GOVERNMENT OF INDIA : THE PATENT OFFICE, 214, LOWER CIRCULAR ROAD, CALCUTTA-17.

Specification No. 90957. Application No. 90957, dated 23rd November 1963. [Complete Specfication leftion 24th August 1964.] (Application accepted 24th May 1965.)

PROVISIONAL SPECIFICATION.

PREPARATION OF POROUS CARBON ELECTRODE USING VEGETABLE CARBONS FOR USE IN AIR DEPOLARISED CELLS.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, OLD MILL ROAD, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860).

The following specification describes the nature of this invention.

This is an invention by ABDUL KHADER ABDUL WAHEED, KONAKANCHI VENKATA NARAYANA RAO and KADARUNDALIGE SITARAMADOSS GURU RAJA DOSS all of the Central Electro-Chemical Research Institute, Karaikudi, Madras State, India, all Indian citizens,

Invention.—This invention relates to a process for the preparation of porous carbon electrodes (by the addition of acetylene black to vegetable carbon and using a high Polymer as a binder) for use in Air Depolarised Cells.

Introduction.—The well-known Air Depolarised Cell is a primary type of cell which utilises the oxygen of the air as the cathode component and consists of zinc as the anode, porous carbon as the cathode element (through which oxygen (air) circulates and takes part in the reaction) and sodium hydroxide as the electrolyte. The Air Depolarised Cells operate at 1.10—1.20 Volts and have a constant voltage-discharge curve for almost entire service period at normal discharge rates. They are designed to be assembled in the field.

Air Depolarised Cells have been used for lighting several thousand troop kitchens and sleeping cars during World War II. These find their principal uses in Coast Guard Buoy Service and other marine signalling installations, Railway Switch Lamp lighting, telephone and other general instrument operation. These cells can also be used for emergency lighting purposes. Of much commercial value is the railway type cell. A typical Cell of the Railway type is designed to operate under the following conditions.

The initial open circuit voltage	1.40—1.45 Volts
Operating Voltage	1.10—1.20 Volts
Rated current	2 Amperes
Discharge current	2 Amperes
Time of discharge	275 Hours
Capacity (Ampere-hours)	550
Capacity (Watt-hours)	620
Volume of electrolyte	4400 c.c.
Active electrode area	43 Sq.in.
Carbon breather surface	6.4 Sq.in.

The present invention consists of the use of porous carbon electrode element prepared by the addition, in particular, of acetylene black to indigenously available vegetable carbons using a high polymer dissolved in a suitable solvent as binder; the entire mix being pressed in the form of electrode element.

EXPERIMENTAL PROCEDURE.

Carbon element.—A blend containing vegetable charcoal (such as coconut shell charcoal) along with a small percentage of acetylene black was taken for making the electrode. After thorough mixing of the ingredients along with the binder (*e.g.*, perspex in benzene) the carbon mix was pressed in the form of an electrode at a pressure of about 1/4 to 1/2 tons per sq.in. in the hydraulic press, using a wooden mould. After pressing, the electrode was allowed to weather dry in the atmosphere, after which it was removed from the mould. For electrical contact, a central mild steel rod (nickel-plated) with a small mild steel disc (nickel-plated) on top and a bigger one at the bottom of the electrode, were used. The discs were kept in contact with the electrode using suitable nuts. A seamless plastic or rubber ring 2" wide and 1/16" thick was then inserted around the top portion of the electrode. Wax coating was given at the lower end of the plastic or rubber ring to avoid seepage of the electrolyte to the top surface of the carbon electrode. The electrode made in the above manner could then be assembled into a cell.

ASSEMBLY OF THE AIR DEPOLARISED CELL (RAILWAY TYPE).

The porous carbon electrode and the circular zinc anode were fixed to the cell cover by means of the connectors provided in both the electrodes using suitable washers and nuts, care being taken to avoid shorting. Sufficient quantity (about 4.4 litres) of 20 per cent. sodium hydroxed was prepared in the cell container and the electrolyte cooled. After cooling, the cell cover, with the electrodes fixed to it, was placed on the cell container. The electrolyte would immerse the zinc electrode completely and it partially covers the rubber or plastic ring provided at the top end of the porous carbon electrode. A suitable oil was poured on top of the electrolyte to prevent evaporation of electrolyte and carbon dioxide absorption. The oil should be added last of all and it should not directly come in contact with the electrodes.

Details regarding the mould for making a porous carbon electrode, dimensions and shapes of the porous carbon electrode as well as zinc electrode, cell container, cell cover, etc., are given in figures Nos. 1 to 6 of accompanying drawings which are as follows:

FIGURE 1.

Cell container.

(*a*) Front view.
(*b*) Top view.

FIGURE 2.

Cell cover.

(*a*) Top view.
(*b*) Section.
(*c*) Bottom view.

FIGURE 3.

Zinc electrode.

(*a*) Top view.
(*b*) Section.

FIGURE 4.

Porous carbon electrode.

(*a*) Top view.
(*b*) Section.

FIGURE 5.

Assembled A.D. Cell.

(*a*) Front view.

Price: TWO RUPEES.

FIGURE 6.

Mould for making the porous carbon electrode.

(a) Mould with both plunger and base plate removed (Top view).
(b) Mould with both plunger and base plate removed (Front View).
(c) Mould with plunger removed (Top view).
(d) Base plate (Section).
(e) Plunger (Top view).
(f) Plunger (Sectional view on AB).
(g) Assembled mould with plunger and base plate (Side view).

The air depolarised cell incorporating the porous carbon electrode element (prepared by using the materials and technique outlined above) when assembled in the form of the special railway type cell gives an open circuit voltage of 1.40-1.45 volts and a short circuit current of about 6 amperes. The cell is designed to give a capacity of 500 ampere-hours.

EVALUATION OF CARBONS (WITHOUT ACETYLENE BLACK)

Experiments on the evaluation of active carbons without any admixture have shown that out of various varieties of active carbon, the electrode element made with vegetable carbon when incorporated in the railway type air depolarised cell, gives the highest short circuit current and offers the lowest resistance. (For example, values of short circuit current 1.8 amps. Resistance of block of (3 × 2.6 cm.dia size), 12 ohms are obtained for the above as compared to the values of short circuit current ranging from a few milliamperes to a maximum of 800 milliamperes and resistance (under identical conditions) ranging from 57 ohms to 125 kilo-ohms for the other varieties (blends) tried.

The porous carbon electrode element made by blending vegetable carbon with acetylene black when assembled in the form of the air depolarised cell, fulfils all the requirements, *i.e.*, 0.06 ampere for 30 minutes each and 30 times a day, 3.0 amperes for 15 seconds each and 30 times a day and 0.17 ampere continuous discharge all the 24 hours.

ADVANTAGES OF THE PRESENT INVENTION.

The following are among the advantages of the present invention:

1. The porous carbon electrode element consisting of a blend of vegetable carbon and acetylene black and with a polymer as binder, for use in air depolarised cell, can be prepared by a simple procedure involving no costly equipment (a mixer and a hydraulic press is all that is required by way of equipment).

2. The porous carbon electrode element of the air depolarised cell is made from indigenously available vegetable carbon which forms the bulk of the electrode element, the acetylene black addition being only 10 per cent. W/W.

3. The binder used in this invention acts also a water-proofing agent. As a result, instead of the four operations, that of blending, pressing, baking and water-proofing as done in the usual method of making air depolarised carbon electrode element, the present invention requires only two steps, that of blending and pressing.

4. In view of (1), (2) and (3) above, the air depolarised cell which consists of the porous carbon electrode prepared in the manner described in this invention, would work out at a lower cost.

5. In view of (1), (2) and (3) above, the present invention results in a large saving of foreign exchange and the necessity of import of the finished product.

R. BHASKAR PAI

PATENTS OFFICER,

Council of Scientific & Industrial Research.

Dated this 12th day of November 1963.

COMPLETE SPECIFICATION.

PREPARATION OF POROUS CARBON ELECTRODE USING VEGETABLE CARBONS FOR USE IN AIR DEPOLARISED CELLS.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, OLD MILL ROAD, NEW DELHI-1, INDIA, AN INDIAN REGISTERED BODY INCORPORATED UNDER THE REGISTRATION OF SOCIETIES ACT (ACT XXI OF 1860).

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed.

This is an invention by ABDUL KHADER ABDUL WAHEED, KONAKANCHI VENKATA NARAYANA RAO and KADARUNDALIGE SITARAMDOSS GURU RAJA DOSS all of the Central Electro-Chemical Research Institute, Karaikudi, Madras State, India, all Indian citizens.

This invention relates to a process for the preparation of porous carbon electrodes (by the addition of acetylene black to vegetable carbons and using a high polymer as a binder) for use in Air Depolarised Cells and for other uses.

The well-known Air Depolarised Cell is a primary type of cell which utilises the oxygen of the air as the cathode component and consists of porous carbon as the cathode element (through which oxygen (air) circulates and takes part in the reaction), zinc as the anode and sodium hydroxide as the electrolyte. The Air Depolarised Cell has an open circuit voltage of 1.40—1.45 volts; it operates at 1.10—1.20 volts and has a constant voltage discharge curve for entire service period at normal discharge rates. The cell is designed to be assembled in the field.

Air Depolarised Cell has several civil and military applications such as Railway and Marine signalling and switch lamp lighting, telephone and other general instrument operations, emergency lighting, etc.

The object of the present invention is to provide with a process for making porous carbon electrode element from indigenously available carbon (which forms the bulk of the electrode) in conjunction with other necessary materials, which when assembled in the Air Depolarised Cell gives the desired results. To that end, the invention consists of making the porous carbon electrode element from indigenously available activated vegetable carbon (which forms the bulk of the electrode), by the minor additions, in particular, of acetylene black and a high polymer (dissolved in a suitable solvent), the latter to act as a binder; the entire mix being pressed in the form of the electrode element.

The present invention consists of the following advantages:

The porous carbon electrode element of the Air Depolarised Cell is made from indigenously available vegetable carbon which forms the bulk of the electrode element, the other additions being in minor amounts, namely acetylene black about 10 per cent. w/w and a high polymer binder, about 3 per cent. wt./wt.

The binder used in this invention acts also as a water-proofing agent. This results in reducing the number of steps involved in the process from four, those of blending, pressing, baking and water-proofing as done in the usual method of making Air Depolarised porous carbon electrode, to two, those of blending and pressing as in the present method.

The fact that the porous carbon electrode element, consisting of a blend of vegetable carbon, acetylene black, and a high polymer as binder, can be prepared

by a simple procedure as described hereinafter, involving no costly equipment (a mixer and a hydraulic press is all that is required), makes the process economical.

By virtue of some of the advantages outlined above, more particularly the utilisation of the indigenously available carbon and less costly equipment, the present invention results in a large saving of foreign exchange and the necessity of import of the finished product.

In order that the invention may be clearly understood and readily carried into effect, the procedure for making porous carbon electrode element for one particular type used in Railways, namely, AWC2 type Air Depolarised Cell* is described in detail along with diagram.

Example.

A blend consisting of activated vegetable carbon (such as activated coconut shell charcoal) in powdered form, preferably between —100 mesh and +140 mesh size, along with a small percentage of acetylene black (ranging from 5 to 15 per cent. but preferably 10 per cent. wt./wt.), to which a high polymer binder-cum-water-proofing agent such as perspex (ranging from 1.5 —3.0 per cent., preferably 3 per cent. of the mass of the electrode) dissolved in a suitable solvent (such as benzene or trichlorethylene) had been added, was used for making the electrode.

Approximately 720 gms of activated coconut shell charcoal and approximately 80 gms of acetylene black were mixed using a blender (mixing machine), with the addition of about 25 gms of a high polymer (such as perspex) dissolved in about 500 c.c. of a suitable solvent (such as benzene or trichlorethylene). The carbon mix was then pressed in the form of an electrode at a pressure of about ¼ to ½ ton per square inch in the hydroulic press, using a mould such as one made of wood. After pressing, the electrode '*in situ*' was allowed to weather-dry in the atmosphere before removal from the mould.

(For electrical contact, a central mild steel rod (nickel plated) with a small mild steel disc (nickel plated) on top and a bigger one at the bottom of the electrode, was used. The discs were kept in contact with the electrode using suitable nuts. A seamless plastic or rubber ring 2" wide and 1/16" thick was then inserted around the top portion of the electrode. Wax coating was given at the lower end of the plastic or rubber ring to avoid seepage of the electrolyte to the top surface of the carbon electrode. The electrode made in the above manner could then be assembled into an Air Depolarised Cell.

Details regarding the mould for making a porous carbon electrode, dimensions and shapes of the porous carbon electrode as well as zinc electrode, cell container, cell cover, etc., are given in figures Nos. 1 to 6 of the drawings accompanying the Provisional specification which are as follows:

Figure 1.

Cell container.

(*a*) Front view.
(*b*) Top view.

Figure 2.

Cell cover.

(*a*) Top view
(*b*) Section.
(*c*) Bottom view.

Figure 3.

Zinc electrode.

(*a*) Top view.
(*b*) Section.

Figure 4.

Porous carbon electrode.

(*a*) Top view.
(*b*) Section.

Figure 5.

Assembled A.D. Cell.

(*a*) Front view.

Figure 6.

Mould for making the porous carbon electrode.

(*a*) Mould with both plunger and base plate removed (Top view).
(*b*) Mould with both plunger and base plate removed (Front view).
(*c*) Mould with plunger removed (Top view).
(*d*) Base plate (Section).
(*e*) Plunger (Top view).
(*f*) Plunger (Section view on A B).
(*g*) Assembled mould with plunger and base plate (Side view).

The Air Depolarised Cell incorporating the porous carbon electrode element (prepared by using the materials and technique outlined above), when assembled in the form of the special Railway type (AWC2) cell, gives an open circuit voltage of 1.40 to 1.45 volts and a short circuit current 6 amperes. It also meets the following typical set of requirements,

0.06 ampere for 30 minutes each and 30 times a day
3.0 amperes for 15 seconds each and 30 times a day, and
0.17 ampere continuous discharge all the 24 hours until 500 ampere hour designed capacity is realised.

(Note.—Experiments on the evaluation of active carbons without any admixture have shown that out of various varieties of active carbon, the electrode element made with the above blend, when incorporated in the Railway type (AWC2) Air Depolarised cell, gives the highest short circuit current and offers the lowest resistance. (For example, values of short circuit current 1.8 amps., resistance of a block of 3×2.6 cm. dia., size, 12 ohms, are obtained for the above blend as compared to the values of short circuit current ranging from a few milliamperes to a maximum of 800 milliamperes and resistance (under identical conditions) ranging from 57 ohms to 125 kilo-ohms for the other blends tried).

The example describes in detail the method of making porous carbon electrode element, in particular, that of the AWC2 type Air depolarised Cell. However, the invention may be utilised in the manufacture of porous carbon electrode elements for other types of air depolarised cells, as also porous carbon electrodes for any other use.

Having particularly described and ascertained the nature of our said invention and the method of manufacture thereof.

We claim:

1. A process of making porous carbon electrode element, (more particularly for use in Air depolarised Cell) wherein activated vegetable charcoal is used as the bulk constituent of the electrode.

2. A process as claimed in (1) wherein activated vegetable charcoal, more particularly activated coconut shell charcoal is used.

3. A process, as claimed in any of the preceding Claims, wherein acetylene black has been added to activated vegetable charcoal to the extent of approximately 5 to 15 per cent. wt./wt.

4. A process, as claimed in any of the preceding Claims, wherein a hgih polymer, more particularly one of the perspex type, in ratio of 1.5 to 3.0 per cent. of the mass of the electrode (in conjunction with a solvent such as of the benzene or the trichlorethylene type) is used to act either as a binder or a water-proofing agent or as both.

* The Awc2 type A.D. Cell is more fully defined in British Standards B.S. 1335:1946.

5. A process for making porous carbon electrode element, substantially as described in the example.

6. A process for the manufacture of porous carbon electrode elements substantially according to the invention as hereinbefore described.

R. BHASKAR PAI
Patents Officer,
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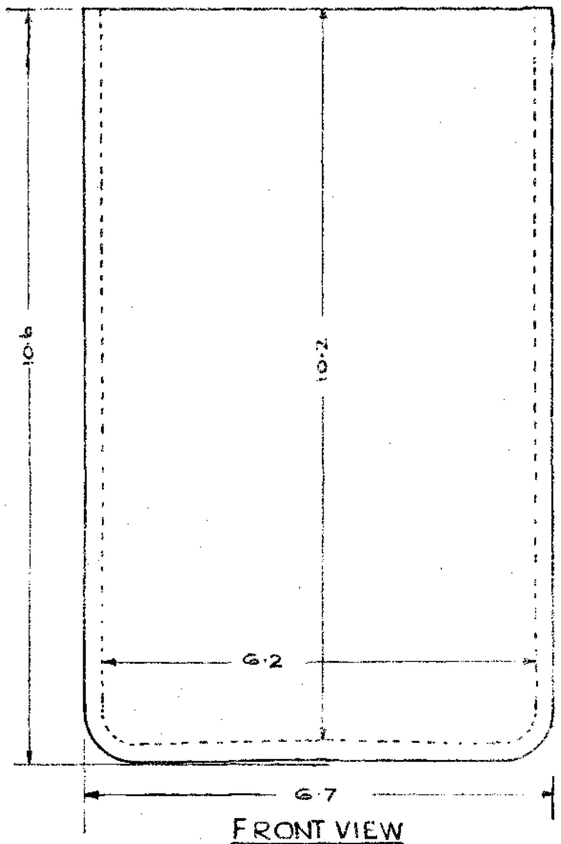
Dated this 13th day of August 1964.

MGIPC—55—35 Patent/65—9.6.66—100.

PROVISIONAL SPECIFICATION

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
No. 90957.

No. of sheets 3
Sheet No. 1.



FRONT VIEW
(CELL CONTAINER)
Fig. 1a

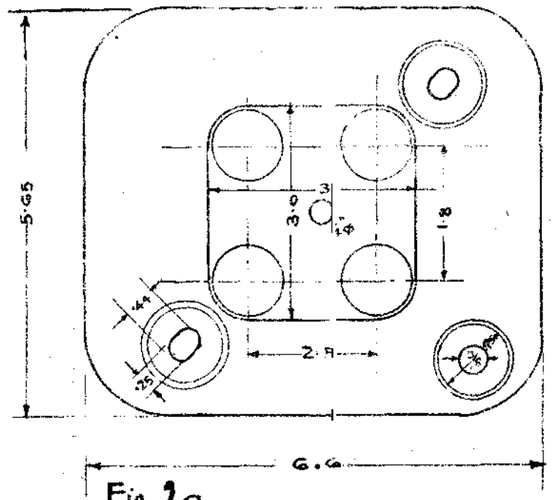


Fig. 2a TOP VIEW
(CELL COVER)

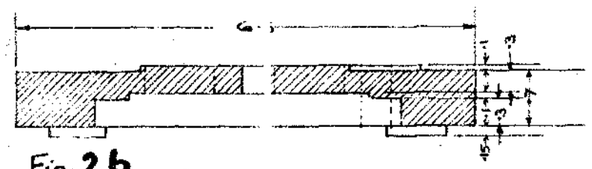
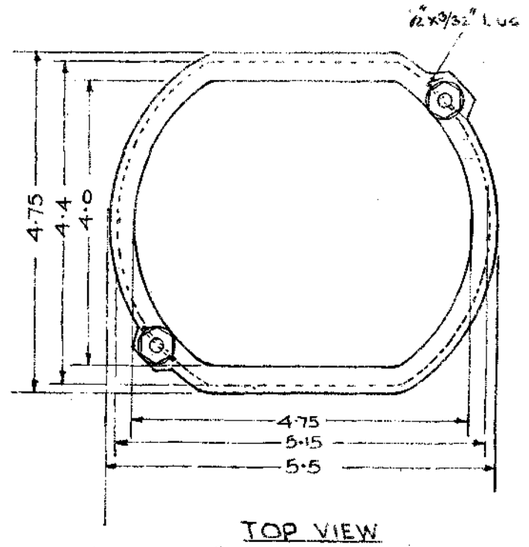
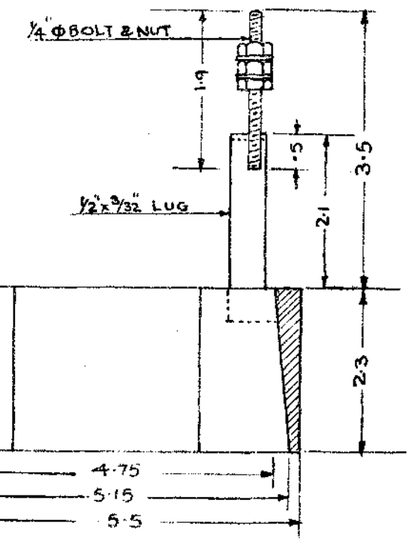


Fig. 2b SECTION

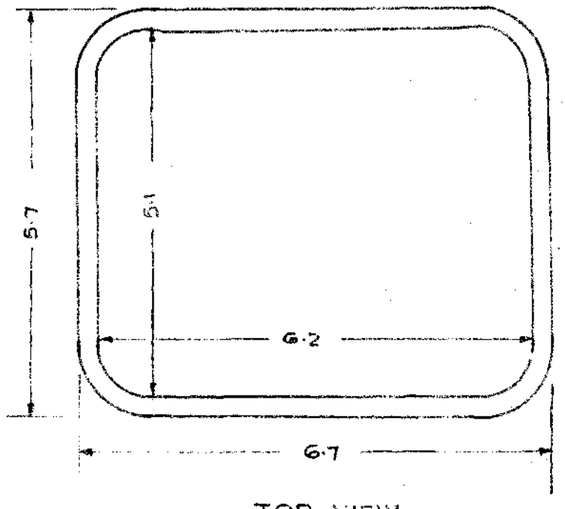


TOP VIEW
(ZINC ELECTRODE)
Fig. 3a

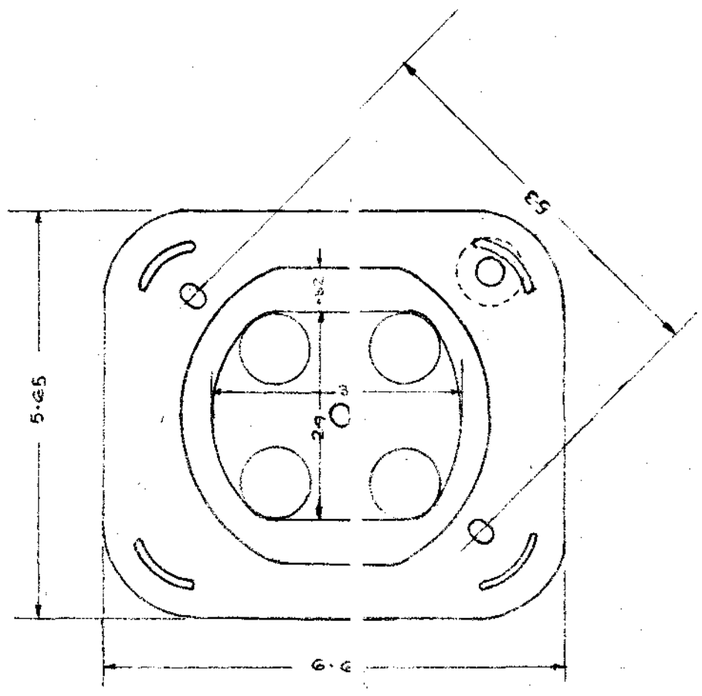


SECTION

Fig. 3b



TOP VIEW
Fig 1b



BOTTOM VIEW

Fig. 2=

NOTE
SCALE: HALF FULL SIZE.
ALL MEASUREMENTS IN INCHES.
SHEET No. 1.

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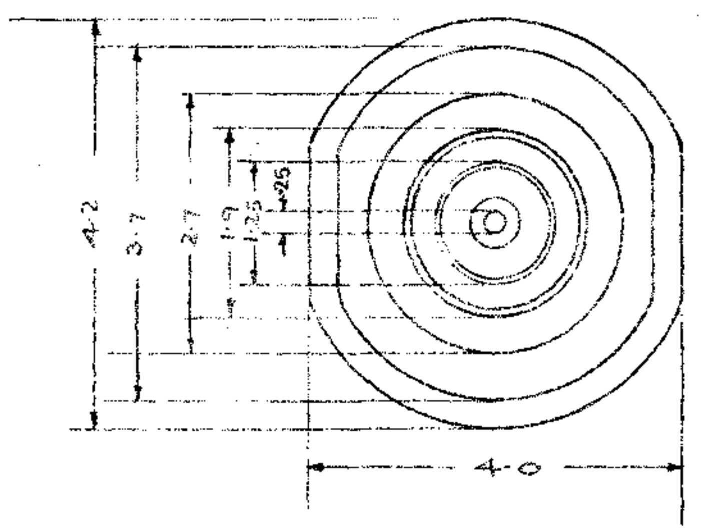
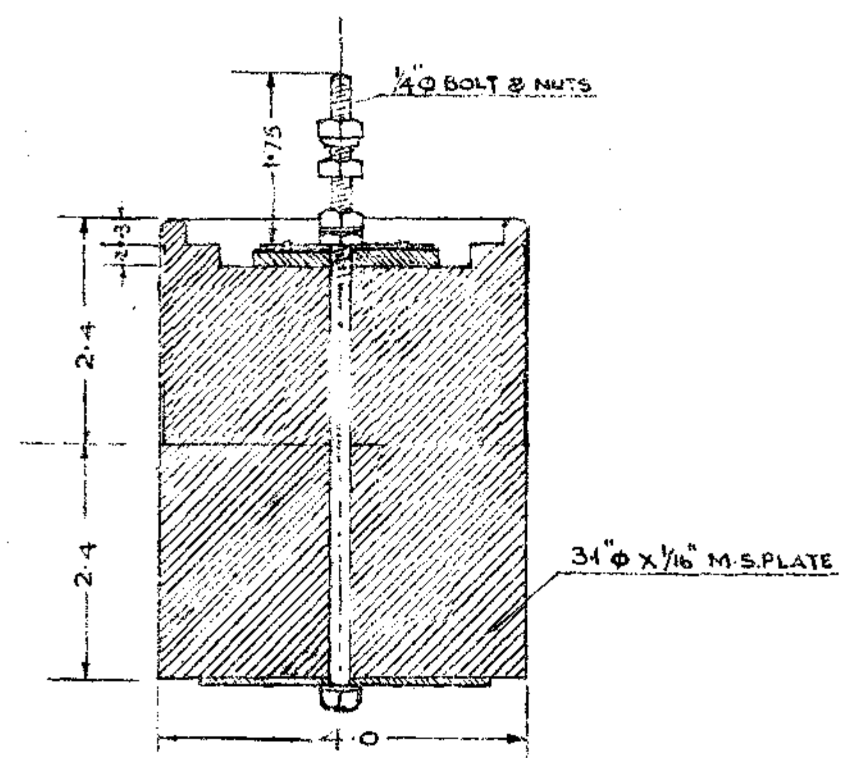
No. of Sheets 3
Sheet No. 2

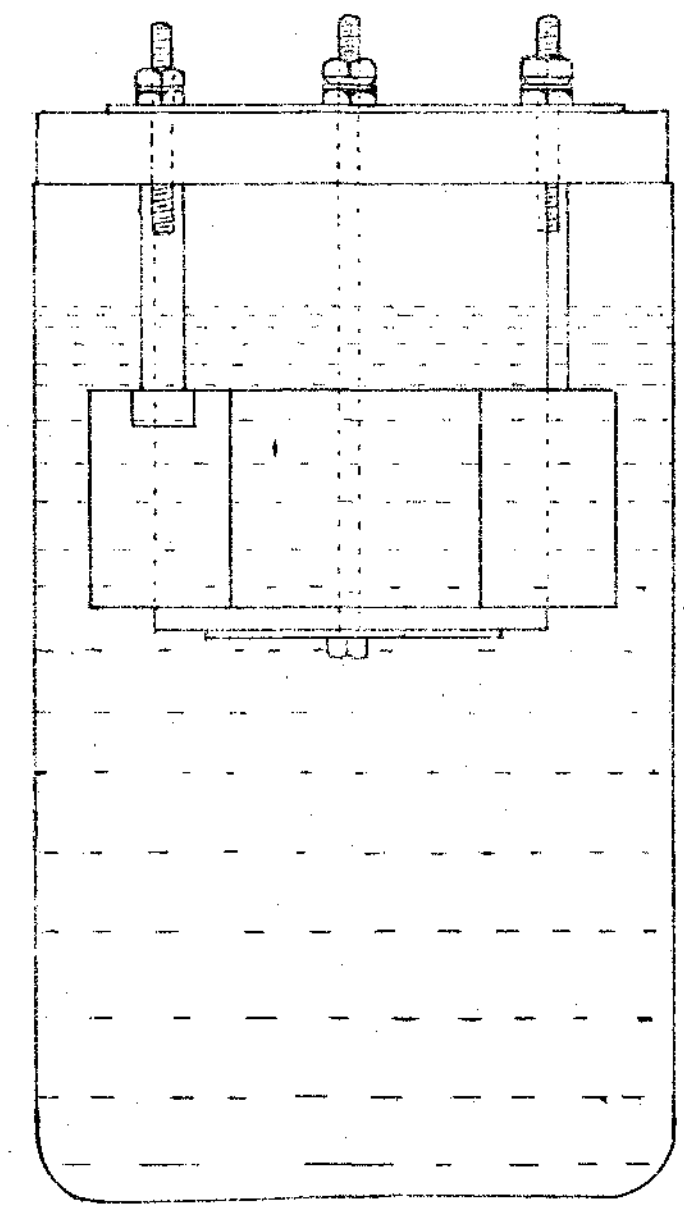


TOP VIEW
(POROUS CARBON ELECTRODE)
Fig 4a.



SECTION

Fig. 4b



ASSEMBLED VIEW
(FRONT VIEW)
Fig. 5

NOTE
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ALL MEASUREMENTS IN INCHES
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PROVISIONAL SPECIFICATION

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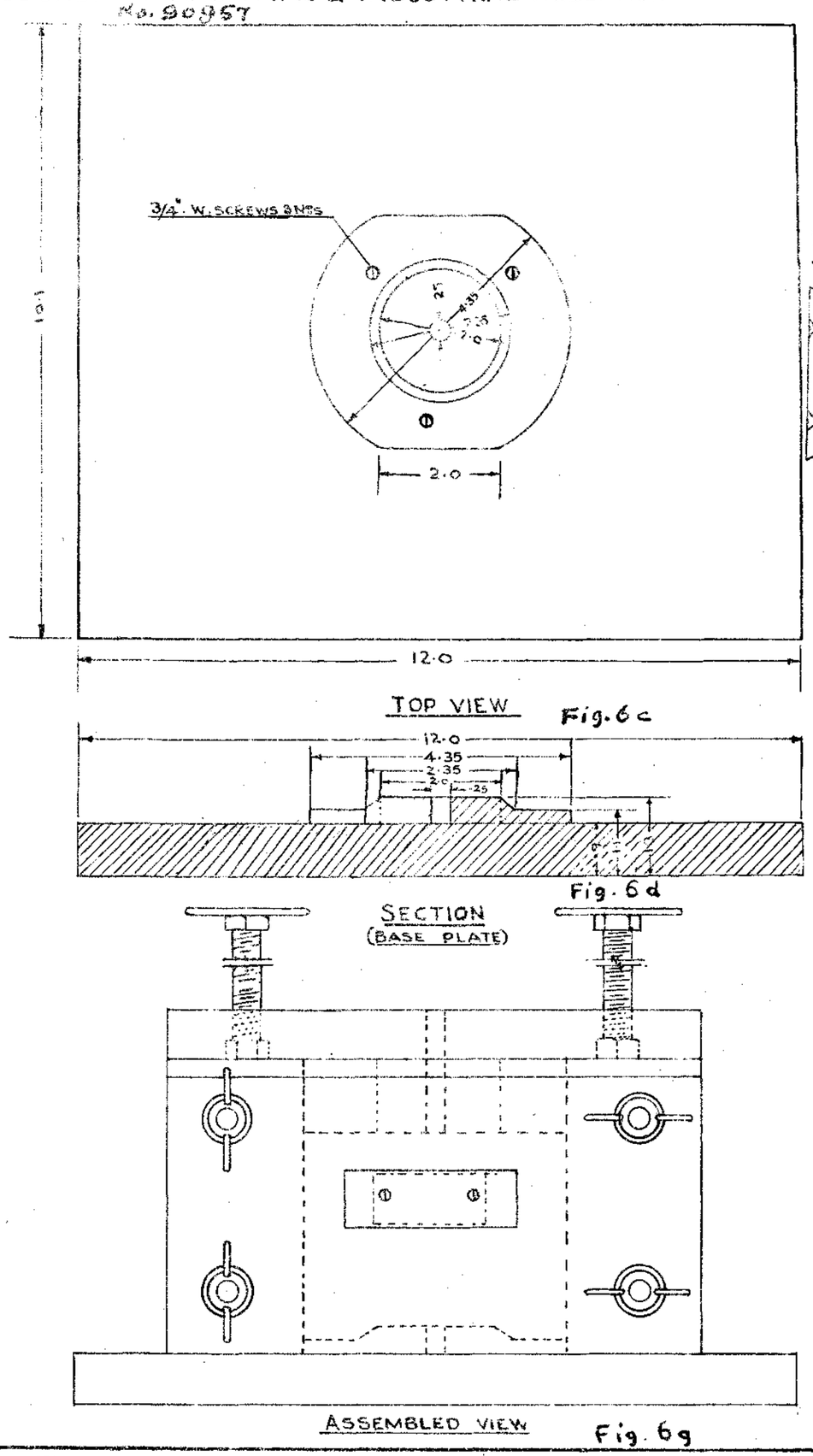
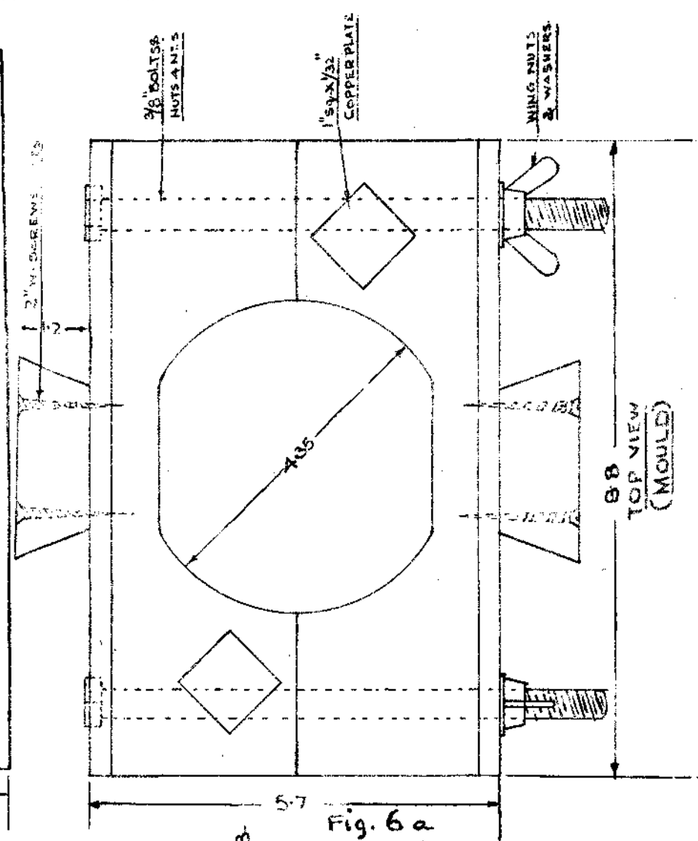
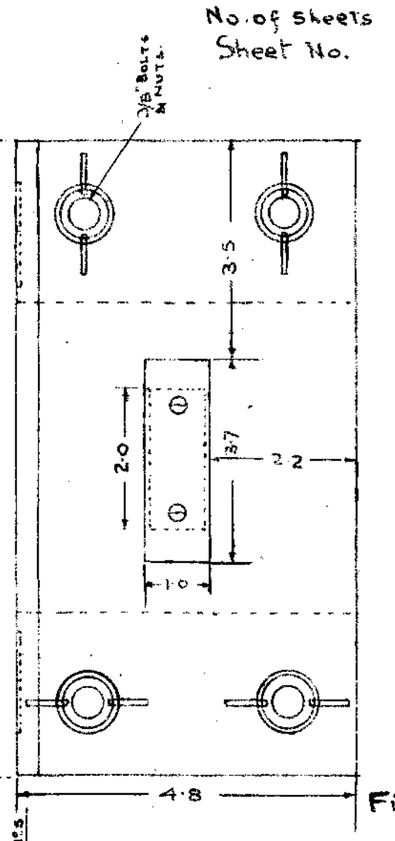
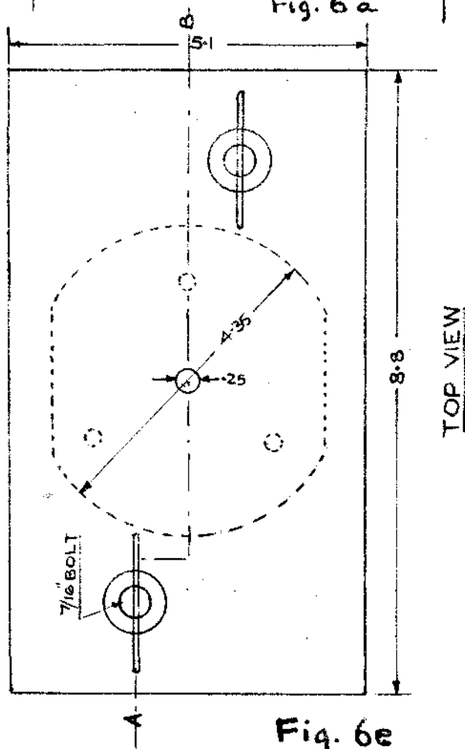
No. 90957

No. of sheets 3
Sheet No. 3









NOTE
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ALL MEASUREMENTS IN INCHES.
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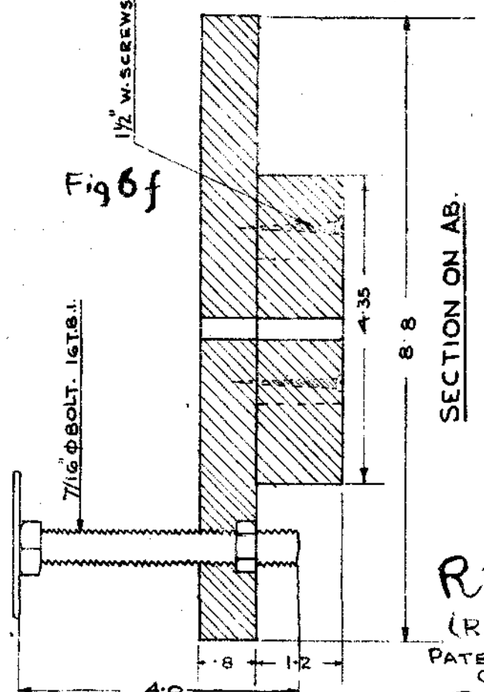

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MOULD FOR PREPARING POROUS CARBON ELECTRODE ELEMENT

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