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Solar Operated Wood-Cutter

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ABSTRACT

This project is on the design and construction of a solar power hacksaw machine for cutting of metal to different size and length with the help of solar hacksaw. The objective of this project is to save manpower and time, energy in cutting metals in order to achieve high productivity. It is a cutting machine with teeth on its blade used specially for cutting material. The power to the hacksaw is provided by the Solar Energy. The motor drives the flywheel connected to the shaft of the motor. The flywheel is connected through a link that transmits the required force for cutting the work piece. Finally connecting rod is connected to the vertical arm connected to the horizontal arm. Rotary motion of the shaft is converted into reciprocating motion of the hacksaw with the help of crank and connecting rod. Work piece of desired length can be cut by feeding it to hacksaw by holding it into bench vice. The various component of the machine were designed and constructed. Test was carried out on the machine using different metals.

A solar panel connected to power hacksaw is considered as a solar operated power hacksaw in which sun's energy is used to drive the hacksaw in order to cut wood, metal rod etc. A solar connected to the hacksaw converts the solar energy into electrical energy which is stored in a 12 v battery as a direct current to run the motor connected to the hacksaw .A DC motor is connected to the hacksaw which is used to give the rotary motion to the flywheel connected to the shaft of the dc motor .The energy stored in battery is supplied to the dc motor which rotates the flywheel connected to the shaft of motor.

The rotary motion of the flywheel is converted to reciprocating motion which gives back-forth motion to blade of the hacksaw by a mechanism known as reciprocating mechanism . The reciprocating motion of the hacksaw reciprocates the blade on the work piece which performs the cutting action. The work piece is clamped in a clamper to fix it. The clamper is made of cast iron or mild steel. A solar power hacksaw is a cheap and environmental friendly device that is operated without the consumption of any energy other than the solar energy .Solar energy is cheap and easily available on the earth. No heavy machines or devices are required for energy conservation. SOLAR OPERATED WOOD-CUTTERcan be used in work shop, industries, and many fields where there is a requirement of hacksaw.

Keyword- ***Solar Panel, DC Motor, Battery, Flywheel, Mild Steel.***

INTRODUCTION

General

A hacksaw is a handheld tool used to cut through materials like plastic tubing and metal pipes. Its cutting mechanism is provided by removable blades which feature sharp teeth along their outer edge. In most

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cases, a hacksaw consists of a metal frame that resembles a downward-facing. A handle of plastic, wood, or metal is typically affixed to one end of the frame. The frame's ends feature adjustable pegs that can be tightened to secure a blade in place, and loosened to remove it.

Hacksaw blades are long, thin strips of hardened steel that feature a row of teeth along their cutting edge.

Each end of the blade is punched with a small hole that fits onto the saw frame's pegs. Most blades range in length from ten to 12inches (25.4 to 30.48 cm), although six-inch (15.24 cm) blades can be purchased to fit smaller hacksaw models.

A device that applies force, changes the direction of a force, or changes the strength of a force, in order to perform a task, generally involving work done on a load. Machines are often designed to yield a high mechanical advantage to reduce the effort needed to do that work. A simple machines a wheel, a lever or an inclined plane. All other machines can be built using combinations of these simple machines.

Example: A drill uses a combination of gears (wheels) to drive helical inclined planes (the drill bit) to split a material and carve a hole in it.

Scope of the project

- The machine can solve the problem of time consumption.
- Waste of resources in face of labor cost is reduced.
- The machine can be used in the industry where it is manufactured, at the packaging sector.
- It is used as hardware in large quantity like in fabrication machine
- It provide alternative for industries aiming toward reducing human effort.
- It generates sustainable and practical solutions for the future industrial development.

Objectives of the project

- To cater to the issue of competition in mechanical industry the need for solar energy is assess by all the industry.
- Identify the key policy avenues considered to be appropriate to meet the challenge of sustainable manufacturing and packaging industry for the future.
- To provide alternative for industries aiming toward reducing human effort.
- Sustainable and practical solutions for the future industrial environment.

LITERATURE REVIEW

General

After the study of many literatures about design, construction and working of solar power hacksaw machine, some of them describe the methodology of solar power hacksaw. Lots of factor have been consider for the design, construction and working of solar power hacksaw machine such as cutting speed, cutting material, cutting time ,power ,efficiency etc. So, lots of literatures have been found which gives the relevance information and methodology of constructing an solar power hacksaw machine.

Historical Background

The problem of cutting-off material to size is common to practically every industry. Often, sawing is the first operation carried out on bar stock. Therefore, it is surprising that so little work has been done to understand the problems of this common operation.

Many reasons have been consider better methods. Often the foreman will assign a new trainee to a sawing task, on the principle that it is easy to learn and difficult to foul up. Furthermore cut-off machines are frequently housed in stores away from the main production areas and the operation of the sewing machines appears to be simple. The fact remains that cutting-off operations can account for a significant part of the cost per piece (Remmerswaa and Mathysen, 1961).

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The reason for carrying out the present work is the growing realization on the part of manufacturers of both blades and machines, that the factors which control the mechanics and economics of power hacksaw cutting are complex. Also power hacksaw cutting has been receiving increased competition from other cutting off processes, such as band and circular sawing.

Whilst the British Standard BS 1919: 1974 gives specifications for hacksaw blades regarding dimensions etc. the standard relates to testing of hacksaw blades for hand use only and does not include power hacksaw blade testing. Thus, both manufacturers of hacksaw blades and users have experienced considerable difficulty in establishing standard testing procedures and in obtaining consistency in test data using power hacksaw machines. Preliminary investigations by the author have revealed that existing blade testing methods were not independent of the machine characteristics, which could contribute to one of the reasons for the inconsistency in the test data. Hence, there has been requirement to identify the machine.

PROJECT METHODOLOGY

General

Solar Power Hacksaws are used to cut large sections of metal or plastic shafts and rods. Cutting of solid shafts or rods of diameters more than fifteen millimeters is a very hard work with a normal hand held hacksaw. Therefore solar power hacksaw machine is used to carry out the difficult and time consuming work. This power hacksaw machine is considered as an energy saving machine because the operator need not be there to provide the reciprocating motion and downward force on the work-piece in order to cut it. Once the operator has fed the work-piece till the required length in to the machine and starts the machine, then the machine will cut until the work-piece has been completely cut in to two pieces. The Solar Power hacksaw machine though being able to cut the shaft or rod without requiring any human effort to cut, it does require a human intervention to feed the work-piece many times with measurements being taken each time before feeding.

Fig.3.1 (SOLAR POWERED HACKSAW)

Reciprocating mechanism :

This mechanism is used for converting rotary motion into a reciprocating motion. The inversion is obtained by fixing either link 1or link 3.in fig link 1 is fixed. In this mechanism when the link 2 (which correspond to crank) rotates about Bas centre, the link 4 (which correspond to frame) reciprocates. The fixed link 1 guides the frame.

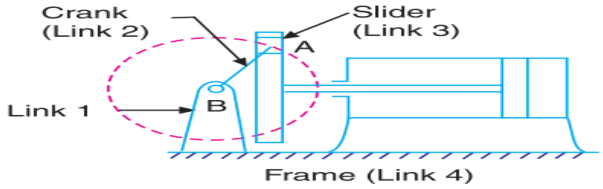

Fig 3.2 (Reciprocating mechanism)

Components Used

Following components has been used to construct this project

Flywheel:

Flywheel used in machines serves as a reservoir which stores energy during the period when the supply of energy is more than the requirement and releases it during the period when the requirement of energy is more than supply.

Flywheels have a significant moment of inertia and thus resist changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by

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applying torque to a mechanical load, thereby decreasing the flywheel's rotational speed. Flywheels are typically made of al and rotate on conventional bearings; these are generally limited to a revolution rate of a few thousand RPM .Some modern flywheels are made of carbon fiber materials and employ magnetic bearings enabling them to revolve at speeds up to 60,000 RPM. In case of steam engines, internal combustion engines, reciprocating compressors and pumps, the energy is developed during one stroke and the engine is to run for the whole cycle on the energy produced during this one stroke. For example, in I.C. engines, the energy is developed only during power stroke which is much more than the engine load, and no energy is being developed during suction, compression and exhaust strokes in case of four stroke engines and during compression in case of two stroke engines. The excess energy developed during power stroke is absorbed by the flywheel and releases it to the crankshaft during other strokes in which no energy is developed, thus rotating the crankshaft at a uniform speed. A little consideration will show that when the flywheel absorbs energy, its speed increases and when it releases, the speed decreases. Hence a flywheel does not maintain a constant speed; it simply reduces the fluctuation of speed. In machines where the operation is intermittent like punching machines, shearing machines, riveting machines, crushers etc., the flywheel stores energy from the power source during the greater portion of the operating cycle and gives it up during a small period of the cycle. Thus the energy from the power source to the machines is supplied practically at a constant rate throughout the operation.

Fig. 3.3.1(a) Flywheel

Fig.3.3.1 (b) Flywheel

Flywheels are often used to provide continuous energy in systems where the energy source is not continuous. In such cases, the flywheel stores energy when torque is applied by the energy source and it releases stored energy when the energy source is not applying torque to it. For example, a flywheel is used to maintain constant angular velocity of the crankshaft in a reciprocating engine. In this case, the flywheel—which is mounted on the crankshaft—stores energy when torque is exerted on it by a firing piston, and it releases energy to its mechanical loads when no piston is exerting torque on it. Other examples of this are friction motors, which use flywheel energy to power devices such as toy cars.

Hacksaw

A hacksaw is a fine-tooth saw with a blade under tension in a frame, used for cutting materials such as metal. Hand-held hacksaws consist of a metal frame with a handle, and pins for attaching a narrow disposable blade. A screw or other mechanism is used to put the thin blade under tension.

A power hacksaw (or electric hacksaw) is a type of hacksaw that is powered by electric motor. Most power hacksaws are stationary machines but some portable models do exist. Stationary models usually have a mechanism to lift up the saw blade on the return stroke and some have a coolant pump to prevent the saw blade from overheating. Hacksaw blades (both hand & power hacksaw) are generally made up of carbon steel or high speed steel strip rolls. The blank of required size is obtained by fixing the strip rolls on the stand of semi-automatic strip cutting machine and punched a hole at their both ends. Then, teeth are being made on the blank by milling or hobbling process. Once teeth are being cut, the hacksaw blades are heat treated and tempered for the required hardness. The last step in the manufacturing process is surface cleaning, painting, printing and packing of the hacksaw blades for market supply.

Fig. 3.3.2(a) Hacksaw Blade

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Selecting a Power Hacksaw blade

Proper blade selection is important. Use the three-tooth rule at least three teeth must be in contact with the work. Large sections and soft materials require a coarse-tooth blade. Small or thin work and hard materials require a fine-tooth blade. For best cutting action, apply heavy feed pressure on hard materials and large work. Use light feed pressure on soft materials and work with small cross sections. Blades are made in two principal types: flexible-back and all-hard. The choice depends upon use.

Flexible-back blades -should be used where safety requirements demand a shatterproof blade. These blades should also be used for cutting odd-shaped work if there is a possibility of the work coming loose in the vise.

All-hard blade -For a majority of cutting jobs, the all-hard blades best for straight, accurate cutting under a variety of conditions. When starting a cut with an all-hard blade, be sure the blade does not drop on the work when cutting starts. If it falls, the blade could shatter and flying.

Blades are also made from tungsten and molybdenum steels, and with tungsten carbide teeth on steel alloy backs. The following "rule-of-thumb" can be followed for selecting the correct blade: Use a 4-tooth blade for cutting large sections or readily machined metals. Use a 6-tooth blade for cutting harder alloys and miscellaneous cutting. Use 10- and 14-tooth blades primarily on light duty machines where work is limited to small sections requiring moderate or light feed pressure cause injuries.

Fig 3.3.2(b) classification of tooth

DC MOTOR

This Dc or direct current motor works on the principal, when a current carrying conductor is placed in a magnetic field. It experiences a torque and has a tendency to move. This known as motoring action. If the direction of electric current in wire is reversed, the direction of rotation is also reverses. When magnetic field and electric field interact they produce mechanical force, and based on the working principal of DC motor establish.

Fig 3.3.3(a) Fleming's Left hand rule

The direction of rotation of this motor is given by Fleming's left hand rule, which states that if the index finger, middle finger and thumb of your left hand are extended mutually perpendicular to each other and if the index finger represent the direction of magnetic field, middle finger indicate the direction of current, then the thumb represent the direction in which the force is experienced by shaft of the DC motor. DC motor consist of one set of coils, called armature winding, inside another set of coil or a set of permanent magnet, called the stator. Applying a voltage to the coil produces torque in the armature, resulting in motion.

Fig. 3.3.3b **(**DC MOTOR**)**

STATOR:

- The stator is the stationary part outside the motor.
- The stator of permanent magnet Dc motor is composed of two or more permanent magnet pole pieces.
- The magnetic field can alternatively be created by electromagnet. In this case DC coils (field winding) is wound around a magnetic material that forms part of stator.

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ROTOR:

- The rotor is the inner part which rotates.
- The rotor is composed of winding (called armature winding) which are connected to the external circuit through a mechanical commutated.
- Both stator and rotor are made of ferromagnetic materials. The two are separated by air gap.

WINDING:

A winding is made up of series and parallel connection

- Armature winding- the winding through which the voltage is applied or induced.
- Field winding- the winding through which the current is passed to produced current (for the electromagnet).
- Winding are usually made of copper

Bolt and Nuts

A screw thread is formed by cutting a continuous helical groove on a cylindrical surface. A screw made by cutting a single helical groove on the cylinder is known as single threaded (or single-start) screw and if a second thread is cut in the space between the grooves of the first, a double threaded (or double-start) screw is formed. Similarly, triple and quadruple (i.e. multiple-start) threads may be formed. The helical grooves may be cut either right hand or left-hand. A screwed joint is mainly composed of two elements i.e. a bolt and nut. The screwed joints are widely used where the machine parts are required to be readily connected or disconnected without damage to the machine or the fastening. This may be for the purpose of holding or adjustment in assembly or service inspection, repair, or replacement or it may be for the manufacturing or assembly reasons. The parts may be rigidly connected or provisions may be made for predetermining.

Advantages and Disadvantages of Screwed Joints:

(a) Following are the advantages of the screwed joints:

- Screwed joints are highly reliable in operation.
- Screwed joints are convenient to assemble and disassemble. A wide range of screwed joints may be adapted to various operating conditions.
- Screws are relatively cheap to produce due to standardization and highly efficient manufacturing processes.

(b) Following are the disadvantages of the screwed joints:

The main disadvantage of the screwed joints is the stress concentration in the threaded portions. Which are vulnerable points under variable load conditions.

(c) Important Terms Used in Screw Threads

The following terms used in screw threads are important from the subject point of view:

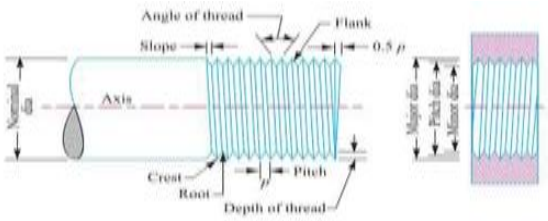

Fig.3.3.4 Screw Threads

Fig. 3.3.5a (Solar panel)

Components of Photovoltaic Cells:

Photovoltaic Effect: PV cells are able to create electricity at the atomic level using the photovoltaic effect. Often the photovoltaic effect is confused with the photoelectric effect. One is related to the other as both begin with the basic understanding that the universe is created of two core entities: matter and energy. Matter is anything that has mass and takes up space. In physics energy is defined as a source providing the ability to do work (e.g. light, heat, sound, electricity). In the photoelectric effect, there are two components photons (energy) and electrons

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(matter). Photons are light "packets". Each one carries a specific quantity (quanta) of energy revealed in different frequencies of light (higher energy photons are found in higher frequencies of light waves). Using the correct light frequency (photons) focused on a material (usually metal), it is possible to knock off or release electrons. So, the photoelectric effect uses light to eject electrons. Similarly, in the photovoltaic effect photons are used to eject the electrons, but these electrons are harnessed to produce an electric current or electricity.

Semi-Conductor: The flow of electrons or an electric current is possible within the photovoltaic effect if a conductor is present. Electricity is conducted through a material by moving electrons through orbitals at varying energy levels in atoms. Electrons move from lower energy levels (valance band) to higher energy levels (conduction band). The energy difference between these levels is known as the band gap. Semi-conductors have an intermediate band gap. Meaning they require more energy to move electrons than a conductor, but less than an insulator. Once electrons are moved they create electron "holes" or unoccupied orbital's in the valance band and easily released electrons in the conduction band. In PV cells, semi-conductors are often used because they can regulate conduction band electrons and electron "holes" more readily, especially if the semi-conductor is "doped" or impurities are added.

P-N Junction (Photodiode): The photovoltaic effect within a PV cell is able to produce an electric current by using a P-N junction. The P-N Junction is made of two kinds of semi-conductors. The N-type (N for Negative or electron-rich) is doped to have a high density of electrons and few holes, while the P-type (P for Positive or electron-poor) is doped to be the opposite. Electrons flow from areas of high to low concentration. The difference between these concentrated areas is known as voltage. A P-N junction regulates the voltage, so current only flows in one direction resulting in an electric current.

Fig. 3.3.6 (Rechargeable battery)

TYPES OF BATTERIES:

The rechargeable battery used in ICE car is a single 12V lead-acid battery. The two main type of batteries used are nickel metal hydride and lithium ion. The name of the battery corresponds to electrolyte used and the material of electrode. Each type of batteries has different type of chemical reactions within its cell. The batteries also differ in their amount and type of harm in human, the environment, and society.

LEAD-ACID BATTERIES:

The battery used in every internal combustion engine (ICE) car on the road is 12V lead-acid battery. This single battery is responsible for powering the alternator, or the engine starter. It also supplies the power to accessories that the car may have, such as the air-conditioning, radio, and power windows and locks etc.

Power Hack sawing:

A power hacksaw machine is designed primarily straight-line sawing. A typical sawing operation is lined below:

Select a hacksaw blade of proper length for the machine and proper pitch for the material to be cut. Install the hacksaw blade with the teeth pointing downward and toward the motor end of the hacksaw machine. Check the alignment of vice and hacksaw blade and mount the work piece in the vice. Make the vice holds the work piece securely. Check the stroke of hacksaw machine and adjust if necessary. After adjusting the stroke, move the hacksaw blade and

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sewing machine frame through one cycle by hand to check the blade clearance at each end of the work piece. Readjust the position of vice if necessary. Position the hacksaw blade about ¼ inches above the work piece and set the feed control to its lightest feed setting. Set desired speed of hacksaw machine. Start the machine and let the blade feed lightly into the work piece for about ¼ inch. Readjust the feed to whatever the material will stand for normal cutting. Permit the hacksaw blade to cut completely through work piece. The blade frame will trip a switch on sawing machine bed to stop the sewing machine.

Power hacksaw machine are used to cut large size of metal such as steel. Cutting diameter is more than 10/15 mm is very hard work with a normal hand held hacksaw. Therefore power hacksaw developed to carry out the difficult and time consuming work. The heavy arm moves forwards and backwards, cutting on the backwards stroke.

The metal to be cut held in machine vice which is an integral part of base. Turning the handle tightens or loses the vice. The vice is very powerful and locks metal in position. When cutting is takes place, the metal especially blade heats up quickly. Coolant should be fed on to the blade, cooling it down and lubricating it as it cut through the metal. Without coolant the blade will over heat and break. This can be dangerous as blade can break with powerful force, shattering.

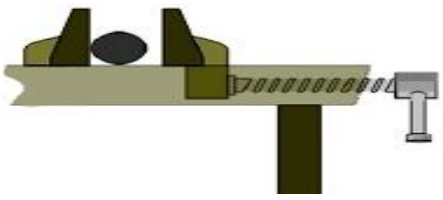

Fig 3.6(a) Vice Bench

Blades of power hacksaw are graded according to the material they are made from and number of teeth per inch. Top quality blades are manufactured by High Speed Steel. Although, there are cheaper alternatives such as Carbon Steel Blades. In general the number of teeth per inch (TPI) range from 14 to 24.the more teeth per inch-the smoother to cut. The power hacksaw has electric motor that powers the blade through flywheel system. Some have ratchet system. The flywheel system transferred the rotary power from the motor and changed to reciprocating motion; allow the blade to cut through material.

Fig 3.6(b) Teeth stand

Cost & Estimation

S.NO	COMPONENTS	QUANTITY	COST
1	D.C MOTOR	1	₹ 1500
2	SOLAR PANEL	1	₹ 550
3	FLY-WHEEL	1	₹ 120
4	MILD STEEL FLAT ROD	2m	₹ 200
5	NUTS AND BOLTS	15	₹ 50
6	HACK-SAW BLADE	2	₹ 20
7	Battery	1	₹ 1800
8	Wire & Switch	2m&1	₹ 40
	Total Cost		□ 4280

RESULT AND DISCUSSION

SOLAR OPERATED WOOD-CUTTERmachine is operated using solar energy. The battery is charged using a solar panel. Solar panel is used for conversion of solar energy into electrical energy which is further stored in the battery D.C. Motor is run using this battery. Flywheel is attached to the shaft of the D.C. motor. The torque generated by the D.C. Motor is transmitted through the flywheel to a link attached to the flywheel. This link is connected to movable link, whose other end is connected to the main link in which hacksaw blade is fixed. The rotational motion of the flywheel is converted to linear motion of the main link. It is based on Scotch-yoke mechanism. The self - weight of the main link and upper link which is moving on the movable link attached to the base provides the required amount of downward force for cutting. The continuous motion of fine tooth of hacksaw blade on work-piece leads to the cutting of this work-piece.

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Test was carried out on this machine using different metal, PVC pipes &wood. For the loaded test, a mild steel shaft of diameter 25 mm and length 12 inch was clamped on the vice and the hacksaw machine was switched on. It took the hacksaw 240 seconds to cut the entire diameter using a new hacksaw blade .The cut was observed to be neat and straight with smooth surface of cut.

The total cost of equipment of the machine was 4280 rupees .The total cost of producing this machine was estimated to be 6000 rupees. Recommendation has been made on the operation and parameters of the machine .Suggestion have been offered on overall machine performance optimization and future work on the machine.

CONCLUSION AND FUTURE SCOPE

It is the need of time to replace conventional power hacksaw machine by solar powered hacksaw. SOLAR OPERATED WOOD-CUTTERis energy efficient as well as eco-friendly in comparison to convention hacksaw being used. The major advantage of this machine is that it requires no exhaustible source of energy for its operation. In this rapid emerging industrial section the use of power Hacksaw is wide and requires lots of energy for its operation. This can be overcome by using solar powered hacksaw.

This machine can be made use of at any of the industries like pump manufacturing industries that involve bulk amount of shafts that have to be cut frequently. Various range of size of work-piece can be cut. Currently, the machine uses 12 inch blade for cutting of shafts of various sizes. This machine is light in weight and thus easily portable. An advancement that can be implemented in SOLAR OPERATED WOOD-CUTTERis that the user can also make it automated using required mechanism and sensors. This is possible with the help of an advanced microcontroller, which should have programmable memory.

This machine has a wider application in remote areas which lacks supply of electricity. Cutting operation is performed by each and every manufacturing industries. So in near future if there would be development of micro-batteries which would supply the required power then this hacksaw machine could be made even more compact.

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