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Solar-Operated Automatic Hammering Machine

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ABSTRACT

This paper proposes a model of design and fabrication of a Solar-Operated Automatic Hammering machine that can perform hammering operations automatically. The source of power for the whole system is solar power. This proposed model will help the industries in prospering and to make the operations easy and safe. Moreover, this project will have a greater impact on the metal industries. This will increase the efficiency of the work, reduce the human errors, wastage of materials and the work can be done in less time. The machine will be capable of performing fast and accurate hammering operations with the help of a 12v battery which is connected to the solar panel. Mild steel is used for fabricating the machine. A large pulley and a shaft are connected with the help of a connecting rod. The spinning of shaft will provide lateral motion to the rod. A mild swinging arrangement is used for attaching the hammer and the connecting rod. A suitable bed will be developed for holding the work piece.

INTRODUCTION

Project Definition

In our college of engineering, we are having mechanical workshops we are doing black smithy operation for making shapes of various metals like cast iron, mild steel etc., for that purpose we are using hammer for hitting purpose giving hitting force manually. It takes more time for shaping for hot and cold forging operations. In order to minimize these difficulties, we design and fabrication of Solar-Operated Automated hammering machine by using this machine we can make shapes very easily and within less time. We don't require manual force and we also get accurate shapes. By using dies we can also make different shapes we can also perform riveting and filleting operations.

Hammering machine can be considered as the backbone of any hammering operation in mass production its principal function is to safely and preciously hammering work like to perform the punching operation, filleting operation, riveting operation and smithy operation i.e., upset forging etc. for all designed operating conditions. This paper describes cad modeling, design and analysis of automatic portable hammering machine. A programmed hammering machine self-working machine going to assume an imperative part in the assembling procedure.

This project is intended to design and fabrication of a solar-operated automatic hammering machine that can perform hammering operations automatically. In industries, fabrication and manufacturing of metal components is done by manual hammering process. Manual hammering ends up with human errors and wastage of materials. By this machine we can prevent wastage of materials and manual errors. To overcome this type of problems we are proposing a solar operated automated hammering machine. It is a low-cost hammering machine with more accuracy, with this the time taken to complete the work will be reduced.

Project objectives

The main objectives of this project are:

1. To design an automated hammering machine that can give automatedblows.
2. To replace the use of manual hammering for heavy-dutyoperations.
3. To fabricate an automated hammering machine that can help workers inhammering processes.
4. To increase the efficiency and accuracy of the hammeringoperations.

Marketing features

Locally:

- Increase profits
- increase production
- reduce cost
- increase safety
- release manpower

Globally and internationally:

- Raise the economy.
- accuracy in international manufacturing.
- increase in the international industrialization.
- fast completion in global manufacturing.

Design Constraints of Engineering Standards

- quality features of hand hammers.
- characteristics and verification.
- Applies to hammers used under normal working.
- Best practices established by experts in the industry.
- Comply with laws that specify design and testing criteria.
- Reduce product liability risk.

Advantages

- User friendly.
- Low tooling cost.
- Accurate repetition and Impact
- Fast Hammering process.
- No manually effort.
- Portable system.
- Easy Maintenance.

Applications

- Use in a production line.
- To perform smithy operations i.e., upset forging.
- To perform shaping operations in sheet metal.
- To perform punching operations.

LITERATURE REVIEW

Project Background

With the evolution of technology and the advancements made in the industry, automation has become an important resource for the industrial operations. Hammering is a very common process in the industries of mechanical engineering. Most of the industries that involve the fabrication and machining of a metal components uses hammering. Moreover, hammering is extensively used in the wood industry. This project aims at designing and fabrication of Solar operated automated hammering machine that that can perform hammering operations efficiently. Moreover, the hammering operation is manually performed that results in different types of injuries to the operators. Adding more to it, the efficiency and accuracy required in hammering operations are not achieved through manual hammering operations. Therefore, this project is selected that aims at designing and fabricating an automated hammering machine.
It is a simple device but it will be helpful in many operations. The industry now requires accuracy and there are very small limitations of allowed tolerances. An important aspect of this project is the improvement of the operations and the safety of the operators. For instance, consider the hammering operation being done on a large metal piece. If this device will be used, there will be small risks of injuries for the operators but manual operations can bring a lot of harm. Moreover, this device will help in gaining the required level of accuracy. If this automated hammering machine is developed on a commercial basis and it is provided to different industries, it can bring a lot of revolution in the industries.

Previous work

First of all, I would like to discuss the work of **Julen Agirre**. He designed and fabricated a monitoring machine for the testing machine of hammer forging. It is quite relevant to our project. In this work, the authors have worked on developing an automated forging machine. Forging is a similar process to hammering and an almost similar machine was designed and fabricated in the work shown in figure 1.

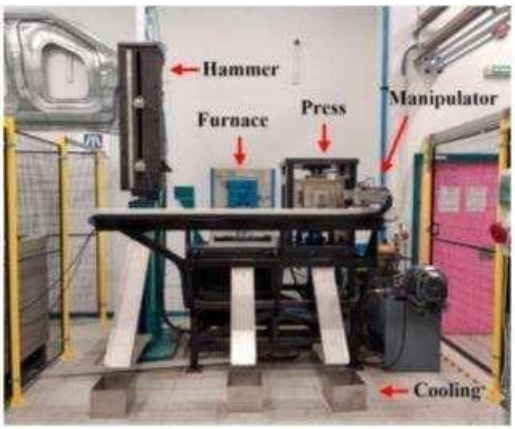

Figure 1: Automated forging Machine

This machine has a furnace for heating the metal, then cooling equipment for cooling the metal after the completion of the operations and a press that is used for hammering. From this literature, we have gained an idea about the required components of the automated hammering machine.

For the second work, the work done by **A.A. Dyakonov** will be discussed. In this work, the author has worked on developing an automated processing machine for testing the vibrations of the components. It is a mega form of our project. This project also involves an automated hammering machine but a separate automated hammering machine is not developed yet. In this work, the authors have also developed a software module for controlling the vibrational press. This software module is a new innovation and it will be very helpful if we integrate a software module in our project for the calculated hammering strokes per minute. Moreover, the authors have used MATLAB for analyzing the results.Some of the new results obtained by the authors are shown in figure 2

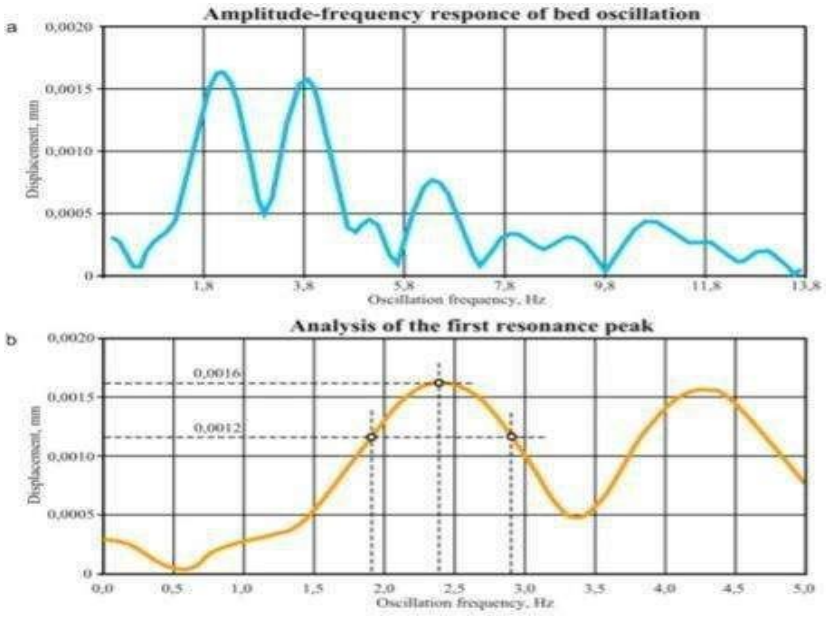

Figure 2: Results obtained by authors

It is an industrial project in which the influence of impact force, stroke length, and impact angle are studied on the hammering machine. In this project, a hammering machine is not developed and a pressing machine is used for the study purposes. Our project is a lot different from this project and our project has a lot of new innovations. Our project will bring a lot of ease to the industry. We have a targeted approach to developing a hammering machine. This project has focused on the residual stresses and MHP of the strokes. Therefore, this project is a lot different than our project. In the following image 3, the results obtained in this project areelaborated

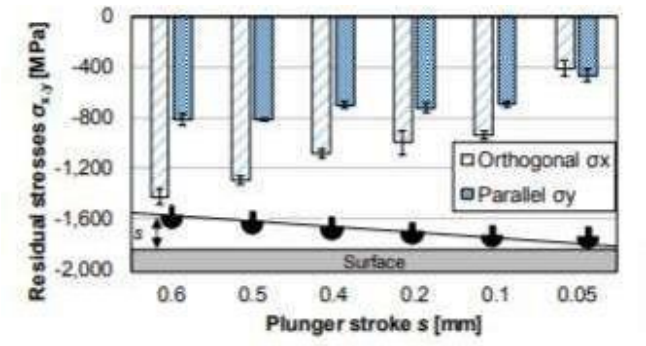

Figure 3: Residual Stresses against plunger stroke

The project also involves the comparative study of different materials and the impact of hammering on those materials. Our focus will be on developing an automated hammering machine that can produce the required impact on each and every material.

Jan Roman Honninge developed an inter-pass rolling machine that is capable of rolling materials under cold temperature. It is a completely different machine but this machine and our machine can be categorized into the same type. Both of the machines are providing ease to the workers in the industries. Moreover, they have used the same software 'Solid works' for designing the machine. This is only made for operations under cold temperature while our machine can perform hammering on hot temperature metals as well as cold temperature metals. The comparison of different materials in their machine are shown in fig.

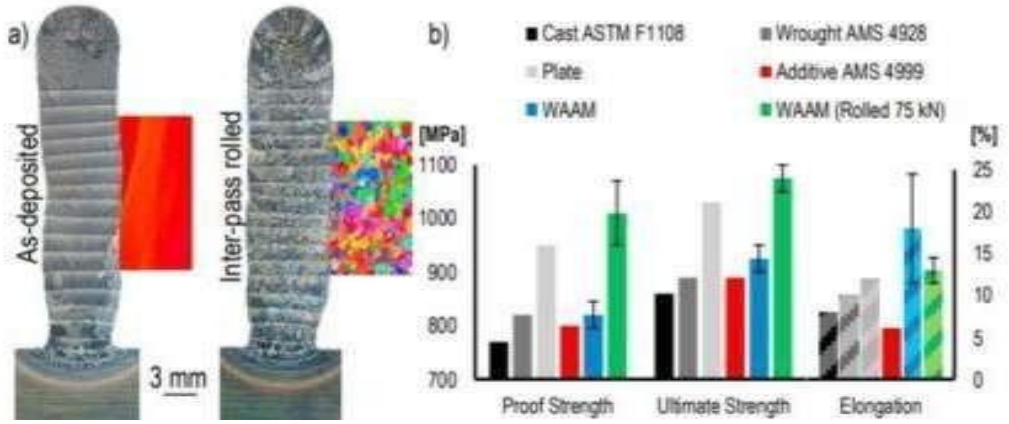

Figure 4: Comparison of materials for their machine

This project is an extended branch of our project. In this project, the authors have performed an analysis of the surface of the materials that are being stroked by the hammers. This project will help us in understanding the force of stroke and the length of the plunger for the given material. However, this project does not involve any design and fabrication of the hammer and it has performed analysis on the manual hammering operations.

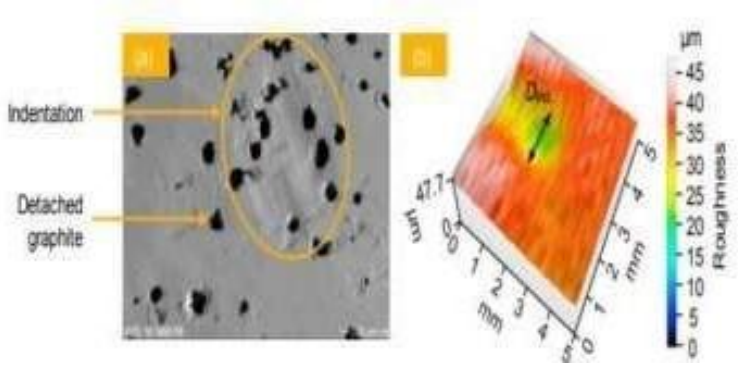

Figure 5: Microscopic image of the Defects and stress Analysis

V.L. Kolmogorov & **S.P. Burkin**all stated that, Modern science and industry have accumulated many efficient methods of forming by hammer forging, such as setting with shift or torsion, sectional forging, expansion by rolls etc. However, they are difficult for realization on forging equipment, what hampers their adoption in industry. Hence technological conservatism in forging. Even state-off-the-art forging complexes have brought no fundamental change into the hammer forging process.

David H.Myaszk stated that, hammering machine utilized as a part of the generation of material extending from instruments, to pivots, car frame forming, molding of metal and so forth. The present development identified with metal squeezing machine and forming machine included certain outstanding challenges in regard of to drive nail, fit parts, forge metal and break separated question.

K. Murofushi, **S. Sakurai** &**K. Umegaki** all stated that Hammer acceleration due to thrower and hammer movement patterns The displacements of the hammer head and the athletes' centers of mass were calculated using three-dimensional analysis procedures. The Asian record holder's Centre of mass and the hammer head on the final two turns exhibited approximate conjunctions of the hammer high point and the thrower's low point and vice versa about thehammer's azimuth angle.

J.Dapena stated that, Hammer speed at release is one of the most important factors contributing to the distance of a hammer throw. Hammer speed follows a generally increasing trend during the throw, with one fluctuation per turn. The purpose of the present paper was to quantify the influence of gravity on the speed fluctuations. Eight experienced hammer throwers were studied with three-dimensional filming methods. Instantaneous values of hammer velocity and speed were calculated from the film data.

MECHANISM AND COMPONENTS

Solar-operated automatic hammering machine
The machine works on the slider crank mechanism where the rotary motion of the disk converted into linear motion of the hammer. Firstly, the solar panels absorb the energy from the sunlight and converts the solar energy into electrical energy and stores it in the battery. Then the motor runs on electrical energy from the battery. The disk and sprocket are connected by a shaft and one sprocket which is mounted on the motor which transmits the energy through chain and the sprocket connected to the one end of the connecting rod. The other end of the connecting rod is attached to the hammer arm. The rotational motion of the sprocket is converted into linear motion, by that the hammer reciprocates and the hammering effect will take place.

Mechanism
The slider crank mechanism is used in this project

Slider-Crank Mechanism:
A slider-crank mechanism is used to convert the rotary motion into linear motion. For we need to connect a slider and crank with that of the rod. Here we have the output of the DC motor in the form of rotary motion, and we use a connecting rod with a slider crank, which then convert the rotary motion of the motor from the gear train from the motion of the hammer

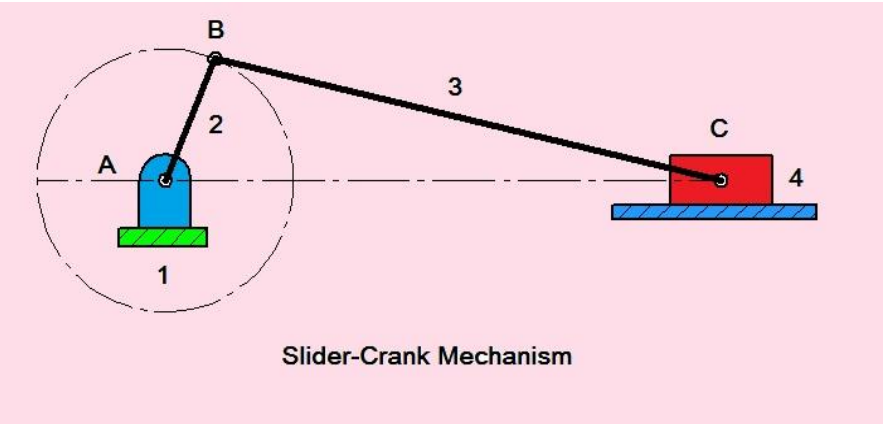

Figure 6: Slider Crank Mechanism

Components
The components of a solar-operated automatic hammering machine are

- Motor
- Disk

- Chain Sprockets
- Solar Charge Controller
- Controller
- Supporting Frame
- Battery
- Solar Panel
- Connecting Rod
- Hammer

Other components include

- Bearings
- Joints &Screws
- Chain
- Bearing Rod
- Toggle Switch

SYSTEM DESIGN

Design of Solar-Operated Automatic Hammering Machine:
Here is the architecture diagram of the Solar-Operated Automated Hammering Machine.

Figure7: Architectural Design

The machine works on the slider crank mechanism where the rotary motion of the disk converted into linear motion of the hammer. Firstly, the solar panels absorb the energy from the sunlight and converts the solar energy into electrical energy and stores it in the battery. Then the motor runs on electrical energy from the battery. The disk and sprocket are connected by a shaft and one sprocket which is mounted on the motor which transmits the energy through chain and the sprocket connected to the one end of the connecting rod. The other end of the connecting rod is attached to the hammer arm. The rotational motion of the sprocket is converted into linear motion, by that the hammer reciprocates and the hammering effect will take place.

Design Constraints:
Sustainability Constraints:
Sustainable design demands the reduction of negative impacts of design on environment, health, and on the comfort of the building occupants, and improving the performance of the building.

Principles of Sustainable design:
1) Optimize the site potential.
2) To minimize the energy consumption of non-renewable.
3) To use the product which is friendly to the environment.
4) Not water waste.
5) To increase maintenance and operational practices.

- Design of the Automated Hammering Machine considered almost all the sustainability constraints

as we made it from scrap material, which uses the waste material.

- Shifting from manual to automatic always increase the efficiency and it helps human for doing his job easily.

But on the other hand, it had some drawbacks

- Like it uses the energy which isnon-renewable
- It makes much noise which causes human discomfort

Geometric Constraints:

Geometric constraints help in controlling the relationships of objects with respect to each other. We use dimensional constraints for the control distance, radius, angle, and length values of objects. With constraints you can: include formulas and equations within dimensional constraints.

We follow the geometric constraints while modeling on the Solid works. Here are the geometries of the model along with dimensions are given below

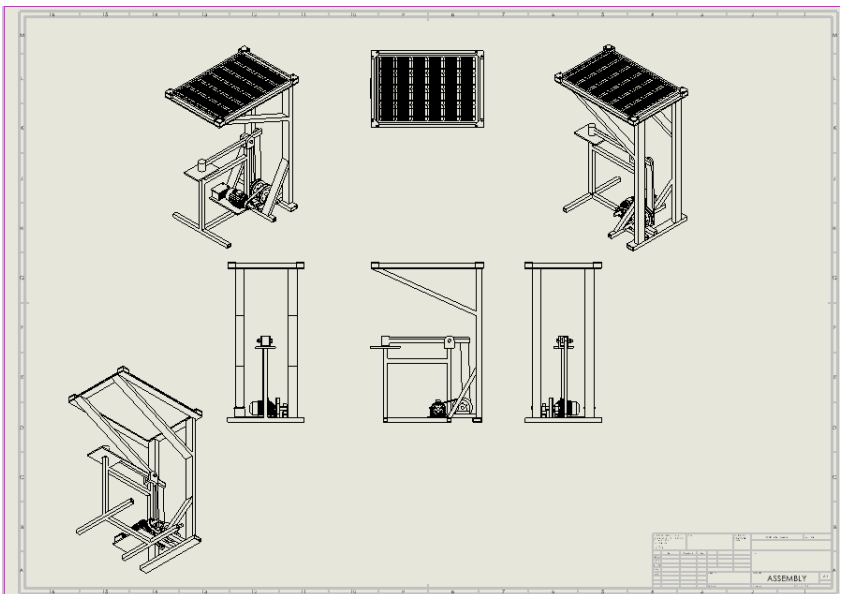

Figure 8: Design of Solar-Operated Automatic Hammering Machine

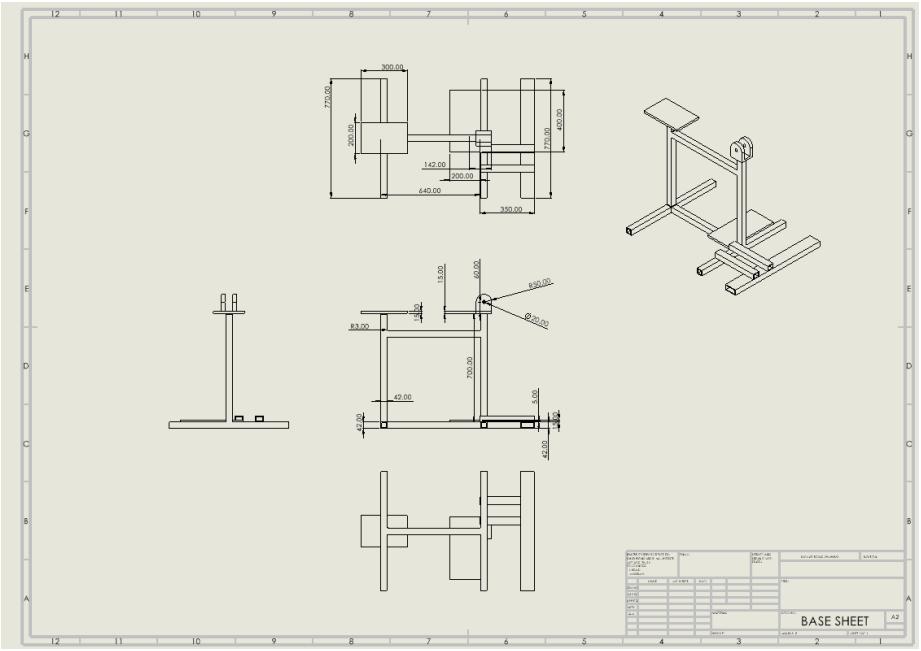

Figure 9: Design of Base

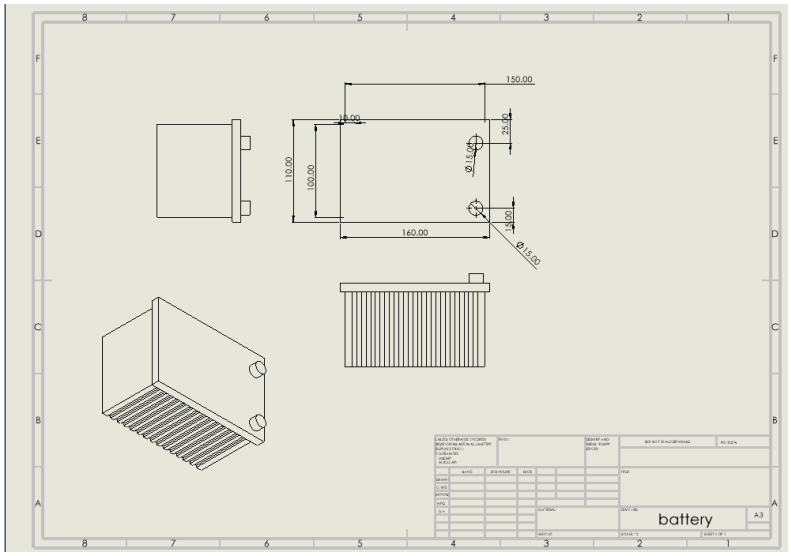

Figure 10: Design of Battery

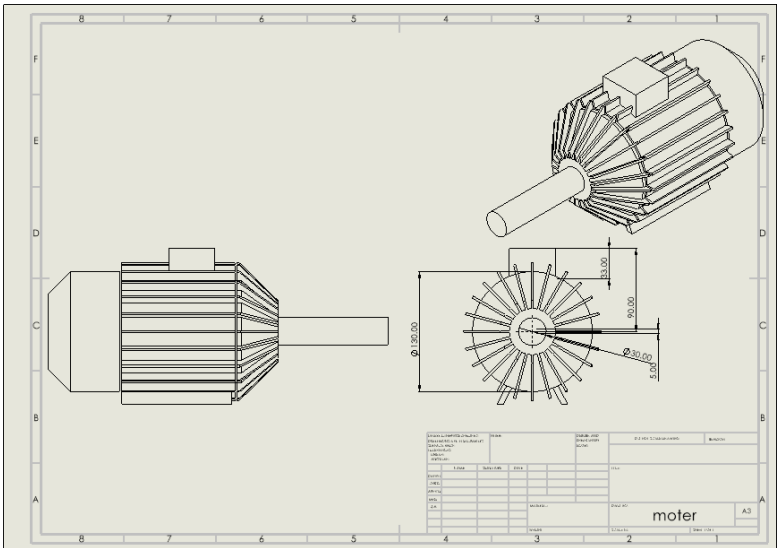

Figure 11: Design of Motor

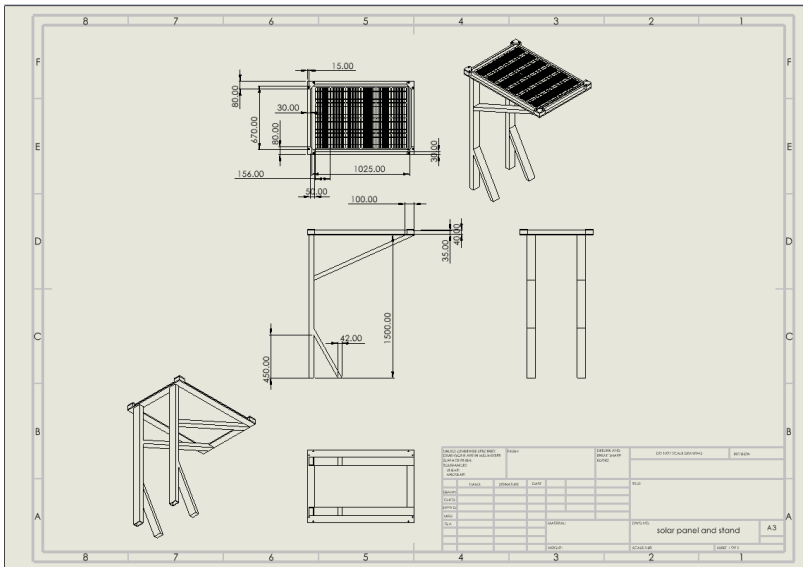

Figure 12: Design of Solar Panel and Stand

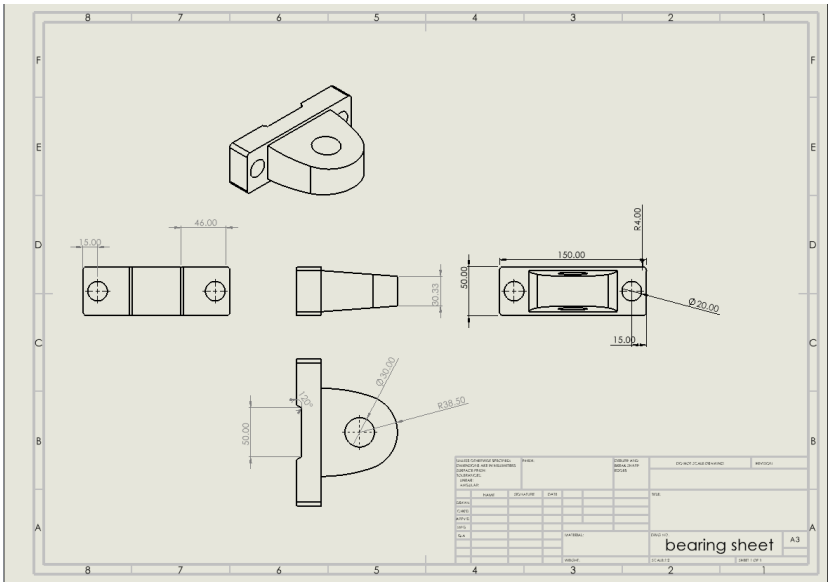

Figure 13: Design of Bearing

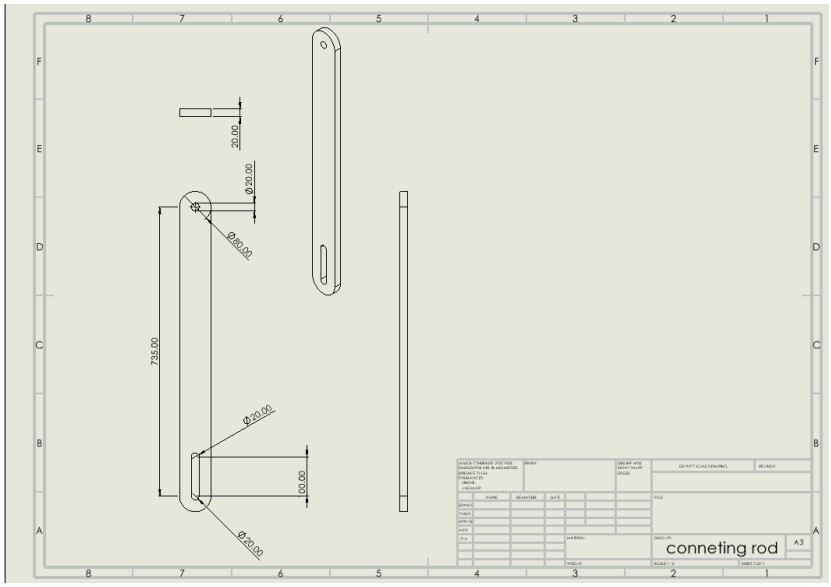

Figure 14: Design of Connecting Rod

Calculations

Motor Capacity (Mc) = 24V/250W
Motor Torque (Tm) = 40 N.m
Speed of Motor (N) = 3300 rpm
Power supplied by the Solar Panels per hour (P) = 24V/45W

Capacity of the batteries (Bc) = 24V-12AH
= 24*12
= **288W**

Time required to fill the battery storage (Bt) = Capacity of the batteries (C) / Power supplied per hour = 288/45 = 6Hrs

Running time of motor (Rt) = Capacity of the batteries (C) / Motor Capacity (Mc)
= 288/250 = 1.152Hrs

Therefore, **Running Time (Tr)** = **1Hr 10mins.**

Hammer calculations

Mass of Hammer (m) = 3.1 kg

Acceleration (a)= 9.81 m/s^2

Displacement of Hammer (D) = 0.6 m

Force of Hammer (F) = M * a
= 3.1 * 9.81

= 30.4 N

Torque of Hammer (Tm) = F * D

= 30.4 * 0.6

= 18.24 N.m

FABRICATION

Fabricated model

Various miscellaneous operations are used to complete the fabrication of a solar-operated automatic hammering machine.The machine works on the slider crank mechanism where the rotary motion of the disk converted into linear motion of the hammer. Firstly, the solar panels absorb the energy from the sunlight and converts the solar energy into electrical energy and stores it in the battery. Then the motor runs on electrical energy from the battery. The disk and sprocket are connected by a shaft and one sprocket which is mounted on the motor which transmits the energy through chain and the sprocket connected to the one end of the connecting rod. The other end of the connecting rod is attached to the hammer arm. The rotational motion of the sprocket is converted into linear motion, by that the hammer reciprocates and the hammering effect will take place.

Figure 15: Solar Operated Automatic Hammering Machine (Front View)

Figure 16: Solar Operated Automatic Hammering Machine (Side View)

Figure 17: Solar Operated Automatic Hammering Machine (Top View)

Circuit Diagram

The solar panels and batteries are linked to the solar charge controller, and the solar charge controller is linked to the machine controller, which is linked to the machine motor.

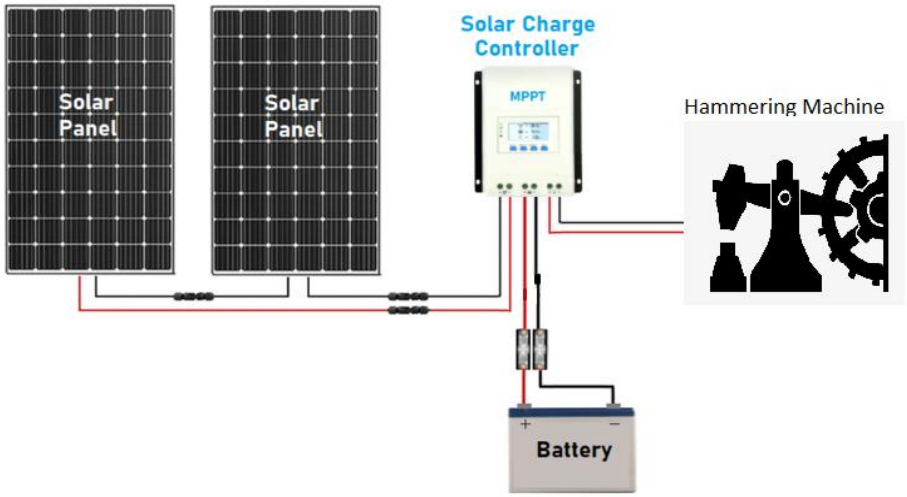

Figure 18: Circuit Diagram

RESULTS AND CONCLUSION

The Fabrication of Solar operated automated hammering machine by using Dc motor, solar panel and some other parts are completed. It is quick process, saves man power and electricity. More number of operations can be performed i.e., forging, punching, filleting and riveting etc. Varying the speeds of hammer motion depending upon type of metal used. It is portable machine so that we can carry easily.

It was noticed that the automatic hammering machine was showing the repeatable process. It is due to the strong structure of the automated hammering machine and the predefined motion of the hammer head. It can be also seen that the point of excitation is also the same for every measurement. From the figure, it can be seen that we got consistent force magnitude from the different measurements. There is some variability in the applied force which is due to the phenomenon of friction in the system. A comparison between manual and automatic hammering also showed that impact force from the automatic hammering is more repeatable than manual hammering. Due to the high repeatability which is obtained from automated hammering machine cost, time and manual effort will be decreased.

An important aspect of the automatic hammering machine is that the force can be adjusted by changing the dimensions of the cam follower, the angle between the joints in the driver cam group, and the distance between the target and that of the hammer head. The force adjustment aspect of the automatic hammering machine maintains repeatability.

CONCLUSIONS

Solar Operated Automatic Hammering Machine has excellent repeatability of force and ability to reduce the time and manual efforts required for the process. Using automatic hammering eliminates double hits and a single hit was obtained from every measurement. All the components of the machine were designed on Solid Works and a prototype was manufactured. This machine is a unique machine and no other automatic hammering machine of this design exists. This machine can be controlled and operated for the required number of strokes per minute. Previously designed automatic hammering machines did not involve variable strokes. If this product is manufactured on a commercial basis, it can be proved as a useful product for the industry. The operate-independent process can be achieved using automatic hammering. Highly skilled operator is not required for operating an automatic hammering machine hence reduce the cost of the process. This device was designed for a low impact and therefore is suitable for only small structures. The maximum force which can be obtained using an automatic hammering machine is limited.

FUTURE SCOPE

The concept of an automatic hammering machine has been shown to have a place in the actual market and to fill a need demanded by potential customer. The automatic hammering machine designed in this project can be improved from many perspectives. The first perspective is the design of the stroke of the hammer, it can be further improved and made lightweight. It will help in production line where many workers are used for the material handling purpose.

The strength of the hammer should be improved so that it can be used for proper hammering operations in the in dustry. It also reduces the cost and requirement of a greater number of workers will be completely reduced, only few workers can carry out the complete operation. Moreover, the time lag between two strokes of the hammer can be reduced so that time can be saved during hammering operations. Adding more to it, the aesthetics of the machine can be enhanced. The project objective is to reduce human efforts in manufacturing industries. In future the complete stress analysis of the project could be done.

It can also add another hammer i.e., Double hammer so that we can operate two hammers at a time by using a single mechanism (slider crank mechanism). we have to increase the capacity of motor. The solar power may not be sufficient to run two hammers in real time. But with the use of electricity and solar power it is possible to run two hammers at a time. By using different types of Dies at the work piece bed we can get different die shapes of metal component. By fixing cycle wheel to dc motor to generate electric power by giving manual force externally to the cycle pedal to rotate the wheel. So, that we can generate power parallelly use this power to dc motor indirectly for hammer motion.

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