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Solar Grass Cutter With Linear Blades By Using Scotch Yoke Mechanism

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ABSTRACT
A Solar grass cutter is a machine that uses sliding blades to cut a lawn at an even length. Even more sophisticated devices are there in every field. Power consumption becomes essential for future. Solar grass cutter is a very useful device which is very simple in construction. It is used to maintain and upkeep lawns in gardens, schools, college's etc. We have made some changes in the existing machine to make its application easier at reduced cost. Our main aim in pollution control is attained through this. Unskilled operation can operate easily and maintain the lawn very fine and uniform surface look. In our project, "Solar grass cutter" is used to cut the different grasses for the different application.
Keywords: scotch yoke mechanism, linear blades,

I. INTRODUCTION

Moving the grass cutters with a standard motor powered grass cutters is an inconvenience, and no one takes pleasure in it. Cutting grass cannot be easily accomplished by elderly, younger, grass cutter moving with engine create noise pollution due to the loud engine, and local air pollution due to the combustion in the engine. Also, a motor powered engine requires periodic maintenance such as changing the engine oil. Even though electric solar grass are environmentally friendly, they too can be an inconvenience. Along with motor powered grass cutter, electric grass cutters are also hazardous and cannot be easily used by all. Also, if the electric grass cutter is corded, mowing could prove to be problematic and dangerous. The prototype will also be will be charged from sun by using solar panels.

Figure 1 solar grass cutter with linear blades

1.1 SOLAR ENERGY:

Solar energy is very large, inexhaustible source of energy. The power from the sun interrupted by earth is approximately 1.8/10MW, which are many thousands of times larger than the present consumption rate on the earth of all energy sources. The quantum of energy India's land area receive from sun is equivalent to 15,000 time sits consumption requirement (500 billion kWh) as projected for 2004. In addition to its size, solar energy has two other factors in its favor. Firstly, unlike fossil fuels and nuclear power, it is an environmentally clean source of energy. Secondly, it is free and available in adequate quantities in almost all parts of the world people live. But there are some problems associated with its. The real challenge in utilizing solar energy is of and economic concern. One has to strive for the development of cheaper methods of collection and storage so that large initial investments required at preset in most applications are reduced, solar energy in India:

A large amount of solar radiation fall on India and for most of the country very few days are without sunshine. India lies within the latitude of 7 N to and 37 N with annual average intensity of solar radiation as500 to 600 cal/cm/day with more such insulations available in arid and semi arid regions. Average solar radiation falling on India in arid and semiarid regions is 7.5 K w h/m/day. Solar energy 5× 10 K w h/year potential to meet basic energy needs of teeming millions who live in rural India.

Solar energy is an important, clean, cheap and abundantly available renewable energy. The sun radiates heat and light. The heat, light received from the sun supports the environment on the earth through the following well known natural effects.

- Temperature balance on the earth
- Photo-synthesis by biological plants production of oxygen and organic materials, production of organic chemicals and bio-mass.
- Wind due to unequal heating of water, land surfaces.
- Heating of ocean water: ocean thermal energy (OTEC)
- Waves in ocean: ocean wave energy
- Tides in ocean: ocean tidal energy (due to gravitational forces)

The sun produces enormous amount of energy of heat and light through sustained nuclear fusion reactions. The solar energy received on the earth in the form of radiation is used for heating and producing an electrical energy.

Among the non-conventional sources of energy solar energy is the most promising. Hence our project is based on the solar energy conversion to mechanical energy to run a normal grass cutter.

Table1: COMPARISION

Sl. No	SOLAR SYSTEM	FUEL SYSTEM
1	Totally free from pollution	Pollution is a great factor
2	No fuel consumption	Fuel is the important need
3	No. of reciprocating parts are less	No. of reciprocating parts are more
4	Friction is greatly reduced	Frictions between the parts are high.
5	Low cast and maintenance	Maintenance is difficult & costly
6	Load carrying capacity is low	Load carrying capacity is high
7	Continuous ride for hours together is not possible	Continuous ride is possible
8	Ratio of speed reduction more when weight increases very much	Speed reduction ratio is less and it does not vary

1.2. PROBLEMS IDENTIFICATION

Earlier most of the activities are done by manually. Gradually so many big and small equipments are developed to ease human activities ,thus to reduce the human efforts to do the things . Now a day's most of the activities which included human efforts are either replaced or automated by the use of machines or other kinds of equipments. Skilled persons are required for conventional grass cutter .why because here we uses animals like bulls .now a days the technology is developed in other hands skilled persons with convention grass cutter were decreased. Now we have a need to depend on the technology.

Due to the risk involved in a conventional grass cutter, now days very few peoples coming forward to grass cutting by conventional grass cutter .moreover, educational background of Indian youth is improving. So most of people hesitate to use conventional grass cutter.

1.3. COMPONENTS USED

The main components of the solar powered grass cutter are,

- ❖ Solar panels
- ❖ Batteries
- ❖ Brush less DC motor
- ❖ Solar charger
- ❖ Mechanism used
- ❖ Circuit breaker
- ❖ Blades

This are explained below one by one

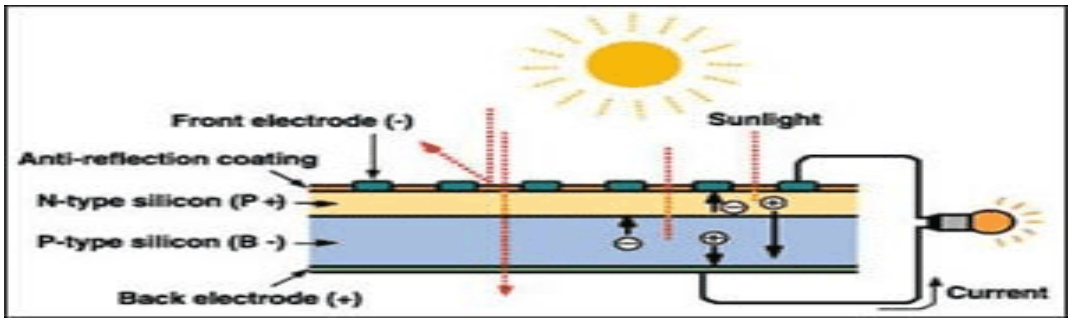
1.3.1SOLAR PANEL:

1.3.1.1Photovoltaic principles:

The photo- voltaic effect can be observed in nature in a variety of materials that have shown that the best performance in sunlight is the semiconductors as stated above. When photons from the sun are absorbed in a semiconductor, that create free electrons with higher energies than the created there must be an electric field to induce these higher energy electrons to flow out of the semi-conductor to do useful work. A junction of materials, which have different electrical properties, provides the electric field in most solar cells for the photon interaction in a semiconductor.

A solar cell consists of

- Semi –conductor in which electron hole pairs are created by the absorption of incident solar radiation.
- Region containing a drift field for charge separation.
- Charge collecting front and back electrodes.



1.3.1.2 Photovoltaic effect

The photo-voltaic effect can be described easily for p-n junction in a semi-conductor. In an intrinsic semi-conductor such as silicon, each one of the four valence electrons of the material atom is tied in a chemical bond, and there are no free electrons at absolute zero. If a piece of such a material is doped on one side by a five valance electron material, such as arsenic or phosphorus, there will be an excess of electrons in that side, becoming an n-type semi-conductor.

The excess electrons will be practically free to move in the semi-conductor lattice. When a three valance electron material, such as boron dopes the other side of the same piece, there will be deficiency of electrons leading to a p-type semi-conductor. This deficiency is expressed in terms of excess of holes free to move in the lattice. Such a piece of semi-conductor with one side of the p-type and the other, of the n-type is called p-n junction. In this junction after the protons are absorbed, the free electrons of the n-side will tends to flow to the p-side, and the holes of the p-side will tend to flow to the n-region to compensate for their respective deficiencies. This diffusion will create an electric field from the n-region to the p-region. This field will increase until it reaches equilibrium for voltage, the sum of the diffusion potentials for holes and electrons. If electrical contacts the connected through an external electrical conductor, the free electrons will flow from the n-type material through the conductor to the p-type material as shown in the figure. Here the free electrons will enter the holes and become bound electrons thus both free electrons and holes will be removed. The flow of electrons through the external conductor constitutes an electric current, which will continue as long as move free electrons and holes are being formed by the solar radiation. This is the basis of photo-voltaic conversion that is the conversion of solar energy into electrical energy. The combination of n-type and p-type semiconductors thus constitutes a photo-voltaic cell or solar cell. All such cells some rate direct current that can be converted into alternating current it desired.

The photo-voltaic effect can be observed in almost any junction of material that have different electrical characteristics, but the best performance to date has been from cells using semiconductor material especially all of the solar cells used for both space and terrestrial applications have been made of the semiconductor silicon. Future cells may use such materials as the semiconductors like Gallium arsenate, copper sulphate cad sulphide etc. The device used to utilize the photovoltaic effect is solar cell.

1.3.1.3 SPECFICATIONS:

Array size : 67×60cm
Maximum Power : 50W
Maximum Voltage : 12V
Maximum Current : 2.9A
No of modules : 1
Type : Poly crystalline

1.3.2 BATTERY:

The batteries are used as a storage device for solar energy which can be further converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage, 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 following particular combination of properties:

(1) Low cost
(2) Long life
(3) High reliability
(4) High overall efficiency

Figure 2 Li-ion batteries

1.3.3 BRUSHLESS D.C MOTOR:

This is a relatively new class of motors whose application have been increasing at a rapid rate each year, due to both declining costs as well as increasing functionality.

A brushless DC motor is similar to that brush DC motor in that it has an internal shaft position feedback which tells which windings to switch on at which an exact moment. This internal feedback gives both the brush DC motor and brushless DC motor their unique characteristics. Linear speed-torque curves which are well suited for speed and position control and high starting torque. The internal feedback is accomplished in a brush type DC motor with the mechanical commutator (a series of copper bar which are insulated from each other) and the mechanical brushes through which the current is fed into the commutator bars and switched sequentially into the appropriate winding in the armature.

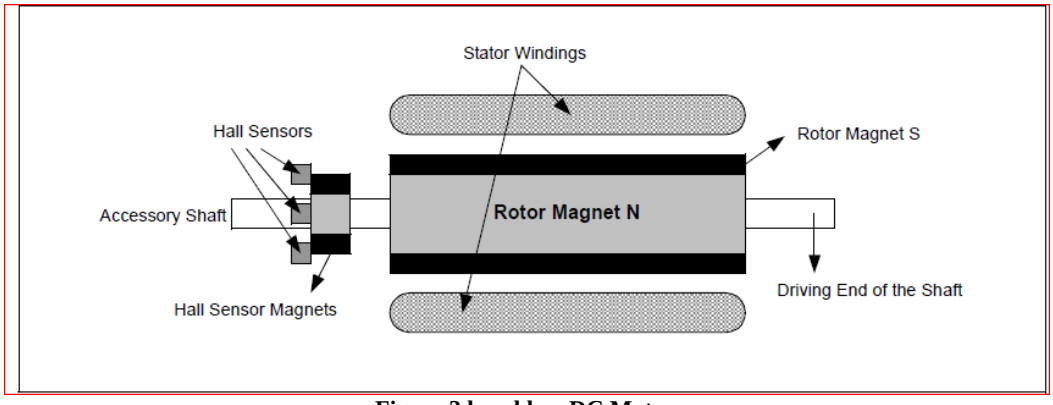


Figure 3 brushless DC Motor

1.3.3.1 Theory of DC motor speed control:

The speed controller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect.

When we watch a film in the cinema, or the television, what you are actually seeing is a series of fixed pictures, which change rapidly enough that your eyes just see the average effect - movement. Your brain fills in the gaps to give an average effect.

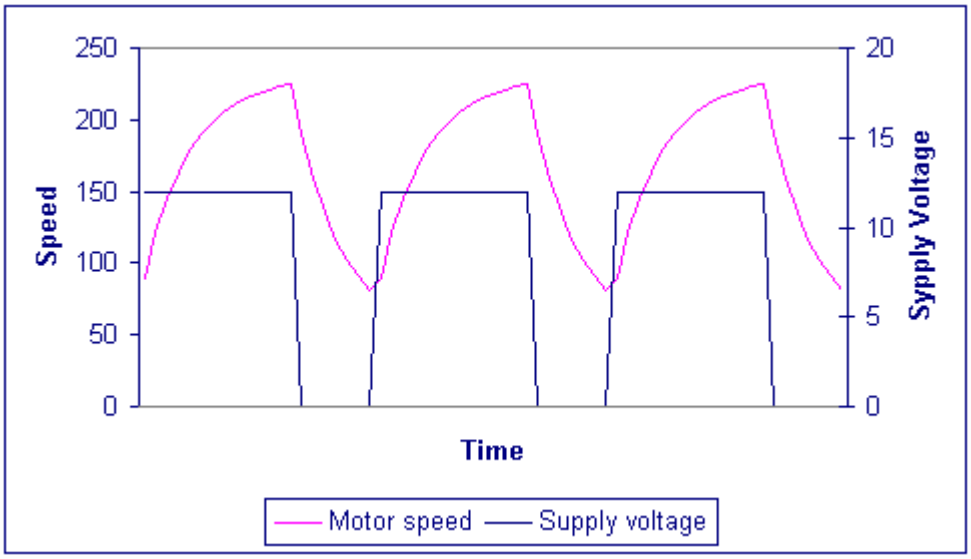
Now imagine a light bulb with a switch. When you close the switch, the bulb goes on and is at full brightness, say 100 Watts. When you open the switch it goes off (0 Watts). Now if you close the switch for a fraction of a second, and then open it for the same amount of time, the filament won't have time to cool down and heat up, and you will just get an average glow of 50 Watts. This is how lamp dimmers work, and the same principle is used by speed controllers to drive a motor. When the switch is closed, the motor sees 12 Volts, and when it is open it sees 0 Volts. If the switch is open for the same amount of time as it is closed, the motor will see an average of 6 Volts, and will run more slowly accordingly.

As the amount of time that the voltage is time that it is off, the average speed of the motor increases.

This on-off switching is performed by power MOSFETs. A MOSFET (Metal-Oxide-Semiconductor Field Effect Transistor) is a device that can turn very large currents on and off under the control of a low signal level voltage.

The time that it takes a motor to speed up and slow down under switching conditions is dependent on the inertia of the rotor (basically how heavy it is), and how much friction and load torque there is.

The graph below shows the speed of a motor that is being turned on and off fairly slowly:



We can see that the average speed is around 150, although it varies quite a bit. If the supply voltage is switched fast enough, it won't have time to change speed much, and the speed will be quite steady. This is the principle of switch mode speed control. Thus the speed is set by PWM – Pulse Width Modulation.

1.3.4 SOLAR CHARGER:

The power charge regulator is also known as charge controller, voltage regulator, charge-discharge controller or charge-discharge and load controller. The regulator sits between the array of panels, the batteries, and the equipment or loads.

By monitoring the voltage of battery, the regulator prevents overcharging or over discharging. Regulators used in solar applications should be connected in series: they disconnect the array of panels from the battery to avoid overcharging, and they disconnect the battery from the load to avoid over discharging. The connection and disconnection is done by means of switches which can be of two types: electromechanical (relays) or solid state (bipolar transistor).

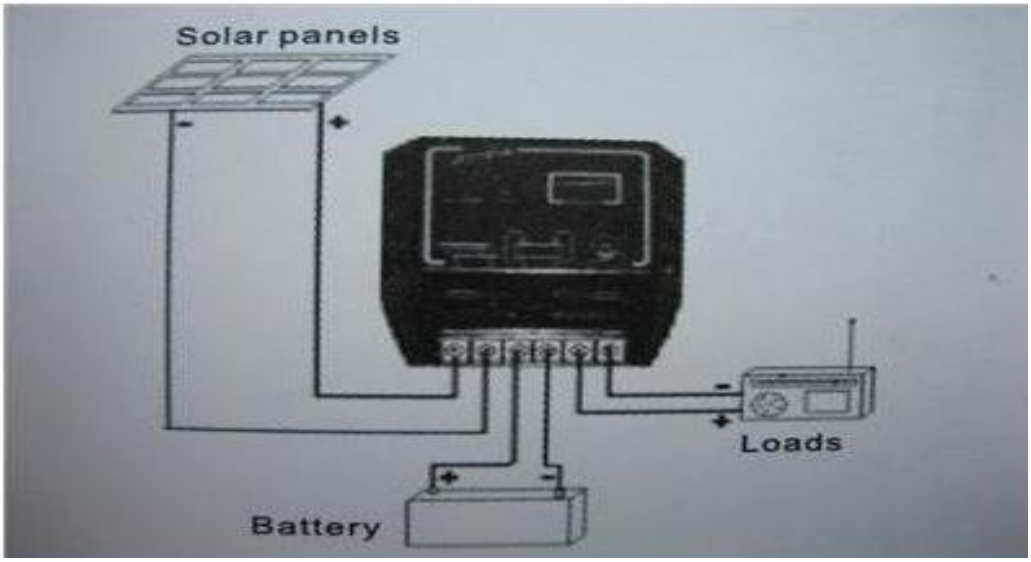


Figure 4 Solar charger

Solar chargers should never be connected in parallel. In order to protect the battery from gasification, the switch opens the charging circuit when the voltage in the battery reaches its high voltage disconnects (HVD) or cut-off set point.

The low voltage disconnects (LVD) prevents the battery from over discharging by disconnecting the load. The most modern regulators are also able to automatically disconnect the panels during the night to avoid discharging of the battery. They can also periodically overcharge the battery to improve their life, and they may use a mechanism known as pulse width modulation (PWM).

Solar charger has three light indicators. The first light blinks when the batteries are charging by using solar energy. The second light glows when the charging in the batteries is very low. The third light glows when the batteries are fully charged and an extra load (charging) is applied on the batteries.

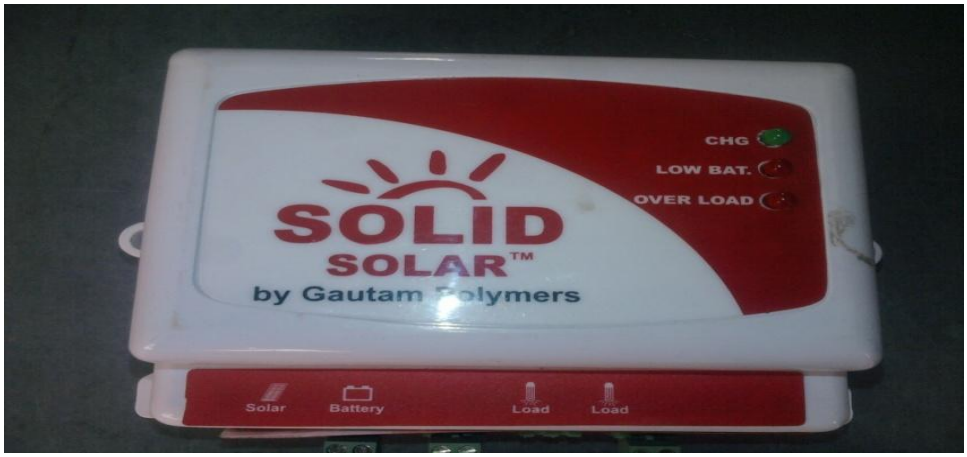


Figure 5 readymade solar charger

2.0 Scotch yoke mechanism

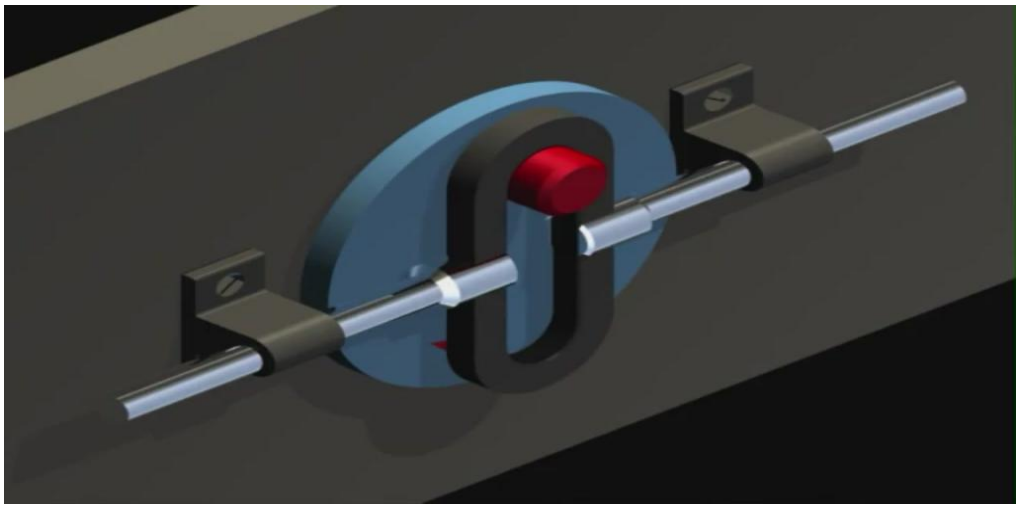


Figure 6 animation view of scotch yoke mechanism

The **Scotch yoke** (also known as **slotted link mechanism**) is a reciprocating motion mechanism, converting the linear motion of a slider into rotational motion or vice versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The shape of the motion of the piston is a pure sin wave over time given a constant rotational speed.

Figure 7 scotch yoke mechanism

2.1 Applications:

This setup is most commonly used in control valve actuators in high pressure oil and gas pipelines. Although not a common metalworking machine nowadays, crude shapers can use a Scotch yoke. Almost all those use a Whitworth linkage, which gives a slow speed forward cutting stroke and a faster return. It has been used in various internal combustion engines, such as the Bourke engine and many hot air engines and steam engines.
The term scotch yoke continues to be used when the slot in the yoke is shorter than the diameter of the circle made by the crank pin. For example, the side rods of a locomotive may have scotch yokes to permit vertical motion of intermediate driving axles.

2.2 Circuit breaker:

A **circuit breaker** is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and

interrupt current flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switch gear designed to protect high voltage circuits feeding an entire city.

Figure 8 A two-pole miniature circuit breaker

Types of circuit breakers

2.2.1 Low-voltage circuit breakers

Low-voltage (less than 1,000 V_{AC}) types are common in domestic, commercial and industrial application, and include:

- MCB (Miniature Circuit Breaker)—rated current not more than 100 A. Trip characteristics normally not adjustable. Thermal or thermal-magnetic operation. Breakers illustrated above are in this category.

There are three main types of MCBs:

1. Type B - trips between 3 and 5 times full load current;
2. Type C - trips between 5 and 10 times full load current;
3. Type D - trips between 10 and 20 times full load current. In the UK all MCBs must be selected in accordance with BS 7671.

- MCCB (Molded Case Circuit Breaker)—rated current up to 2,500 A. Thermal or thermal-magnetic operation. Trip current may be adjustable in larger ratings.
- Low-voltage power circuit breakers can be mounted in multi-tiers in low-voltage switchboards or switchgear cabinets.

2.2.2 Magnetic circuit breakers

Magnetic circuit breakers use a solenoid (electromagnet) whose pulling force increases with the current. Certain designs utilize electromagnetic forces in addition to those of the solenoid. The circuit breaker contacts are held closed by a latch. As the current in the solenoid increases beyond the rating of the circuit breaker, the solenoid's pull releases the latch, which lets the contacts open by spring action. Some magnetic breakers incorporate a hydraulic time delay feature using a viscous fluid. A spring restrains the core until the current exceeds the breaker rating. During an overload, the speed of the solenoid motion is restricted by the fluid. The delay permits brief current surges beyond normal running current for motor starting, energizing equipment, etc. Short circuit currents provide sufficient solenoid force to release the latch regardless of core position thus bypassing the delay feature. Ambient temperature affects the time delay but does not affect the current rating of a magnetic breaker

2.3 Blades:

A **blade** is that portion of a tool, weapon, or machine with an edge that is designed to cut and/or puncture, stab, slash, chop, slice, thrust, or scrape surfaces or materials. A blade may be made from a flaking stone, such as flint, metal (usually steel), ceramic, or other material.

Here we used two blades i.e fixed blade and sliding blade

2.3.1 Fixed blade:-the blade which has no motion is called Fixed blade. This fixed blade is welded to the frame .And this is placed below the sliding blade.

2.3.2 Sliding blade:-This blade slide over the moving blade .This blade is connect to wheel and this is connected to DC motor.

Figure 9 showing sliding and moving blade

3.0 CIRCUIT DIAGRAM:

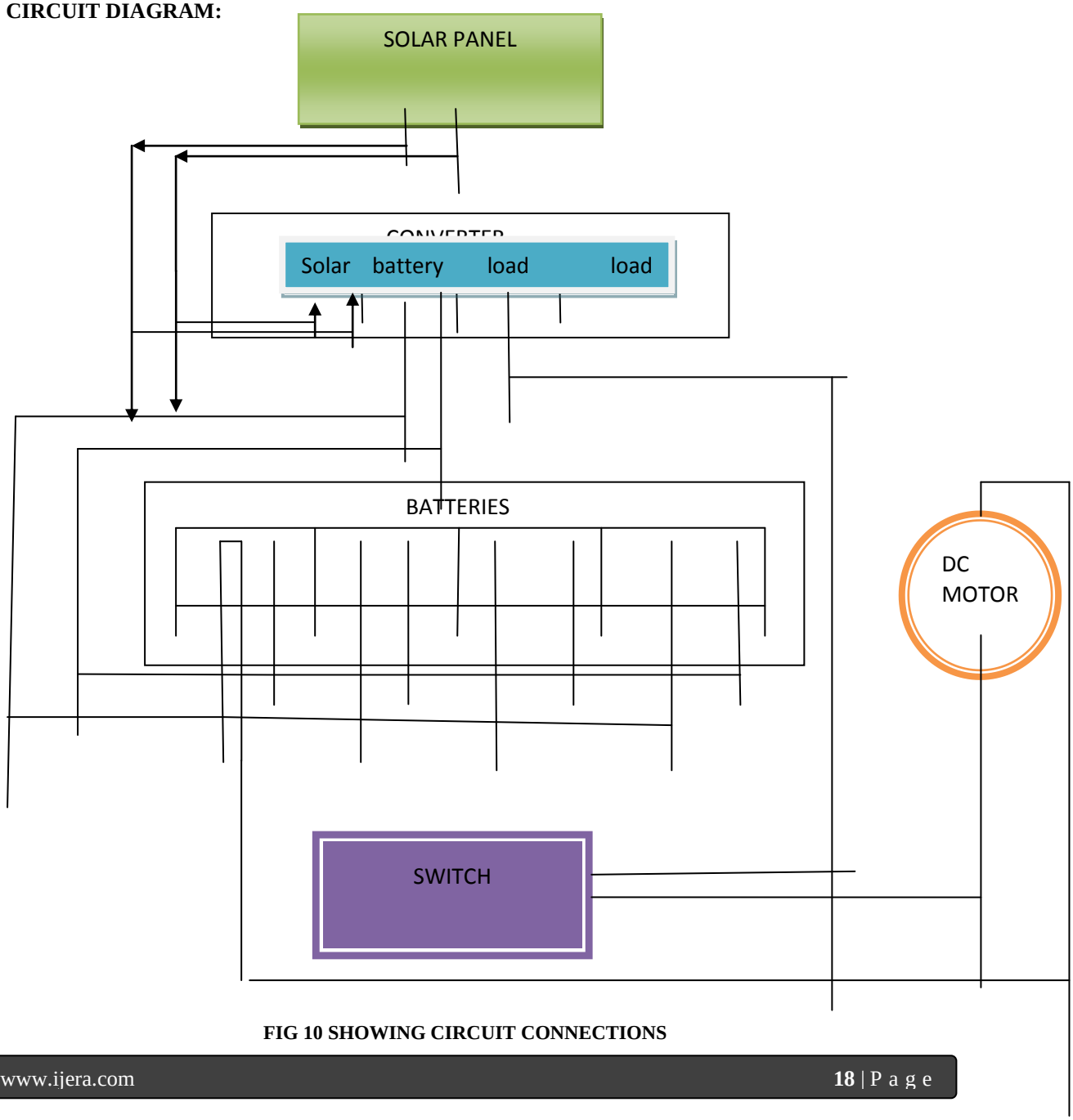


FIG 10 SHOWING CIRCUIT CONNECTIONS

3.1 WORKING OF SOLAR POWERED GRASS CUTTER:

Coming to the working of solar powered grass cutter , it has panels mounted in a particular arrangement at an angle of 45 degrees in such a way that it can receive solar radiation with high intensity easily from the sun. These solar panels convert solar energy into electrical energy as studied earlier. Now this electrical energy is stored in batteries by using a solar charger. The main function of the solar charger is to increase the current from the panels while batteries are charging, it also disconnects the solar panels from the batteries when they are fully charged and also connects to the panels when the charging in batteries is low. The motor is connected to the batteries through connecting wires .Between these two mechanical circuit breaker switch is provided. It starts and stops the working of the motor. From this motor, the power transmits to the mechanism and this makes the blade to slide on the fixed blade and this makes to cut the grass.

Figure 10 orthographic view of solar powered grass cutter

4.0 CALCULATIONS AND RESULT

P = $\frac{2\pi NT}{60}$ watts

P = power

N = Speed of motor

T = Torque

Then P=V*I

V=voltage

I=current

❖ TORQUE AND POWER OF A MOTOR WITH NO LOAD CONDITIONS :

P=V*I

=12*25

=300W

N= 800 RPM

Then

P = $\frac{2\pi NT}{60}$

300=$\frac{2*\pi*800*T}{60}$

18000=2*π*800*T

T=3.58N-m

❖ TORQUE AND POWER OF A MOTOR WITH LOAD CONDITIONS :

P=V*I
=12*29
=348W
N=600 RPM
Then
$P = \frac{2\pi NT}{60}$
$348=\frac{2*\pi*600*T}{60}$
20880=2*π*600*T
T=5.53 N-m

OBTAINING RESULTS

Torque with No Load Conditions =3.58N-M
Torque with Load Conditions =5.53 N-M

4.1 ADVANTAGES AND LIMITATIONS

ADVANTAGES:

- Compact size and portable
- Easy to move from one place to another place
- Operating principle is simple.
- Non-skilled person also operate this machine

LIMITATIONS

- Large time required to remove the grass
- Manually operated
- Difficult to operate in rainy seasons

APPLICATION

- For cricket ground.
- The football ground.
- All garden
- All Playground

5.0 COST BENEFIT ANALYSIS:

In our market, the approximate cost of an electric grass cutter is □., 25000/-.Coming to our project, we are modeling a solar powered grass cutter with an estimated cost of

Table 2: Cost benefit analysis

S.No	Component	Quantity	Estimated cost (Rs.)
1	Solar panel	1	**3500**
2	DC motor	1	**3000**
3	Batteries	4	**3600**
4	Solar charger	1	**2000**
5	Materials a. Square pipe=3 a. L angular =2 a. Flat plate=3	8	**2000**
6	Electrical components a. Mechanical switch = 1 b. Wires = 5 Meters	18	**300**

	c. Connections pins = 12		
7	Expenses	1	**600**
	Total	34	**15000**

5.1 Product Description;

Table 3: Specifications

Motor power	350w,24v,2500rpm
Battery type	Li –on Battery
Battery speciation	12v ,7.2 Ah
Charging time	5 to 6 Hrs
Solar charger	12 v,10Ah
Solar panel	50w,12v

CONCLUSION:

Our project entitled Fabrication of solar powered grass cutter is successfully completed and the results obtained are satisfactory. It will be easier for the people who are going to take the project for the further modifications.

This project is more suitable for a common man as it is having much more advantages i.e, no fuel cost, no pollution and no fuel residue, less wear and tear because of less number of moving components and this can be operated by using solar energy. This will give much more physical exercise to the people and can be easily handled.

As we are nearer to Equator, the solar energy (non-conventional energy) is vastly available, so it is easy to charge the battery and is also pollution free. But the initial investments of the solar powered grass cutter is high. At present in order to curtail global warming and ozone depletion, the Government of India is offering subsidy for the solar equipments. The industries are producing these components in mass productions, so the cost of the system may come down. So in future it is expected to run all equipments by using solar energy.

This system is having facility of charging the batteries while the solar powered grass cutter is in motion. So it is much more suitable for grass cutting also. The same thing can be operated in night time also, as there is a facility to charge these batteries in day light.

FUTURE WORK

We completed our project successfully with the available sources. But the results and modifications are not up to the expectations. This can be further improved by incorporating the following modifications to obtain better results.

The mechanism which we used ie scotch yoke mechanism does not given excepted efficiency. This efficiency can be increased by using some other mechanism. and speed of motor is reduce because we have used heavy material and this material can be replaced by using light weight material .and design of blades should be done based on types of grass is used to cut.

The project which we have done surly reaches the average familes because the grass can be trimmed with minimum cost and with minimum time Finally this project may give an inspiration to the people who can modify and can obtain better results.

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