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Efficient Energy Harvesting from Harvester in Farming

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ABSTRACT

Agriculture is the art and science of crop and livestock production. Energy harvesting is the process in which energy is derived from external sources. Solar energy is widely used as ambient energy that can be efficiently harvested and converted into electrical energy via solar panel. Farm has lot of equipment's and most of it uses energy. The farm can add up to meaningful generation of energy and reduce operating costs. Renewable energy and farming are winning combination. Crop cutting machine is a harvester used for grain break required less human effort and reasonable for middle class farmers.

Keywords : Farming, Harvesting, CMOS, DC Generator, Voltage Regulator, ABXYCD

I. INTRODUCTION

The shortage of labour from rural regions due to the development of industrial areas and series-increase 2-3 time of harvesting cost of many crop. Harvesting mechanization is to keep harvest timely and to reduce cost of labour and high production. Solar energy is used to run the harvester. This mechanical movement of harvester will be converted into electrical energy and inverter is used for converting DC into AC voltage and used for our purpose.

II. OBJECTIVES

- ✓ To establish definitions and measurements techniques that
- ✓ permit assessment of efficiency and effectiveness of energy harvester technologies in different applications.
- ✓ To enable the development of
- ✓ effective, commercially successful energy harvesting technologies.
- ✓ To grow energy in the form of digestible nutrients.
- ✓ To develop an effective harvester which is used for both crop cutting and energy generating.
- ✓ To design and fabricate machinery which can reduce workers which give much effect to our country in maximizing the profits to the farmers.
- ✓ To design and fabricate low cost machine.
- ✓ To provide solution for the problem of lack of energy faced by the farmers.

III. BLOCK DIAGRAM DISCRIPTION CIRCUIT DIAGRAM

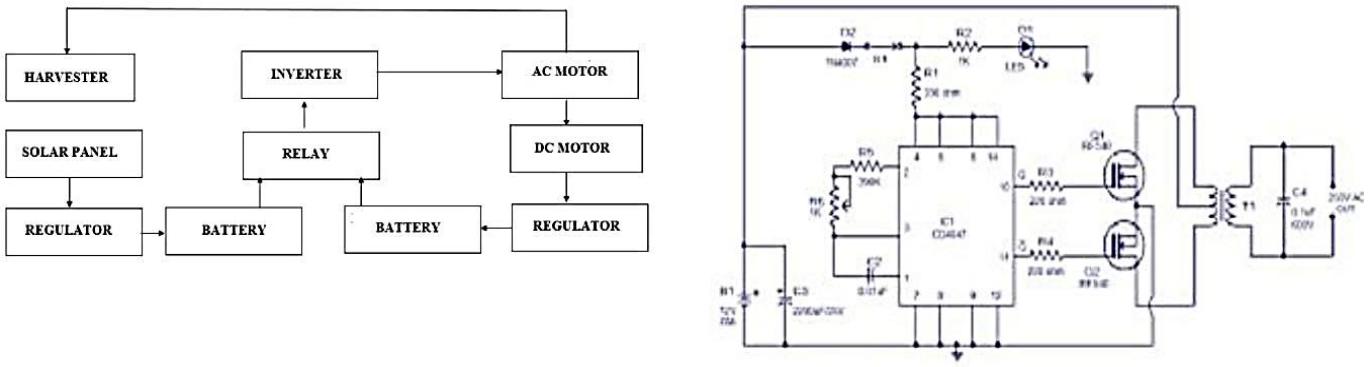

Figure 1

BLOCK DIAGRAM INVERTER

WORKING

CD 4047 is a low power CMOS astable /monostable multivibrator IC. Here it is wired as an astable multivibrator producing two pulse trains of 0.01s which are 180 degree out of phase at the pins 10 and 11 of the IC. Pin 10 is connected to the gate of Q1 and pin 11 is connected to the gate of Q2. Resistors R3 and R4 prevents the loading of the IC by the respective MOSFETs. When pin 10 is high Q1 conducts and current flows through the upper half of the transformer primary which accounts for the positive half of the output AC voltage. When pin 11 is high Q2 conducts and current flows through the lower half of the transformer primary in opposite direction and it accounts for the negative half of the output AC voltage

AC MOTOR

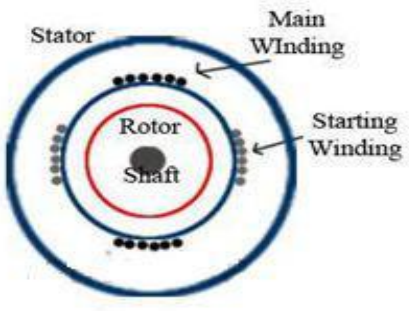

Figure 2

CONSTRUCTION OF SINGLE PHASE INDUCTION MOTORS

Similar to a d.c motor, single phase induction motor also has two main parts, one rotating and other stationary. The stationary part in single phase induction motors is Stator and the rotating part is Rotor.

The stator has laminated construction, made up of stampings. The stampings are lotted on its periphery to carry the winding called stator winding or main winding. This is excited by a single phase a.c supply. The laminated construction keeps iron losses to the minimum. The stampings are made up of material from silicon steel which minimizes the hysteresis loss.

The stator winding is wound for certain definite number of poles means when excited by single phase a.c supply, stator produces the magnetic field which creates the effect of the certain definite number of poles. The number of poles for which stator winding is wound decides the synchronous speed of the motor. The synchronous speed is denoted as 'Ns' and it has a fixed relation with supply frequency ' f ' and number of poles 'P'. The relation is given by,

Ns = 120f/p r.p.m

WORKING PRINCIPLE OF SINGLE PHASE INDUCTION MOTORS

For the motoring action, there must exist two fluxes which interact with each other to produce the torque. In d.c motors, field winding produces the main flux while d.c supply given to armature is responsible to produce armature flux. The main flux and armature flux interact to produce the torque.

In the single phase induction motor, single phase a.c supply is given to the stator winding. The stator winding carries an alternating current which produces the flux which is also alternating in nature. This flux is called main flux. This flux links with the rotor conductors and due to transformer action e.m.f gets induced in the rotor. The induced emf drives current through the rotor as rotor circuit is the closed circuit.

This rotor current produces another flux called rotor flux required for the motoring action. Thus second flux is produced according to induction principle due to induced e.m.f hence the motor is called induction motor. As against this in dc motor a separate supply is required to the armature to produce armature flux. This is Single phase induction motors are an important difference between d.c motor simple, robust, reliable and cheaper and an induction motor. for small ratings. They are available up to 1 KW rating.

COMPARISON BETWEEN SINGLE PHASE AND THREE PHASE INDUCTION MOTORS

- ✓ Single phase induction motors are simple in construction, reliable and economical for small power rating as compared to three phase induction motors.
- ✓ The electrical power factor of single phase induction motors is low as compared to three phase induction motors.
- ✓ For the same size, the single-phase induction motors develop about 50% of the output as that of three phase induction motors.
- ✓ The starting torque is also low for asynchronous motors / single phase induction motor.
- ✓ The efficiency of single phase induction motors is less compared to that of three-phase induction motors.

DC MOTOR

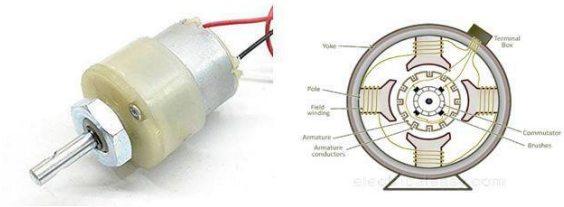

Figure 3. DC MOTOR

YOKE OF DC GENERATOR:

Yoke or the outer frame of DC generator serves two purposes,

1. It holds the magnetic pole cores of the generator and acts as cover of the generator.

2. It carries the magnetic field flux. In small generator, yoke are made up of cast iron. Cast iron is cheaper in cost but heavier than steel. But for large construction of DC generator, where weight of the machine is concerned, lighter cast steel or rolled steel is preferable for constructing yoke of DC generator.

Normally larger yokes are formed by rounding a rectangular steel slab and the edges are welded together at the bottom. Then feet, terminal box and hangers are welded to the outer periphery of the yoke frame.

POLE CORES AND POLE SHOES OF DC GENERATOR:

There are mainly two types of construction available. (i): Solid pole core, where it is made of a solid single piece of cast iron or cast steel. (ii): Laminated pole core, where it made of numbers of thin, limitations of annealed steel which are riveted together. The thickness of the lamination is in the range of 0.04" to 0.01". The pole core is fixed to the inner periphery of the yoke by means of bolts through the yoke and into the pole body. Since the poles project inwards they are called salient poles.

ARMATURE CORE OF DC GENERATOR:

The purpose of armature core is to hold the armature winding and provide low reluctance path for the flux through the armature from N pole to S pole. Although a DC generator provides direct current but induced current in the armature is alternating in nature. That is why, cylindrical or drum shaped armature core is buildup of circular laminated sheet. In every circular lamination, slots are either die - cut or punched on the outer periphery and the key way is located on the inner periphery as shown ducts are also punched of cut on each lamination for circulation of air through the core for providing better cooling. Up to diameter of 40", the circular stampings are cut out in one piece of lamination sheet. But above 40", diameter, number of suitable sections of a circle is cut. A complete circle of lamination is formed by four or six or even eight such segment.

ARMATURE WINDING OF DC GENERATOR:

Armature winding are generally formed wound. These are first wound in the form of flat rectangular coils and are then pulled into their proper shape in a coil puller. Various conductors of the coils are insulated from each other. The conductors are placed in the armature slots, which are lined with tough insulating material. This slot insulation is folded over above the armature

conductors placed in it and secured in place by special hard wooden or fiber wedges. Two types of armature windings are used – Lap winding & Wave winding.
holder or brush box. As shown in figure, the brush face is placed on the commutator segment which is attached to the brush holder.

COMMUTATOR OF DC GENERATOR:

The commutator plays a vital role in DC generator. It collects current from armature and sends it to the load as direct current. It actually takes alternating current from armature and converts it to direct current and then send it to external load. It is cylindrical structured and is buildup of wedge - shaped segments of high conductivity, hard drawn or drop forged copper. Each segment is insulated from the shaft by means of insulated commutator segment shown below. Each commutator segment is connected with corresponding armature conductor through segment riser or lug.

BEARING OF DC GENERATOR:

For small machine, ball bearing is used and for heavy duty DC generator, roller bearing is used. The bearing must always be lubricated properly for smooth operation and long life of generator.

WORKING PRINCIPLE OF DC GENERATOR

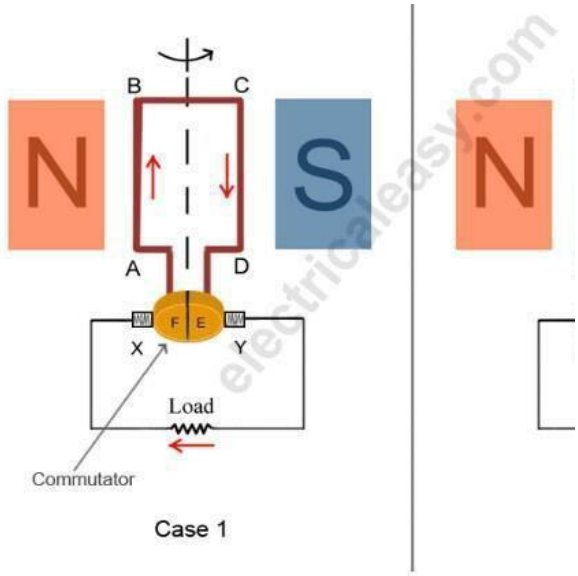

Figure 4

It is seen that in the first half of the revolution current flows always along ABXYCD i.e. brush No 1 in contact with segment a. In the next half revolution, in the figure the direction of the induced current in the coil is reversed. But at the

same time the position of the segments a & b are also reversed which results that brush no 1 comes in touch with the segment b. Hence, the current in the load resistance again flows from X to Y. The wave from of the current through the load circuit is as shown in the figure. This current is unidirectional.

This is basic working principle of DC generator, explained by single loop generator model. The position of the brushes of DC generator is so arranged that the changeover of the segments a and b from one brush to other takes place when the plane of rotating coil is at right angle to the plane of the lines of force. It is so become in that position, the induced emf in the coil is zero.

VOLTAGE REGULATOR

As we have previously talked about that regulated power supply is a device that mechanized on DC voltages and also it can uphold its output accurately at a fixed voltage all the time although if there is a significant alteration in the DC input voltage. ICs regulator is mainly used in the circuit to maintain the exact voltage which is followed by the power supply. A regulator is mainly employed with the capacitor connected in parallel to the input terminal and the output terminal of the IC regulator. For the checking of gigantic alterations in the input as well as in the output filter, capacitors are used. While the bypass capacitors are used to check the small period spikes on the input and output level. Bypass capacitors are mainly of small values that are used to bypass the small period pulses straightly into the Earth.

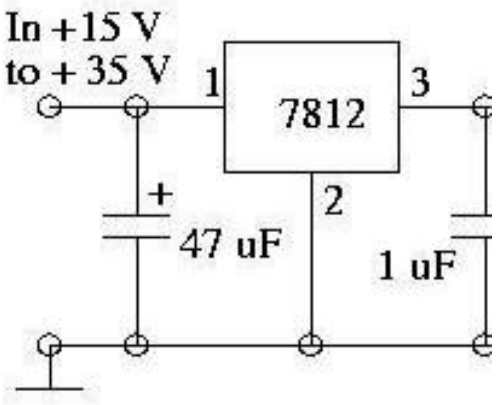

Figure 5

ADVANTAGES OF IC 7812

- ✓ 7812 voltage regulator IC does not require any component to balance or saturate their output voltage.
- ✓ The 7812 IC has a built-in protection from the high current.

There is a heat-sink with the common ground connected with which is helpful in order to prevent our regulator IC from overheating and short-circuits making it uncompromising in the most application.

BATTERY

Figure 6. Battery

BATTERY CHARGING TIME

To fully recharge a 12V 7Ah hour Sla battery using a 12V 7Ah charger would take approximately 4.5 hours if the battery is fully discharged.

Charging time of battery = Battery Ah /
Charging Current

T = Ah / A

Where,

T = Time hrs.

Ah = Ampere Hour rating of battery

A = Current in Amperes

SOLAR PANEL

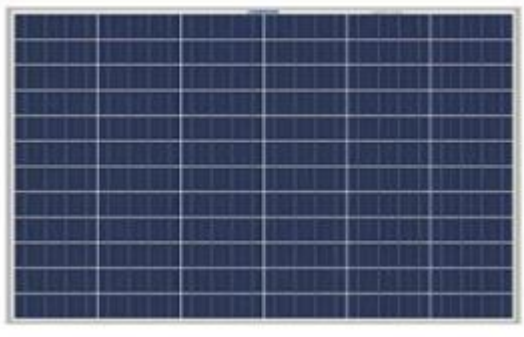

Figure 7. Solar Panel

It is a device which converts the light energy into electrical energy. When light is allowed to fall on this cell, the cell generates a voltage across its terminals. This voltage increase whit increase in the light intensity. The cell is so designed that a large area is exposed to light which enhances the voltage generation across the two terminals of the cell. Construction and working is explained below.

CONSTRUCTION AND WORKING OF SOLAR CELL

It essentially consists of a silicon PN junction diode with a glass window on top surface layer of P material is made extremely thin so, that incident light photon's may easily reach the PN junction. When these photons collide with valence electrons'. They comport them sufficient energy as to leave their parent atoms. In this way free electrons and holes are generated on both sides of the junction. Due to these holes and electrons current are produces. This current is directly proportional to the illumination's (mw/cm2) and also depends on the size of the surface area being illuminated.

The open circuit voltage is a function of illumination. The symbol is shown below.

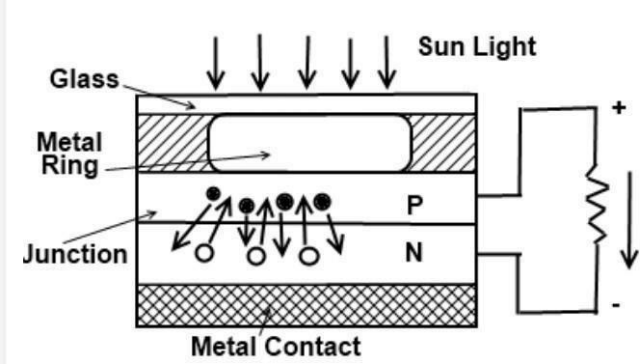

Figure 8. Solar

Cell Construction

As shown in the given diagram the Solar cell is like an ordinary diode. It consist of silicon, germanium PN junction with a glass windows on the top surface layer of P-Type, the P-Type material is made very thin and wide so that the incident light photon may easily reach to PN junction.

The P nickel plated ring around the P layer acts as the positive output terminal's (anode) and the metal contact at the bottom acts as a Cathode. Silicon and germanium are the most widely used semiconductors

materials for solar cells although gallium arsenide, Indium arsenide and Cadmium arsenide are also being used nowadays.

RELAY

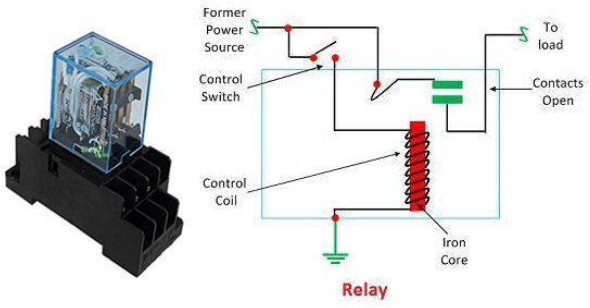

Figure 9

It works on the principle of an electromagnetic attraction. When the circuit of the relay senses the fault current, it energises the electromagnetic field which produces the temporary magnetic field.

This magnetic field moves the relay armature for opening or closing the connections. The small power relay has only one contact, and the high power relay has two contacts for opening the switch.

The inner section of the relay is shown in the figure. It has an iron core which is wound by a control coil. The power supply is given to the coil through the contacts of the load and the control switch. The current flows through the coil produces the magnetic field around it. Due to this magnetic field, the upper arm of the magnet attracts the lower arm. Hence close the circuit, which makes the current flow through the load.

If the contact is already closed, then it moves oppositely and hence open the contacts

INVERTER CIRCUIT DIAGRAM & DESCRIPTION INVERTER

are 180 degree out of phase at the pins 10 and 11 of the IC. Pin 10 is connected to the gate of Q1 and pin 11 is connected to the gate of Q2. Resistors R3 and R4 prevents the loading of the IC by the respective MOSFETs. When pin 10 is high Q1 conducts and current flows through the upper half of the transformer primary which accounts for the positive half of the output AC voltage. When pin 11 is high Q2 conducts and current flows through the lower half of the transformer primary in opposite direction and it accounts for the negative half of the output AC voltage.

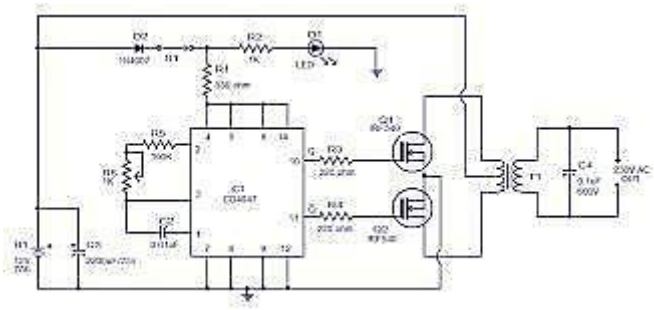

Figure 10. ACMotor

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DC MOTOR

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VOLTAGE REGULATOR

The C1 capacitor is known as bypass capacitor and is employed to bypass extremely tiny duration spikes to the ground with no distress the other components. C2 is the filter capacitor employed to steady the slow changes in the voltage applied at the input of the circuit. Escalating the value of the capacitor amplify the stabilization as well as the declining value of the capacitor reduces the stabilization. Moreover this capacitor is not alone capable to ensure very constricted period spikes emerge at the input. C3 is known as a filter capacitor employed in the circuit to steady the slow alterations in the output voltage. Raising the value of the capacitor enlarges the stabilization furthermore delining the value of the capacitor declined the stabilization. Moreover this capacitor is not alone capable to ensure very fine duration spikes happen at the output. U1 is the IC with positive DC and it upholds the output voltage steady exactly at a constant value even although there are major deviation in the input voltage. Input pin of the IC positive unregulated voltage is given in regulation. Ground pin where the ground is given. This pin is neutral for equally the input and output. The output of the regulated 12V volt is taken out at this pin of the IC regulator.

SOLAR PANEL

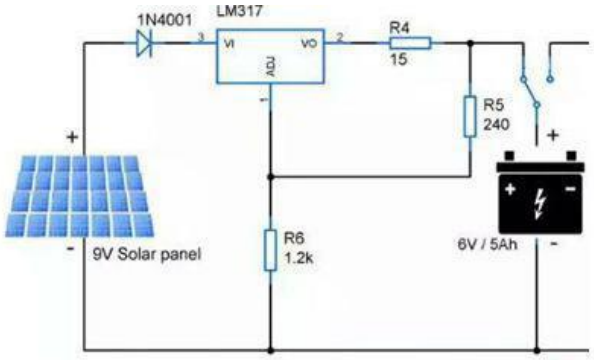

Figure 11

The working of the above circuit starts with the 9V solar panel which converts the incident solar power into the electrical energy. A diode 1N4001 was connected to eliminate the risk of reverse flow of current during night time. The input from the solar power is fed into the LM317 regulator IC. A resistor of R5 and R6 was connected to it to obtain the required output from the IC. Let's do some math Applying the R5 and R6 values in the LM317 Vout formula Vout = 1.25 * (1 + 1200 / 240) = 7.5 Volts. We will get 7.5 V in the output pin of the IC LM317. The reason we are using 7.5 V to charge a 6 V battery because the property of lead acid batteries. A 6v Lead acid battery will only charge to 100% when 7.3 V is applied to it. So considering the losses we have chosen R5 and R6 to give 7.5 V as output in the Vout pin. R4 resistor is to limit the input charging current to the battery because a battery must be given current of 1/10 of its Ah rating. Since we are using a 5Ah rated battery the input charging current should be of .5 A

or 500 mA. 15 ohm R4 resistor was used to limit the current to 500mA in the above circuit.

The 12v primary battery supplies the power to the inverter circuit which uses Tha CD4047 astable-monostable IC for converting the supplied DC power to alternating current.

RELAY

The solar panel connected to the secondary battery charger it.when the primary battery has no sufficient charge to drive the circuit the secondary battery will be used as a backup. Meanwhile the primary battery will be disconnected by the relay circuit and only the secondary battery is used.

CIRCIUT DIAGRAM AND WORKING PRINCIPLE

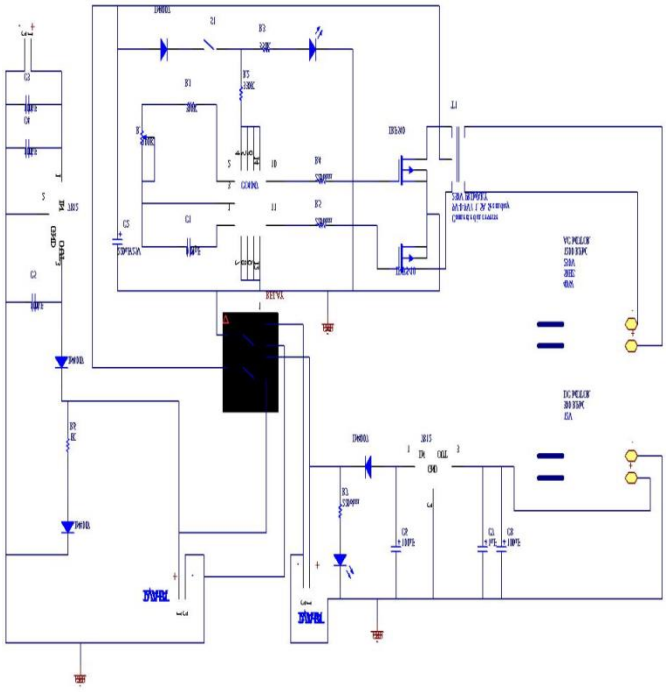

Figure 12

The 12v primary battery supplies the power to the inverter circuit which uses the CD4047 astable-monostable IC for converting the supplied DC power to alternating current.

When the switch S1 connected between the battery and the convertor circuit is switched ON, the current drives the inverter circuit which starts to work in the monostable mode and generate an alternating current. The output of the inverter is connected to a 230V-9V transformer which is connected in reverse, so that it can be used to convert the generated 9V AC to 230V at a frequency of 50Hz.

The 230V AC output from the transformer is used to drive the AC motor. The motor is in turn connected to the harvester and also to the DC generator via the driver belt. The transformer output drivers the motor causing the harvester to operate. The motor also causes the DC generator connected via the driver belt to run. The generator is driver to generate a DC voltage of 12V.the voltage is used to change the same battery that was used to drive the inverter circuit. The output as it is used to charge the battery in turn is supplied partly to the inverter.

SECONDARY POWER SUPPLY:

In some cases the output of the generator may not be sufficient enough to change the battery and also run the inverter circuit, so a secondary power supply is used which utilized solar power.

As the harvester works using the primary power supply, the solar panel connected to the secondary battery charger it.when the primary battery has no sufficient charge to drive the circuit the secondary battery will be used as a backup. Meanwhile the primary battery will be disconnected by the relay circuit and only the secondary battery is used.

This causes the primary battery to be sufficiently changed. When the secondary battery is drained, the relay circuit switches to the primary power supply and the circuit works back using the primary power supply. The secondary battery now charges using the solar panel, so that it can be used when the primary power supply cannot supply the sufficient power.

ADVANTAGES

- ✓ They allowed big farmers to rapidly clear large tracts, breakup the soil, remove the grass and prepare the ground for cultivation.
- ✓ These machines reduced dependence on labour and increased efficiency. With power driven machinery four men could plough, seed and harvest 2,000 to 4,000 acres of wheat in a season.
- ✓ The machines helped increase production by bringing virgin land under cultivation, to meet the growing demands of urban dwellers and the export market.
- ✓ Product cost is very low and user friendly.

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