

DESIGN AND CONSTRUCTION OF ALTERNATING AND DIRECT CURRENT OPERATED ELECTROEJACULATOR FOR ANIMAL BREEDERS

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ABSTRACT

The supply of voltage is obtained by using a transistorised converter. It is designed to give a square wave output of 200v at up to 80mA from an input of 12 volt d.c car battery. The output of the 12v push-pull square-wave oscillator is transformer-coupled to step up 30 volts square wave by a specially wound transformer. The transformed voltage is then used as output to energize the probe that will go into the rectum of an animal in order to stimulate it for the ejaculation of the semen. The semen collected is analysed and used to inseminate female animals.

Keywords: semen ejaculator, car battery, rectum stimulation.

INTRODUCTION

Artificial insemination (A.I) as defined by Collins (1902), as the introduction of semen into the genital organs of a female animal so that offspring may be produced without sexual union. The importance of artificial Insemination are:- for genetic improvement, makes maximum use of proven male animals, reduces cost of keeping many male animals, control of sexually transmitted diseases, and the result obtained from the semen analysis could be used to improve record keeping and stimulate interest in live stock breeding. It is used for teaching aid and screening such as evaluation and selection of bull for A.I in the field based on semen analysis.

As reported by Cole and Cupps (197), the realization of the maximum benefits of arti-

cial insemination depends upon the collection of maximum number of viable sperm cells at frequent intervals from genetically superior males. This involves equipment and procedures which can be used repeatedly while maintaining libido in the male. Collection techniques and frequencies which harvest the largest number of sperm over the longest period of time are desirable. One of such techniques is by the use of the electroejaculator. An electroejaculator is used to stimulate a bull, buck or ram (uncastrated male sheep) to ejaculate, especially in cases where these animals are not trained in the use of the artificial vagina for semen collection or suffer from injury or when conditions are not conducive for normal mounting and ejaculation. Electroejaculation provides a method for collecting healthy semen of normal viability. Electroejaculators generally employ a single rectal probe with bipolar electrodes. Rhythmic application of electrical stimulation through the rectum sensitises the nerves and leads to semen ejaculation.

Apparently, the first attempts at inducing ejaculation by electrical stimulus were made by Batteli (1922), who introduced an electrical shock (30 volts, 47 cycles alternating current) at the base of the brain of a mature male guinea pig. Gunn (1936), pioneered investigations of electroejaculation of farm animals with his work on rams, which he reported in 1936. Gunn's method consisted of stimulating the spinal cord between the fourth lumber and the first sacral vertebrae by placing one electrode in the rectum and the other in the back muscle. By passing a few 5 to 10 second rhythmic stimuli (30 volts, 50 cycles alternating current) through the electrodes, ejaculation

was produced and semen was collected in a glass tube.

Local research scientists and workers in professional fields such as animal science and veterinary medicine have difficulty in using electroejaculators operated with alternating current (AC) supplied by the National Electrical Power Authority (NEPA) due to frequent interruption of electricity supply. Besides, most animals are found in the rural areas where there is no AC supply. These problems render such precision instrument - AC electroejaculators useless. Based on the constraints mentioned, the availability of 12 volt batteries normally used by cars and lorries or the arrangement of eight-dry cells connected in series to give 12 volts can be adapted to operate electroejaculator.

Nevertheless, the 240 VAC from NEPA could also be stepped down to operate electroejaculators.

MATERIALS AND METHODS

In the circuit shown in Fig. 1, the transistors TR₁ and TR₂ of 2SB555 were used in the circuit to provide the power of 0.375 watts for the probe. There are two current paths through a transistor. One is the base emitter (via base) path. The transistor's value arises from the fact that it can link circuit connected to each path so that the current in one controls that in the other. The resistors are used to control the amount of current that flows in the circuit while the transformer is designed to step up and deliver alternating current voltage (ACV).

This power supply consist of self-oscillating push-pull inverter with an output of 40 ACV which is applied to a bipolar electrodes.

The circuit is powered by either a 12 volts battery through a resistance of one kilo ohm to deliver a 240 volts alternating current as designed and quoted by Clement Brown (1969) to deliver 18 joules of energy. This implies that, 30 alternating current voltage

(ACV) will deliver 7.5 joules of energy to the rectal probe of bipolar electrodes, when a specially designed transformer is used to supply the voltage. This 30 ACV can be varied between 0-30 ACV by using variable resistor (Table 1).

Designing a Transformer

The purpose of designing a transformer in the project is to step up the required voltage which is obtained from a transistorised converter to provide the appropriate supply of energy for the probe. For the design of 40VAC power transformer, the core area is the place where the winding would seat and it has to be calculated. To determine the core size as indicated in Fig. 2., it is first necessary to estimate the power requirements from the transformer, then we may apply the empirical relation of equation 1.

$$A = \frac{\sqrt{VA}}{5.58} \dots\dots\dots \text{Eq.(i)}$$

Where A is optimum cross-sectional area in square inch, and VA is required voltage Amper output.

This optimum value gives an ideal area expected for the transformer and it was used for the design. This area must be equal to or less than the measured area of the transformer to avoid heating and for good operation of the transformer.

To know the number of laminations required, the width of the core was divided by the thickness of the lamination (Fig. 2.). Lamination of 'E' and 'I' used as core of the transformer are not made locally. They can only be obtained from ready-made imported transformers.

In order to calculate the number of turns per volt, we use the formular as indicated by Langford Smith (1954).

$$\text{Turns/volt} = \frac{N}{E} = \frac{10^8}{4.44 \times \text{B.A.F.}} \dots\dots\dots \text{Eq.ii}$$

Fig. 1

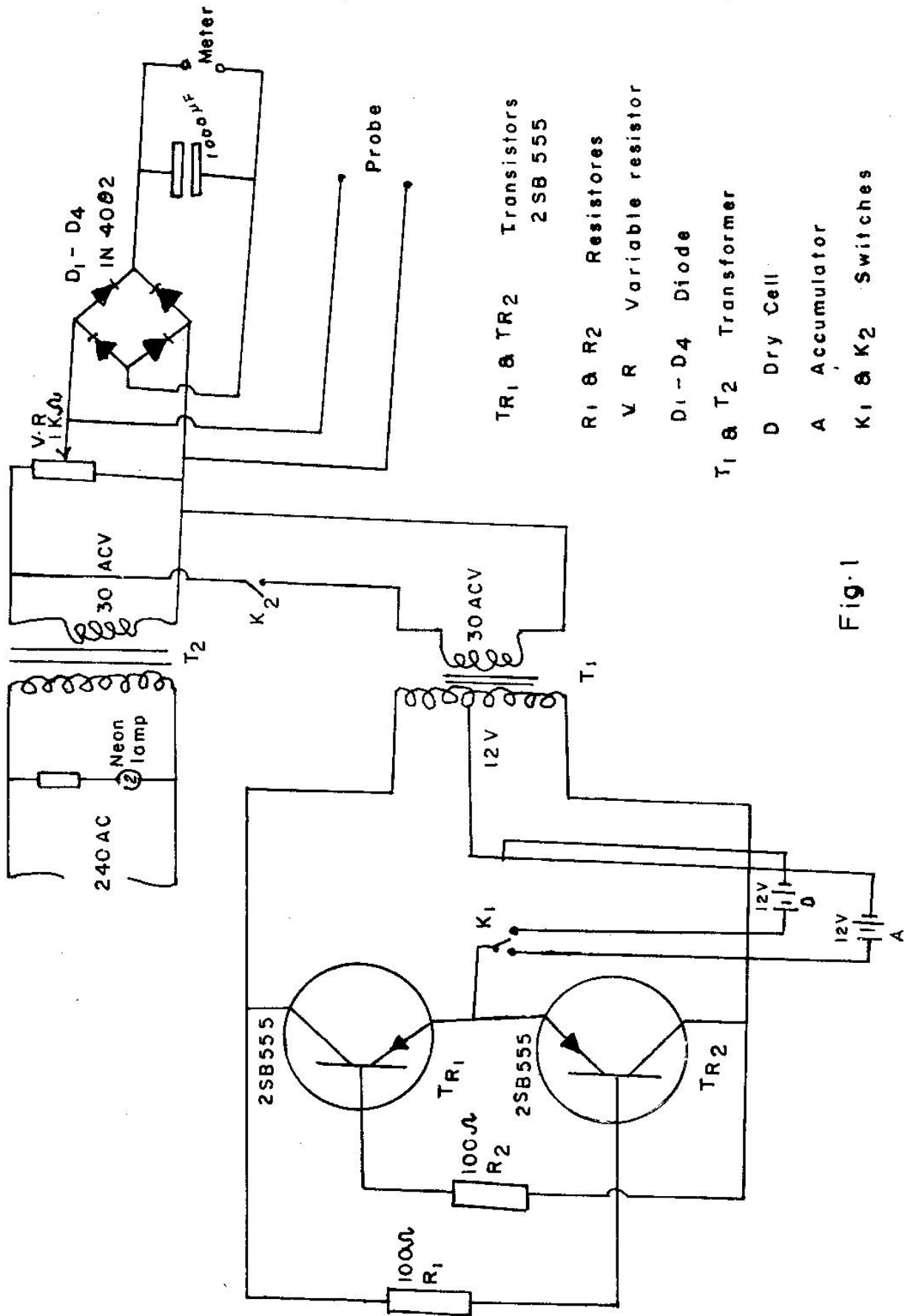


Fig. 1

Table 1

APPLICATION OF ACV TO GIVE APPROPRIATE ENERGY

Voltage in Volts	Current in Ampere	Time in Sec.	Power in Watts	Energy E in Joule (J)
30	12.5×10^{-3}	20	0.375	7.50
25	12.5×10^{-3}	20	0.313	6.26
20	12.5×10^{-3}	20	0.250	5.0

Where

N = turn of coils

B = flux density in lines sq in

A = cross-section area of core (in sq cm)

F = applied frequency in Herz

E = applied voltage

The flux density depends on the type of material to be used for the transformer. Permalloy material has a flux density of 22000 lines per square inch and was used for the design.

Assembly of the Transformer

The coils were manually wound on plastic bobbins. Two plastic bobbins were provided for both primary and secondary winding (Fig. 3). This was to avoid physical contact and improve the insulation between the two windings. Care was taken to see that the turns were close together without any crossover of turns and that there were no scratches on the coils.

Wires of about seven centimetres each in length were drawn out to be the output terminals for the secondary windings. Two wires together with a centre-tapped wire produced from the centre of the primary windings, seven centimeter also, were drawn out to be the input terminals. The 'E' and 'I' laminations were stacked alternatively into the former window until it was filled up. A mallet was then used to force in laminations so that fit well into the plastic bobbings.

The collectors of coupled transistors were connected to each terminal while the emitters and wire that centre-tapped the windings were

connected to positive terminal and **negative** terminal of the battery respectively.

The second transformer of input 240 VAC was connected directly to the bipolar electrode by using secondary terminals; the two transformers are used to supply alternating current voltage by using a switch of double pole double throw (DPDT), to change the alternating current voltage from one transformer to the other.

The bipolar electrodes that will go into the rectum were separated by solid insulating material such as wood (Plate 2). During construction, the components were joined together as illustrated in the circuit diagram. The wiring and connection of the circuit were done with the aid of a hot soldering iron using a high quality "savbit", soldering lead.

Application/Precaution

Electroejaculators generally employ a single rectal probe with bipolar electrodes (Plates 1 and 2). The rectal probe is inserted in the rectum of an animal to stimulate it after the probe might have been lubricated with soap solution or parafin/vaseline in order to attain slippery movement and to avoid injury to the mucosa of the rectum. The bipolar electrodes are connected to the voltage control. When the switch is turned on, there is no signal voltage applied to the probe. The voltage is applied by rotating the knob which controls the amount of current that energises the probe. As the energy from power is increasing, the number of electrons going into the

Fig. 2

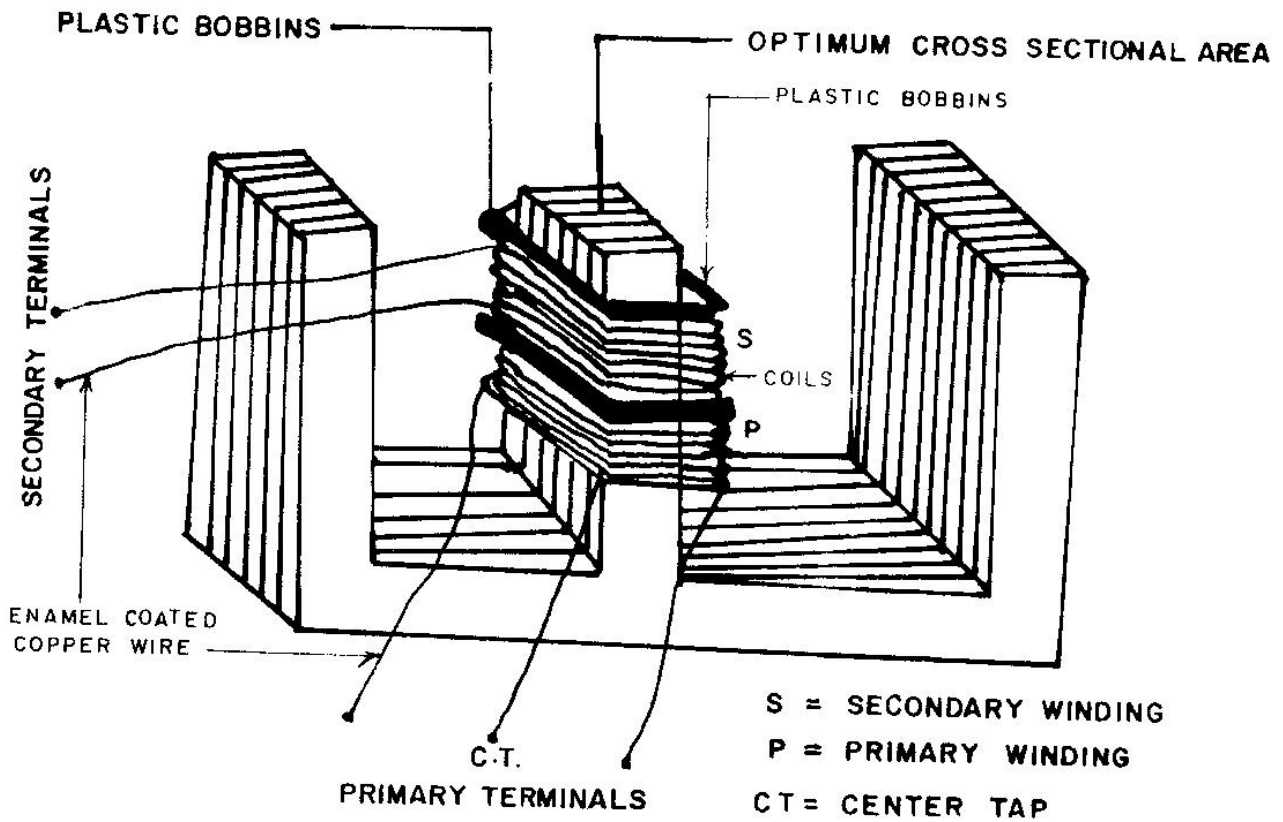
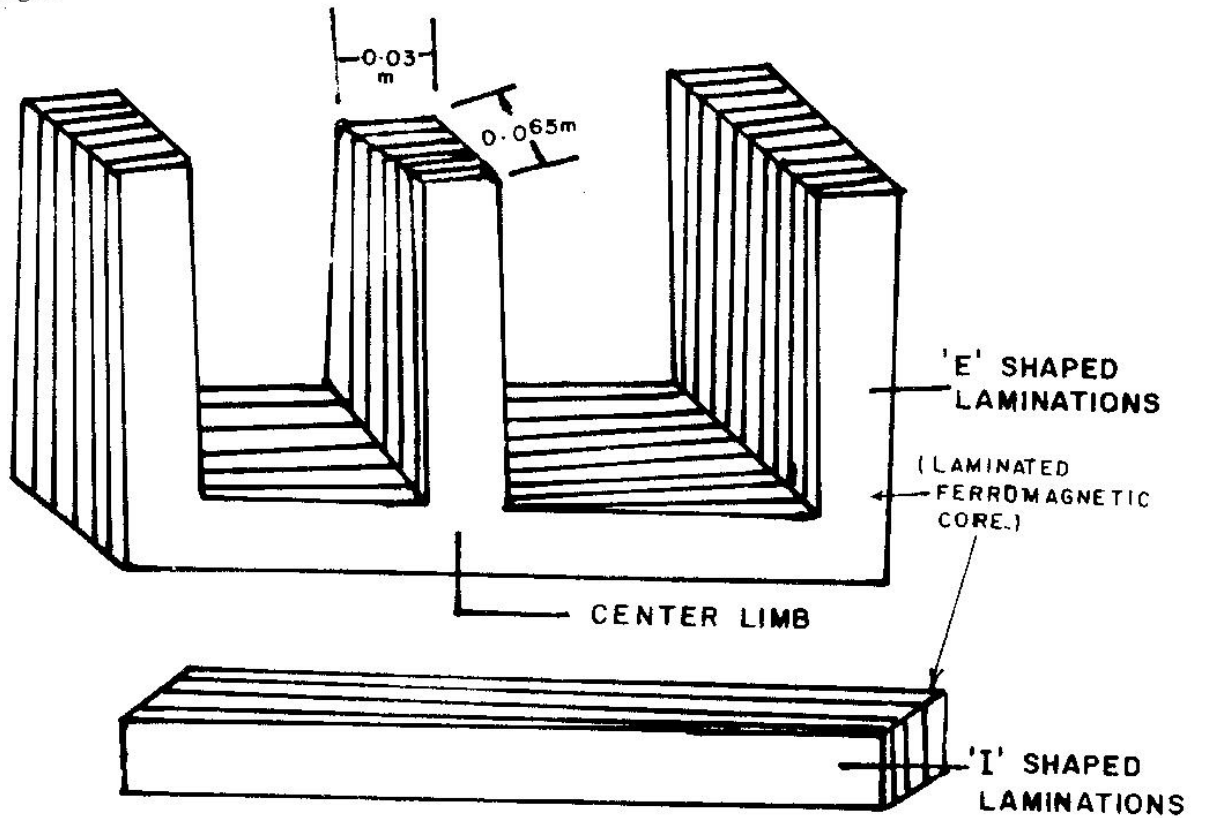
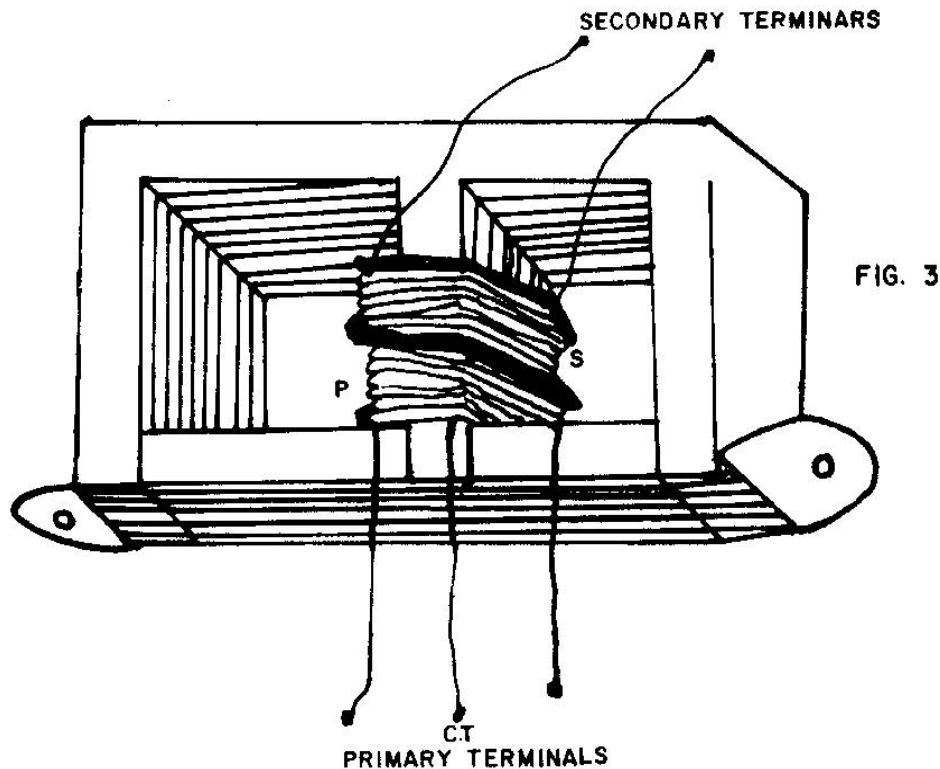


Fig. 3 COMPLETE ASSEMBLY OF THE TRANSFORMER



animal is also increasing. Rhythmic application of electrical stimulation through the rectum sensitises the nerves and leads to semen ejaculation. The penis is controlled in order to direct its tip into a funnel which is attached to a conical test tube which is also placed on the container of warmed water.

In operating the instrument, the operator should ensure that the energy control is not at maximum voltage at the instant of application as this could give unexpected stimulation to the animal and could make the animal to be over excited or collapse and this may lead to eventual death of the animal if the voltage is not quickly brought back to zero. The voltage control should move forward and backward from zero to the required voltage and should not exceed the requirement for the particular species. This would gradually inject the animal with electrons and then stimulate it for ejaculation. One or two persons(s) cannot collect semen conveniently with the instrument but three persons are ideal and this also depends on the type of animal. For example,

as illustrated on Plate 3 using a ram, one person must handle or hold the ram in such a way that the animal will not have the freedom to struggle very much, the second person must be ready to collect the semen by properly holding the container with one hand and observing the erectile penis; the tip of the penis is directed downward to the funnel which is attached to the container, while the third person must be a person who knows how to control the knob and observe the movement of the animal. This will enable such a controller to know whether the applied voltage is too much or too little. If there are not enough people to collect the semen and the instrument is not working properly, semen collection will be difficult and the ultimate benefits of artificial insemination would not be realized. However, the way it is done, many sources of sperm losses exist. These include losses before collection, during collection and while handling during processing and storage.

PLATE 1 PHOTOGRAPH OF AC/DC OPERATED ELECTROEJACULATOR, BIPOLAR ELECTRODE, SYRINGE, ARRANGEMENT OF CONTAINERS FOR SEMEN COLLECTION, CATHETER FOR INSEMINATION



PLATE 2 BIPOLAR ELECTRODE BEING INSERTED INTO THE RECTUM OF A RAM.



PLATE 3 ELECTROEJACULATOR BEING OPERATED WITH ALTERNATING CURRENT FROM THE MAINS TO INDUCE ELECTRONS AND STIMULATE THE ANIMAL FOR SEMEN EJACULATION.



RESULTS AND DISCUSSION

Instrument Evaluation

With the assistance of a Scientist and Senior Laboratory Technologist working in Veterinary Reproduction Laboratory in the Department of Veterinary Surgery and Reproduction, University of Ibadan, it was possible to have a general examination of the semen of a goat that was collected by using the newly constructed electroejaculator and the result compared with that collected from an AC operated electroejaculator imported from Sweden (Table II).

According to Cole and Cupps (1977), a properly collected semen sample should be near the volume characteristic of the species and freed of urine, hair, foreign matters and, depending on the species, the colour will vary from a creamy white (bull) to a wattery gray (dog), but all should be opaque in appearance, indicating a high sperm concentration. In some incomplete bulls, yellowish semen is

normal but off colours' may be indicative of contamination with urine, blood or foreign materials.

With the above results, the newly constructed electroejaculator does the same work as the one imported from Sweden.

Uses of the semen collected

Production of high quality semen depends upon males that have been kept under good condition. When young males are properly fed and managed, semen can be collected successfully at the following approximate ages - bulls, 12 months, rams, goats and boars 7-8 months, stallions (uncastrated male horse for breeding), 24 months.

The semen collected must be processed before it could be used for inseminating the female animal (Plate 4). The healthy semen is deposited in sufficient quantity at the proper site in the female reproductive tract at the optimum time in relation to ovulation. Skillful herdsmen, technicians and proper semen

Table 2

GENERAL EXAMINATION OF THE SEMEN OF A GOAT

Parameter	D. C./A. C. electroejaculator	A. C. electroejaculator
Volume (ml)	0.9	0.8
Sperm Concentration 10^9 /ml	2.5	2.4
Total Sperm 10^9	2.2	2.0
Motile Sperm (%)	82	80
Morphologically Normal Sperm	92	90

handling are a pre-requisite for this work.

As found in Physiology of Reproduction and Artificial Insemination of cattle (Salisbury *et al*, 1961), a healthy, vigorous, fertile bull can produce enough spermatozoa to impregnate 50,000 or more cows in a year. About one bull is kept for each 3,600 cows bred; this is much lower than the potential number of cows per bull, but much greater than the earlier 5 to 20 cows usually bred per bull before AI became popular. It is generally agreed that it is more economical to use AI than to keep male animals. The Plate 5 shows illustration of a ram produced with artificial insemination.

CONCLUSION

The positive terminal of the battery must be connected to the emitter of the two transistors while the negative terminal of the battery could be connected to the centre tap of the transformer. The collectors of the two transistors must be properly connected to the input

terminals of the transformer. The 12 volts car battery is very cheap and economical to operate an electroejaculator as the users always go to the field to collect semen with either official or private vehicles. With this model of electroejaculator, the electromotive force (e.m.f.) could be tapped from the nearest vehicle or well arranged eight dry cells. (Plates 6 and 7).

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PLATE 4 THE PROCESSED SEMEN BEING INSEMINATED INTO THE FEMALE ANIMAL



PLATE 5 THE ANIMAL PRODUCED WITH THE ARTIFICIAL INSEMINATION

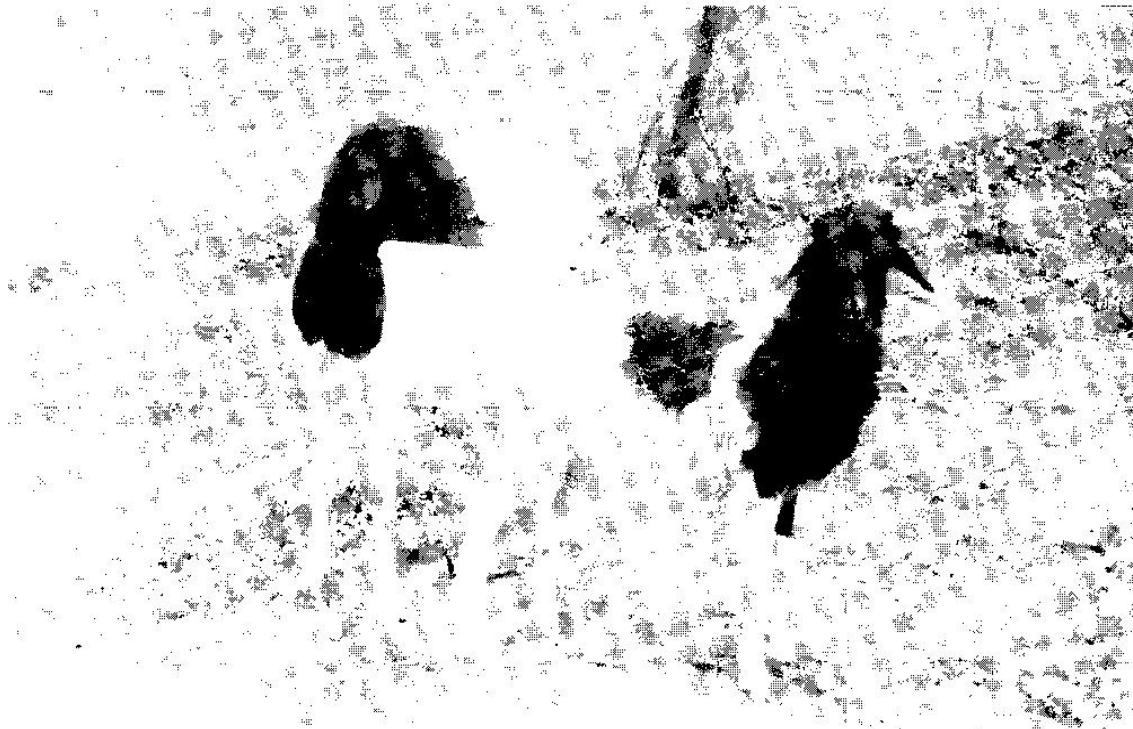


PLATE 6 THE CAR BATTERY USED TO OPERATE ELECTROEJACULATOR

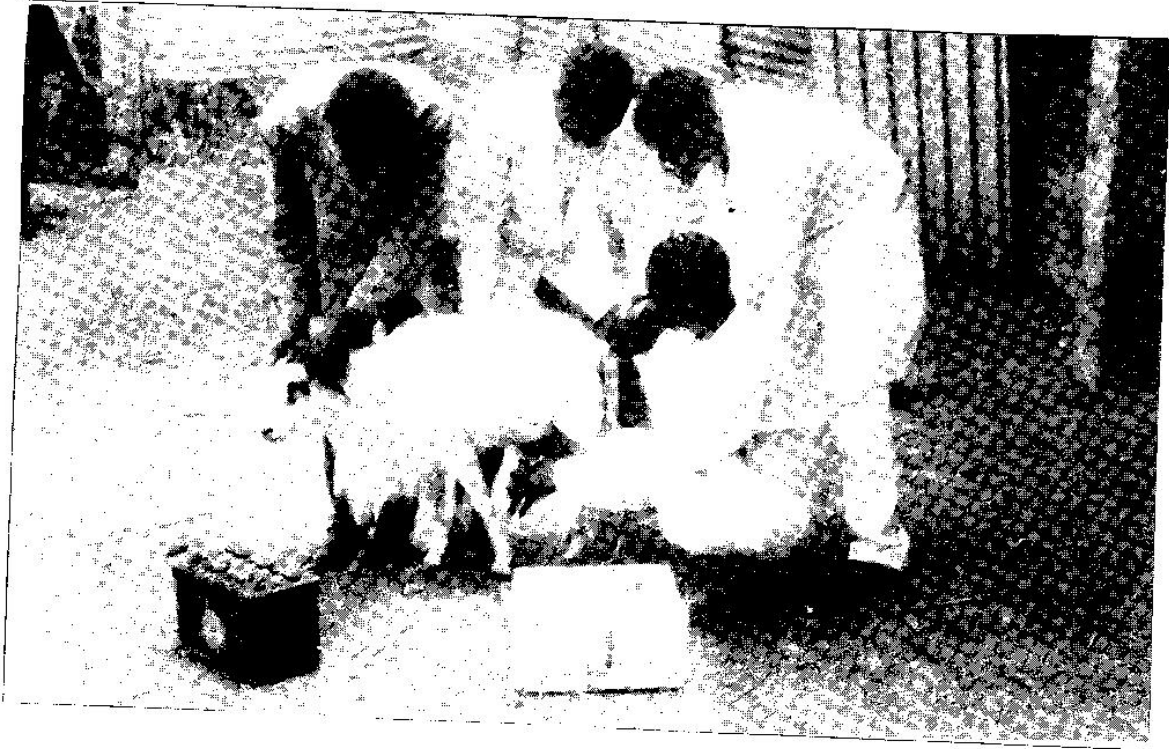
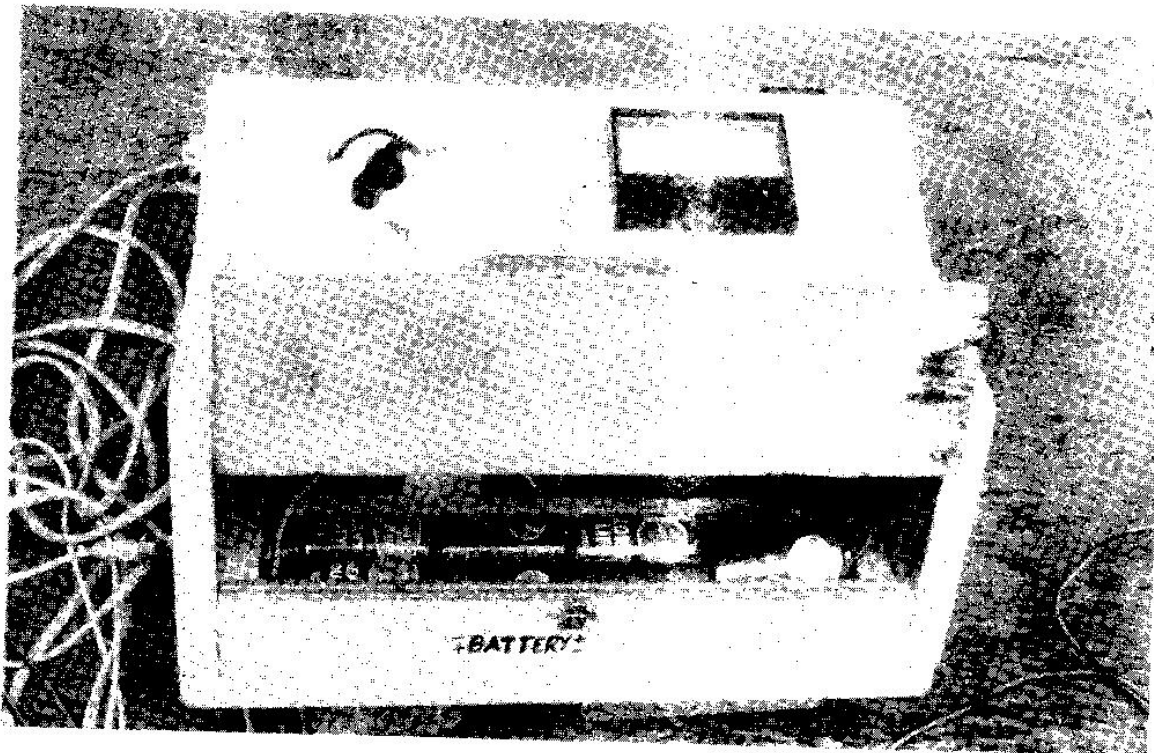


PLATE 7 THE INSTRUMENT COULD ALSO BE OPERATED WITH DRY CELLS



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