# Solar Powered Vehicle

Yogesh Sunil Wamborikar, Abhay Sinha

***Abstract*—The renewable energy is vital for today's world as in near future the non renewable sources that we are using are going to get exhausted. The solar vehicle is a step in saving these non renewable sources of energy. The basic principle of solar car is to use energy that is stored in a battery during and after charging it from a solar panel. The charged batteries are used to drive the motor which serves here as an engine and moves the vehicle in reverse or forward direction. The electrical tapping rheostat is provided so as to control the motor speed. This avoids excess flow of current when the vehicle is supposed to be stopped suddenly as it is in normal cars with regards to fuel. This idea, in future, may help protect our fuels from getting extinguished.**

**All recent electric vehicles present drive on AC power supplied motor. The setup requires an inverter set connected to battery through which DC power is converted to AC power. During this conversion many losses take place and hence the net output is very less and lasts for shorter duration of time. Although this is cheaper the setup and maintenance required is much more in AC drive than DC drive. The vehicle designed is controlled by ELECTRICAL means and not by ELECTRONIC means**

*Index Terms*— **D.C. Motor, Rheostat Control, Lead-acid batteries, Solar panel, Battery Cycle.**

## I. Introduction

T Energy is one of the most vital needs for human survival on earth. We are dependent on one form of energy or the other for fulfilling our needs. One such form of energy is the energy from FOSSIL FUELS. We use energy from these sources for generating electricity, running automobiles etc. But the main disadvantages of these FOSSIL FUELS are that they are not environmental friendly and they are exhaustible. To deal with these problems of FOSSIL FUELS, we need to look at the NON-CONVENTIONAL SOURCES of energy. With regard to this idea we have designed an Electrical vehicle that runs on solar energy. The vehicle designed is a three wheel drive and can be used for shuttle and short distances. As these vehicles form the future of the automotive industry, we need to concentrate on improving their design and making them cost effective. This vehicle is an initiative in this direction.

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F. A. Yogesh Wamborikar was with the SRM university as a student of Electrical and ElectronicsEngineering,Chennai,TamilNadu,India (Ph-+91-9730891972,yogesh670@gmail.com).

S. B. Author, Abhay Sinha., is with SRM University, Chennai. He is a final year student of Electrical and Electronics Department in SRM university(Ph-+91-9789811380,email:-abhay.s.4u@gmail.com).

## II. Basic Functional Diagram

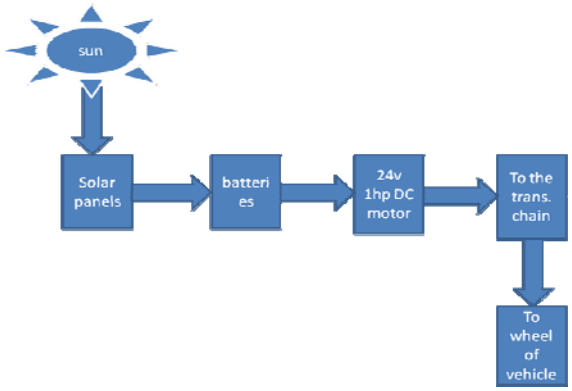


Fig. 1 Basic block Diagram Representation of Solar vehicle

The above diagram gives an overview of the working of solar vehicle. Sun is the main source of energy for the vehicle. Energy from Sun is captured by the solar panels and is converted to electrical energy. The electrical energy thus formed is being fed to the batteries that get charged and is used to run 24 V DC high torques DC series motor. The shaft of the motor is connected to the rear wheel of the vehicle through chain sprocket. The batteries are initially fully charged and thereafter they are charged by panels. This helps in completing the charging-discharging cycle of the batteries, which is very important for proper working of batteries.

## III. Basic Circuit Diagram

The fig 2 shown below represents the connections of the motor for forward and backward motion. The connections are made from battery to motor via switch, controller unit and the solar panel. As stated before, the motor used in this vehicle is 24 V dc series motor. There are four terminals on motor, namely A1, A2, F1, F2, as A1, A2 are the armature terminals and they are internally shorted. All the connections are made keeping the DPDT switch at the centre. The either connections on DPDT switch are made for forward direction motion of motor and the next side of DPDT switch is made for reverse direction of motor. The motor will work as the switch is kept in either of the directions as per requirements. The A2 is directly taken from battery to the positive side of DPDT switch and F2 is taken via controller unit to the negative terminal of switch. For the DPDT the centre

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terminals are given the upper side as positive from battery and the lower as the negative from battery. The controller unit used here is a high resistance setup box which can withstand up to the current of 60amps. Now the A1, A2 are the internally shorted terminals of the motor. Thus either of the one is the main and another one is the dummy. In case of our motor the A1 terminal is dummy and A2 is the main terminal. Thus all connections are made keeping A2 as the main terminal. In the switch the A2 and F1 are the terminals that are responsible for the reverse motion of motor. All the connections are directly to switch, A2 is given to positive and F1 given to the negative of switch.

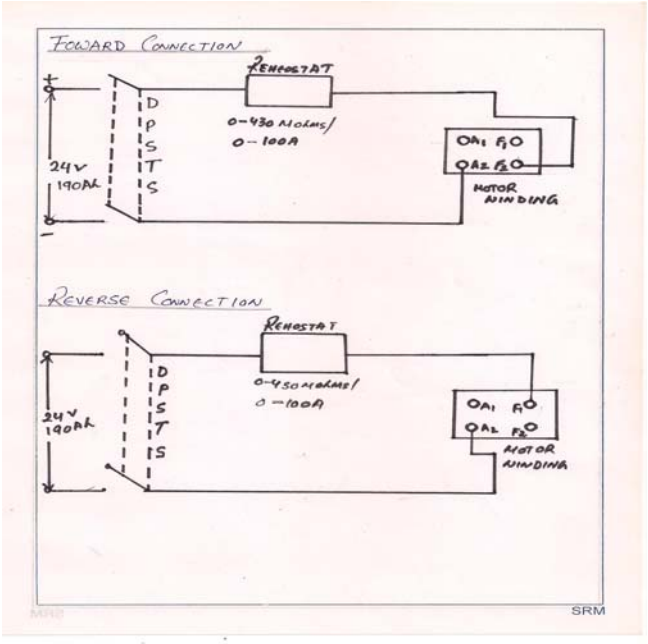


Fig. 2 Circuit diagram for the movement of the vehicle

## IV. COMPONENTS USED

Various types of electrical components were used for making the solar powered vehicle. A list of these components used with their range and the specific quantities that were required for making the solar vehicle is given in the following table.

TABLE I
LIST OF VARIOUS COMPONENTS USED

| **Components used** | **Range** | **Quantity** |
|---|---|---|
| Batteries( heavy inverter batteries) | 24V 190Ah | 2*12V |
| Solar module | 140Wp(Watt Peak) | 1 |
| Connecting Cables | Motor connection:-25Sq.mm high voltage cables.<br><br>Solar module to charge controller unit:-1Sq.mm<br><br>Charge controller to battery unit:-2Sq.mm | 10 meters<br><br>1 meter<br><br>1 meter |
| Motor | High torque DC motor 1Hp=746W | 1 |

Apart from the above listed components the main component that is responsible for speed control of the motor is the speed control switch. It is defined as follows:-

### *A. SPEED CONTROL SWITCH*

The speed control of the DC motor is the essential part of the vehicle. For controlling speed of the motor, a switch was designed with 8 tapping, giving different values of resistance at each tapping, hence limiting the current that flows in the motor. The switch uses pure Nichrome wire for resistances. It uses a 8 tapping DC switch. The front view of the switch is as follows:-


Fig. 3. The front view of the speed control unit

The switch has been provided with two terminals; one for the motor connections and the other for the battery connections. The arrangement of the switch is more or less like a rheostat. The different tapping act as resistance points. With each increase in the tapping value the value of resistance decrease, thus at the last tapping the motor will run at the highest speed as the limiting resistance will be minimum whereas the high torque condition of the motor will arise when the minimum tapping will be used, since the limiting resistance will be maximum.

The picture showing the view of the tapings is shown below in fig 4. It can be easily concluded that two coils are connected in a series to give one taping hence increasing the resistance.

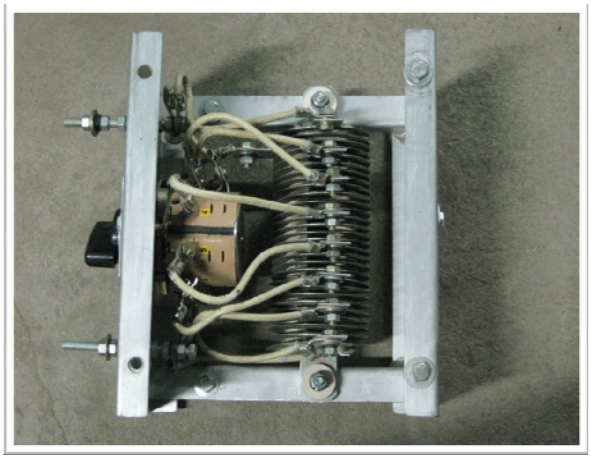

Fig 4. The upper view if Speed control switch depicting the taping connections

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The value of resistance at each taping is given in the table below. This resistance value is used for controlling the 1 hp motor.

TABLE II

VALUES OF RESISTANCE AT VARIOUS TAPINGS OF THE SWITCH

| TERMINAL NUMBER | RESISTANCE |
|---|---|
| 1 | 435 milli-ohms |
| 2 | 405 milli-ohms |
| 3 | 358 milli-ohms |
| 4 | 290 milli-ohms |
| 5 | 220 milli-ohms |
| 6 | 150 milli-ohms |
| 7 | 076 milli-ohms |
| 8 | ZERO |

### *B. SOLAR PANEL DETAILS - 140Wp*

The solar panel used in the solar vehicle is of the rating of 140 WP. The main point that should be kept in mind while making a solar vehicle is the mounting of the solar panel. The panel should be mounted in such a way that it receives maximum sun rays so that it gives its maximum efficiency.
For the vehicle designed, we have mounted the solar panel in SOUTH-EAST direction during the time 6 AM to 11.30 AM. After that the panel is changed to a SOUTH-WEST direction. We have used the conventional roof-top mounting technique for the solar panel A 6 feet by 4 feet plywood has been used and mounted on the top of vehicle.
The solar cell used in the vehicle is multi-crystalline. The reason behind using the multi crystalline cell is that it is more efficient than the mono-crystalline cell and the rate of conversion of energy is faster in the former. 36 cells are used in the PV module of this vehicle. The upper frame of this solar module is covered with thick glass to avoid breakage of the solar panel.

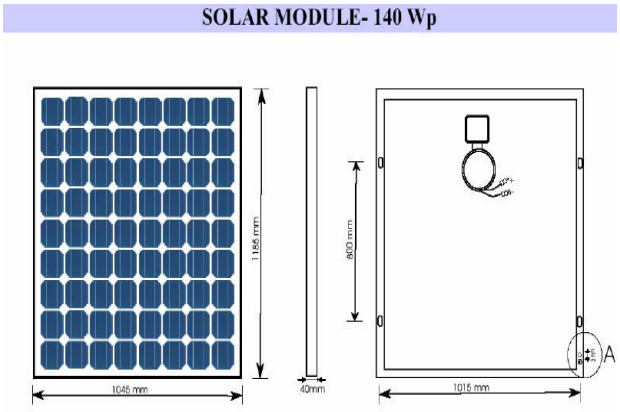


Fig 5. The digrammatic representation of the panel and the panel connections

## V. WORKING OF THE VEHICLE

The solar module mounted on the top of car is used to charge the batteries via charge controller. A 140 WP solar module is used with output ranging from 24V to 25V at STC. The batteries are initially fully charged and then they are connected to solar module for charging. This helps to keep the battery charged always. This is also done as the efficiency of solar module is only 15%.Thus under this condition the battery gets fully charged again within 3hrs-3.5hrs. Thus to keep the full sine wave of charging this time lap is made. The maximum solar radiations are obtained between morning 10am to evening 3:30pm. Hence the panel is so mounted that maximum output may be obtained. As the supply is given through DPDT switch the motor takes a high starting current to propel the wheel to move in forward direction. On start the load on motor is nearly 250kg including the weight of person driving it. The motor after start acquires the maximum speed of 20kmph to 30kmph. The batteries get charged always from the solar panel and so it provides the continuous run for the vehicle. Motor must be started on top most gear so as to get maximum torque and speed to lift the full load. The speed may be varied later according to the driver's requirements. As the speed varies the load current also varies. So the speed variation must be low to keep battery alive for maximum duration of time. For stopping the motor, the speed control switch should be brought to minimum gear and then switch should be open; thereafter the mechanical brakes should be applied. The mechanical brakes can be applied instantly during emergency but this should be avoided as this could damage the motor and also produce unnecessary back emf.
The average battery back-up is around four hours. The batteries are continuously charged by the solar panel but to increase their rate of charging three dynamos each of 24 V can be connected to the wheels of the vehicle. As the vehicle moves these dynamos will generate EMF and will charge the batteries. Hence the charging and discharging cycle of the batteries will be complete.

## VI. ADVANTAGES OF THE VEHICLE

The solar vehicles are the future of the automobile industry. They are highly feasible and can be manufactured with ease. The main advantages of a solar vehicle are that they are pollution less and are very economical. Since they cause no pollution they are very eco-friendly and are the only answer to the increasing pollution levels from automobiles in the present scenario. By harvesting the renewable sources of energy like the solar energy we are helping in preserving the non-renewable sources of energy. The other main advantages of the solar vehicle are that they require less maintenance as compared to the conventional automotives and are very user friendly.

## VII. CONCLUSION

The solar vehicle solves many problems related to the environment and is the best pollution free method. We need to make use of them so that we can reduce our dependence on fossil fuels. Solar vehicles do have some disadvantages like small speed range, initial cost is high. Also, the rate of conversion of energy is not satisfactory (only 17%). But these disadvantages can be easily overcome by conducting further research in this area; like the problem of solar cells can be solved by using the ultra efficient solar cells that give about 30-35% efficiency.
As this field of automobiles will be explored the problems will get solved. The solar automobiles have a huge

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prospective market and we should start using them in our day to day life. We have already completed making a solar vehicle prototype as our project and the vehicle is running successfully on solar power.
The picture of the running vehicle is shown below.


Fig.6 running vehicle

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