DEVELOPMENT OF AN EXTERNAL CHARGING SOURCE FOR POWER GENERATION OF A BATTERY CAGE SYSTEM

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Abstract

Battery cage system serves as a subsidiary occupation to supplement the income of small and marginal farm families in Nigeria. The device is aimed at providing an alternative solution to the epileptic power supply by Power Holding Company of Nigeria for poultry raising. External charging source for power generation of a battery cage system was developed. Cage provides an efficient and cost effective means of collecting eggs, disposing of waste, reducing feed wastage, maintaining an adequate environmental temperature and easy inspection of individual bird. An inverter changes Direct Current (DC) from a battery (12 Volt, deep-cycle) into conventional Alternating Current AC to operate some electrical devices. The battery will need to be recharged as the power is drawn out of it by the inverter. Materials used includes; Auto transformer, rectifier, charge regulator which keeps the battery from discharging. The device working efficiency of 55.6% was achieved. Researches on energy generation and the use of micro controller can produce a more efficient system.

Keywords: Power generation, inverter, battery cage system

1. INTRODUCTION

Poultry farming is an important integral of the agricultural systems in Nigeria. A considerable proportion of the populace depends on livestock production as a source of food, fertilizer or income generation in order to sustain the economy. Battery cage system of poultry raising serves as a subsidiary occupation to supplement the income of small and marginal farm families. The production of these birds involves selection, breeding, feeding, care and marketing. The success in raising livestock depends on factors such as stable electricity supply, anti-bird *flu* influenza, right feed formulation and steady supply and proper sanitary and environmental conditions. The poultry battery cage system occupies a pivotal position because of its enormous potential to bring about rapid economic growth, particularly benefiting the weaker section. Further, it needs low capital investment and yet assures quick returns within weeks and months in case of broilers and layers respectively (Akinyosoye, 1985).

In poultry farming, battery cages are industrial agricultural confinement systems used primarily for raising birds. Eggs and poultry have emerged next to milk as a major contributor to the output from livestock sector in recent years. Nigeria has the potentials to produce a wide range of livestock based on its climate and agro-ecological conditions. While the Northern part and middle belt can guarantee the production of sheep, cattle, goat and poultry the Southern part of the country have potentials to produce goat, pig and poultry. Thus poultry production takes place in all parts of the country. The cage system is the best because it makes the most economic use of land and labour (Penda, 1985).

Cage provides an efficient and cost effective means of collecting eggs, disposing of waste, reducing feed wastage, maintaining an adequate environmental temperature and easy inspection of individual bird. Cages are of different types, the wooden type or metal, each unit having drinking and feeding trough attached to it. Each cell can accommodate one, two, three or more birds depending on the dimension of the cells used (North, 1984). Ideally 3 matured birds can be kept in a cage measuring only 41.5 cm by 41.5 cm while 5 birds can be kept in a cage measuring 50 cm squared (Ekunwe *et al.*, 2007).

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. This device is essentially the opposite of a rectifier. Static inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. The electrical inverter is a high-power electronic oscillator. This was as a result of early mechanical AC to DC converters was made to work in reverse, and thus was "inverted", to convert DC to AC (Newmar, 2010). An inverter changes Direct Current (DC) from a battery (12 Volt, deep-cycle) into conventional Alternating Current AC to operate some electrical devices. Alternators are used in modern automobiles to charge the battery and to power a car's electrical system when its engine is running. Automotive alternators use a set of rectifiers (Diode Bridge) to convert AC to DC.

An alternator is an electromechanical device that converts mechanical energy to electrical energy in the form of alternating current. Most alternators use a rotating magnetic field though linear alternators may be used. In principle, any AC electrical generator can be called an alternator, but usually the word refers to small rotating machines driven by automotive and other internal combustion engines. Alternators generate electricity via the same principle as DC generators, here when the magnetic field around a conductor changes, a current is induced in the conductor. Typically, a rotating magnet called the rotor turns within a stationary set of conductors wound in coils on an iron core, called the stator. The field cuts across the conductors, generating an induced Electromotive Force (EMF), as the mechanical input causes the rotor to turn (Nathan and Ben, 2000).

An electrical battery is a combination of two or more electrochemical cells used to convert stored chemical energy into electrical energy. The battery converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cations (positively charged ions) migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, reduction (addition of electrons) occurs to cations at the cathode, while oxidation (removal of electrons) occurs to anions at the anode. The electrodes are not contact with each other but are electrically connected by the electrolyte. Most cells use two half-cells with different electrolytes. In that case each half-cell is enclosed in a container, and a separator that is porous to ions but not the bulk of the electrolyte prevents mixing.

The frequent interruption of power supply by the power authority has led to the irregular supply of power needed for the proper management of poultry battery cage system. This study is directed towards developing an alternative means of power supply for poultry houses.

1. MATERIALS AND METHODS

2.1 Materials:

- Inverter (500 watts)
- Battery (45 Amp)
- Alternator (12V)
- Transformer (250 watts)
- Electric Bulb (200 watts)

2.2 Methods

The transformer was used instead of an electric motor to turn the alternator. The transformer was used to produce the current generated by the coil when rotating. The diode rectifier, charge regulator was connected to the transformer. The wires connected the diode rectifier and charge regulator to the battery system. These four connections were made to properly hook up the diode rectifier and charge regulator battery. The negative point was connected to the battery's negative terminal. The diode rectifier output wire 'B', was connected to the positive terminal of the battery, through which current to the battery will flow when the transformer is operating. Three additional wires were also connected to the top of the alternator. 'S' connected the regulator and the transformer to the battery. The wire which connected the regulator and goes directly to the field was determined, using a millimetre, via the resistance between each of the wires and the case (ground). The connection between ground and the regulator had a very high resistance across it. The connection between ground and the field will have a low resistance. The regulator wire was attached directly to the battery's positive terminal.

2. RESULTS AND DISCUSSION

The load comprised of the electric bulb (200 Watts) and the transformer (250 Watts).

The total capacity of load the inverter can carry with the battery powered, in watts.

Load in Watts = Amp × 10

W = Watts

A = Amps (DC)

Battery capacity, 45 Amps × 10 = 450 Watts

The power delivered by the battery based on the run time and the usable energy.

Power delivered by battery = Time × DC current delivered

Power delivered by battery = 0.4 × 45

= 18 W

The DC cable was connected the inverter positive (red) terminal to the positive terminal of the battery. The negative (black) terminal was connected to the negative terminal of the battery. Two electric bulbs were connected to the inverters which were allowed to run for 45 minutes, a transformer was also connected to charge the battery for 50 minutes, various readings were taking and recorded respectively as presented in tables 1 and 2 respectively.

Table1. Running Appliance without Charger

AC Appliance	Appliance Running Power (Watts)	Measured battery Capacity consumed after 24 minutes (AH)
Electric bulb	200	10

Table 2. Running Appliance with Charger

AC Appliance	Appliance Running WATT (Watts)	Measured battery Capacity consumed after 24 minutes (AH)
Electric bulb and charger	450	15

3.1 Discussion of Results

The alternator has four stator leads, which is the Wye style. One of the leads is called the Neutral Junction, which is common to all the other leads. Wye wound stators are used in alternators that require high voltage output at low alternator speeds. Two windings are in series at any one time during charge output.

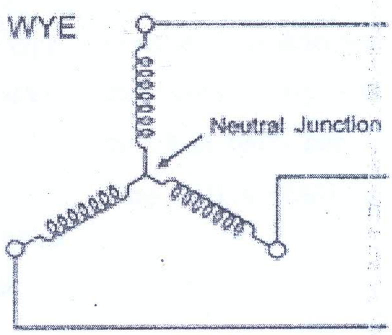

Fig 1. Stator Design of Nodes connected to Diode.

The Diode Rectifier Bridge converts or rectifies the AC voltage into DC voltage. Two diodes are connected to each stator lead, one at the positive terminal the other at the negative terminal, because a single diode will only block half the AC voltage. Six or eight diodes are used to rectify the AC stator voltage to DC voltage. Diodes in this configuration will redirect both the positive and negative polarity signals of the AC voltage to produce DC voltage (Full – Wave Rectification).

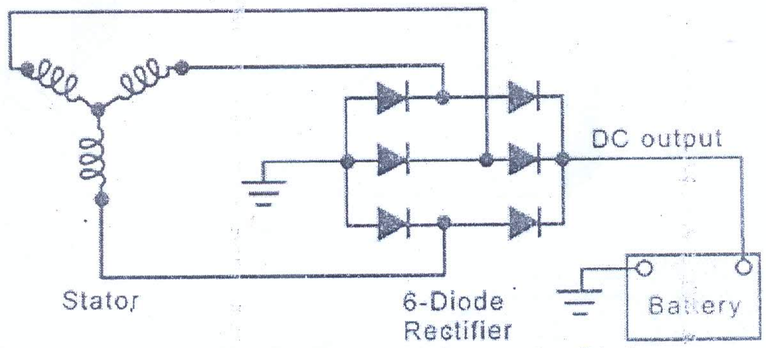

Fig 2. Wyle Wound Stator connected to Diode.

The rectifier mode of operation is as shown in fig. 3. The red, B+ current passes through to the rectifier as it goes into the battery. The green is the return path

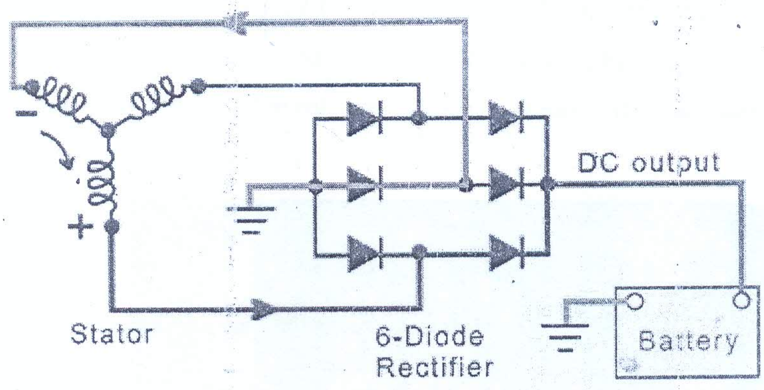

Fig. 3. Rectifier Operation.

The regulator is the Grounded Regulator type. The regulator controls the amount of battery ground (negative) going to the field.

The battery capacity is the measure of the energy that it can store and deliver the load through the inverter. It is determined by how much current any given battery can deliver over a stipulated period of time. The energy rating, expressed in Ampere Hours (AH), as the bench mark.

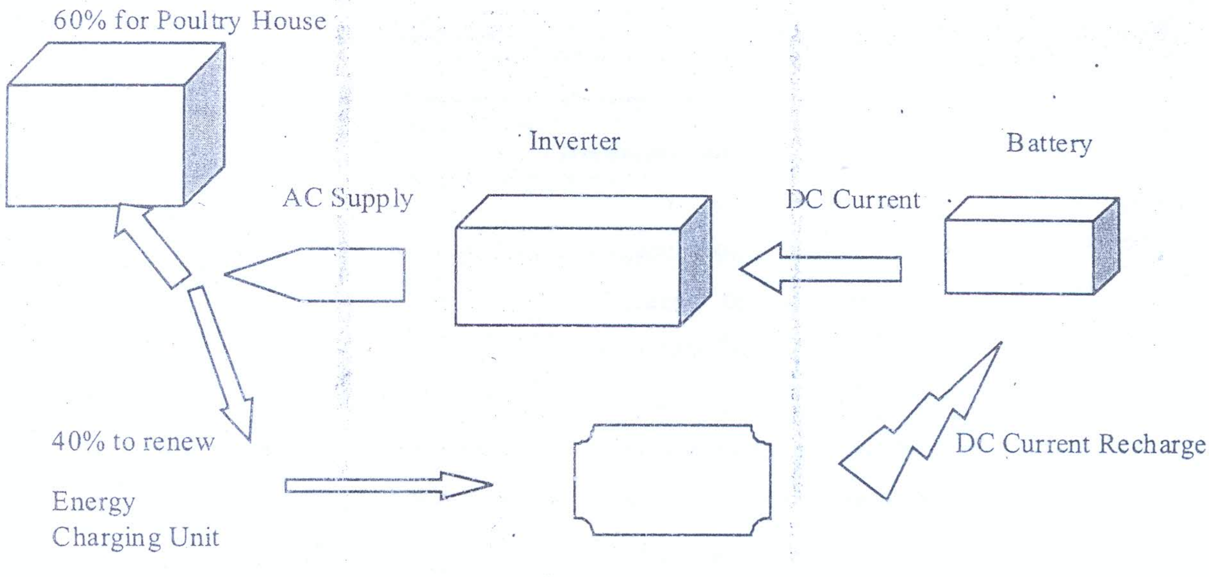

Fig 4.Flow chat of system

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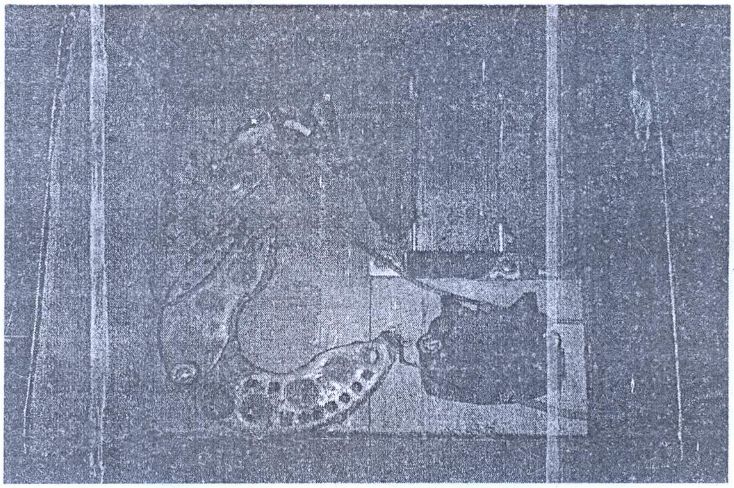

Plate 1: internal mechanism of an inverter

3.2 Working Efficiency

The inverter off- load current, Quonset power (due to copper loses) = 4.5 Amps

When the inverter is loaded with 200 watts filament bulb consumes (8 – 4.5) Amps = 3.5 Amps

The self charging of the system with the Quonset and bulb load will cause a demand of (10 + 4.5 + 3.5) Amps = 18 Amps

Efficiency of the charging unit can be determined from equation 3.1

$$Efficiency = \frac{output}{input} \times 100$$

$$= \frac{10}{18} \times 100 = 55.6\%$$

3.3 Cost Analysis

Table 3. Material cost

Items	Amount
Inverter	N10, 000
Battery	N8, 000
Charging Unit	N8, 000
Total	N26, 000

The cost benefit ratio:.

Labour cost = 60% of Materials cost

0.6 × 26000 = ₦ 15600

Overhead cost = 25% of Labour cost

0.25 × 15600 = ₦ 3900

Total cost = Material cost + Labour cost + Overhead cost

2600 + 15600 + 3900 = ₦ 45500

Profit = 10% of the Total cost

0.1 × 45500 = ₦ 4550

1. CONCLUSION

The design and development of this device is aimed at providing an alternative solution to the epileptic power supply by Power Holding Company of Nigeria (PHCN) for poultry raising (Battery Cage system). A careful selection and analysis of material suitable for various components was carried out with regard to durability, efficiency and its availability locally. The working efficiency of the device (inverter) was calculated as 55.6% and was able to keep the battery from draining which power the house for 5 hours.

Recommendation's

i More research on alternative energy generation should be conducted in order to relieve the over dependence on Hydro-electric Power.

ii Proper guidelines regarding the cost and efficiency of the various source of electric power generation should be investigated and resolved so as to fastening growth of agriculture in this country.

iii Micro controller should be used for further research so as to regulate the operation of the charging unit.

iv Dynamo requires less power for rotation that can produce DC current. Its efficiency can be tested for its charging state.

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