Nov. 24, 1936. J. BILLITER 2,061,554

ELECTROLYTIC DEPOSITION OF METALS

Original Filed Dec. 11, 1930 2 Sheets-Sheet 1

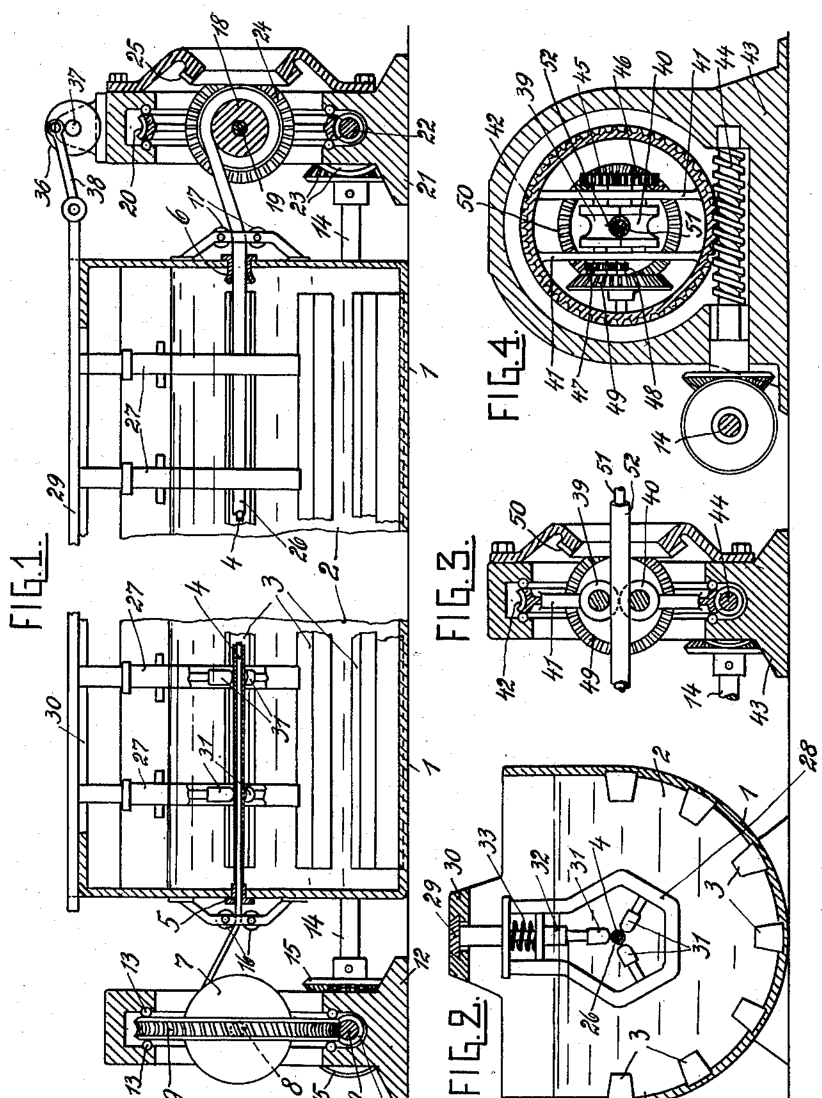

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FIG. 5.

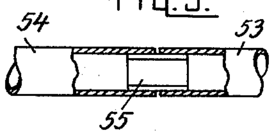


FIG. 6.

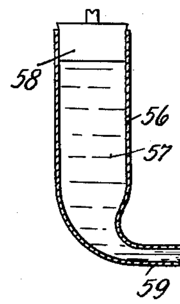


FIG. 7.

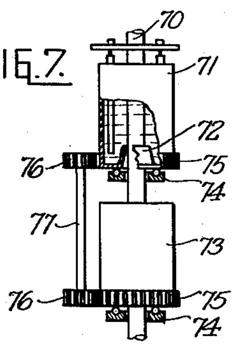
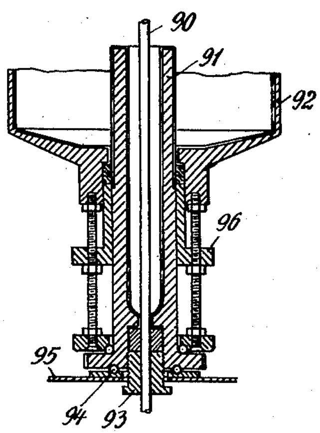


FIG. 8.



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Patented Nov. 24, 1936

2,061,554

UNITED STATES PATENT OFFICE

2,061,554

ELECTROLYTIC DEPOSITION OF METALS

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Application December 11, 1930, Serial No. 501,569. Renewed February 25, 1936. In Austria December 14, 1929

4 Claims. (Cl. 204—11)

My invention refers to the deposition of metals by electrolytic action and more particularly to the production of tubular metal shapes, which may either be tubes or tubular deposits on another tube or on a wire or rod forming a core.

It is another object of my invention to provide cathodes for use in the electrolytic process which are better suited and more efficient than the cathodes hitherto used for the same purpose. With these and other objects in view I will now describe my invention and how the same can be performed, having reference to the drawings affixed to this specification and forming part thereof, in which various forms of apparatus embodying my invention are illustrated diagrammatically by way of example.

In the drawings

Fig. 1 is an elevation, partly in vertical section, of apparatus for depositing metal on an endless row, wire or tube extending horizontally across a cell or series of cells.

Fig. 2 is an elevation, drawn to a larger scale, of one of the polishing members shown in Fig. 1.

Figs. 3 and 4 are a vertical axial section and an end elevation, respectively, of apparatus for pulling a tubular wire or tube across the cell, while keeping same rotating about its own axis.

Fig. 5 is an elevation, partly in axial section, of means for connecting the ends of two tubular cathodes.

Fig. 6 is a diagram showing means for forming molten metal into a rod or wire and introducing same into the cell.

Fig. 7 is an elevation, partly in axial section, of a pair of superposed cells with an endless cathode extending vertically across the cells.

Fig. 8 is an axial section of a stuffing box adapted for use with apparatus as shown in Fig. 7.

Referring to the drawings and first to Fig. 1, 1 is a trough containing a body 2 of a suitable electrolyte, which is kept in constant circulation. In the practical operation of my invention I may employ a plurality of such cells, which may be connected in series, but in the drawings only a single cell is shown. 3 are anodes disposed on the bottom and sidewalls of the cell and 4 is the cathode which has the form of an endless wire extending lengthwise across the cell, being introduced through a stuffing box 5 in one and leaving the cell through another stuffing box 6 in the other endwall. This wire is originally wound on a reel 7 mounted for rotation about an axis 8 in a ring 9 or worm wheel, which is set rotating by a worm 10, mounted in horizontal bearings 11 of a casing 12, ball bearings 13 inserted between the casing 12 and the worm wheel securing frictionless rotation of the worm wheel in the casing. The worm 10 is set rotating by a driving shaft 14 extending alongside of the cell 1 and acting on the worm by means of bevel gearing 15. Guide wheels 16 mounted on the front wall of the trough 1 near the stuffing box 5 serve for guiding the core wire 4 (cathode) centrically with regard to the worm wheel 9.

Similar guide wheels 17 are mounted on the other endwall of the trough 1. The wire 4, on which a tubular layer of metal has been deposited in the cell by electrolytic action, is kept taut during its passage through the cell and is wound upon another reel 18 mounted on an axis 19 extending across and secured in bearings of an annular worm wheel 20, which is also mounted for rotation in a casing 21 in which is supported a worm 22 driven in exact synchronism with worm 10 by the driving shaft 14 and bevel gearing 23. On the reel 18 is mounted a bevel gear rim 24 gearing with a bevel gear ring 25 fixed to the casing 21.

Obviously rotation of the shaft 14, which may be driven by an electric motor or by suitable transmission from some other power engine, will cause synchronous rotation of the worms 10 and 22, of the worm wheels 9 and 20 and of the reels 7 and 18, whereby the core wire or cathode 4 is kept rotating about its longitudinal axis, while passing through the cell 1. The reel 18 at the farther end of the cell being coupled by bevel gearing with the stationary toothed ring 25 is at the same time positively rotated about its axis 19 and therefore exerts a constant pull on the wire 4. While in Fig. 1 the reel 18 is shown as being coupled directly with the ring 25, it is obvious that in order to provide for a slow travel of the cathode wire 4 across the cell, suitable intermediate gearing may be inserted between the reel 18 and the ring 25.

Before entering the cell the cathode wire 4 is preferably rinsed and cleaned and also polished by suitable means, which are preferably operatively connected with the worm wheel 9, so as to rotate with it. In this manner torsional strain on the wire 4 is avoided.

In order to prevent a slack in the cathode wire 4 during its passage across the cell I provide suitable supports which may at the same time serve for polishing the deposit 26 on the wire. 27, 27 are the supports, one of which is shown more particularly in Fig. 2. 28 is a strap-shaped support suspended from a slide 29, which is guided between rails 30 extending on top of and along-

side of the trough 1. In the support 28 are radially mounted three polishing tools 31, two being fixed to the support 28, while the third one is adjustably mounted in a sleeve 32 acted upon by a spring 33, which tends to force the sleeve 32 and the tool 31 mounted therein towards the core wire 4. The slides 29 of all the supports 28 are connected by a rod 34 mounted in bearings 35 on the end walls of the trough 1, this rod being set reciprocating by an eccentric wheel 36 mounted on a shaft 37 and connected with rod 34 by a connecting rod 38.

In Figs. 3 and 4 are shown means for pulling across the cell, instead of the core wire 4, a tubular cathode which cannot be wound around a reel. Here the reel is replaced by a pair of grooved clamping rollers 39, 40, the journals of which are mounted in stays 41 extending across and forming part of a worm wheel 42 which is mounted for rotation in a casing 43 and operated by a worm 44 acted upon by the driving shaft 14. The grooved rollers 39, 40 are coupled by means of gear wheels 45, 46 and one of them is driven by means of intermediate gearing 47, 48 from a bevel gear 49 meshing with and rolling on a stationary toothed rim 50 fixed to the casing 43.

If the casing 21 with its reel and worm gear shown on the right hand side of Fig. 1 is replaced by a device of the kind shown in Figs. 3 and 4, a tubular cathode 51, for instance a lead tube having a copper shell 52 deposited thereon in the cell 1 may be pulled across the cell by the coacting rollers 39, 40 which firmly grip the composite tube, at the same time exerting a pull on it, being set rotating by cooperation of the bevel wheel 49 with the toothed rim 50. Thus, while the tubular cathode, if of soft metal, may be unwound from a reel such as the one shown on the left hand side of Fig. 1, the bending of the copper-coated tube which might cause a detaching or breaking of the copper layer, is effectfully avoided. The worm wheel 42 carrying the rollers 39, 40, being rotated in exact synchronism with the worm wheel 9, from which the cathode is being unwound, the cathode will rotate about its longitudinal axis during its passage through the cell.

During this passage the polishing tools which also serve as guiding and supporting means exert a compressive action on the metal deposited on the core wire or tube, thereby rendering it denser. Being reciprocated by the eccentric wheel 36 they also polish the surface of the deposited metal.

In order to produce endless bitmetallic tubes, when the core wire or tube has been unwound from the reel and is about to enter the electrolytic cell, the end 53 of this tube may be connected with the end 54 of a fresh tube wound on another reel by means of a short connecting piece 55, as shown in Fig. 5.

Instead of depositing metal on a finished wire or tube wound on a reel, I may also produce such wire or tube right at the cell by arranging in close vicinity to the cell an extruding press filled with the core metal, the wire or tube formed by extrusion entering the cell through the stuffing box 5 (Fig. 1).

The press for extruding solid metal may be replaced by a heated press containing molten metal which in being moulded to form a wire or rod solidifies, being then fit to enter the cell. A device of this kind is shown in Fig. 6 where 56 is a metal container, heated by suitable means (not shown) to keep the metal 57 molten, which on being forced by the action of a plunger 58 through the cool narrow conduit 59 solidifies to form a rod or wire 60 ready to enter the cell 1 through the stuffing box 61.

Instead of conducting the endless cathode across the cell or cells in horizontal direction, I may also operate with a vertically extending cathode, as illustrated for instance in Fig. 7, where the cathode tube 70 enters a cylindrical cell 71 from above, extending downwardly through a projecting part 72 of the bottom into another cell 73, concentrically arranged with regard to the first one etc. The cells are mounted on supports 74 for rotation about their vertical axis, being formed with toothed rims 75, which are acted upon by gear wheels 76 mounted on a driving shaft 77. Here the cells rotate, while the cathode 70 is pulled downwardly by a suitable device, such as the coacting rollers 39, 40 shown in Figs. 3 and 4. A stuffing box, which is particularly adapted for use in connection with rotary cells, is illustrated in Fig. 8, where 90 is an endless cathode wire, rod or tube extending through a sleeve 91 which projects from below into the cell 92, being closed at its bottom end by a stuffing box 93. The sleeve is mounted with ball-bearings 94 on a support 95 and is packed in the cell bottom by means of a stuffing box 96. The cell and sleeve are thus enabled to rotate about the cathode. Both the cell and sleeve are lined with insulating material wherever they are in contact with the electrolyte.

In practising my invention I have found that the detaching of the metal deposits from the cathodes, more especially in the case of tubular shapes, is connected with considerable difficulties, and I have therefore taken recourse to certain cathode materials which I have found to be particularly suitable for the purpose. It has already been suggested to employ cathodes consisting of chromium or chromium alloys, but the ordinary chromium alloys as well as the silicon alloys generally in use were found to be unsuitable as after some time the metal deposited thereon by electrolytic action will either firmly adhere to the cathode or will be pierced by holes. I have now found that these drawbacks are not encountered if cathodes are employed consisting of absolutely homogeneous alloys of chromium and/or silicon, i. e. alloys in which these metals are distributed absolutely uniformly. I have found that alloys of the kind described in the German Patent Specifications Nos. 341,793 and 369,191, for instance iron silicide, chromium silicide and other iron and chromium alloys containing from 13 to 25 per cent silicon are particularly suitable for this purpose. The same applies to the well known steel alloys described in U. S. patents to Strauss, Nos. 1,316,817, 1,339,378, 1,404,907, 1,404,908, 1,533,712, and 1,587,614, which contain from 18 to 30 per cent chromium and up to 20 per cent nickel, which are known under the name of non-rusting steel alloys. However of these steel alloys only the very best specimens, as far as homogeneity is concerned, should be employed.

Instead of the metallic cathodes used in the production of tubes, I may also employ non-metallic plastic masses coated with graphite or the like to render the surface conductive.

When using easily fusible metal cathodes, I may remove these subsequently from the tube deposited thereon by heating and fusing the cathode.

Various changes may be made in the details disclosed in the foregoing specification without departing from the invention or sacrificing the advantages thereof.

I claim:—

1. Apparatus for the electrolytic production of metal deposits comprising a cell, a body of electrolyte in said cell, a reel in front of said cell, means for causing rotation of said reel in the plane of its axis of revolution, a wire wound on said reel, means to the rear of said cell comprising a pair of clamping rollers for pulling said wire across said cell and means for causing said pulling means to rotate in synchronism with said reel.

2. Apparatus for the electrolytic production of metal deposits comprising a cell, a body of electrolyte in said cell, means for causing a rod- or wire-shaped cathode to pass continuously in a substantially straight line through the electrolyte and to rotate in said electrolyte and reciprocatory means for polishing the metal deposit during such rotation.

3. Apparatus for the electrolytic production of metal deposits comprising a plurality of superposed cells, an anode in each cell, means for moving a cathode rod or wire through the cell bottoms and means for causing rotation of said cells about said rod or wire.

4. Apparatus for the electrolytic production of metal deposits comprising a plurality of superposed cells, an anode in each cell, means for moving a cathode rod or wire longitudinally through the cell bottoms and means for causing rotation of said cells about said rod or wire.

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