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DESIGN AND FABRICATION OF COPPER WIRE STRANDING MACHINE

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Abstract: **At present, the world is facing a huge energy crisis where demand of energy keeps on increasing while resources are scarcer and prices are constantly increasing. Hence, the Indian government has emphasized more on power saving utilities. For instance, the alarming growth of LPG consumptions has led to alternative such as induction cooking. The Induction Industry uses stranded copper wires extensively but these wires are being manually stranded which is a time consuming and tedious task. The aim of this project is to solve this problem by designing and fabricating a copper wire stranded machine which will strand copper wires automatically and simultaneously spool it. The machine is also designed for multipurpose applications involving stranding of materials like rope, metal wires, yarn, etc., The stranded copper wires are also used in wiring, electrical and data cables, as conductors in power transmission applications.**

Keywords: **huge energy crisis, LPG consumptions, power transmission applications.**

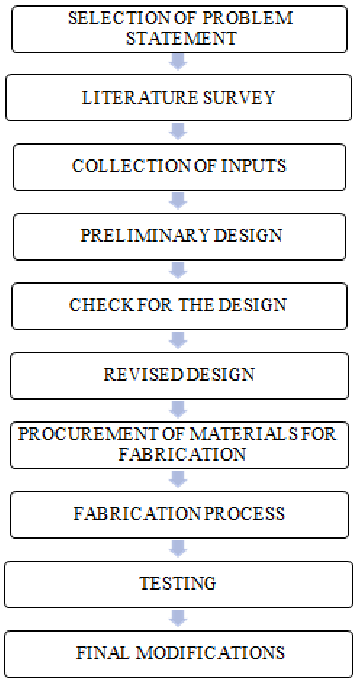
1. OBJECTIVES AND METHODOLOGY

OBJECTIVES

- To develop a compact and a portable machine
- To successfully design and develop the concept of the machine
- To successfully fabricate and test the machine

METHODOLOGY

PROCESS FLOW CHART



- **SELECTION OF PROBLEM STATEMENT**

Keeping all the engineering aspects and curriculum rules in mind an appropriate problem statement was selected. The statement selected has to appropriate and should serve justice to the opted domain and curriculum.

- **LITERATURE SURVEY**

Based on the problem statement a literature survey will be done and important points are noted. Also, literature survey helps in identifying the advancements and drawbacks of pervious work so focus can be laid on further improvements.

- **COLLECTION OF INPUTS**

Required inputs are extracted from the literature survey and also from industry. These inputs play a very crucial role throughout all the process of the project.

- **PRELIMINARY DESIGN**

A basic outline of design will be made using any modelling software. This step can be achieved only by keeping in mind all the inputs collected also material availability and machinability.

- **CHECK FOR DESIGN**

The design will be subjected to scrutiny and check for any kind of flaws. Analysis can also be carried out used finite element methods in order to determine mechanical failure.

- **REVISED DESIGN**

The design will be corrected based on the results obtained from the analysis if there are any flaws.

- **PROCUREMENT OF MATERIALS**

Required materials for fabrication need to be purchased from the market after a brief market survey

- **FABRICATION PROCESS**

Fabrication process of the machine will be made using sound engineering practices.

- **TESTING**

Proper testing of the machine will be carried out in order to detect any flaws or defects in manufacturing.

- **FINAL MODIFICATIONS**

If there is any discrepancy or if the machine is providing a satisfactory output, final modifications will be done to the machine in order to correct those discrepancies.

DESIGN

2. DESIGN AND FABRICATION

The design of the machine was carried out using SolidWorks software 2016 edition. The machine was designed keeping in mind that the machine has to twist and spool the copper wires simultaneously. All dimensions used for the design process and the dimensions of the part drawings shown in this section are in cm. The design is three-part assembly using a main frame. SolidWorks weldment feature was used in order to provide the required part profile for the frame of the machine. Different views of the machine parts are shown in this section.

- **FRAME**

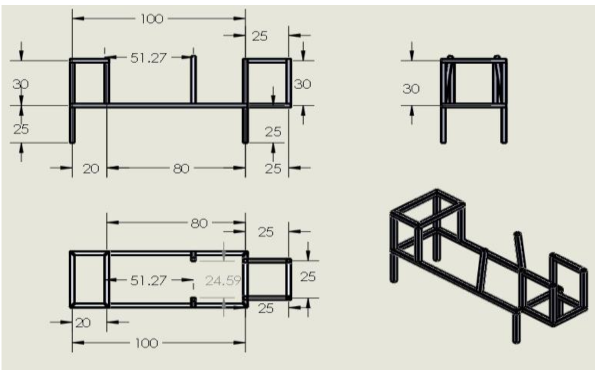


FIGURE 1

The above figure 1 shows the different views and dimensions of the frame design of the machine.

- **CLAMP AND CLAMP ASSEMBLY**

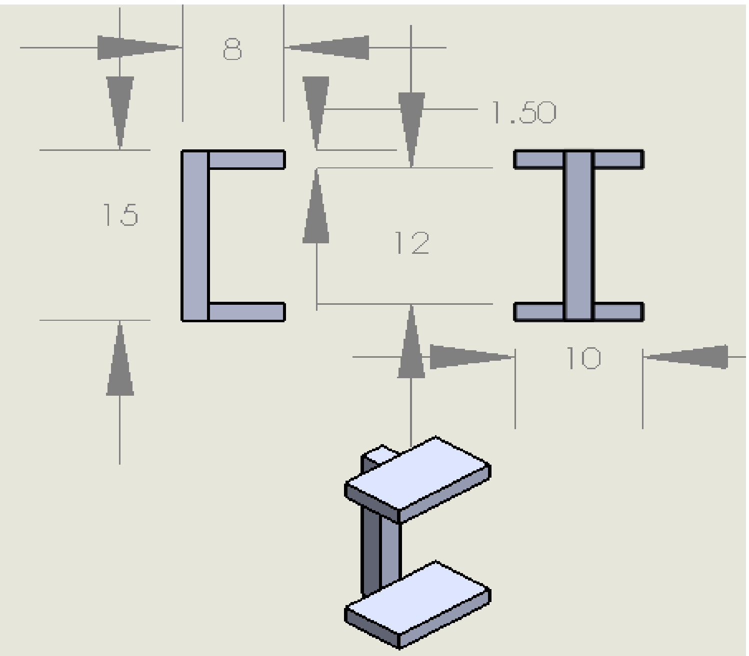


FIGURE 2

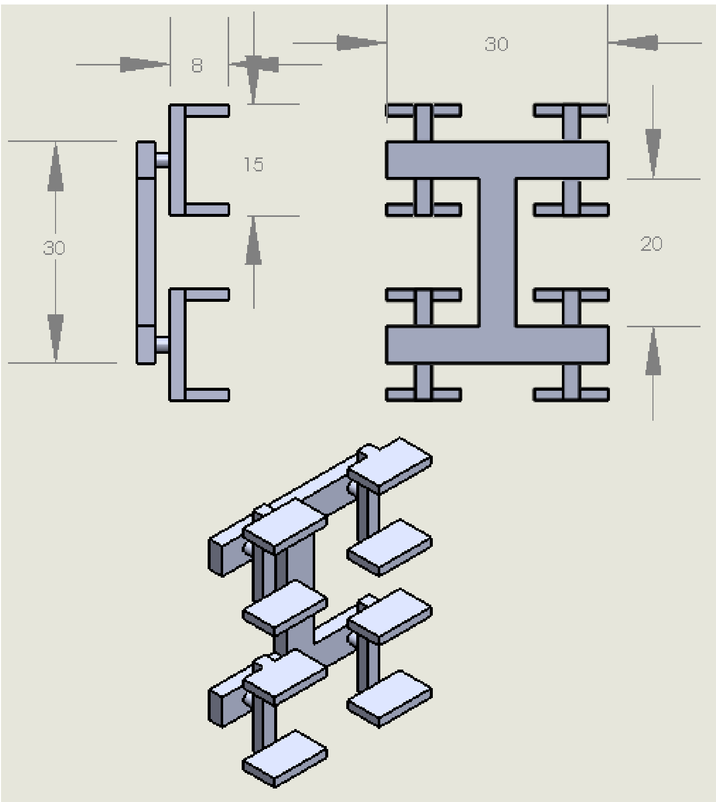


FIGURE 3

The above figure 2 shows the different views and dimensions of the clamp design of the machine. The clamp assembly and its dimensions are shown in figure 3. The above parts are responsible for holding the spools of copper wire which needs to be twisted together

- **ROTATING PLATE**

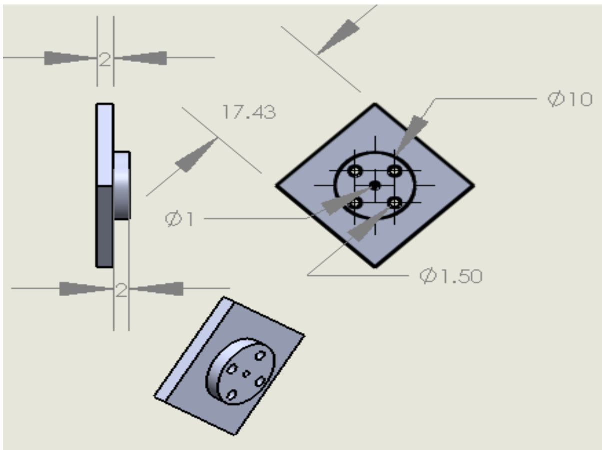


FIGURE 4

The above figure 4 shows the different views and dimensions of the rotating plate mechanism used in the machine. This mechanism is connected with the clamp assembly using a shaft.

- **SPOOL**

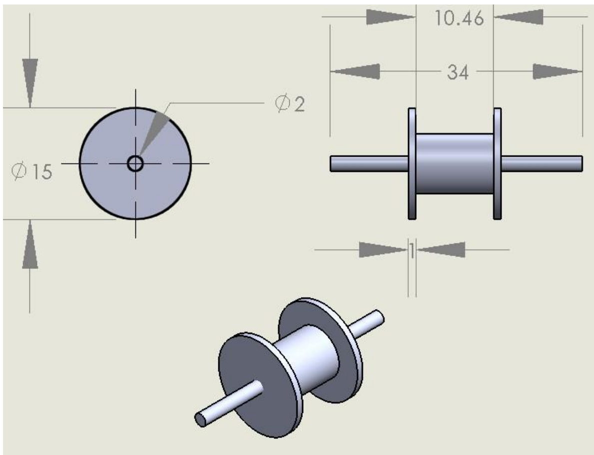


FIGURE 5

The above figure 5 shows the different views and dimensions of the spool used in the machine. This spool is used in spooling the twisted copper wire

- **FINAL ASSEMBLY**

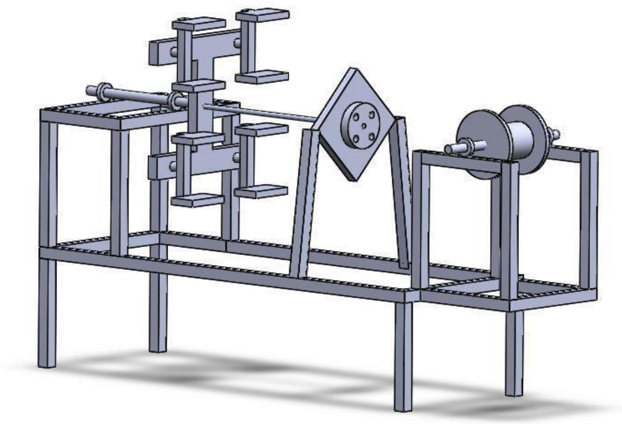


FIGURE 6

PART LIST

TABLE 1

SL.NO	PART NAME	Quantity
1.	Frame	1
2.	Clamp	4
3.	Shaft	3
4.	Metal Plates	1
5.	Nut and bolt	13
6.	Bearings	4
7.	Metal Spool	1

FABRICATION

MATERIAL USED

Mild steel is the most commonly used steel. It is used in the industries as well in the different everyday objects we use. Even the pans and spoons of the kitchen are sometimes made of mild steel. The main target of this article is to discuss about different mild steel properties. The mild steel is very important in the manufacturing of metal items. Almost 90% steel products of the world are made up of mild steel because it is the cheapest form of steel. Mild steel is the most widely used steel which is not brittle and cheap in price. Mild steel is not readily tempered or hardened but possesses enough strength.

- **COMPOSITION**

Carbon 0.16 to 0.18 % (maximum 0.25% is allowable)

Manganese 0.70 to 0.90 %

Silicon maximum 0.40%

Sulfur maximum 0.04%

Phosphorous maximum 0.04%

The use of mild steel is huge and a person who is into manufacturing or production business need to know a lot about the important characteristics of mild steel. The study of mild steel becomes more significant for a student of mechanical engineering or metallurgical engineering. Mild steel is an alloy. And alloy is a product made by mixing metals and non-metals. Sometimes a pure metal cannot fulfill all the properties needed for manufacturing product. So, additives are included in the pure metal to obtain some specific properties necessary for the production. Mild steel is made by adding carbon and other elements in the iron. These elements improve the hardness, ductility and tensile strength of the metal.

- A small amount of carbon makes mild steel to change it properties. Different amount of carbon produces different types of steels. There are small spaces between the iron lattice. Carbon atoms get attached to this space and makes it stronger and harder. The harder the steel the lesser the ductility.

- The modulus of elasticity calculated for the industry grade mild steel is 210,000 MPa. It has an average density of about 7860 kg/m^3.

- Mild steel is a great conductor of electricity. So, it can be used easily in the welding process.

- Because of its malleability, mild steel can be used for constructing pipelines and other construction materials. Even domestic cookware's are made of mild steel. It is ductile and not brittle but hard.

- Mild steel can be easily magnetized because of its ferromagnetic properties. So electrical devices can be made of mild steel.

- Mild steel is very much suitable as structural steel. Different automobile manufacturers also use mild steel for making the body and parts of the vehicle.

- Mild steel can be easily machined in the lathe, shaper, drilling or milling machine. Its hardness can be increased by the application of carbon.

- Mild steel is very much prone to rust because it has high amount of carbon. When rust free products are needed people prefer stainless steel over mild steel.

JOINING PROCESS

An electric current, in the form of either alternating current or direct current from a welding power supply, is used to form an electric arc between the electrode and the metals to be joined. The workpiece and the electrode melts forming a pool of molten metal (weld pool) that cools to form a joint. As the weld is laid, the flux coating of the electrode disintegrates, giving off vapors that serve as a shielding gas and providing a layer of slag, both of which protect the weld area from atmospheric contamination. Because of the versatility of the process and the simplicity of its equipment and operation, shielded metal arc welding is one of the world's first and most popular welding processes. It dominates other welding processes in the maintenance and repair industry, and though flux-cored arc welding is growing in popularity, SMAW continues to be used extensively in the construction of heavy steel structures and in industrial fabrication. The process is used primarily to weld iron and steels (including stainless steel) but aluminum, nickel and copper alloys can also be welded with this method. Figure 7 shows a typical arc welding workpiece set up.

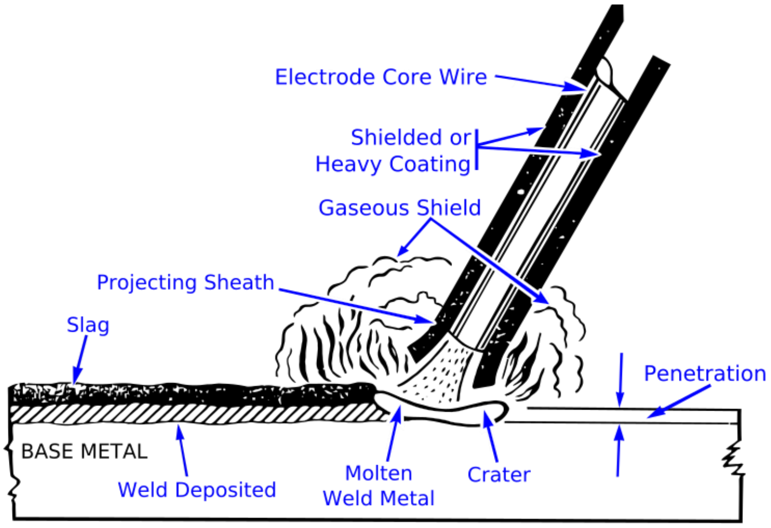


FIGURE 7

COMPONENTS USED

- **WIPER MOTOR**

FIGURE 8

PRODUCT SPECIFICATIONS

TABLE 2

Item		MITSUBA WIPER MOTOR	
Voltage		DC motor 24V	DC motor 12V
No-load speed	high speed	35 ±5 rpm	
	low speed	25 ± 5 rpm	
No-load current	high speed	4.5A Max	3.0A Max
	low speed	2.5A Max	2.0A Max
Brake	stall torque	100N.m Min	
	current	65A Max	35A Max
Temperature rise		-40°c~+65°c	
Weight		4950g	

- **HIGH TORQUE DC MOTOR**

FIGURE 9

FEATURES:

- 150RPM 12V DC motors with Metal Gearbox and Metal Gears.
- 18000 RPM base motor.
- 6mm Día shaft with M3 thread hole.
- Gearbox diameter 37 mm.
- Motor Diameter 28.5 mm.
- Length 63 mm without shaft.
- Shaft length 30mm.
- 180gm weight.
- 32 kg cm torque.
- No-load current = 800 mA, Load current = up to 7.5 A (Max).

- **TOGGLE SWITCHES**

FIGURE 10

PRODUCT SPECIFICATIONS

TABLE 3

Switch Function	On-Off
Current Rating	10 Amp
No of Leg	2
Voltage	250 V

- **BEARINGS**

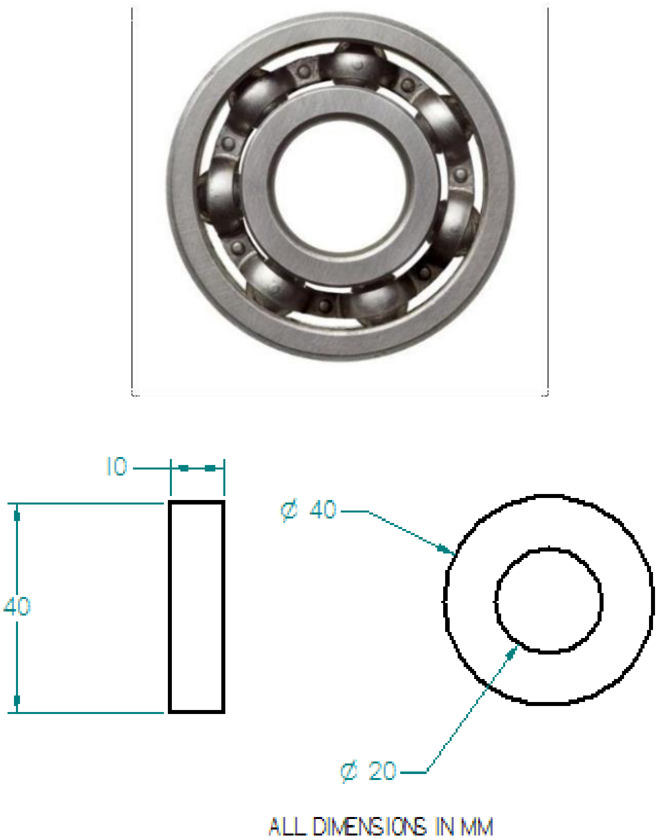


FIGURE11

- **METAL FASTENERS**

FIGURE 12

3. WORKING PRINCIPLE AND MACHINE SPECIFICATIONS

WORKING

The design of this machine can be mainly classified into three main sections namely,

- Loading section
- Twisting section
- Spooling section

LOADING

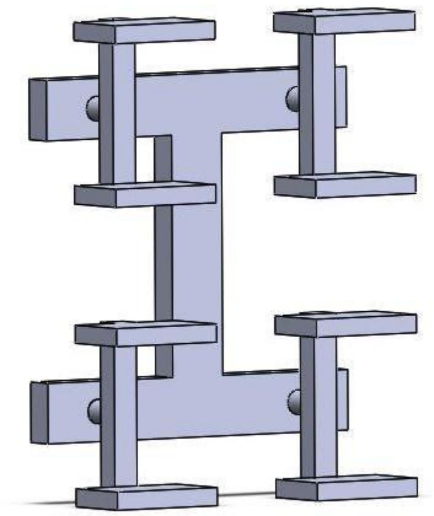


FIGURE 13

Figure 13 shows the loading section of this machine. In this section, four number of copper wire spools can be loaded in the corresponding clamps provided. The clamps provided to secure the copper wire spools are free to rotate. During operation, the body of the loading section is powered using a shaft and motor arrangement as the body starts to rotate, the clamps also tend to rotate on their own axis dude to rotational inertia. This mechanism is solely responsible of the twisting operation. The motor which is used to power the loading section is a high torque variable speed motor so that the machine can be calibrated in order to obtain high accuracy and productivity.

TWISTING

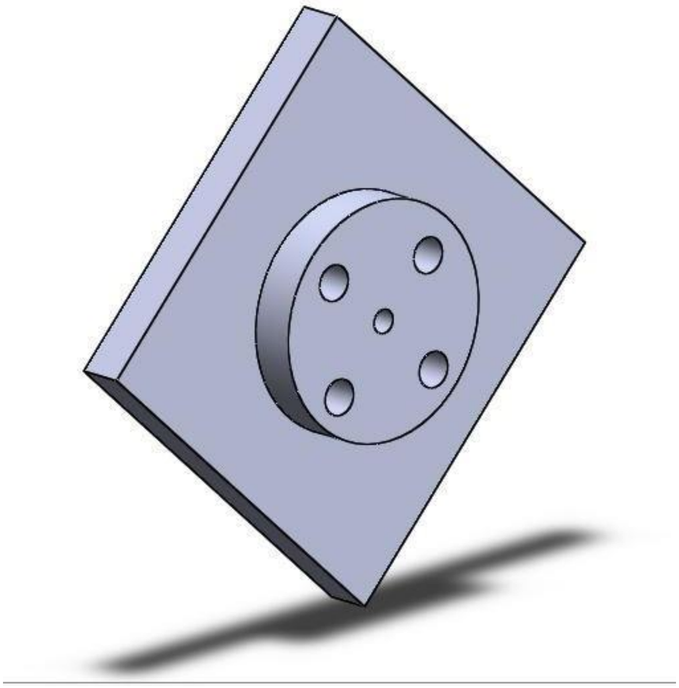


FIGURE 14

Figure 14 shows the twisting section of the machine. This section consists of four holes. The loading section and twisting section are connected through a small shaft. This arrangement is mage because the loading section and the twisting section has to rotate at same speed in order to obtain the twist. The wires loaded to the loading section are drawn and inserted into the corresponding holes of the twisting section. During operation the holes also rotate simultaneously in sync with the loading section. This operation is responsible for the twisting of wires.

SPOOLING

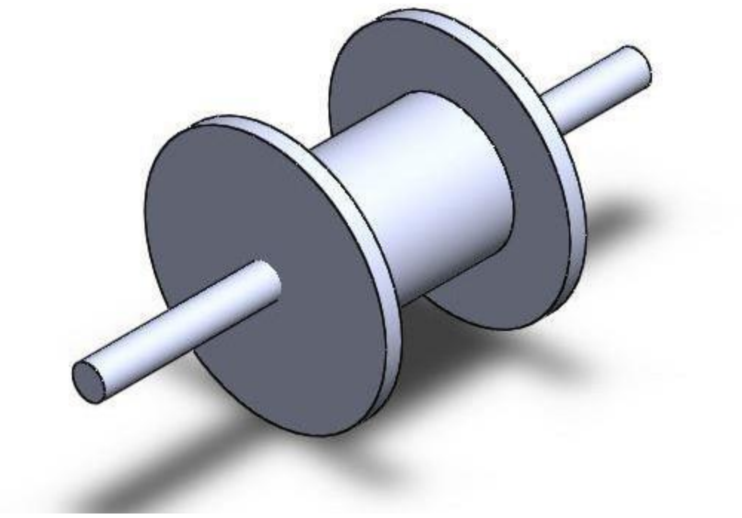


FIGURE 15

Figure 15 shows the spooling section of the machine. In this section of the machine, the twisted wires are spooled on a spool. This section uses a high torque dc motor. The speeds of loading section and spooling section have to be synchronized in order to maintain accuracy. The twisted wires can be re spooled to smaller spools and can be loaded again in order to increase the number strands in the wire.

4. MACHINE SPECIFICATIONS

SPECIFICATIONS

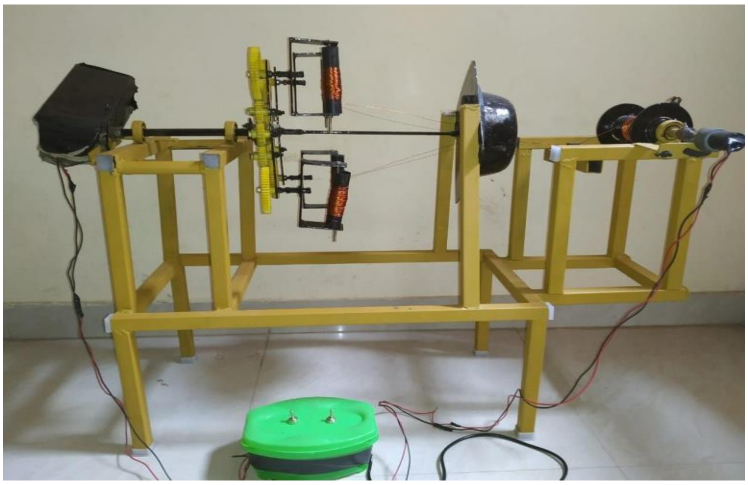


FIGURE 16

Figure 16 shows an image of the machine after fabrication. The specifications of the machine are shown in the below table.

TABLE 4

Machine type	Semi- automated
Description	Wire twisting machine
Machine weight	15.8 Kg
Overall length	1250 mm
Overall width	300 mm
Overall height	550 mm
Number of spools that can be loaded at a time	4
Maximum diameter of the wire that can be twisted	8 mm
Speed of the twisting section	30 RPM – 60 RPM (Variable)
Speed of the spooling section	5 RPM – 15 RPM (Variable)
Time taken to twist 1m wire	47 sec
Power required	12V 5A DC Power Supply
Direction of rotation of motors	Reversible

OUTPUT

FIGURE 17

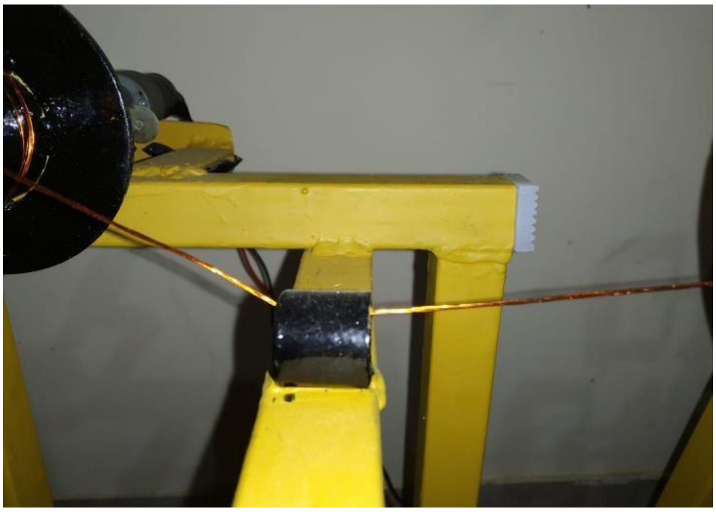


FIGURE 18

Figure 17 and 18 show the twisted wired obtained by loading four spools of 28 Gauge copper spools to the machine. The wires are twisted and helically wound on a metallic spool which can be later removed and used for further processing. The best speed of operation was found at speeds of 30 RPM on the loading section and 8 RPM on the spooling section. The above-mentioned speed values gave best results during testing phase.

5. ADVANTAGES AND LIMITATIONS

ADVANTAGES

- Reduction in human effort
- Reduction of time
- Portable machine
- Multipurpose applications

LIMITATIONS

- Only 4 spools can be loaded at a time.
- Initial setup is required
- In order to obtain a greater number of strands, the stranded wires are spooled again in smaller spools and reloaded
- There is less variation in operating speed limiting its application

6. CONCLUSION AND SCOPE OF FUTURE WORK

Currently the twisting machines available in the market are very expensive and bulky. Small and Medium size industries are unable to gather the investment for purchasing or even there is no availability of floor space. The machine has been designed in such a way that it is in compact in size, portable and also can be used for multiple stranding applications involving materials such as Aluminum wires, yarn, nylon, rope, threads etc., can be also stranded.

After the designing the machine, successful fabrication of the machine was accomplished with materials available in the market and with the use of simple processes such as arc welding. Competitive prices of materials in the market and simple processes for fabrication have maintained the fabrication cost within the desired budget. The machine has been tested and a satisfactory output of stranded wires was obtained. All the objectives of this project have been fulfilled.

In future, with development in technology, those machines would be expected to be cheaper and more compact. Thus, all industries would be able to procure such machine and workers no longer need to manually twist the wires or materials, hence, reducing human effort. Machines would also become more complex with new technology and applications of stranded wires will increase.

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