July 10, 1951 J. D. BEEBE 2,559,926

ANODE BASKET

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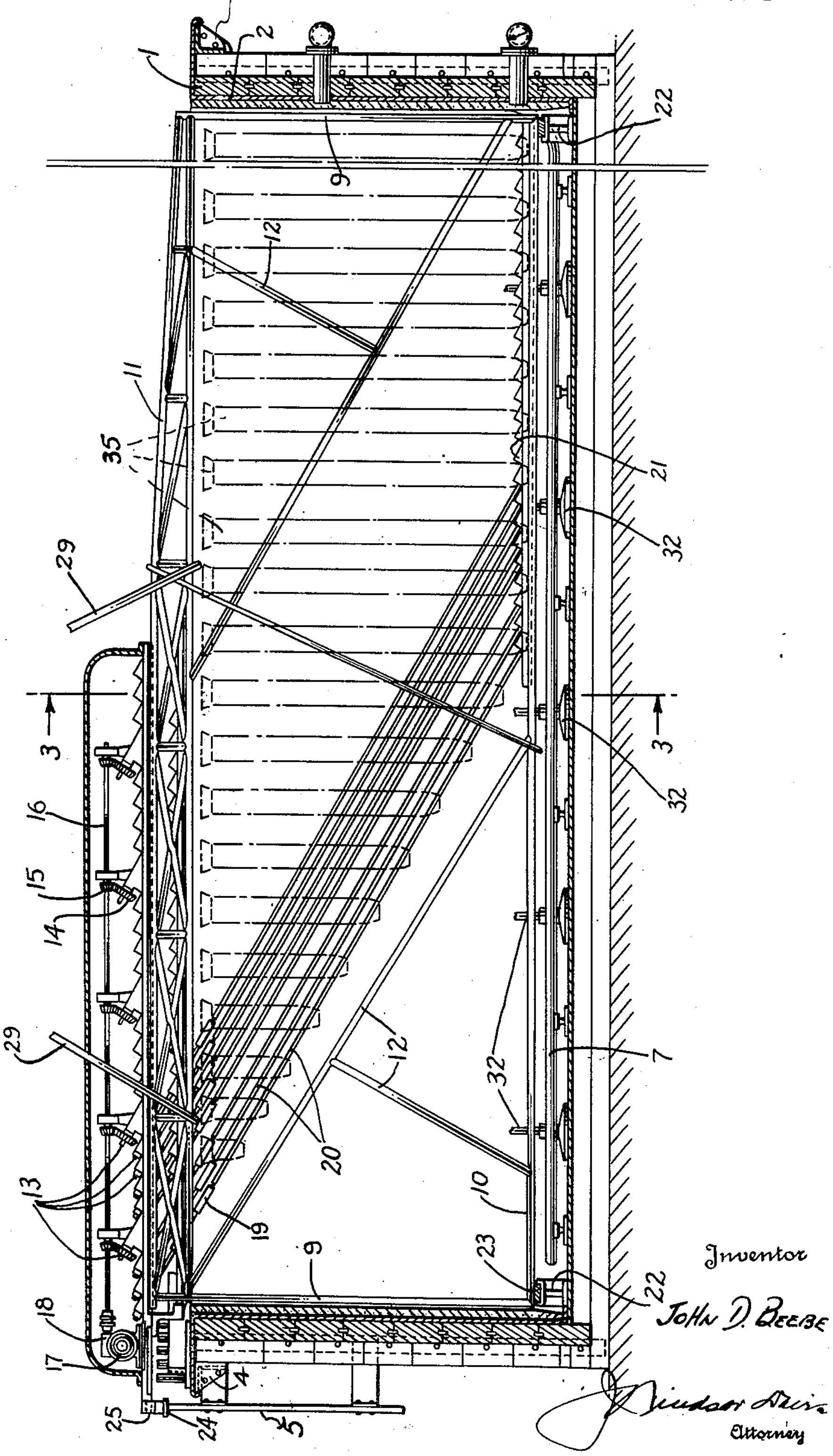

Fig. 1

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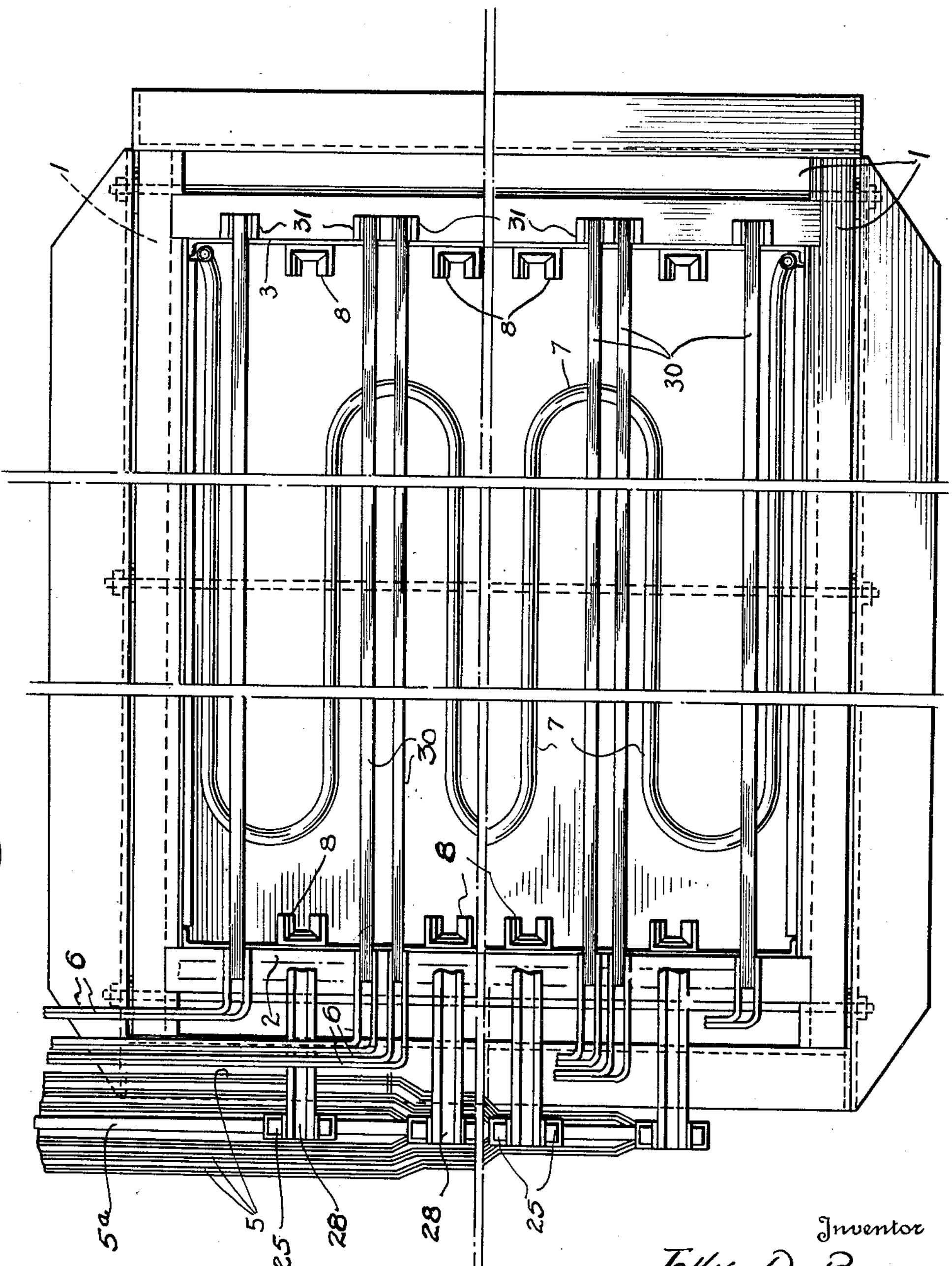
Fig. 2.



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ANODE BASKET

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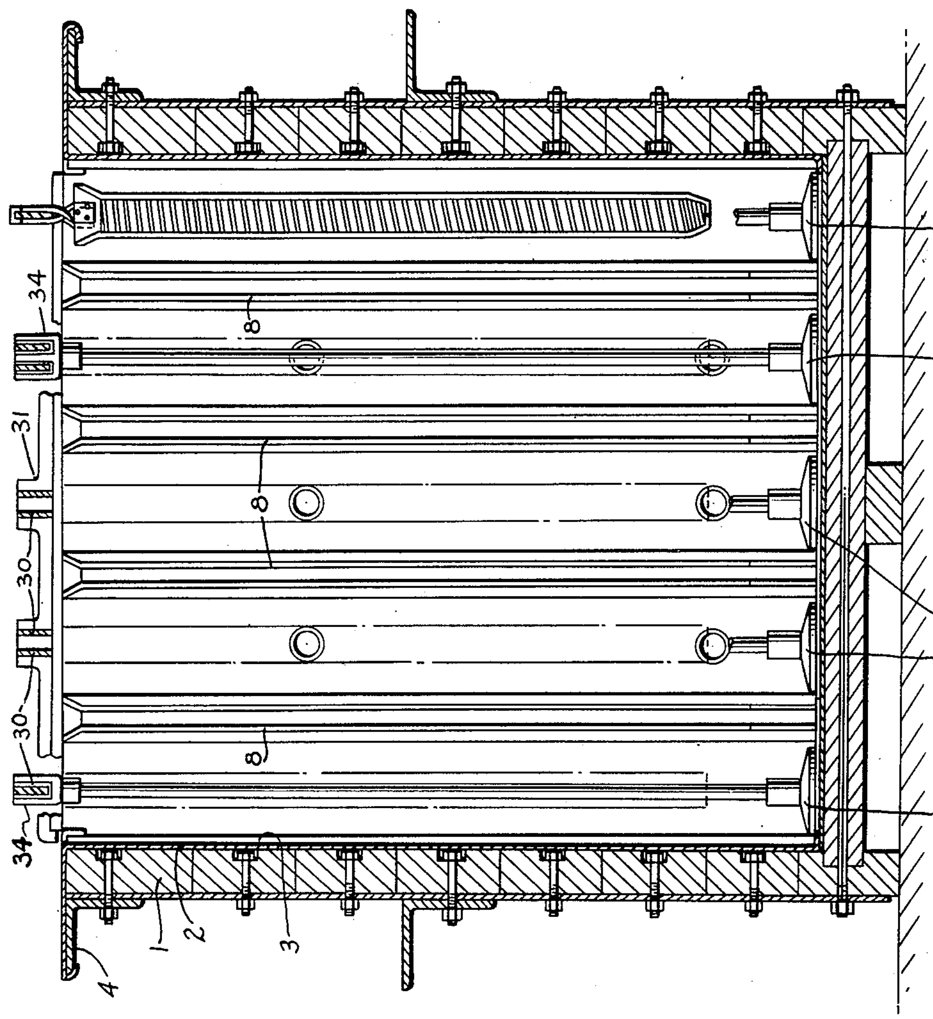

Fig. 3.

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Fig. 4.

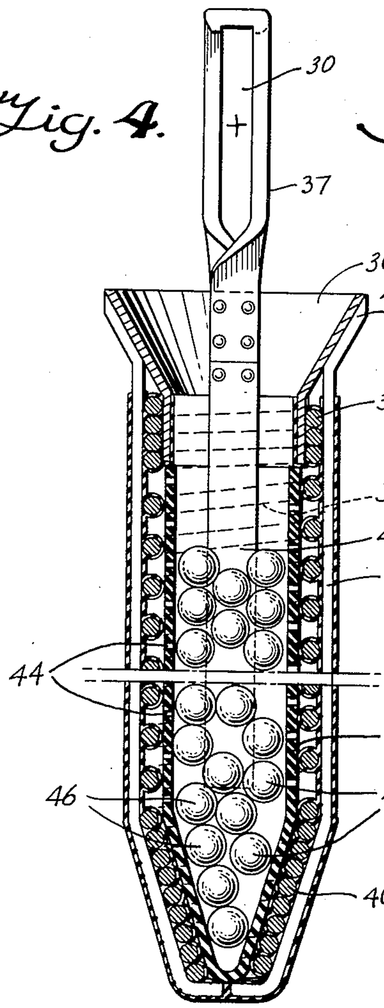

Fig. 5.

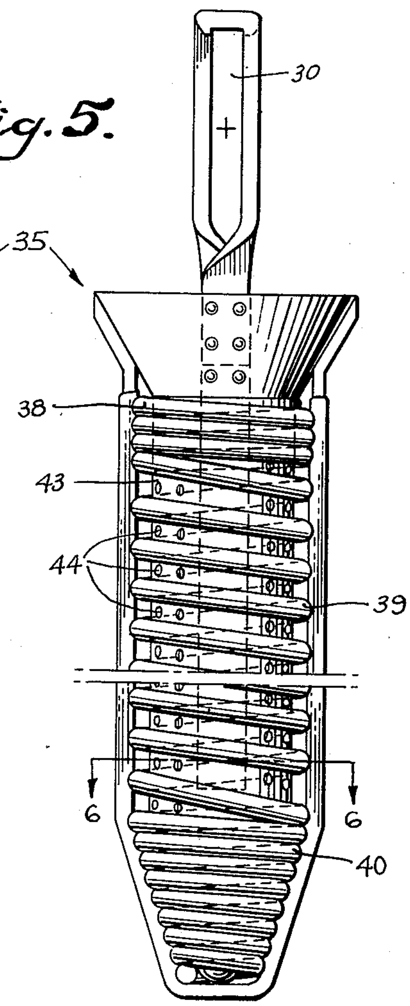

Fig. 6.

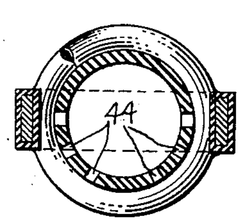

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Fig. 7.

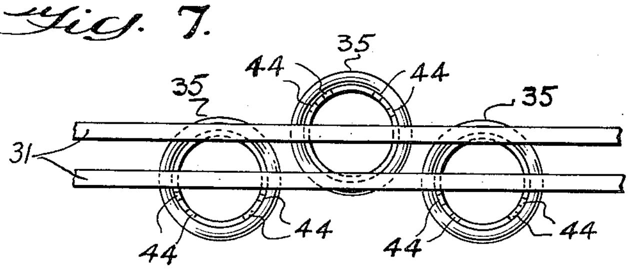
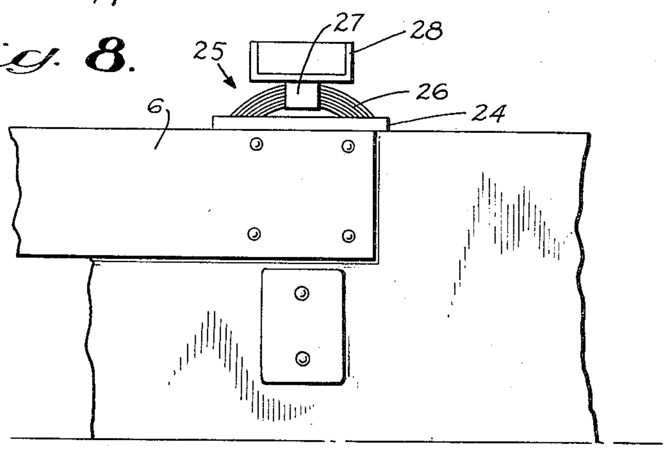


Fig. 8.



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Patented July 10, 1951

2,559,926

UNITED STATES PATENT OFFICE

2,559,926

ANODE BASKET

John D. Beebe, Detroit, Mich., assignor of one-half to John C. Schwartz, New York, N. Y.

Application February 4, 1947, Serial No. 726,303

1 Claim. (Cl. 204—287)

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This invention relates to an electrolytic method of manufacturing tubing together with certain apparatus therefor and has for its object to teach the manufacture of tubing which will be uniform in wall thickness, which will be free of pin holes and other imperfections, which will be of a predetermined hardness which can be varied at the will of the operator throughout the entire range from dead soft to brittle, and which will be at low cost.

The general method herein referred to contemplates the use of a vat of steel, wood or the like, lined with lead and containing a suitable electrolyte. For instance, if copper tubing is to be made the electrolyte may be composed of copper sulphate, sulphuric acid and water, as is understood in the art. The anode is composed of copper suspended in the electrolyte and the cathode is composed of a suitable material, such as stainless steel, upon which deposition is made.

My co-pending application, Serial Number 640,090, now abandoned, filed January 9, 1946, reveals a general method of plating and of electroforming certain types and classes of articles by directing the ionic flow from the anode to the cathode with an exactitude such that all deposition is made on a limited and prescribed area. Many of the principles of operation of the vat therein set forth are applicable to the process herein revealed, the difference here being that, from the standpoint of the final product, the object is not to restrict the deposit to a restricted and prescribed area but to obtain a uniformity of diffusion of the ionic streams in such manner that absolute uniformity of deposit is obtained over a tube which, of course, has an elongated surface of comparatively small cross sectional area.

A principal object of this invention is to provide a series of anode baskets suitable for obtaining uniformity of diffusion of the ionic streams over a bank of cathode rods and to teach the control of the vat as a whole in order to obtain electroformed tubing having the qualities above described.

More particularly, it is the object of this invention to teach the application of the general principles of my above mentioned co-pending application to the specific problems of tube making and to provide the apparatus necessary to this

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purpose. As will become hereinafter more fully apparent, the method and apparatus herein provided may be used for uniformly coating a surface generally and may be employed, for instance, to form sheet metal and the like.

Other objects and advantages will become hereinafter more fully apparent as reference is had to the accompanying drawings wherein my invention is illustrated and in which:

Figure 1 is a longitudinal vertical section through an electrolytic vat equipped to make tubing according to my invention,

Figure 2 is a top plan view of the vat equipped only with heating coils, rack guides and electrical connections,

Figure 3 is a transverse vertical section of the vat equipped with one anode, the rack slides and other equipment for purposes of explanation, this section being taken along the line 3—3 of Figure 1,

Figure 4 is a vertical section through the basket fully completed,

Figure 5 is a side elevation of a complete anode basket,

Figure 6 is a horizontal section taken along the line 6—6 of Figure 5,

Figure 7 is a top plan view of three adjoining anode baskets showing their relative positions in the vat,

Figure 8 is a detail view showing the electrical connection between the cathode racks and the main bus bars carried by the vat.

The vat is rectangular in horizontal and vertical cross section and is composed of wooden boards 1 having a lead lining 2. A glass lining 3 (Figure 2) interiorly of the lead lining is also recommended. Large angle irons 4 are secured to the uppermost of the boards 1 and the lead lining 2 is carried across the top of these boards and across the top of the angle irons 4.

At one end of the vat negative bus bars 5 and 5*a* and positive bus bars 6 are attached, these bus bars being connected to a suitable source of direct electric current at high amperage and low voltage as will be hereinafter referred to.

Along the bottom of the vat I provide means 7 for heating the electrolyte. This may be either in the form of an electrical heating element or in the form of a pipe through which a suitable hot fluid is pumped. The temperature of the electrolyte may thus be elevated into the normal plating range of 80°–90° F. before plating is started.

Secured to opposite ends of the vat are vertical guides 8, each guide at one end of the vat being directly opposite a guide at the other end of the vat to form a pair. Each pair receives a rack as illustrated in Figure 1. Each rack is composed of vertical members 9 at each end connected by a bottom horizontal member 10 and connected at the top by a horizontal truss work 11. Interior braces 11*a* are also provided. The truss work 11 has secured thereto, but electrically insulated therefrom, a plate 12 composed preferably of copper having a multiplicity of parallel, inclined openings therethrough which constitute bearings for cathode driving shafts 13. Each of these shafts has a gear 14 at its outer end for engagement with a gear 15 carried by a common shaft 16, a small motor 17 being supported on the end of the vat for driving the shaft 16 through reduction gearing 18 so that the drive shafts 13 rotate at slow speed, for instance, one revolution per second.

The other end of each shaft 13 has a chuck 19 to receive a stainless steel cathode rod 20 upon which electrodeposition is to be performed. The lower horizontal member 10 carries a plate 21 composed of a non-conductive material which will not be affected by the acidity of the electrolyte and which has a multiplicity of inclined parallel openings therethrough to receive the lower ends of the rods 20 and to hold them as bearings, for rotation therein. The verticals 9 are retained by the guides 8, and base members 22, capped by a pad 23 of insulating material, support the racks in spaced relation from the bottom of the vat.

It will be noted that the negative bus bar 5*a* is integrally secured to a horizontal member 24 which is also made of copper and which receives the electrical contactor 25 best illustrated in Figure 8. The contactor is composed of a plurality of curved laminations 26 of copper which are jointly machined at their ends into a flat surface for joint contact with the plate 24 and which are held firmly by a retainer 27. The retainer is fixedly secured to the copper plate 12 by its end extension 28, so that a negative electrical path is established from the cathode rods 20 to the negative bus bars 5 and 5*a* through the contactor 25 carried by the rack through the plate 12, through the shafts 13 and through the chucks 19. Thus, the contact is broken when a rack is lifted from its guides, as may be done by attaching the straps 29, provided for the purpose, to an overhead hoist (not shown). When a rack is lifted the gears 15 and the shaft 16 remain in place and the gears 14 and shafts 13 may go with the rack, or the gears 15, shaft 16, gears 18 and motor 17, may also be mounted to go with the rack.

It will be noted that the rods 20 reside at an angle with respect to the vertical. Two main purposes are accomplished by this. First, it has been found that if the rods are placed horizontally there is a tendency for gas bubbles to cling to the rods, which is detrimental to uniformity of deposit. While I do not believe that there is any critical angle at which the rods should incline, I strongly recommend that they be given a substantial angle of at least 15° and preferably around 30° out of the horizontal. The second advantage of this arrangement is that the vat can be made comparatively shallow. If the rods were vertically placed the vat would have to be much deeper and I therefore believe that the arrangement as illustrated will prove most satisfactory for production work.

The positive bus bars 6 are connected to the bus bars 30 which extend longitudinally of and above the vat. The bars 30 are supported at each end of the vat by metallic brackets 31 from which they are insulated so that there is no electrical path from the bus bars to the walls of the vat. Intermediate their length they are supported by a plurality of standards 32 and 33 which rest on the bottom of the vat and each of which terminates in a slotted head 34, two of these being fully illustrated in Figure 3. The slots are lined with insulation so that there will be no electrical path from the bus bars 30 to the electrolyte through these standards.

It will be noted that the interior rows of standards 32 have a doubly slotted head for supporting two parallel bus bars 30 while the outside rows of standards have only a singly slotted head. The reason for this is that the anode baskets are carried by the bus bars 30 and each one supplies a stream of ions in only one direction, as will be explained.

The anode baskets 35 will be first described with reference to Figures 4 and 5. Each basket is composed of a hopper 36 of a good conductive material, such as copper, which has conductive supporting straps 37 arising therefrom for electrically contacting support of the basket on a bus bar 30. Encircling the neck of the hopper are several coils 38 of heavy wire which may be brazed thereto if desired. This wire then spirals downwardly in a series of open coils 39 which together have a cylindrical profile. The coils are then progressively restricted in diameter and closed upon each other towards their lower end 40. A metallic strap 41 is brazed at each end to the hopper 36 and cradles the coils 38, 39 and 40 so that they will not expand or elongate. When this much of the basket has been completed it is coated with rubber except that the interior of the hopper is not coated and the exterior of the hopper need not be coated above the uppermost coil. This coating is preferably applied by spraying so that each open coil and each strap is individually coated except at their points of actual contact. A conductive strip 42 extends from the hopper or from a strap 37 downwardly into the coils. Inserted in the coils as a liner therefor is a tube 43 which extends from the bottom of the hopper 36 downwardly into the upper ones of the coils 40. This liner has a plurality of openings 44 through approximately one-half its surface, circumferentially, and throughout that portion of its height which lines the open coils 39. The line of openings 44 follows the inclination of the tubes so that one row of holes is opposite a rod 20, another row is slightly above a rod and a third row is slightly below a rod. There are no openings through the liner in the area closest to the rods 20.

The baskets 35 are given a length (or heighth) such that there will be rows of openings 44 opposite each rod adjacent thereto. The baskets will therefore vary in length as illustrated in Figure 1 and the number of openings will vary, depending on the depth of that particular portion of the rods being served. Thus the baskets near the right end of Figure 1 will have great length but there will be no openings 44 materially above the rod 20 at the right end of the bank of rods.

The operation is as follows for making copper tubing: the vat is filled with electrolyte composed preferably of seven ounces of sulphuric acid per gallon of water to which I add thirtyfour ounces of copper sulphate, to a depth sufficient to cover that portion of the cathode to be plated and sufficient to cover the top openings 44 of the anode baskets 25. The racks with their full complement of stainless steel rods 20 are then inserted in the guides 8 and allowed to rest on the pads 23, the gears 14 meshing with the gears 15 and the contactors 25 being in pressure engagement with the bus bars 6. Thereupon, or prior to insertion of the racks, the temperature of the electrolyte is raised to its normal operating temperature of 80°–90° F. before current is turned into the anodes. It will be understood that the anode baskets will be filled with copper pellets 46 or bits of copper scrap in ample time so that they, the rods 20 which are preferably composed of stainless steel, and the electrolyte will all be brought to operating temperature before the plating current is turned on.

The anode baskets are equally spaced along the bus bars 30. This may be done without difficulty along the outside rows 33. In the inside rows 32 they will be more or less nested as shown in Figure 7 with the baskets of one bar 31 having openings facing one bank of rods 20 and the baskets of the other bar 30 facing the other bank of rods. The openings in each basket lie in the 180° portion of the circumference thereof facing the rods 20 upon which they will emit a stream of ions and the area of each opening will be predetermined in size so that it will deposit upon an area five times its own size. A convenient way to compute the area of the openings is to space the rods 20 so that the total of half of their areas will equal a sheet covering the space between the two end rods and then regulate the area of the openings 44 in each row of baskets to one-fifth of that area.

Before turning the current on, it must be remembered that the desired normal current density of about forty amperes at about six volts per square foot of cathode area is too great for initial deposit since the stainless steel rods 40 are inferior to copper as electrical conductors. The current density should therefore be reduced by about twenty-five percent until the rods 20 have been slightly coated, whereupon the current density is increased. Before turning on the current the rods should be caused to rotate at slow speed, say 20 to 60 revolutions per minute, so as to permit gas bubbles clinging to the rods to release themselves, and I also recommend some type of agitator for the electrolyte to aid in dislodging such bubbles.

When the deposit has reached the desired thickness, the current is turned off, the racks are removed, the tubing is removed from the rods 20, the rods are reinstalled in the racks and the racks are again inserted in the guides 8 for receiving another deposit.

The method herein described is for the manufacture of dead soft tubing. If harder tubing is desired the areas of the openings 44 should be increased with respect to the area of the rods and the proportion of the sulphuric acid in the electrolyte should also be increased as is generally explained in my co-pending application above referred to. With the method herein described, however, the deposit will be smooth and it will be entirely uniform if the openings 44 are judiciously spaced to obtain uniform distribution of ions. While I have referred to the computation of the area assigned to each opening 44 it should be understood that, in operation, the ions from some openings will overlap those from other openings and that that is necessary to obtaining uniformity of thickness of deposit so that I do not contemplate restricting the actual area upon which deposit takes place but I do insist that the total area of openings be proportioned to the total area upon which deposit is being made at any instant. This will explain the instructions to employ an area of openings equal to one-fifth the area of the total tube surface.

Agitation should be maintained throughout the operation in order to prevent cluster deposits on the cathode and in order to prevent the formation of clusters on the anode. If there is no agitation, copper flour will be found on the bottom of the vat and such copper as is deposited will vary in hardness and in wall thickness along the mandrels. If the agitation is insufficient, a similar but smaller effect will be found. If sufficient agitation cannot be maintained, for any reason, the detrimental conditions above described may be corrected by a reduction in voltage but if the voltage is reduced to the extent that the rate of deposit is reduced in the neighborhood of fifty percent, variations in hardness along the length of the tube may result. It will thus be found that substantial agitation both before and during deposition is highly important. For tube making, I recommend that the electrolyte be withdrawn from one portion of the vat and returned at substantial velocity into the vat at one or preferably several spaced points. While the flow may be crosswise, lengthwise or vertically upwardly from the bottom of the vat, I find it satisfactory to withdraw the electrolyte from one end of the vat and to return it at spaced points along the same or the opposite end. The essential point is that there must be an agitative flow of electrolyte over the exposed surface of the anode and over the area of cathode upon which deposition is desired.

It will be seen from the foregoing that there is similarity in effect and therefore a relation between the spacing of the anodes from the cathodes and agitation of solution. If, for instance, a rough deposit is being obtained it may possibly be caused by too great current density and may be remedied either by decreasing the voltage or by increasing the spacing between the anodes and cathodes. Thus, the solution, the current density, the spacing of the anodes and cathodes, the degree of agitation of the solution and the relative areas of anode to cathode must all be carefully correlated with respect to each other for proper electroforming.

It will be seen from the foregoing that uniformity of deposit on rods in the formation of tubing is closely similar to the manufacture of a sheet of metal and that if a single sheet of stainless steel having an area on each side equal to one-half the area of the tubes were inserted in place in the position of the rods 20 a uniform deposit of fairly uniform thickness throughout would result. The uniformity of thickness of deposit on the tubes is enhanced by the rotation of the rods which could not be done in the case of the plate. I therefore desire to be extended protection within the scope of the appended claim.

What I claim is:

An anode basket for immersion in an electrolyte comprising an electrically conductive hopper, a metallic structure in substantial resemblance of a coil spring having two top coils closed upon each other and integrally secured to said hopper, a plurality of intermediate open coils and a plurality of lower coils closed upon each other and of diameter which decreases upon approach to the lower end thereof, said structure being covered with insulation except at the region of attachment thereof to said hopper and containing anode metal, a non-conductive liner of substantially cylindrical shape within said coils extending from the bottom of said hopper downwardly into said lower coils, said shield having a series of openings circumferentially confined to one-half thereof to define the area of electrolytic material contained therein to be exposed to the electrolyte.

JOHN D. BEEBE.

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