July 26, 1938. W. SYKES 2,125,037

ELECTROLYTIC APPARATUS

Filed June 12, 1935 2 Sheets-Sheet 1

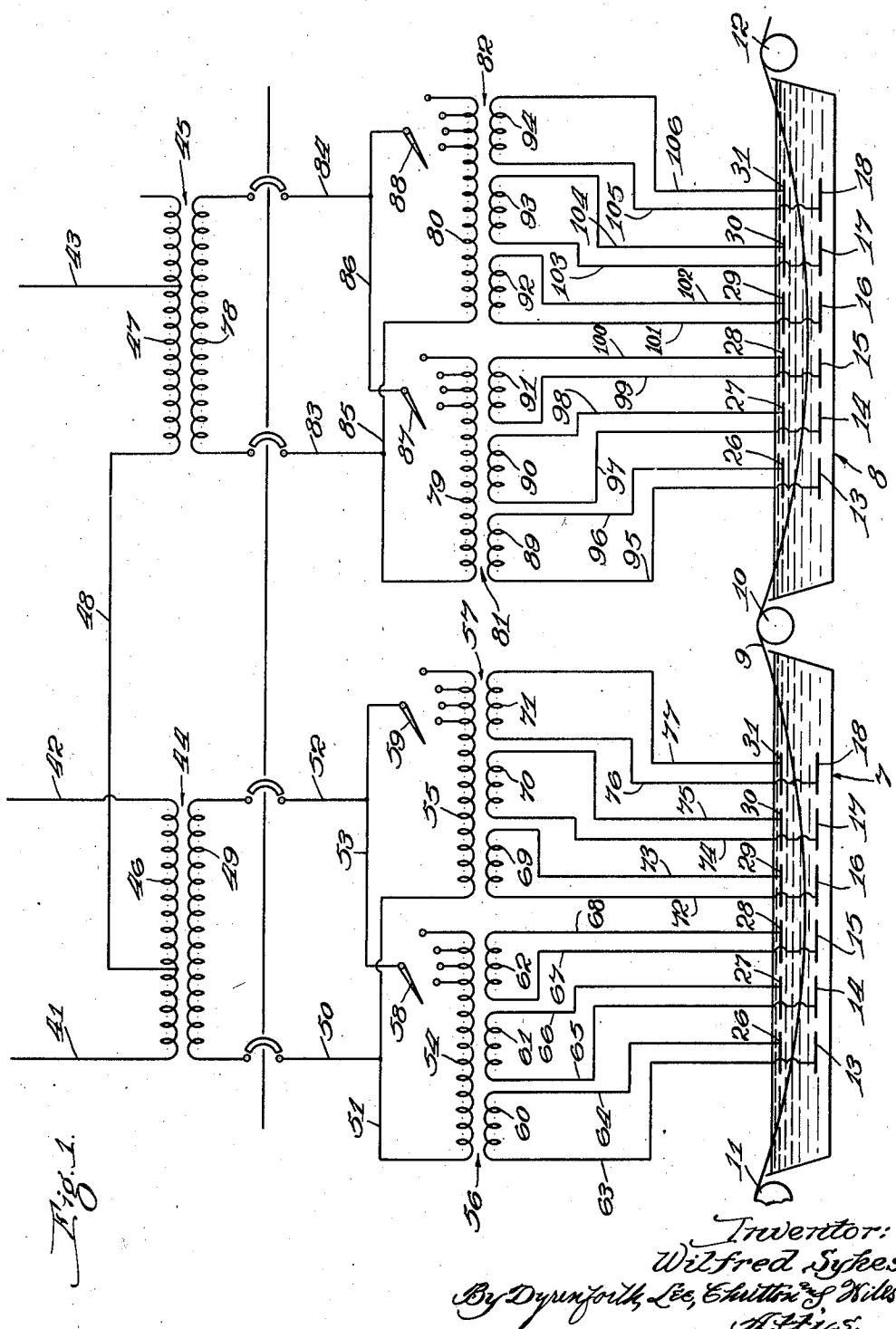

Fig. 1.

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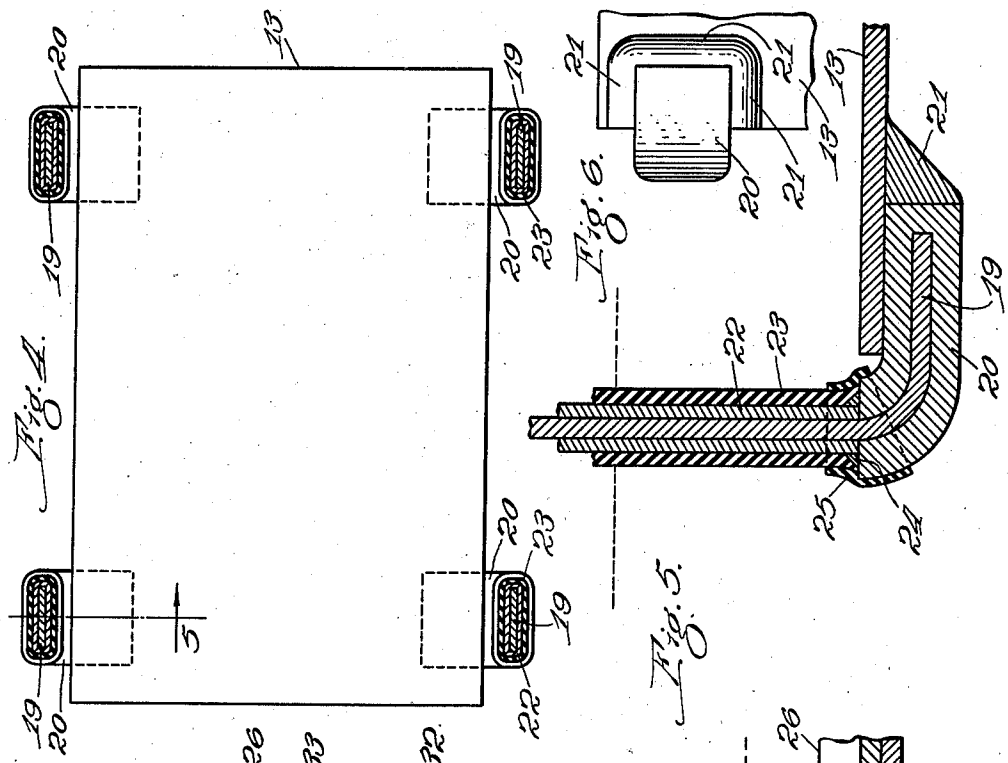

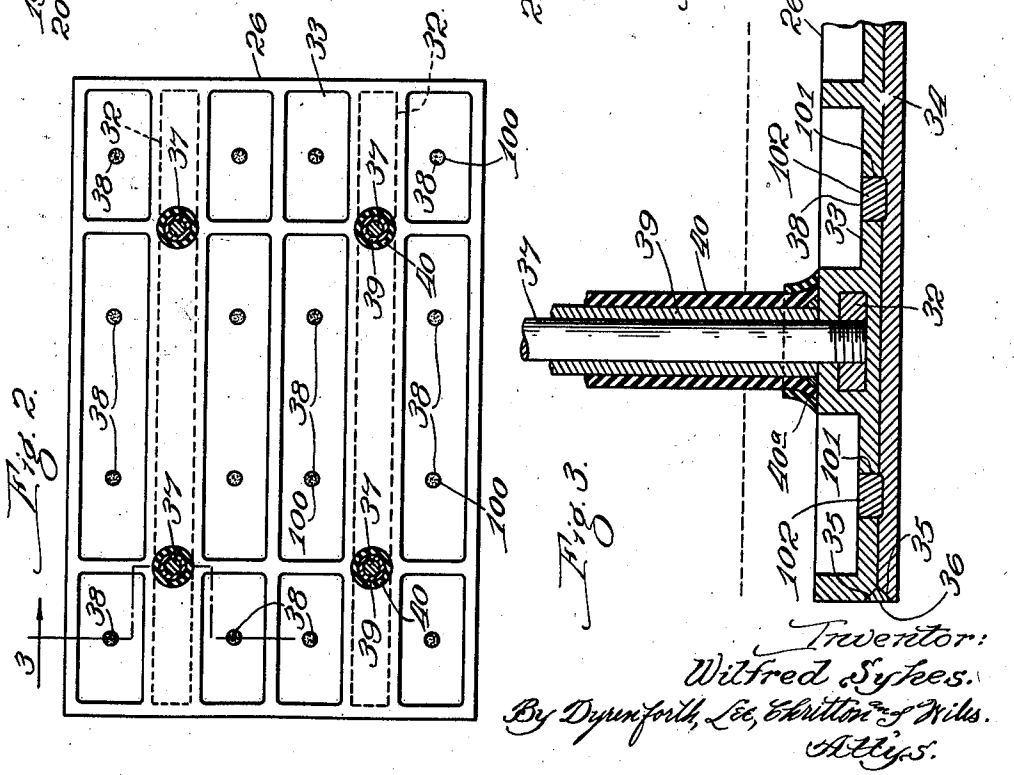

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UNITED STATES PATENT OFFICE

2,125,037

ELECTROLYTIC APPARATUS

Wilfred Sykes, Chicago, Ill., assignor to Inland Steel Company, Chicago, Ill., a corporation of Delaware

Application June 12, 1935, Serial No. 26,274

7 Claims. (Cl. 204—5)

My invention relates to electrolytic apparatus the electrodes of which are of relatively large size and which present problems in the matter of the most effective distribution of the current through the electrolyte, my invention having been devised for use more particularly, though not exclusively, in electrolytic apparatus for use in the electrolytic pickling of metal objects such as disclosed in my pending application for United States Letters Patent Serial No. 737,653, filed July 30, 1934, on which the present invention is an improvement.

While provision is made in the apparatus of my copending application for accomplishing in a measure a diversification of the paths through which the current flows through the electrolyte and thus a degree of distribution of the current in the electrolyte, it has been found in practice, wherein the electrodes are as long as approximately 40 feet, that the desired distribution of the current could not be effected alone by dividing the electrodes into sections such as disclosed in said application.

A main object of the invention is to provide for more nearly uniform distribution of the current throughout the electrolyte than has hitherto been possible, to the end of rendering more nearly uniform the action of the current on the electrolyte.

Another object is to provide for the adequate protection of the current conductors leading to the electrodes and immersed in the acid electrolyte, against the deleterious action of the electrolyte and the leakage of current due to imperfect insulation; and other objects as will be manifest from the following description.

Inasmuch as I have devised my invention more particularly as an improvement on electrolytic pickling apparatus generally as disclosed in my said copending application, I have chosen to illustrate it in connection with such an apparatus a description of the accompanying drawings being as follows:

Figure 1 is a view in the nature of a diagram of a series of two electrolytic pickling tanks in which a metal strip of relatively great length and fed through these tanks in succession, is to be subjected to an electrolytic pickling action, generally as set forth in my said copending application, this view showing the electrodes and the connections between the latter and a source of three-phase alternating current, and embodying my invention.

Figure 2 is a plan view of one of the similar upper electrode sections of the apparatus shown in Fig. 1, the rods for supporting the sections and through which current is supplied thereto being shown in section.

Figure 3 is an enlarged fragmentary sectional view of a portion of the electrode of Fig. 2 the section being taken at the irregular line 3—3 on Fig. 2 and viewed in the direction of the arrow.

Figure 4 is a plan sectional view of one of the similar lower electrode sections.

Figure 5 is an enlarged fragmentary sectional view of one of the lower electrode sections, the section being taken at the line 5 on Fig. 4 and viewed in the direction of the arrow; and

Figure 6, a fragmentary bottom plan view of the electrode section of Figs. 4 and 5.

In the particular illustrated embodiment of my invention 7 and 8 represent tanks arranged in tandem and in which the material to be pickled and shown herein as a strip 9, is passed in succession, the tanks containing any suitable pickling solution, such as any of the acid solutions commonly used in the pickling of the kind of sheet material to be operated on.

The illustrated apparatus is provided more particularly for the pickling of relatively long lengths of sheet material, such as ferrous sheet material of relatively small cross section and relatively great widths commonly supplied in coiled condition on reels, and which may be stitched together at their ends to render the strip continuous, the strip being fed through the tanks 7 and 8 in any desirable way and supported on rollers 10, 11 and 12 located between, and at the ends of, the tanks 7 and 8.

Located in the bottom of each tank beneath, and in spaced relation to, the strip 9 to be pickled, and extending lengthwise of the tanks and submerged in the pickling baths therein, are two groups of plate electrodes 13—13, inclusive, as for example of lead which are spaced apart in end-to-end relation, are of substantially the same length and of a width greater than the strip 9 to be pickled, and corresponding with the lower plate electrodes of my copending application.

Each of the plate electrodes 13—13 is provided with a series of strip-leads 19, as for example of copper, shown as connected with the plate adjacent each of its four corners as shown in Fig. 4, all of the strip-leads common to the several plate electrodes being connected together, respectively, and to the conductors hereinafter referred to whereby current is separately supplied to the several plate electrodes.

Each strip lead 19 is preferably embedded at one end in a lead lug 20 cast thereon, and secured

to the underside of the plate electrode and in intimate electric-current conducting relation thereto, as by lead-burning a fillet represented at 21 to the adjacent surfaces of the lugs and plate, as by means of a lead welding rod in accordance with the art of welding together lead objects.

The lugs 20 are shown as extending upwardly to substantially the level of the upper surface of the electrode and to protect the portions of the leads 19 above the lugs against the action of the acid bath, these portions are sheathed in lead as represented at 22, in turn covered by rubber current-insulating sleeves 23. A fillet 24 is preferably provided at the base of the sheathing 22 which expands the lower end of the sleeve 23. To ensure acid-tight joints between the sleeves 23 and the lugs 20, strips 25 of rubber are wrapped tightly around the sleeves and lugs at the joints between them preferably to cause each strip to extend in superposed layers, the sleeves 23 and the strips 25 being preferably preliminarily coated with rubber cement.

Located in each tank 7 and 8 directly above the electrodes 13—18, inclusive, respectively, and in flatwise-opposed relation thereto and to the strip 9, is a group of plate electrodes 26—31, inclusive, which are spaced apart in end-to-end relation, extend lengthwise of the tank, and in operation are immersed in the pickling bath.

Each electrode 26—31, according to the illustrated embodiment of the invention, comprises a pair of substantially parallel bars 32 as, for example, of copper which extend lengthwise of the tank and are completely sheathed in lead, as for example by casting about them, a lead plate represented at 33 and shown as of general rectangular shape, the lead plate, not being subject to corrosion by the acid of the electrolyte, serving to protect the copper bars 32, from contact with the acid and thus avoid corrosion thereof.

Extending over the bottom surface of the plate 33 is a lead pad 34 sealed to the plate along its marginal edges at the joint between it and the plate as by a continuous lead-burnt joint produced as for example by endlessly grooving these plates at their meeting edges as represented at 35 and burning a lead fillet 36 to the walls of the groove 35 as by the use of a lead welding rod.

At intervals over the area of each upper electrode I provide zones 100 of reduced resistance to current flow between the plate 33 and pad 34 with the result of causing the current to be distributed to a relatively large number of points in the area of the electrode; these zones being shown as arranged in rows at opposite sides of, and substantially parallel with, the bars 32, the zones of each row being substantially equidistantly spaced apart and spaced a substantially uniform distance from the adjacent longitudinal edges of the bars 32, sixteen of these zones being provided in the particular construction illustrated.

These zones in the construction shown are produced by a metal-fusing operation producing a bond between the plate and pad at each zone, resulting in continuous metal contact between these parts at each zone. The pressing together of the plate and pad may be effected either with or without extra metal such as is supplied when a lead welding rod is used, the construction shown involving the use of such a rod. In this construction openings 101 are provided in the lead plate 33 at the points where the zones are to be located and masses 102 of lead are burnt to the walls of the openings 101 and to the upper surfaces of the pad at these openings, as by means of a lead welding rod, thus rendering the metal continuous between the plate and pad at these zones, these masses being shown as filling the openings though this is not necessary.

Rising from each plate electrode 26—31 is a group of rods 37 of current conducting material as for example copper which extend through the plate 33 and screw into the bars 32, the rods for each of these electrodes being arranged in rectangular formation, two of each being connected with each bar 32.

The rods 37 of each electrode are electrically connected together in any suitable way to a common lead in any suitable way this lead being, in turn, connected with a suitable source of current supply as hereinafter explained.

The rods 37 not only serve as conductors along which the current passes but also serve as means for supporting the electrodes, preferably in vertically adjustable position especially to the end of permitting these electrodes to be elevated clear of the bath when the apparatus is not in use, as for example, as described for the construction disclosed in my said copending application.

While the provision of the bars 32 and connectors 37 as shown results in a measure of distribution of current in the electrodes it is desirable that such distribution be augmented and this is accomplished by producing the above referred to zones or small areas 100 of reduced resistance to current flow between the plates 33 and 34.

By the provision of the zones referred to the current is substantially uniformly distributed throughout the entire area of the electrode as distinguished from the distribution of the current through only those areas of the electrode which are immediately adjacent the bars 32 and which would occur were the zones not provided.

The rods 37, as in the case of the lead-strips 19, are encased in lead sheathings 39 covered by rubber sleeves 40, both the sheathings and sleeves extending above the level of the bath, the joints between the lower ends of the sleeves 40 and the electrodes being rendered acid-tight by winding strips of rubber about the lower ends of these sleeves and against the bodies of the electrodes as represented at 40a and generally as described of the coverings for the joints between the sleeves 23 and the lugs 20.

My invention contemplates the use of either direct or alternating current as the means for effecting, in its passage from one set to the other of the vertically spaced electrodes and through the interposed bath and strip 9, the desired electrolytic action for accelerating the action of the bath on the strip and thus greatly reducing the time required for effecting the desired pickling of the strip.

Inasmuch, however, as it is preferred that alternating current be used, I have illustrated the invention as embodied in apparatus designed for operation by such current employing a three-phase circuit.

Referring more particularly to Fig. 1 the three line current conductors leading from a suitable generator (not shown) for supplying current to such a circuit are represented at 41, 42 and 43. Two single-phase step-down transformers 44 and 45 are employed, the primary windings 46 and 47 of which are connected to the three leads 41, 42 and 43 and with each other by the current conductor 48 in accordance with common practice.

The secondary winding 49 of the transformer

44 is connected, in parallel, by current conductors 50, 51, 52 and 53 with the primary windings 54 and 55 of single phase step-down transformers 56 and 57, respectively, the current conductor 53 connecting with the primary windings 54 and 55 through the medium of tap selector switches 58 and 59, respectively. The secondary of the transformer 56 comprises three separate and individual low-voltage windings 60, 61 and 62 connected, respectively, in circuit with the pairs of opposed electrodes 13 and 26; 14 and 27; and 15 and 28 of tank 7, by current conductors 63–68, inclusive.

Likewise the secondary of the transformer 57 is formed of three separate and individual windings 69, 70 and 71 connected, respectively, in circuit with the pairs of opposed electrodes 16 and 29; 17 and 30; and 18 and 31 of tank 7, by current conductors 72–77, inclusive.

The secondary winding 78 of transformer 45 is connected, in parallel, with the primary windings 79 and 80 of single-phase transformers 81 and 82, by current conductors 83, 84, 85 and 86, with interposed tap selector switches 87 and 88, as explained of the connections between the secondary 49 and the primary windings 54 and 55.

The secondaries of the transformers 81 and 82 comprise separate and individual windings 89, 90 and 91; and 92, 93 and 94, respectively, the windings, 89–94, inclusive, being connected, respectively, in circuit with the pairs of opposed electrodes 13 and 26; 14 and 27; 15 and 28; 16 and 29; 17 and 30; and 18 and 31 of tank 8 by current conductors 95–106, inclusive, respectively.

The three-phase current is thus converted by the transformers 44 and 45 into two-phase current, the strip 9 itself representing the neutral connection of the two-phase secondary, each phase of the two-phase current being connected with the electrodes of a tank so that a substantially balanced load is maintained on the three-phase circuit.

By the provision of the secondaries of each transformer 54 and 55 and 79 and 80 of sectional form and the connections between these transformer taps and the various sections of the top and bottom electrode sections all as shown and described, the current flow between all of the opposed electrodes is substantially uniform.

While I have illustrated and described a particular embodiment of my invention, I do not wish to be understood as intending to limit it thereto as the same may be variously modified and altered and the invention embodied in other forms of structure without departing from the spirit of my invention.

In this connection it may be stated that the invention is not limited to use in an apparatus wherein spaced apart electrodes separate from the object to be treated by the electrolytic action, are provided, as the invention may have utility where such object, for example, the strip 9, may form one of the electrodes and which would be opposed by electrode sections presenting the features as shown and above described of the upper electrode sections.

What I claim as new, and desire to secure by Letters Patent, is:

1. An electrode comprising a body of relatively low current conducting material, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, a pad of current conducting material extending across said body, and means providing continuous metal contact between the bar and pad at spaced apart zones, the points of contact affording zones of reduced resistance to current flow between said body and pad.

2. An electrode comprising a body of relatively low current conducting material, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, and a pad of current conducting material extending across said body, said body and pad being fused together at spaced apart points to afford spaced apart zones of reduced resistance to current flow between said body and pad.

3. An electrode comprising a body of lead, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, a pad of lead extending across said body, and means providing continuous metal contact between the bar and pad at spaced apart zones, the points of contact affording zones of reduced resistance to current flow between said body and pad.

4. An electrode comprising a body of lead, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, and a pad of lead extending across said body, said body and pad being fused together at spaced apart points to afford spaced apart zones of reduced resistance to current flow between said body and pad.

5. An electrode comprising a plate-like body of relatively low current conducting material, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, a pad of current conducting material extending across said body, and means providing continuous metal contact between the bar and pad at spaced apart zones, the points of contact affording zones of reduced resistance to current flow between said body and pad, the pad being of a thickness relatively small compared with its superficial area.

6. An electrode comprising a body of relatively low current conducting material, a bar of relatively high current conducting material for connection with an electric circuit, said bar being enveloped by said body, conductor means leading to the said bar, a lead coating on said conductor means, a sheathing of insulating material surrounding said coating, a pad of current conducting material extending across said body, and means providing continuous metal contact between the bar and pad at spaced apart zones, the points of contact affording zones of reduced resistance to current flow between said body and pad.

7. An electrode comprising a body of relatively low current conducting material, spaced apart bars of relatively high current conducting material for connection with an electric circuit, said bars being embedded in said body, a pad of current conducting material extending across said body, and means providing continuous metal contact between the bars and pad at spaced apart zones, the points of contact affording zones of reduced resistance to current flow between said body and pad.

WILFRED SYKES.