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Electric Vehicle Driven by Single Phase Induction Motor

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ABSTRACT

This paper presents a model of an electric vehicle based on the utilization of solar energy and electricity. Battery driven inverter is used to feed the single phase induction motor. The speed of the induction motor is controlled through voltage regulator using TRIAC. This model presents a new concept of hand driven electric vehicle with use of solar energy to charge the battery of the inverter. This vehicle being hand driven makes it applicable for physically handicapped people.

1. INTRODUCTION

Due to the problems caused by the gasoline engine on the environment and people, the automotive industry has turned to the electrical powered vehicle. The use of renewable energy has recently received worldwide attention in view of the continuous growth in energy consumption and the pressing need for reduction carbon emission to the atmosphere. Photovoltaic power has been a promising renewable energy source due to its zero pollution. Photovoltaic cells convert light into an electric current.

The electric vehicle which has been made before was by using DC motor, and power to the motor has been controlled using potentiometer. The battery was directly connected to the DC controller and to the DC motor, which drives the vehicle [1].

The use of 3 phase AC motors are also been done in the electrical vehicle. They have used 3 phase 4 pole induction motor. No transmission was required; the motor was directly connected to the rear wheels. Power of the motor was across 280KW. Once the battery was fully charged, the car can run till 400km assuming a constant speed of 60km/hr [3].

In this work,1 AC induction motor has been used instead of DC motor because it is robust and the power loss is less. Due to the use of single phase motor the power consumed by the motor is less, so it is good for lighter load applications. All the controls are been done by hand, there is no need of using the foot to control the vehicle. So it is very useful for physically challenged people who are unable to drive an ordinary vehicle.

The speed of the motor is been controlled by controlling the supply voltage of the motor using voltage regulator.

Literature shows that the first electric vehicle was built in 1832, in Scotland by Robert Anderson, who created the first electric carriage, and in 1895 A.L. Ryker built an electric tricycle and William Morrison built a six passenger wagon [1]. In 1902 Wood created the Electric Phaeton, the Phaeton had a range of 28.2km, and a top speed of 22.4km and cost of Rs 1,20,000 [2].In 1911, the first gasoline electric hybrid car was released by the Woods Motor Vehicle Company of Chicago. The hybrid was a commercial failure, proving to be too slow for its price, and too difficult to service [2].

2. PROJECT MODEL AND IMPLEMENTATION

2.1. Block Diagram Of The Model.

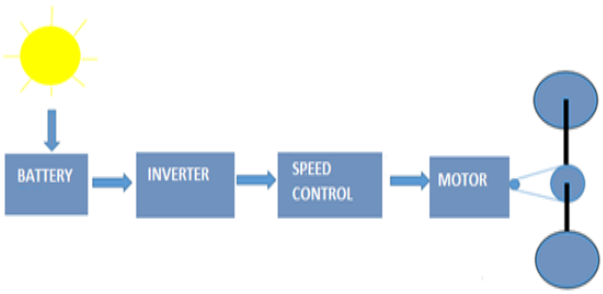

Fig 1.Block diagram showing the working of the model.

Solar power is feed to the battery of the vehicle, from which the battery will get charged. Solar power is the conversion of sunlight into electricity directly by using photovoltaic cells. The battery which has been used is low voltage level battery which is 12v car battery.

The inverter is used for converting the DC signal to AC signal with the help of switches. The output of the inverter is 12V AC, so by using step up transformer the voltage level has been increased to 220V AC. The amplified AC power is fed to the induction motor, which rotate the wheels of the vehicle.

2.2. INVERTER

A half bridge inverter, which uses only two switches has been used to convert Direct Current (DC) to Alternating Current (AC).The switches used are N channel MOSFETS (IRF540). The gate pulse for these MOSFETS has been generated from IC(CD4047) which is wired as astable-multivibrator. The operating frequency of the astable-

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multivibrator is been set to 50Hz. The MOSFET are directly driven by the Q and $\bar{Q}$ output of the IC (CD4047). The MOSFETS are connected in push pull configuration. The pulses Q and $\bar{Q}$ are feed to the gate terminal of the switches S1 and S2 respectively. As a result a square wave is generated from the drain terminal of the MOSFETS.

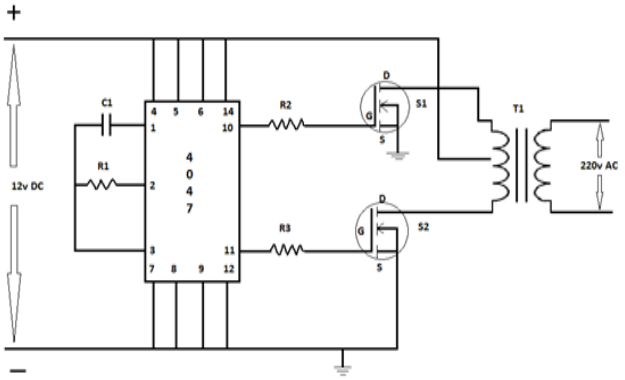

Fig 2. Circuit diagram of inverter using IC CD4047.

[The values of C1 is 0.2µF, R1 is 20 kΩ, R2 and R3 are 2.2 kΩ.]

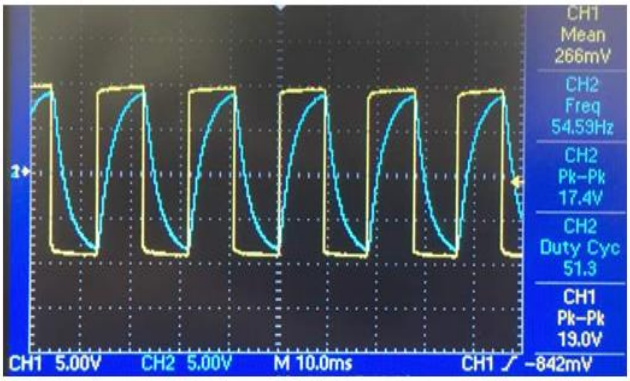

Fig 3. Output of the inverter in DSO.

2.3. MOTOR SPEED CONTROL

- **Variable voltage control.**

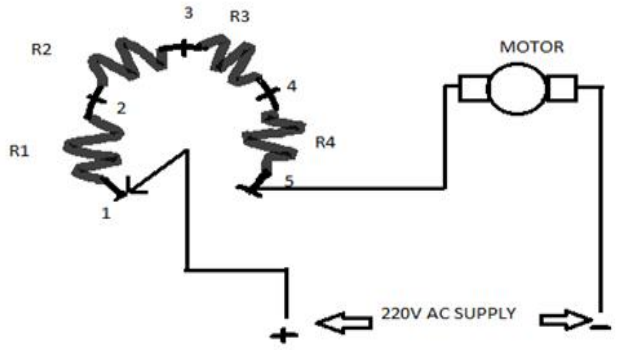

Fig 4.Circuit diagram of voltage control using variable resistance.

The motorspeed canbe controlled by controlling the supply voltage. It can be done by adding maximum resistance in series with the single phase AC motor. Thus the voltage drop across the resistance will be maximum and hence a reduced voltage will be applied to the motor. When we move the knob to position 2, resistance R1 will be neglected and only the resistance from point 2 to point 5 will be in the circuit. Hence the voltage applied to the motor will be more than the previous case. When the knob is at the position 5 full voltage will be applied to the motor as there is no external resistance in the circuit, and hence the speed will be maximum.

- **Voltage control using TRIAC**

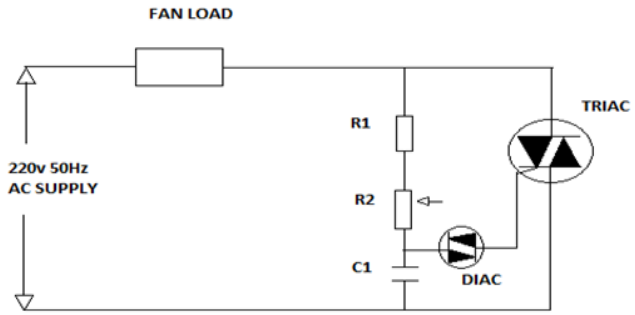

Fig 5.Circuit diagram of voltage regulator using TRIAC and DIAC.

This is also a voltage control technique but it is more efficient than conventional resistive type regulators, voltage drop in the resistance is converted to the heat energy, so there is loss of energy. In TRIAC based circuit the power loss is very less.

We have to keep the variable resistance to maximum position, so that there is no triggering is applied to the TRIAC. Then we have to give the supply and we have to vary the potentiometer so that the capacitor will start charging depending on the value of the resistance R1 and R2..Once the voltage of the capacitor is greater than the break over voltage of the DIAC, the DIAC will start conducting, thus the capacitor start discharging towards the gate terminal of TRIAC.

TRIAC start conducting and the main current will start to flow through into the fan. So by varying the potentiometer, the rate at which capacitor is going to be charged get varied. If the resistance is less the capacitor will charge at the faster rate, so that earlier will be the conduction of TRIAC.

[The value of R1 is 10 kΩ, R2 is 100kΩ and C1 is 1µF.]

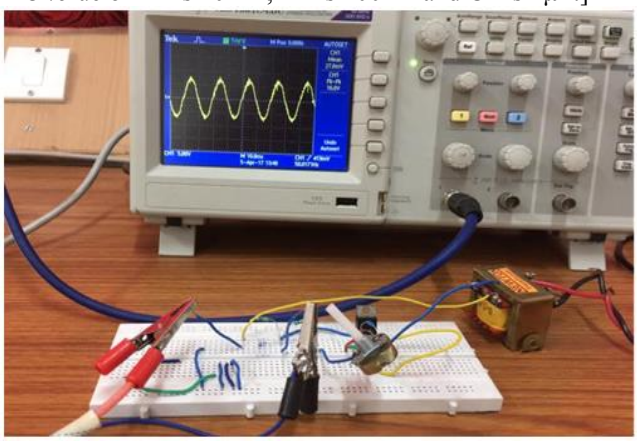

Fig 6.Output of voltage regulator which is used to control the speed of the motor.

3. COMPONENTS USED

- **Motor used**

I1n this project the motor used is a single phase induction motor, which has been taken out from an exhaust fan. The motor ratting are as follows:

Input voltage – 220V.
Input current – 0.8A.
Power required – 140W.

- **Battery used**

The battery used is Lead Acid battery. Ratting of the batter:-

Output voltage – 12V.
Output current – 35A.

- **Solar panel used**

Specification of panel
Nominal voltage – 12V

Number of cells – 36 cells.
Maximum voltage – 20V.
Maximum current – 0.64A.

Fig 7. Output voltage of solar panel for charging the battery of the vehicle.

4. VEHICLE FINAL MODEL

Fig 8.Solar power fed electric vehicle.

The final working model of the vehicle has been shown in the figure (Fig.8). The vehicle can only run in low speed, since the torque produced by the motor is low.

5. TORQUE CALCULATION OF THE MOTOR

Input electrical power to motor:
[Pin = I X V]
I = current in Amperes (A).
V = applied voltage (v).
Output mechanical power:
[Pout = T X W.]
T = torque measured in Nm.
W = angular speed in (rad/sec).

$$[W = \text{rpm X } \frac{2\prod}{60}]$$

Efficiency of the motor:

$$E = \frac{\text{mechanical output}}{\text{electrical input}}$$

$$E = \frac{Pout}{Pin}$$

Pout = Pin X E.
Replacing all the values:
T x W = I X V X E
So motor torque is given by:

$$T = \frac{I \text{ X } V \text{ X } E \text{ X } 60}{\text{rpm x } 2\prod}$$

$$T = \frac{0.6X \text{ } 220 \text{ X } 0.1 \text{ X } 60}{720 \text{ x } 2\prod}$$

T = 0.24Nm.

6. CONCLUSION

In this work, the designing of single phase inverter, designing of voltage control was successfully carried out. All the circuit were combined and been placed in the vehicle to drive the AC induction motor using solar power.

During the normal days, the solar panel gives the output voltage around 18v, this voltage is used for charging the battery. The battery power is been fed to the inverter. The inverter is been loaded with 220v 0.45A AC induction motor. The current drawn by the motor was 0.7A on full load.

The vehicle was successfully driven by the motor, but at low speed due to the heavy load of the battery and vehicle frame.We can use big high torque ratted motorto gain high speed for the vehicle.

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