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FABRICATION AND TESTING OF METAL SURFACE CLIMBER FOR VISUAL INSPECTION.

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Abstract: Most of the process industries use mild steel and carbon steel ducts for transfer of large amounts of gases. However due to corrosion or improper welding the ducts get damaged. Inspection of larger size ducts and pipes like chimneys takes lot of time and effort due to lesser accessibility in terms of size and hurdles. We can use wheel-based movers for horizontal surfaces, but it is not possible for vertical surfaces.

As a part of our project work, we are planning to fabricate and test a Magnetic Metal Surface Climber which can climb on metallic surfaces (made up of mild steel or carbon steel) for inspection. We are using electromagnets and Lead Screw to make the machine capable of travelling on horizontal as well as vertical surfaces having good magnetic properties. This machine can make video of the path it is travelling on, and camera can transfer data to mobile phone or computer.

Index Terms **- Electromagnets; Mild Steel/Carbon Steel; Electric Motor; Inspection Camera; Ducts and Pipes.**

I. INTRODUCTION

Inspection of larger size ducts and pipes like chimneys takes lot of time and effort due to lesser accessibility in terms of size and hurdles. We can use wheel-based movers for horizontal surfaces, but it is not possible for vertical surfaces. In many industries the visual inspection of ducts is doing by human. We can replace human with a machine which can inspect these large size ducts and chimneys. We are going to use electromagnets, camera for visual inspection and a spine which allow its movement on metal surfaces vertically. Most of the process industries use mild steel and carbon steel ducts for transfer of large amounts of gases. However due to corrosion or improper welding the ducts get damaged.

II. LITERATURE SURVEY

To inspect the chimneys and ducts in industries like thermal power plants. While inspecting some accidents will occur so for reducing the accidents, we are using metal climber. If any industry wants to inspect the chimneys or ducts per inspection cost is high. Instead of more workers we can use metal climber. If any industry got problem with chimneys and ducts the company must keep the worker to inspect the chimneys or ducts it takes some time and we have to pay the daily wages to the worker. If we use metal climber, we can reduce the company loss.

III. RESEARCH METHODOLOGY

3.1. The materials used in the project are:

3.1.1. Electromagnets

In this project we used 8 Electromagnets which it helps the machine to climbing vertically upward and downward direction. 4 Electromagnets are placed below the four corners of the Shoulder plate and 4 Electromagnets are placed below the four corners of the Hip plate. The shoulder plate electromagnets are engaged to the surface when the hip plate is moving towards the shoulder plate. Hip plate electromagnets are engaged to the surface when the shoulder plate is moving away from the shoulder plate. Each electromagnet is 10N.

3.1.2. Flexible coupling

Threaded rod and Motor shaft are coupled with the flexible coupling. High torque geared motor.
This motor is used to move shoulder plate and hip plate by thread screw mechanism.

3.1.3. Threaded rod

The shoulder plate and hip plate are moved with the help of threaded rod. Threaded rod and nut work similar to bolt and nut.

3.1.4. Camera

Camera will inspect the surface of the ducts and pipes. It will record the improper welding, holes and corrosion on the pipes and ducts. Camera is directly connected to the computer or Mobile.

3.1.5. MS plate

Figure 1. MS Plate 100mmx100mm.

Mild Steel is used to prepare the Shoulder plate and Hip plate.

3.2. Electro Magnetic Mechanism

Magnetism is created when electricity flow through metals. The magnetic force starts when electricity flows and stops if the electric current is disconnected. This kind of magnetism is called electromagnetism and it is very useful for making magnets that can be switched on and off.

Electromagnetism is a process where a magnetic field is created by introducing the current in the conductor. When a conductor is electrically charged it generates magnetic lines.

3.3. Lead screw mechanism:

A lead screw converts rotary motion into linear motion that combines a screw and nut, with the screw thread in direct contact with the nut thread. In this project the hip plate and shoulder plate are moved upward and downward direction by using the lead screw mechanism. The lead screw is attached to the motor shaft by using a flexible coupling.

1. Working

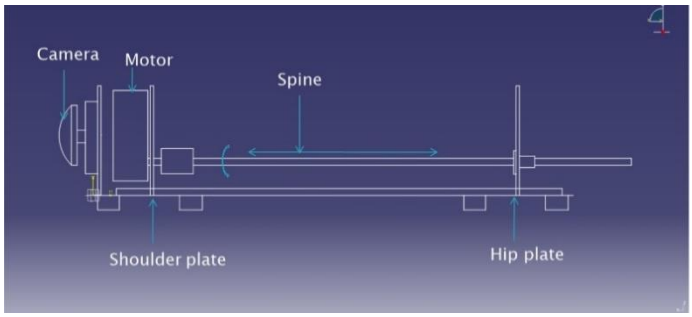

Figure 2. 2D sketch of Testing of Metal Surface Climber.

Motor will be mounted over shoulder plate and motor shaft will be coupled with lead screw using flexible coupling. Motor will rotate both clockwise and anti-clockwise direction. According to the moment of the machine.

If motor shaft is rotating in clockwise direction, will move hip plate closer to the shoulder plate with the help of lead screw. Shoulder plate electromagnets are engaged to the surface and hip plate electromagnets not engaged.

If motor is rotated in anticlockwise it will move shoulder plate away from hip plate. Shoulder plate electromagnets are not engaged to the surface and hip plate electromagnets engaged.

In other to hold the machine as its fixed position we engage all electromagnets. By this the machine moves upwards and downwards. The camera is fixed on the shoulder plate. Camera will inspect the ducts and pipes. Camera is connected to the computer or phone.

IV. RESULTS AND DISCUSSION

At most care is taken while fabricating the parts, so that the length and width of the linear magnetic climber upper and lower platforms can accommodate magnets, lead screw, springs, telescoping channel and camera, at the same time mass of the machine does not exceed 1.2 kg. We have used 4 magnets of 27N individual capacity on each platform i.e., total 8 number of electromagnets are used on climber.

Reason behind giving 4 magnets on each platform is to keep the machine stable (avoid tilting of machine during vertical travel) and to bear machine load along with electrical wiring load while climbing.

100 x 100 mm plates are used for platforms considering 2 x 20mm magnet diameter and 40mm telescoping channel width. 1.5mm plate thickness is chosen as it adds very little mass on the machine without compromising weld strength

250mm telescoping channel is selected as our stroke length ranges between 100 to 150mm and 250mm channel will be stable / zero deflection up to 150mm telescoping.

Linear Magnetic Climber is fabricated, and wiring is done to meet the requirements of the project

Fig (3) Fabrication and Assembly of Magnetic Climber

We have considered Mild steel material for fabrication of components as it is cheaper, easy to source, easy to machine. Though mild steels' density is higher than aluminium it avoids several fittings (screws, nuts , bolts and joints) by which we can keep our mass in limits.

- Present machine is given with 1500mm wiring as we have considered maximum test climbing is 1500mm. However, we can increase wiring length as per requirement. Based on length of wire we can use higher capacity magnets to take additional wire mass

- As per Calculations Total Power required while upper platform ascending (P_{tu}) is 48.16 Watts and Total Power required while lower platform descending (P_{tl}) is 48.0995Watts**,** that means maximum power required per hr is 48.16Watts and with 50 Watts capacity battery we can inspect for around 1 hr.

- We have tested the linear electromagnetic climber on metal surface / section of duct, and it was able to hold with metal surface using bottom 4 magnets as shown in Fig (4)

Fig (4) Contraction Condition

- Once bottom platform is firm on metal surface, we have to expand the telescoping channel by using lead screw motor actuation arrangement as shown in Fig (5)

Fig (5) Climbing

- While climbing on metallic surface we can perform visual inspection of the metal surface with the help of camera mounted on the climber as shown in Fig (6)

Fig (6) Metal Surface Camera Image 1

- Once the top platform reaches 150mm expansion of telescoping channel we have to engage the top platform electromagnets as shown in Fig (7) and the process continues

Fig (7) Expanded Condition

Larger ducts and chimneys are common piece of sight in most of thermal power plants, oil & gas, fertilizers, and other process industries. During maintenance / overhaling these ducts / chimneys are inspected manually, which is one of the time consuming and risky process as they are tall to climb or descend. During such inspections accidents also occurs hence the situation demands for equipment's which they themselves can climb and send visuals to inspection professionals.

As the ducts and internals of chimneys are made-up of thick carbon steel / mild steel we can use electromagnetic climbers to climb over the surfaces of these ducts and chimneys to inspect the surfaces. Linear electromagnetic climber I have developed can easily climb and send the visuals of surfaces to professionals.

Inspection of thick and large ducts & chimneys using Linear electromagnetic climber will have fallowing advantages when compared to manual inspection.

- Requires less manpower to operate.
- No accidents as no manual climbing or descending is involved.
- Low cost of inspection.
- Low Investment as it is indigenous technology.
- Easy to transport as it hardly requires mobile phone against large computer set up to see the visuals.

During tests it is observed that this climber is very easy to operate and can be easily adopted by inspection professionals. Visuals recorded by the linear electromagnetic climber are shown in Fig (8)

Fig (8) Visuals of Inspection

Total Power required while upper platform ascending (P_{tu}) is 48.16 Watts and Total Power required while lower platform descending (P_{tl}) is 48.0995Watts**,** that means maximum power required per hr is 48.16Watts and with 50 Watts capacity battery we can inspect for around 1 hour.

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