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Solar Powered Tea Leaf Cutting Machine

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Abstract - Our project deals with the design and the fabrication of the solar tea leaf cutting machine. Hilly areas are a great source of tea as the plantation of the tea leafs is sustainable in such areas. The cutting of the tea leafs is usually done manually with more number of labours. This consumes a lot of time and also an extensive labour charge is there. The leaves that are being cut also are not even and hence the consistency of the tea production may be affected. In order to eliminate these types of disadvantages, we propose a simple solar tea leaf cutting machine. Our machine is portable and can be easily carried in bare hands. More number of leaves is cut within a short due to the automated process and also there is no need of any external power source for the successful operation of our machine. The solar panel that is provided with a backpack setup helps to convert the solar energy into the electrical energy and thus the entire system can be powered up. The parts of our project and designed and assembled using the Creo software and finally the fabrication part has been carried out.

Key Words: **Tea leaf, Solar, Labour, Cutting machine, Production.**

1. INTRODUCTION

Tea has been the most popular and low cost beverage around the world. The goal of solar tea leaf cutting machine is to overcome agricultural challenges. An agricultural robot must deal with an unstructured, unknown, uncertain and varying environment. Tea leaves are randomly located on tea plant, and it is difficult to detect different categories in tea leaf (such as bud, fresh leaf, active leaf, mother leaf, etc.) I have found that Tea cutting machines are designed in many countries but they are designed only for cutting with any selective method and these machines are very large and expensive. Therefore quality is being reduced. So in order to improve the quality it is necessary to improve the cutting methodology with more available resources which are less expensive and are renewable. This project is carried out to design and fabricate a simple solar tea leaf cutting machine that can be operated even by layman with solar power system.

The following points reveals why we have to make use of this type of machine,

- Solar Leaf cutting machine reduces the manual work.
- This type of machine reduces working time.
- This is non conventional solar power mechanism

1.1 AIM & OBJECTIVE OF THE PROJECT

Our project deals with the design and the fabrication of the solar tea leaf cutting machine. Hilly areas are a great source of tea as the plantation of the tea leafs is sustainable in such areas. The cutting of the tea leafs is usually done manually with more number of labors. This consumes a lot of time and also an extensive labour charge is there. The leaves that are being cut also are not even and hence the consistency of the tea production may be affected. In order to eliminate these types of disadvantages, we propose a simple solar tea leaf cutting machine. Our machine is portable and can be easily carried in bare hands. More number of leaves is cut within a short due to the automated process and also there is no need of any external power source for the successful operation of our machine. The solar panel that is provided with a backpack setup helps to convert the solar energy into the electrical energy and thus the entire system can be powered up. The parts of our project and designed and assembled using the Creo software and finally the fabrication part has been carried out.

Fig-1.1 Tea leaf harvesting

2. DESIGN CONCEPT

2.1 CAD/CAE

Computer aided design or CAD has very broad meaning and can be defined as the use of computers in creation, modification, analysis and optimization of a design. CAE (Computer Aided Engineering) is referred to computers in engineering analysis like stress/strain, heat transfer, flow analysis. CAD/CAE is said to have more potential to radically

increase productivity than any development since electricity. CAD/CAE builds quality form concept to final product. Instead of bringing in quality control during the final inspection it helps to develop a process in which quality is there through the life cycle of the product. CAD/CAE can eliminate the need for prototypes. But it required prototypes can be used to confirm rather predict performance and other characteristics. CAD/CAE is employed in numerous industries like manufacturing, automotive, aerospace, casting, mould making, plastic, electronics and other general-purpose industries. CAD/CAE systems can be broadly divided into low end, mid end and high-end systems.

Low-end systems are those systems which do only 2D modeling and with only little 3D modeling capabilities. According to industry static's 70-80% of all mechanical designers still uses 2D CAD applications. This may be mainly due to the high cost of high-end systems and a lack of expertise. Mid-end systems are actually similar high-end systems with all their design capabilities with the difference that they are offered at much lower prices. 3D sold modeling on the PC is burgeoning because of many reasons like affordable and powerful hardware, strong sound software that offers windows case of use shortened design and production cycles and smooth integration with downstream application. More and more designers and engineers are shifting to mid end system.

High-end CAD/CAE software's are for the complete modeling, analysis and manufacturing of products. High-end systems can be visualized as the brain of concurrent engineering. The design and development of products, which took years in the past to complete, is now made in days with the help of high-end CAD/CAE systems and concurrent engineering.

2.2 MODELING

Model is a Representation of an object, a system, or an idea in some form other than that of the entity itself. Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest. A model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On the one hand, a model should be a close approximation to the real system and incorporate most of its salient features. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A good model is a judicious tradeoff between realism and simplicity. Simulation practitioners recommend increasing the complexity of a model iteratively. An important issue in modeling is model validity. Model validation techniques include simulating the model under known input conditions and comparing model output with system output. Generally, a model intended for a simulation study is a mathematical model developed with the help of simulation software.

Software for modeling:

- Solid works
- Creo
- CATIA
- Unigraphics, etc

2.3 CREO

CreoElements/Pro(formerlyPro/ENGINEER), PTC's paramet ric, integrated 3D CAD/CAM/CAE solution, is used by discrete manufacturers for mechanical engineering, design and manufacturing. Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful rule-based constraint (sometimes called "parametric" or "variational") 3D CAD modeling system. The parametric modelling approach uses parameters, dimensions, features, and relationships to capture intended product behaviour and create a recipe which enables design automation and the optimization of design and product development processes. This design approach is used by companies whose product strategy is family-based or platform-driven, where a prescriptive design strategy is fundamental to the success of the design process by embedding engineering constraints and relationships to quickly optimize the design, or where the resulting geometry may be complex or based upon equations. Creo Elements/Pro provides a complete set of design, analysis and manufacturing capabilities on one, integral, scalable platform. These required capabilities include Solid Modeling, Surfacing, Rendering, Data Interoperability, Routed Systems Design, Simulation, Tolerance Analysis, and NC and Tooling Design. Like any software it is continually being developed to include new functionality. The details below aim to outline the scope of capabilities to give an overview rather than giving specific details on the individual functionality of the product.

Creo Elements/Pro is a software application within the CAD/CAM/CAE category, along with other similar products currently on the market. Creo Elements/Pro is a parametric, feature-based modeling architecture incorporated into a single database philosophy with advanced rule-based design capabilities. It provides in-depth control of complex geometry, as exemplified by the trajpar parameter. The capabilities of the product can be split into the three main headings of Engineering Design, Analysis and Manufacturing.

2.4 ENGINEERING DESIGN

Creo Elements/Pro offers a range of tools to enable the generation of a complete digital representation of the product being designed. In addition to the general geometry tools there is also the ability to generate geometry of other integrated design disciplines such as industrial and standard pipe work and complete wiring definitions. Tools are also available to support collaborative development.

A number of concept design tools that provide up-front Industrial Design concepts can then be used in the downstream process of engineering the product. These range from conceptual Industrial design sketches, reverse engineering with point cloud data and comprehensive free-form surface tools.

3. COMPONENTS AND DESCRIPTION

The major parts that are effectively employed in the design and the fabrication of the solar powered tea leaf cutting machine are described below:

- Battery.
- Motor.
- Solar panel.
- Frame.
- Cam mechanism.
- Blower.
- Cutting jaw.

3.1. BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt.

Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

(1) Low cost
(2) Long life
(3) High reliability
(4) High overall efficiency
(5) Low discharge
(6) Minimum maintenance

We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery. The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

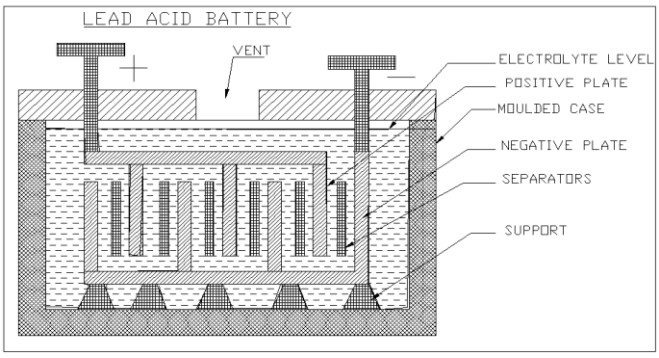

Fig-3.1. Lead acid battery

Inside a lead-acid battery, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulfuric acid. Each plate is a grid or framework, made of a lead-antimony alloy. This construction enables the active material, which is lead oxide, to be pasted into the grid. In manufacture of the cell, a forming charge produces the positive and negative electrodes. In the forming process, the active material in the positive plate is changed to lead peroxide (PbO\₂). The negative electrode is spongy lead (Pb). Automobile batteries are usually shipped dry from the manufacturer. The electrolyte is put in at the time of installation, and then the battery is charged to from the plates. With maintenance-free batteries, little or no water need be added in normal service. Some types are sealed, except for a pressure vent, without provision for adding water.

3.2. DC MOTOR

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors a magnetic force whose direction is given by Fleming's left hand rule.

are also like generators classified into shunt wound or series wound or compound wound motors.

3.2.1. Fleming's Left Hand Rule

Keep the force finger, middle finger and thumb of the left hand mutually perpendicular to one another. If the fore finger indicates the direction of magnetic field and middle finger indicates direction of current in the conductor, then the thumb indicates the direction of the motion of conductor.

3.2.2. Principle Of Operation Of Dc Motor

Figure show a uniform magnetic field in which a straight conductor carrying no current is placed. The conductor is perpendicular to the direction of the magnetic field. The conductor is shown as carrying a current away from the viewer, but the field due to the N and S poles has been removed. There is no movement of the conductor during the above two conditions. The current carrying conductor is placed in the magnetic field. The field due to the current in the conductor supports the main field above the conductor, but opposes the main field below the conductor. The result is to increase the flux density in to the region directly above the conductor and to reduce the flux density in the region directly below the conductor. It is found that a force acts on the conductor, trying to push the conductor downwards as shown by the arrow. If the current in the conductor is reversed, the strengthening of flux lines occurs below the conductor, and the conductor will be pushed upwards. Now consider a single turn coil carrying a current as shown in the above figure. In view of the reasons given above, the coil side A will be forced to move downwards, whereas the coil side B will be forced to move upwards. The forces acting on the coil sides A and B will be of same magnitude. But their direction is opposite to one another. As the coil is wound on the armature core which is supported by the bearings, the armature will now rotate. The commutator periodically reverses the direction of current flow through the armature. Therefore the armature will have a continuous rotation.

The conductors are wound over a soft iron core. DC supply is given to the field poles for producing flux. The conductors are connected to the DC supply through brushes. Let's start by looking at the overall plan of a simple 2-pole DC electric motor. A simple motor has 6 parts, as shown in the diagram below.

- An armature or rotor
- A commutator
- Brushes
- An axle
- A field magnet
- A DC power supply of some sort

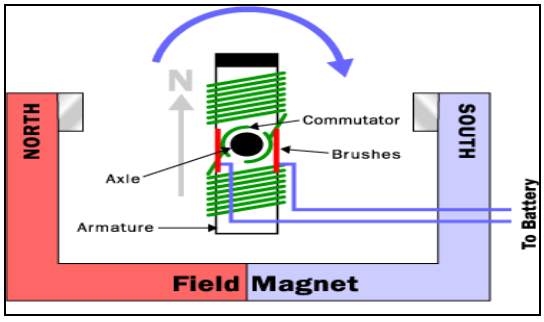

Fig-3.2. DC Motor principle

An electric motor is all about magnets and magnetism: a motor uses magnets to create motion. If you have ever played with magnets you know about the fundamental law of all magnets: Opposites attract and likes repel. So if you have 2 bar magnets with their ends marked north and south, then the North end of one magnet will attract the South end of the other. On the other hand, the North end of one magnet will repel the North end of the other (and similarly south will repel south). Inside an electric motor these attracting and repelling forces create rotational motion. In the diagram two magnets in the motor, the armature (or rotor) is an electromagnet, while the field magnet is a permanent magnet (the field magnet could be an electromagnet as well, but in most small motors it is not to save power).

3.2.3. Electromagnets And Motors

To understand how an electric motor works, the key is to understand how the electromagnet works. An electromagnet is the basis of an electric motor. You can understand how things work in the motor by imagining the following scenario. Say that you created a simple electromagnet by wrapping 100 loops of wire around a nail and connecting it to a battery. The nail would become a magnet and have a North and South Pole while the battery is connected. Now say that you take your nail electromagnet, run an axle through the middle of it, and you suspended it in the middle of a horseshoe magnet as shown in the figure below. If you were to attach a battery to the electromagnet so that the North end of the nail appeared as shown, the basic law of magnetism tells you what would happen: The North end of the electromagnet would be repelled from the north end of the horseshoe magnet and attracted to the south end of the horseshoe magnet. The South end of the electromagnet would be repelled in a similar way.

3.3. SOLAR PANEL

Solar panel refers either to a photovoltaic module, a solar thermal energy panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure. A PV module is a packaged, connected assembly of solar cells. Solar panels can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output - an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. There are a few solar panels available that are exceeding 19% efficiency. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.
Depending on construction, photovoltaic modules can produce electricity from a range of frequencies of light, but usually cannot cover the entire solar range (specifically, ultraviolet, infrared and low or diffused light). Hence much of the incident sunlight energy is wasted by solar modules,

and they can give far higher efficiencies if illuminated with monochromatic light. Therefore, another design concept is to split the light into different wavelength ranges and direct the beams onto different cells tuned to those ranges. This has been projected to be capable of raising efficiency by 50%.
Currently the best achieved sunlight conversion rate (solar module efficiency) is around 21.5% in new commercial products typically lower than the efficiencies of their cells in isolation. The most efficient mass-produced solar module shave power density values of up to 175 W/m^2(16.22 W/ft^2). Research by Imperial College, London has shown that the efficiency of a solar panel can be improved by studding the light-receiving semiconductor surface with aluminum nano cylinders similar to the ridges on Lego blocks. The scattered light then travels along a longer path in the semiconductor which meant that more photons could be absorbed and converted into current. Although these nano cylinders were used previously in which aluminum was preceded by gold and silver, the light scattering occurred in the near infrared region and visible light was absorbed strongly. Aluminum was found to have absorbed ultraviolet part of the spectrum and the visible and near infrared parts of the spectrum where found to be scattered by the aluminum surface. This, the research argued, could bring down the cost significantly and improve the efficiency as aluminum is more abundant and less costly than gold and silver. The research also noted that the increase in current makes thinner film solar panels technically feasible without "compromising power conversion efficiencies, thus reducing material consumption".

4. MANUFACTURING PROCESS

Fabrication involves turning raw material to finished products, to be used for various purposes. There are a large number of processes involved in the fabrication. These are solid state manufacturing processes involve minimum amount of material wastage. This solidifies temperature and large force is applied such the material flows and act in desired shape. The desire shape is controlled by means of a set of tool and dies, which may be closed during fabrication. These processes are normally used for large scale production rates. These are generally economical and in many cases improve the mechanical properties. These are fabrication processes where the starting raw materials are produced by any one of the previous fabrication processes.

4.1. BENDING

In bending operation the material in the form of flat sheet or strip is uniformly strained around a linear axis which lies in the neutral plane and perpendicular it's the length wise direction of the sheet or metal. It is a manufacturing process that produces a V-shape, U-shape, or channel shape along a straight axis in ductile materials, most commonly sheet metals. Commonly used equipment include box and pan brakes, brake presses, and other specialized machine presses. Typical products that are made like this are boxes such as electrical enclosures and rectangular ductwork.

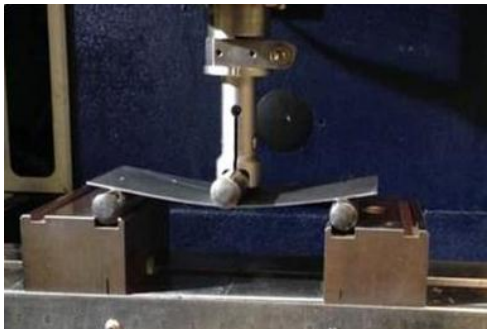

Fig-4.1. Bending

4.2. WELDING

Welding is a process of joining two metal pieces by the application of heat. Welding is the least expensive process and widely used now a days in fabrication. Welding joints different metals with the help of a number of processes in which heat is supplied either electrically or by mean of a gas torch. Different welding processes are used in the manufacturing of Auto mobiles bodies, structural work, tanks, and general machine repair work. In the industries, welding is used in refineries and pipe line fabrication. It may be called a secondary manufacturing process. Arc welding is welding process that is used to join metal to metal by using electricity to create enough heat to melt metal, and melted metals when cool resulting binding of metals there is a type of welding that uses welding power supply to create an electric arc between metal stick and the base material to melt the metals at point of contact. It use either direct or alternating current, and consumable or non consumable electrodes. The process may be manual, semi automatic or fully automatic. The process is very versatile require little operate training and inexpensive equipment so for welding of frame and grippers arc welding is used.

Fig-4.2. Arc Welding

4.3. DRILLING

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from

hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips from the hole as it is drilled. The hole is usually not made through a circular cutting motion, though the bit is usually rotated.

Fig-4.3. Drilling process

4.4. GRINDING

Grinding is abrasive machining process that use grinding wheel as cutting tool. It can produce very fine finishers and very accurate dimension. In mass production it contexts it can also rough out large volumes of metal quite rapidly. It is usually better suited to the machining of very hard materials than regular machining. Grinding is subset of cutting, as grinding is true metal cutting process. Each grain of abrasive function as a microscopic single point cutting edge and shears a tiny chip that is analogues to what would conventionally be called cut chip. Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge, and shears a tiny chip that is analogous to what would conventionally be called a "cut" chip.

Fig-4.4. Grinding

4.5. TURNING

Turning is machining process in which a cutting tool, typically a non-rotary tool bit, describes a helix tool path by moving more or less linearly while work piece rotates. Usually the term turning is reserved for the generation of external surface of cutting action, whereas the same essential cutting action when applied to internal surface is called boring. The phrases turning and boring categorizes the larger family of process known as lathing. Turning can be done manually in tradition form of lathe which frequently requires continuous supervision by the operator. Turning can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using an automated lathe which does not. Today the most common type of such automation is computer numerical control, better known as CNC.

Fig-4.5. Turning

5. WORKING PRINCIPLE

The experimental setup of our project consists of a frame on which the fixed jaw and the movable jaw are mounted. The motion to the movable jaw is delivered with the help of the cam mechanism and the motor. The motor is powered up by a battery. A blower is provided at the side of the machine which helps to blow the leaves which are stuck between the jaws. Another backpack setup is arranged which consists of a solar panel and a backpack. The backpack can be used to wear the solar arrangement in order to carry with the operator.

The operator carries the backpack along with the solar panel. The solar panel helps to convert the solar energy directly into electrical energy which is stored up in the battery. The battery supplies power to the motor. The power from the motor is transmitted to the cutting jaw through a cam mechanism. The cam mechanism is used to convert the rotary motion into the linear motion. The movable jaws moves and the leaves are stuck between the fixed and the movable jaw and the leaves are cut.

6. DESIGN

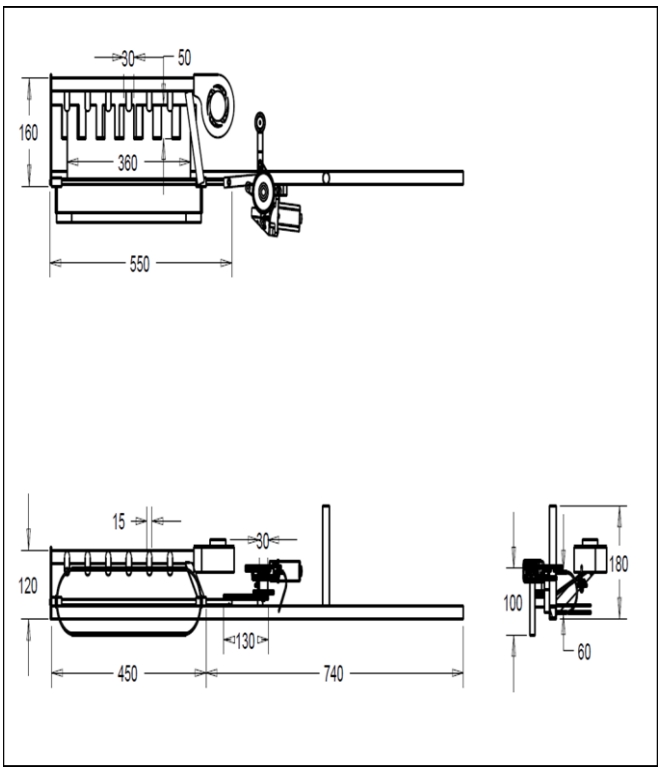

Fig-6.1. 2D Drawing

Fig-6.2. The proposed machine

7. ADVANTAGES

- Simple in construction.
- Easy to fabricate.
- The components used for the fabrication is very simple and is easily available in the market.
- The cost of the system is less.
- The tea leaf cutting operation can be completed within a short period of time.
- Reduced labour charges.
- No need of skilled operators to operate this machine.
- The solar helps to charge the battery and hence no need of external power supply.

8. DISADVANTAGE

- More number of moving parts.
- Must be handles with care since there are lots of chances of getting hurt.
- The weight of the machine is slightly more.

9. APPLICATIONS

These types of solar powered tea leaf cutting machines have a wide range of applications in the fields like,

- Tea estates,
- Agricultural purposes,
- Highly suitable for tea plantations,
- Garden cleaning purposes.

10. LIST OF MATERIALS

Sl. No.	PARTS	Qty.	Material
1	Frame	1	MS
2	Solar panel	1	Silicon
3	Battery	1	Lead acid
4	Blower	1	-
5	Motor	1	DC
6	Cutting jaw	1	MS
7	Cam mechanism	1	MS

Tab-9.1. List of materials

10.1. MILD STEEL

Mild steel is type of carbon steel with low amount of carbon, it is also known as "low carbon steel" although ranges vary depending on source, the amount of carbon typically found in mild steel is 0.05% to 0.25% by weight. Mild steel is not an alloy steel and therefore does not contain large amount of other elements beside iron. Mild steel has ferromagnetic properties and can be machined and shaped easily due to its inherent flexibility. Mild steel is hard at malleable, making it the ideal choice for fabrication of frame, cutting jaw, cam mechanism.

11. COST ESTIMATION

Sl. No.	PARTS	Qty.	Amount(Rs)
1	Frame	1	800
2	Solar panel	1	2000
3	Battery	1	1300
4	Blower	1	900
5	Motor	1	1300

6	Cutting Jaw	1	800
7	Cam Mechanism	1	1700
8	Other expenses	1	1300
	Total		10100

Tab-10.1. Cost estimation

12. RESULT

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries. We are proud that we have completed the work with the limited time successfully. The DESIGN AND FABRICATION OF SOLAR POWERED TEA LEAF CUTTING machine is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus we have developed a "SOLAR POWERED TEA LEAF CUTTING MACHINE" which helps to cut the leaf easily and at a shorter time with simple mechanism and at a low cost. By using more techniques, they can be modified and developed according to the applications.

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