage to slide inside it.

3.3 Cage (Car)

A rectangular hollow structure acting as a cage which would be assumed as an elevator. Inside the cage, space would be provided to add desired loads.

3.4 Pulley for motion transmission

A pulley is a simple machine which uses a rope or cable with a wheel to lift large objects. Pulleys with metal cables of varying sizes are used in elevators. The cable is wrapped around the wheel. The cable is then pulled by a motor or a winch thus lifting the cage between floors. Several pulleys are used to reduce the effort to lift a load.

3.5 Winch

A winch is a device which is used to pull an object by reducing effort using a gear arrangement. It is used in the project to reduce the effort of lifting up the cage up to dropping height.

3.6 Rope

A rope is a wire which has a number of small strands of metal wires twisted into a helix form. Using multiple smaller diameter wires gives strength to the rope as a whole. The round wire of 6mm diameter is used in the project as per weight lifting considerations.

3.7 Speed Sensors

A speed sensor is used in the project which will sense the speed of the falling cage send it to the controller to take a decision whether to apply brakes or not.

Fig. 1: Basic structure

4. WORKING OF THE MECHANISM

In the project, we have built a model of a simple working of the elevator with the inside cage traversing along the guides provided on the structure. The cage will be moved along the guides with help of rope and pulley arrangement and a hoist to wind the rope over it.

Foundation- A structure has been built consisting of L columns along the 4 corners. C-columns are installed to guide the wheels mounted on the inside cage up and down. The cage is also made of L columns and Top and bottom covered with M.S. plates. A mechanism consisting of brake pads, speed sensors, controller, springs, battery and solenoid arrangement has been installed on the top of the cage. The brakes are held in retracted position in normal working condition by a solenoid and spring mechanism. In the case of rope breakage, the increase in speed of the elevator cage is sensed by the sensor which further sends a signal to the controller to take necessary action. The controller further sends a signal to the solenoid to release the brakes. The brake pads rub against the L columns thus reducing the speed of free fall of the elevator cage. Thus severe damage to the cage as well as humans inside has been avoided.

5. BLOCK DIAGRAM

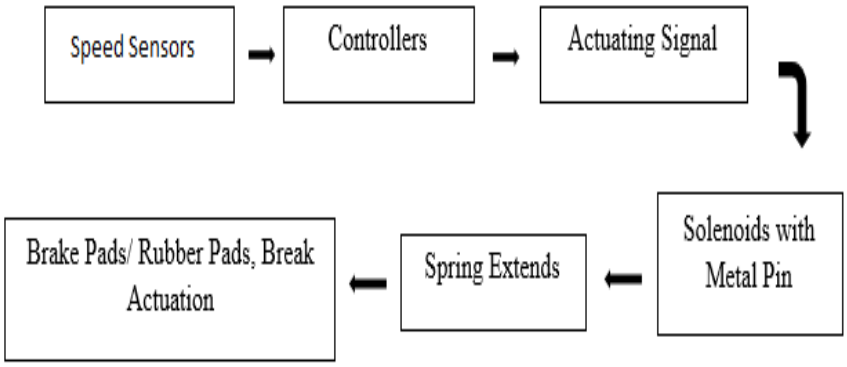

Fig. 2: Block diagram of the actuating mechanism

6. WORKING PRINCIPLE

The mechanism works on the principle of speed sensing and friction. The sensors will sense the speed. The comparison between set speed and the actual speed is done. If the set speed is less than the actual speed, the brakes are applied. The brakes work on the principle of friction. In order to reduce the speed, the brakes are rubbed against the L column inner surface. This causes the frictional force to reduce the speed of the cage falling down.

6.1 Solenoid

A solenoid is a coil of insulated or enamelled wire wound on a rod-shaped core made of solid iron, solid steel, or powdered iron. The core can travel in and out of the coil along its axis. When a current pulse is applied to the coil, the magnetic field pulls the core forcefully inside the coil.

7. CONCLUSION

Thus, implementing such an idea described above will lead to safer travel in elevators. It will also lead to loss of lives due to rope breakage of the cage of the elevator. This is also a less expensive and an easy to use a method which can be easily installed on the top of the cage (car) of the elevator.

8. FUTURE SCOPE

There is a great scope in this field and a number of new things can be implemented through research.

- A system can be implemented that can give an SMS to the building chairmen whenever the elevator is stuck in between floor.
- If the elevator is trapped in between floor the display will show its position on it.
- A separate power supply can be given only to an elevator cage so if the building power supply stops suddenly.

9. REFERENCES

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