

April 6, 1948.

J. T. L. BROWN

2,438,897

METHOD OF PLATING CONTACT SURFACES OF MAGNETIC REEDS

Filed Aug. 26, 1943

3 Sheets-Sheet 1

FIG. 1

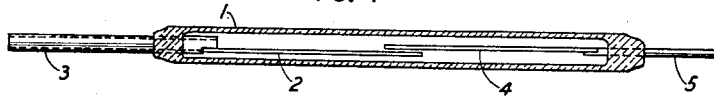


FIG. 2

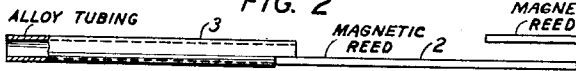


FIG. 3

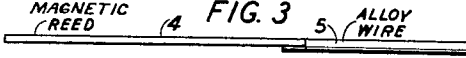


FIG. 4

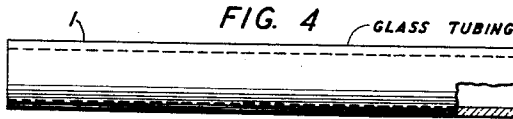


FIG. 5

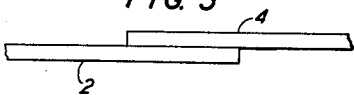


FIG. 6



FIG. 7



FIG. 8



FIG. 9

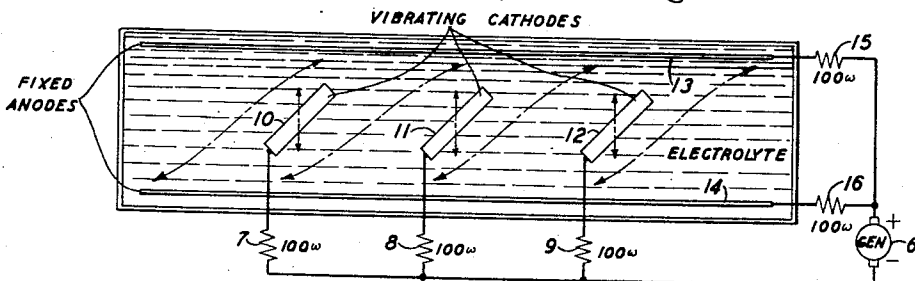
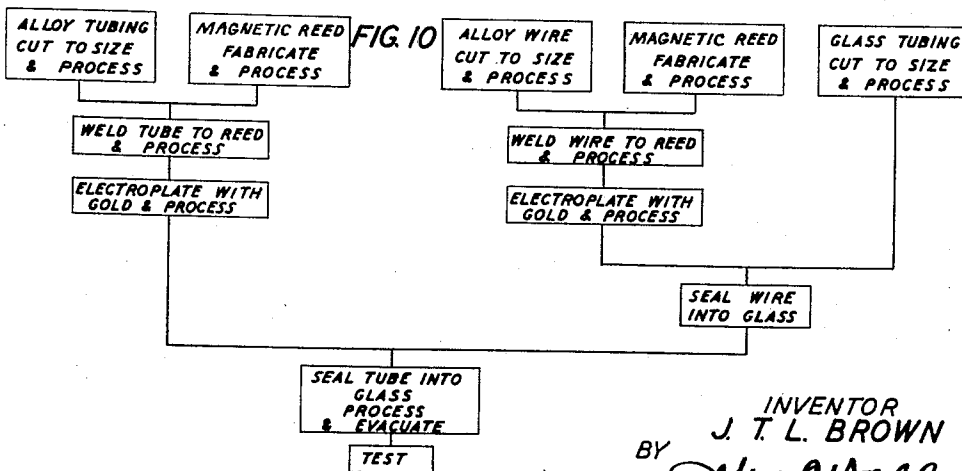


FIG. 10



INVENTOR
J. T. L. BROWN
BY *John A. Hall*
ATTORNEY

April 6, 1948.

J. T. L. BROWN

2,438,897

METHOD OF PLATING CONTACT SURFACES OF MAGNETIC REEDS

Filed Aug. 26, 1943

3 Sheets-Sheet 2

FIG. 13

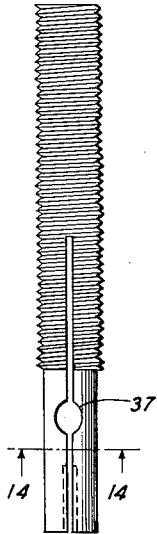


FIG. 14

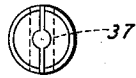


FIG. 15

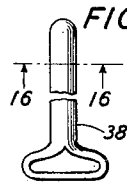
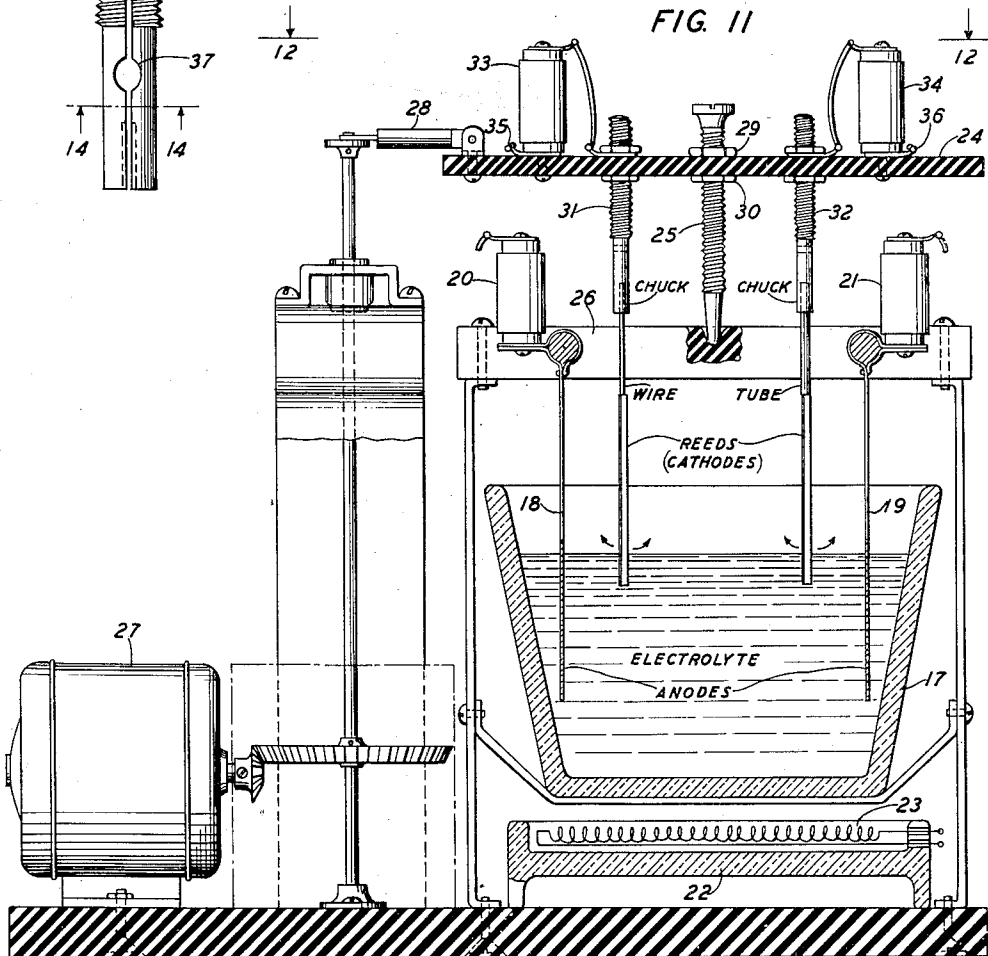


FIG. 16



FIG. 11



INVENTOR
J. T. L. BROWN

BY

Olumattall

ATTORNEY

April 6, 1948.

J. T. L. BROWN

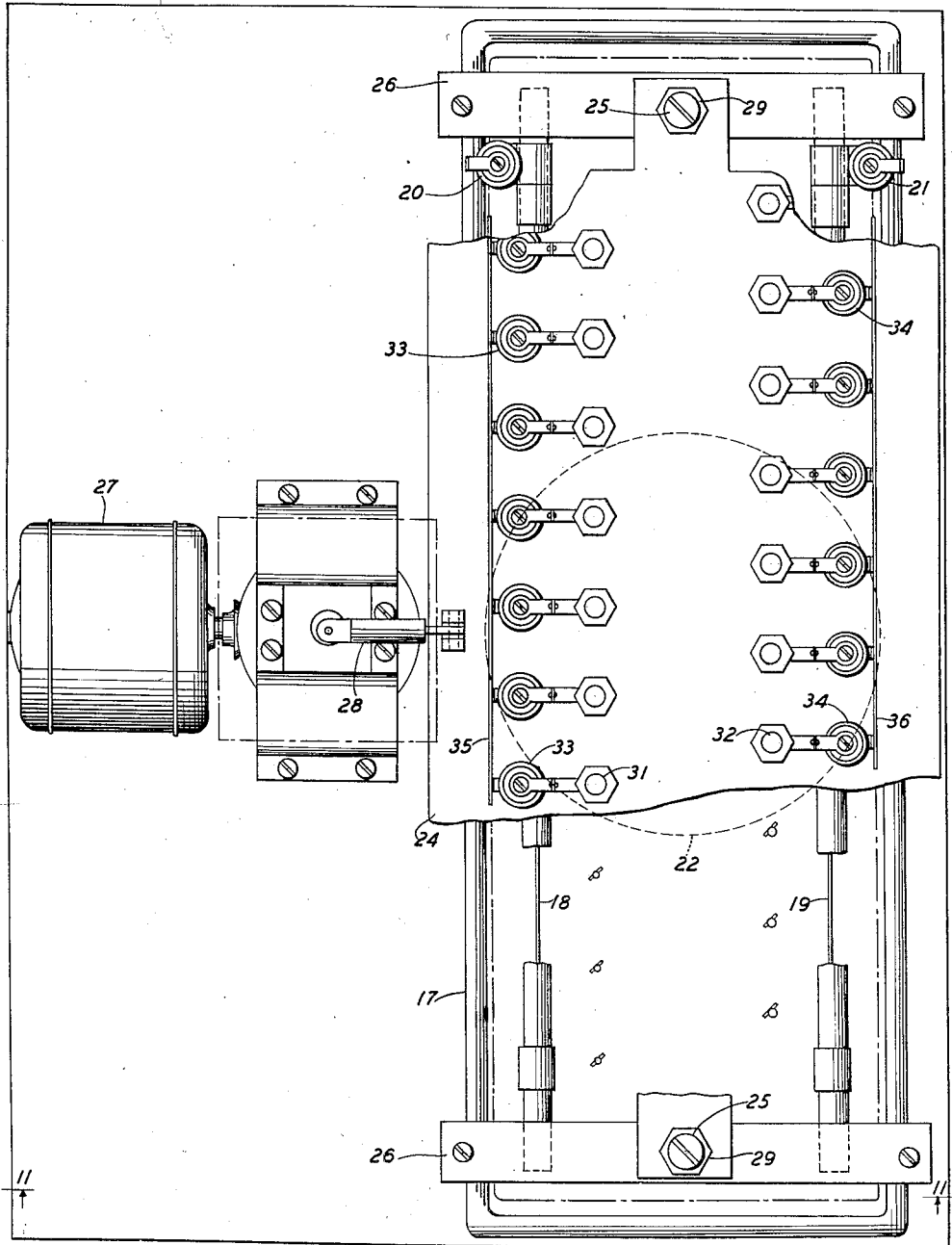
2,438,897

METHOD OF PLATING CONTACT SURFACES OF MAGNETIC REEDS

Filed Aug. 26, 1943

3 Sheets-Sheet 3

FIG. 12



INVENTOR
J. T. L. BROWN
BY *John A. Ball*
ATTORNEY

UNITED STATES PATENT OFFICE

2,438,897

METHOD OF PLATING CONTACT SURFACES
OF MAGNETIC REEDSJohn T. L. Brown, Short Hills, N. J., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

Application August 26, 1943, Serial No. 500,049

1 Claim. (Cl. 204—23)

1

This invention relates to a method of producing contact surfaces used in electrical circuit makers and breakers. More particularly the invention relates to a nicety of control in the art of electroplating.

The object of the invention is to produce great uniformity in the electroplating of a contact surface which due to the service which it will be called upon to perform must deviate from a standard only by the smallest amount. The process of the present invention is particularly applicable to the manufacture of a piece of apparatus known as the Ellwood unit which is disclosed in Patent No. 2,289,830, granted to W. B. Ellwood on July 14, 1942, though it will apply as well to the manufacture of other similar apparatus.

The Ellwood unit, compared to other types of magnetic switches or relays, has certain unique characteristics. It is an assembly of specially stable elements bound to each other entirely by fusion. The parts themselves and the mechanical bonds between them are practically unaffected by humidity and are stable with respect to ordinary temperature variations. This results in a high degree of stability of adjustment, compared, for instance to spring pile-ups molded or clamped in plastic or other insulating materials. No adjustment after assembly or while in service is possible and therefore it is necessary to employ methods of manufacture which will result in a high degree of uniformity in the product. Each manufacturing step must be characterized by nicety of control.

The contact surfaces on the tips of the reeds of magnetic material must be uniform to a very high degree. It has been found that a gold infused surface is superior in many respects to any other. Generally stated the process of forming this surface is to gold plate the surface and then to infuse the gold into the surface of the magnetic material by heat in an atmosphere of hydrogen. A surface of a gold-iron alloy is formed, but in order to render this uniform it is necessary to deposit the gold uniformly over the surface and to produce a specified weight of the noble metal plate. Rapid changes in magnetic and resistance properties follow deviation from a given standard. Uniformity in plating is necessary from certain practical consideration. If the gold at any point is insufficient the contact resistance becomes very high whereas if there is too much gold blisters form on the surface due to insufficient infusion and gold not infused acts as a non-magnetic shim. The high

2

quality contact that results is not believed to be due to any peculiar property of the alloy but rather to another factor. The gold during this alloying process seems to be particularly efficacious in causing the magnetic material to release any entrapped oxygen and the cooler contiguous magnetic material which has not been gold plated acts as a "getter" and will absorb and entrap this released oxygen. The completed contact is therefore particularly free of oxygen and for that reason becomes an excellent low resistance lasting device. Due to its low resistance the energy which might otherwise be expended in melting the contact material is dissipated in a heat wave in the material with the result that the surface remains clean indefinitely.

The ferromagnetic properties of the alloy formed play a considerable part in the sensitivity of the completed device and since as pointed out heretofore no adjustment after assembly or while in service is possible it is necessary for the sake of uniformity to render the alloys formed to uniform character, it is necessary to use nicety of control in the plating operation.

Heretofore in the plating art it has been considered desirable to have the plating circuit as low in resistance as possible for it is a saying that it is the volts for which the plater pays while it is the amperes for which he is paid. On a purely commercial basis this is a rule of great importance and is of a controlling nature. In the present case, however, the cost of the plating is of minor importance in comparison to the importance of producing an even deposit of a predetermined weight.

Where a plurality of reeds are to be simultaneously plated it is therefore of importance to minimize any variation in resistance of the reeds themselves and hence a feature of the invention is the use of an individual resistance in series with each reed to render the resistance of the reed a minor fraction of the total resistance of the plating circuit so that each parallel branch will be as nearly the same as possible. Consequently the rate at which the gold plate is formed is substantially uniform.

Another feature of the invention is the steps taken to render the concentration of the electrolyte uniform over all portions of the surface to be plated. Mere turbulence of the electrolyte does not produce a uniform result, so the reed tips are gently moved backwards and forward and are placed at such an angle that the apparent flow of the electrolyte over their surfaces is uniform and might be said to be akin to

streamlining. If the reed tip is moved in a line normal to its surface the plating becomes thicker at the edges and the same effect is observed if the reed is moved in a line parallel to the flat surface thereof. It has been discovered that if the reed is moved in a line substantially 45 degrees to the plane of its surface that the deposit is of uniform thickness over the whole surface thereof. A feature of the invention therefore is a step in the manufacture of a contact surface consisting in the movement of the contact surface during the electroplating process through the electrolyte at such an angle that the concentration of the electrolyte in contact with the reed tip remains constantly uniform.

Other features will appear hereinafter.

The drawings consist of three sheets having sixteen figures as follows:

Fig. 1 is a side view of the finished contact unit;

Fig. 2 is a detail side view of a reed as welded to the tube used as a support, an electrical lead and as a means to evacuate the assembled unit;

Fig. 3 is a similar detail side view of a reed welded to a wire used as a support and an electrical lead;

Fig. 4 is a side view partly broken away to expose a section of the glass tube into which the details of Figs. 2 and 3 are sealed at either end thereof;

Fig. 5 is a diagrammatic side view of the overlapping ends of two reeds to express the relative positions thereof necessary to provide the most perfect contact therebetween;

Fig. 6 is a greatly enlarged perspective view of the contact end of a reed which has been improperly plated so that a multiplicity of small blisters are formed, making the perfect contact of Fig. 5 impossible;

Fig. 7 is the ideal cross-sectional form of the reed at the contact point;

Fig. 8 is a defective form of cross-section formed when the extreme care in the formation of the plating is not exercised;

Fig. 9 is a diagrammatic view looking down into the surface of the electrolytic bath, showing a diagram of the circuit used during the plating operation and indicating the movement of the tips of the reeds and the general directions of the liquid currents set up in the electrolyte through such movements;

Fig. 10 is a flow chart showing the different steps in the process of manufacturing the sealed reed contact unit;

Fig. 11 is an end view partly in section of the apparatus employed in the plating operation;

Fig. 12 is a top view of the same;

Fig. 13 is a detail side view of the chuck used in holding the details of Figs. 2 and 3 during the plating operation;

Fig. 14 is a cross-sectional view of the chuck taken on line 14—14 of Fig. 13;

Fig. 15 is a side view of the key used to operate the chuck of Fig. 13; and

Fig. 16 is a cross-sectional view of the key taken on line 16—16 of Fig. 15.

The sealed reed contact unit is an assembly of specially stable elements bound to each other entirely by fusion. It consists of a body portion 1 of glass into each end of which there is sealed a flexible reed of magnetic material with their ends overlapping and normally out of contact with each other. These reeds may be made of a suitable magnetic material disclosed in Patent 1,715,647, granted to G. W. Elmen, June 4, 1929.

When such a unit is brought into a magnetic field the reeds may be brought together to make electric contact with each other. Each reed is welded to a support which is used to make the bond to the glass tube as well as to provide electrical connection between the interior and exterior thereof. As shown in Fig. 2, the reed 2 is welded to a tube 3, which may be formed of an alloy of magnetic materials which is peculiarly adapted for making a lasting seal to the particular kind of glass employed for the body 1. This tube provides metal tubulation for the device so that after assembly the unit may be evacuated or filled with any desired type of gas. It also provides means for cleaning the interior surfaces of the unit after assembly with an atmosphere of hydrogen under specified heat conditions. Fig. 3 shows the reed 4 welded to a solid wire 5 which performs the functions of a support of an electrical lead the same as the tube 3.

Due to the fact that no adjustment can be made after assembly, it will be realized that extreme care must be exercised during manufacture to provide uniformity of product. One of the important problems is to provide good contact surfaces on the overlapping ends of the reeds and this depends on two factors, first, the reeds must be so constructed and arranged that the flat surfaces of the two shall come in contact with each other over the whole of the overlapping area and, second, that the surfaces conform to each other in contour as when both are geometrically plane surfaces though it will be recognized that in ordinary practice no such perfect surfaces are produced. This last consideration requires that great care be exercised in the formation of the surfaces. Fig. 6 shows a type of surface produced by ordinary plating methods where the surface is rendered uneven and may be termed a blistered surface. Fig. 8 shows (in greatly exaggerated form) a cross-section of a reed which has been plated by conventional methods in which the electrolyte has been agitated to turbulence. It will be realized that should two reeds with such contours be used, contact will only occur over minute areas along the edges. Consequently, it is desirable to maintain a cross-section such as that shown in Fig. 7, where the faces are geometrically flat.

As a means to this end the tips of the reeds are immersed in a plating electrolyte and then gently rocked back and forth. As indicated in Fig. 9 the reeds are placed so that their faces are at approximately 45 degrees to the direction of motion so that the liquid currents of the electrolyte are such as to preserve an even concentration of the strength of the solution at all points on the surface.

In order to maintain uniformity of the product and to deposit an equal weight of gold on each reed tip the usual practice in electroplating is abandoned and now each article to be plated is placed in a separate comparatively high resistance circuit. Thus in Fig. 9 the source of current 6 is led through a plurality of resistance elements 7, 8 and 9 each of approximately 100 ohms in value to the vibrating cathodes 10, 11 and 12, respectively. The circuit is completed through the electrolyte to the anodes 13 and 14 thence through resistances 15 and 16, respectively to the source of current 6.

The process of manufacture, including the step of electroplating with gold or other noble metal, is shown in Fig. 10 and needs no description. It is given here to make it clear that the

electroplating process is important and needs to be done with great care. In most steps such as this one the step is labeled "Electroplate with gold and process." Thus this step comprehends other minor operations that go with the electroplating such as cleaning and heat treating in an atmosphere of hydrogen whereby the gold is infused into the magnetic material making an alloyed and permanent surface.

In Figs. 11 and 12 an apparatus for performing the electroplating operation is shown. A vessel 17 holds the electrolyte. Two anodes 18 and 19 are deeply immersed in the electrolyte and each is connected through a resistance element 20 and 21 to the electroplating circuit. An electrical stove 22 with its heating element 23 is shown below the vessel 17 to hold the electrolyte at the proper temperature.

The reeds forming the cathodes in the electroplating circuit are supported on a rocking jig. This comprises generally a plate 24 of insulating material. At either end of this plate there is a supporting screw 25 whose pointed end rests in an appropriately shaped depression in the frame piece 26 so that the plate may be rocked about the tip of the screw 25 as a cutter. This is accomplished by a motor 27 which through proper gearing will oscillate a link 28 to rock the plate 24 backwards and forward. The screw 25 is provided with a pair of adjusting nuts 29 and 30 whereby the distance of the plate 24 above the surface of the electrolyte may be adjusted.

The plate 24 forms a base for the mounting of a plurality of chucks 31 and 32 into which the details of Figs. 2 and 3 may be inserted and held during the plating operation. Each such chuck is electrically connected through a resistance unit 33 or 34 which is connected to the bus-bars 35 and 36 to the source of current hereinbefore described.

It has been found in practice that any deformation of the tubing 3 or the wire 5 (Figs. 2 and 3) must be avoided. Consequently, a chuck such as that shown in detail in Figs. 13 and 14 has been provided. The stock from which the chuck is formed is split, as with a saw, longitudinally, then sprung open and drilled laterally. When allowed to spring back to its normal condition the drill hole 37 in Fig. 13 assumes an oval contour. By use of a key 38 having a corresponding oval cross-section as shown in Fig. 16, the jaws of the chuck may be spread sufficiently to allow placement of the tube 3 or the wire 5. On removal of the key the jaws of the chuck spring back to normal position and firmly hold the detail. Since these chucks are drilled longitudinally to fit these details the

pressure exerted on them will not cause deformation and yet the detail will be held firmly in position.

As indicated in Fig. 12 the detail may be placed in the chuck in such a position that the face of the reed is placed at approximately 45 degrees to the direction of motion imparted thereto during the plating operation.

What is claimed is:

- 10 In the manufacture of electrical apparatus consisting of glass sealed magnetic reed contact elements, the step of plating the contact surfaces of the reeds with a noble metal by placing each of a plurality of said reeds in an individual
- 15 cathode circuit including an individual fixed resistance of approximately 100 ohms and completing said circuits in parallel through a noble metal plating electrolyte to a common anode to render the current in each said individual
- 20 cathode circuit substantially uniform and equal to the current in each other of said parallel circuits regardless of variations in the individual resistances of the reeds.

JOHN T. L. BROWN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
602,212	Dessolle	Apr. 12, 1898
645,786	Buck	Mar. 20, 1900
874,374	Muller et al.	Dec. 17, 1907
887,539	Stevens	May 12, 1908
891,361	Murphy	June 23, 1908
2,044,415	Yates	June 16, 1936
2,044,431	Harrison	June 16, 1936
2,149,344	Hull	Mar. 7, 1939
2,236,647	McIlvaine	Apr. 1, 1941
2,249,765	Hulse	July 22, 1941
1,527,095	Turnock	Feb. 17, 1925
2,289,830	Ellwood	July 14, 1942
1,727,736	Taylor	Sept. 10, 1929
542,986	Bossard	July 23, 1895

FOREIGN PATENTS

Number	Country	Date
451,623	Germany	Oct. 29, 1927
88,462	Austria	May 26, 1922

OTHER REFERENCES

- 55 Electrodeposition of Metals, by Langbein, published by Baird & Co., New York (1924), pp. 162, 163, 164, 205, 206, 207.
- The Petroleum Engineer, Oct. 1940, pp. 156, 157.