Applied Physics

PROJECT REPORT

TITLE

HYDRAULIC POWERED ELECTROMAGNETIC CRANE

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ABSTRACT

The objective of this project is to demonstrate how a hydraulic powered electromagnet is used to move steel and iron objects from one place to another.
The crane uses the phenomenon of fluid mechanics and electromagnetism to power its movement and lifting capabilities.
The crane's mechanism relies on the principles of fluid dynamics and hydraulic systems to convert the energy of the pressurized fluid into mechanical energy to lift heavy loads. The crane typically consists of a pump, a cylinder, and a control valve. The pump generates the high-pressure fluid, which then flows into the cylinder, where it is used to extend or retract the cylinder's piston rod. This movement of the piston rod causes the crane's boom to move and lift the load. The control valve regulates the flow of fluid to the cylinder, allowing the operator to control the movement and position of the load.
The crane lifts objects using an electromagnet. When current passes through the windings around the iron core, magnetic field is creating which attracts metal objects around. Cranes using magnets lift and carry their cargo to the dropping point then release and place the cargo, when magnetic force is switched off by the operator of the crane.

INTRODUCTION

Hydraulic powered electromagnetic crane is used in lifting and moving scrap metals. Based on the phenomenon of electromagnetism and hydraulic system, we have created this working model of an electromagnetic lift and crane.

LITERATURE REVIEW

In this section, we will review the literature that is related with Hydraulic Powered Electromagnetic Crane, and we are going to see the review of the crane in the past few centuries and decades.

PREVIOUS WORKS

i. Hydraulic Crane:

In 1840 Armstrong was inspired to create a hydroelectric generator when he observed static electricity emitting from a boiler at the Northumberland coalmine. The hydroelectric generator used an insulated boiler system to produce static electricity. This machine secured his position as a fellow of Newcastle's Literary and Philosophical society the age of 32.
Armstrong's passion would eventually change to hydraulics which led to the creation of the first hydraulic crane in 1845. It was used to unload coal from barges at the quayside. The hydraulic crane helped the North East of England to grow and prosper. Newcastle became one of the most important cities in the world as a result.

ii. Electromagnetic Crane:

An electromagnet is a device in which a magnetic field is produced by an electric current.

Then in 1820, the Danish physicist Hans Christian Oersted reported that an electrical current passing through a wire deflected a nearby compass needle. His publication immediately set physicists to work on the relationship between electricity and magnetism. Directly after this announcement, the German scientist Johann Schweigger constructed his "multiplier," or multi-turn coil, which greatly increased the magnetic power of an electrical circuit. Schweigger's multiplier became the first accurate electrical measuring device--the galvanometer--and remains the basis for modern voltmeters and ammeters. About four years later, William Sturgeon in England invented the electromagnet, a horseshoe-shaped piece of iron wrapped with a loosely wound coil of several turns; the electromagnet became magnetized when a current passed through the coil, and de-magnetized when the current ceased. Sturgeon's electromagnet, which could be regulated by closing and opening the circuit, converted electrical energy into useful and controllable mechanical work

The idea was later used in cranes.

COMPONENTS AND TOOLS DESCRIPTION

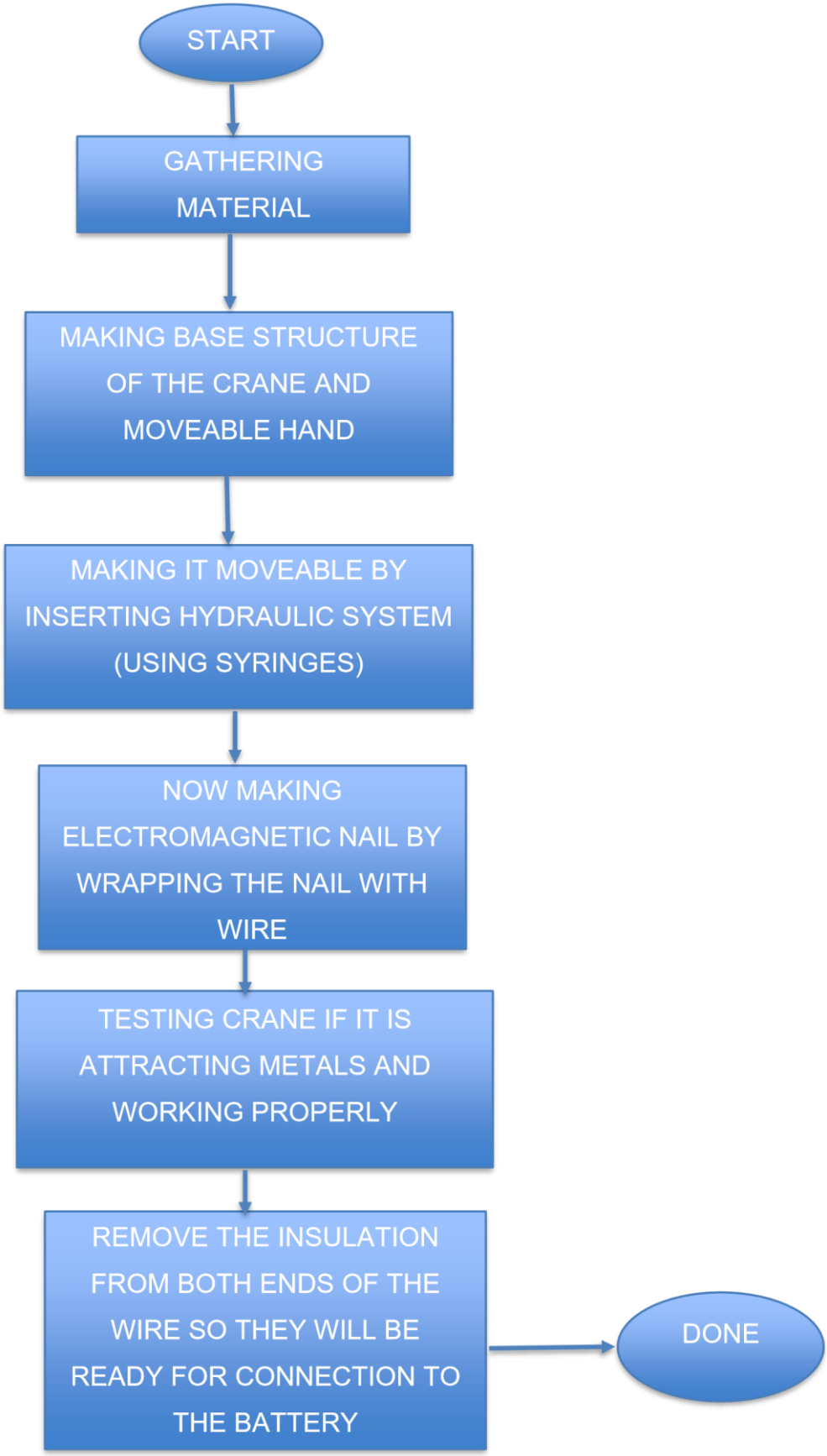
- **Wood:** To make the basic structure of project.
- **Syringes:** To create hydraulic part of crane. The piston of syringe generates the high-pressure fluid, which then flows into the cylinder, where it is used to extend or retract the cylinder's piston rod. This movement of the piston rod causes the crane's boom to move and lift the load.
- **Pipes:** To transfer the fluid from one syringe to another.
- **Battery:** To supply voltage to the circuit.
- **Switch:** To control the flow of current across the circuit. When the switch is turned on current passes through the coil and crane lifts objects. When the operator turns off the switch the load is dropped.
- **Iron Nail:** To make electromagnet. When copper wire is wound around a soft iron core, an electromagnet is created.
- **Copper Wire:** Enamel coated copper wire is wound around soft iron core to make an electromagnet.
- **Wires:** To join the circuit components.

METHODOLOGY

The methodology for a hydraulic crane project would involve several steps, including:

- **Research and planning:** This includes gathering information about the specific requirements of the project, such as the weight and dimensions of the load to be lifted, the height of the lift, and the environment in which the crane will be used.
- **Design:** Based on the information gathered in the research and planning phase, the team would design the crane, including the selection of appropriate hydraulic components, such as syringes and electrical components.
- **Construction:**
    - Construct base structure of crane and moveable arm using wood and nuts.
    - Application of hydraulic system (syringes) to make it moveable.
    - Construction of electromagnet by wrapping coil around the iron nail and supplying voltage
    - Application of electromagnet in crane.
- **Analysis:** This includes analyzing the crane to ensure that it can handle the load and meet all safety requirements**.**
- **Prototype and testing:** A prototype of the crane would be built and tested in a controlled environment to verify the design and ensure that it functions as intended.
- **Implementation:** Once the design has been finalized and the prototype has been successfully tested, the crane can be built and implemented in the field.
- **Maintenance:** The crane must be maintained on a regular schedule to ensure that it continues to function safely and efficiently.

BLOCK / FLOW DIAGRAM



RESULTS AND DISCUSSIONS

The crane uses the phenomenon of fluid dynamics in hydraulic system and electromagnetism in electromagnet.
Hydraulic system is used to operate the crane and control its movement. Whereas electromagnet is used to lift ferrous load and drop it at its destination.
This project is a small-scale demonstration of electromagnetic cranes used in scrap yards, junkyards, recycling plants and steel smelting furnace units for moving and loading scrap metal.

CONCLUSION AND FUTURE WORK

The project is working on two laws of physics 'Pascal's Law' and 'Ampere's Law'.

- If we increase the pressure, the lifting ability of the crane increases. However, pressure should be increased in a controlled manner to avoid breakage.
- If we increase the number of turns around the coil, magnetic field becomes stronger.
- If we increase the size of battery, the strength of magnetic field increases. The crane obeys both the laws and is used to efficiently lift ferrous objects.

An advanced version of this crane is used in scrapyards and junkyards to lift scrap metal.

PROJECT SUMMARY

Hydraulic powered electromagnetic crane is based on **Pascal's law** and **Ampere's Law**.

Pressure applied to a fluid inside a closed system will transmit that pressure equally everywhere and in all directions. A hydraulic system uses an incompressible liquid as its fluid, rather than a compressible gas.

Current passing through the coil creates magnetic field around the solenoid.

What is it?

- The hydraulic crane project employs the principle that any force applied to an incompressible liquid will propagate through the liquid, without significant loss of strength, to affect whatever is on the other side. When pressure is applied, water is forced to transfer to the other part of the crane. This is turn redirects this force where it is needed to lift heavy objects.
- The crane lifts objects using electromagnet, which attracts metal objects present in the magnetic field of electromagnet.

Salient features

- One of the most powerful means of lifting objects is with the strength of a hydraulic crane.
- There are a variety of Hydraulic cranes serving different purposes. The most common systems are based on a jib that is lifted using a piston.
- By harnessing the strength that liquid under pressure gives, and the ease with which it can be used, it is possible to transfer a relatively small amount of effort from one place to another. This is why such cranes are very popular at workplaces.
- Hydraulic cranes use a fixed system of pipes, constant pressure can be maintained once a part of the system has been moved into place, and this makes them extremely stable in use.
- Hydraulic cranes are amongst the simplest systems that you can use within any industrial process and are easy to maintain.

More facts

- The principle of hydraulics is used in the car braking system.
- Hydraulic cranes are also used at construction sites where enormous amount of weights, up to hundreds of tons need to be lifted.
- Airplanes and jet planes use hydraulics in many places.
- The Petro-based industries and shipyards make use of hydraulics.
- Electromagnetic cranes are used in scrapyards, junkyards recycling plants and steel smelting furnace units for moving and loading scrap metal.

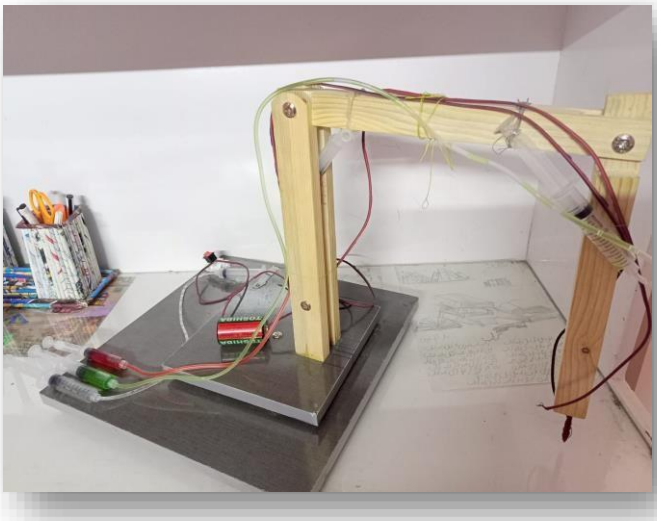
How I went about it

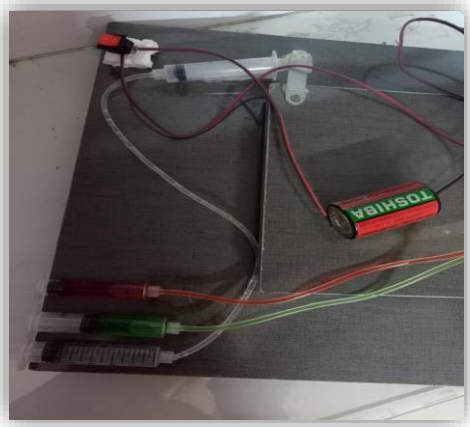
- Construct base structure of crane and moveable arm using wood and nuts.
- Application of hydraulic system (syringes) to make it moveable.
- Construction of electromagnet by wrapping coil around the iron nail and supplying voltage
- Application of electromagnet in crane.

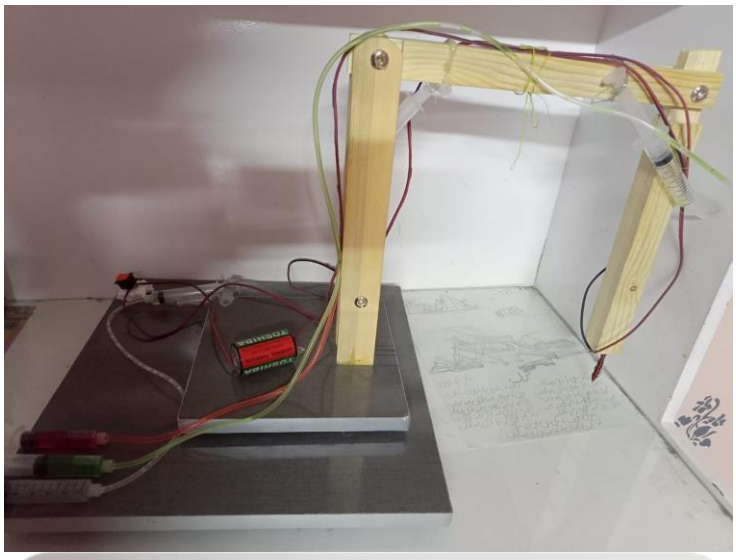
What we can learn…

- The basic aim of making this project is to understand the working of hydraulics in an easy manner which is an abstract subject for many students
- Through this we understood how application of pressure on an incompressible liquid. It was forced to transfer through pipes to the other part, which is the crane that in turn helps in lifting material weighing tons.
- Through this project, we learnt how electromagnets are constructed and applied in different areas.

Project Pictures:







REFERENCES:

For the accomplishment of this project, we brainstormed and gathered ideas from different sources. Links of the sources are given below:

- https://youtu.be/3oisYFi7yYY
- https://youtu.be/vXDhsQo6gbo
- https://youtu.be/P2r9U4wkjcc
- https://www.wikihow.com/Create-a-Magnet-With-a-Wire-and-a-Nail
- http://www.scienceproject.com/projects/detail/elementary/ex067.asp
- https://www.nucleuslearning.com/the-hydraulic-crane-a-great-science-project/