Aug. 28, 1956 L. H. BOGUSKI 2,760,923

PROCESS AND APPARATUS FOR REVERSE CURRENT PROTECTION OF ANODES IN ELECTRO-PICKLING

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Fig. 1

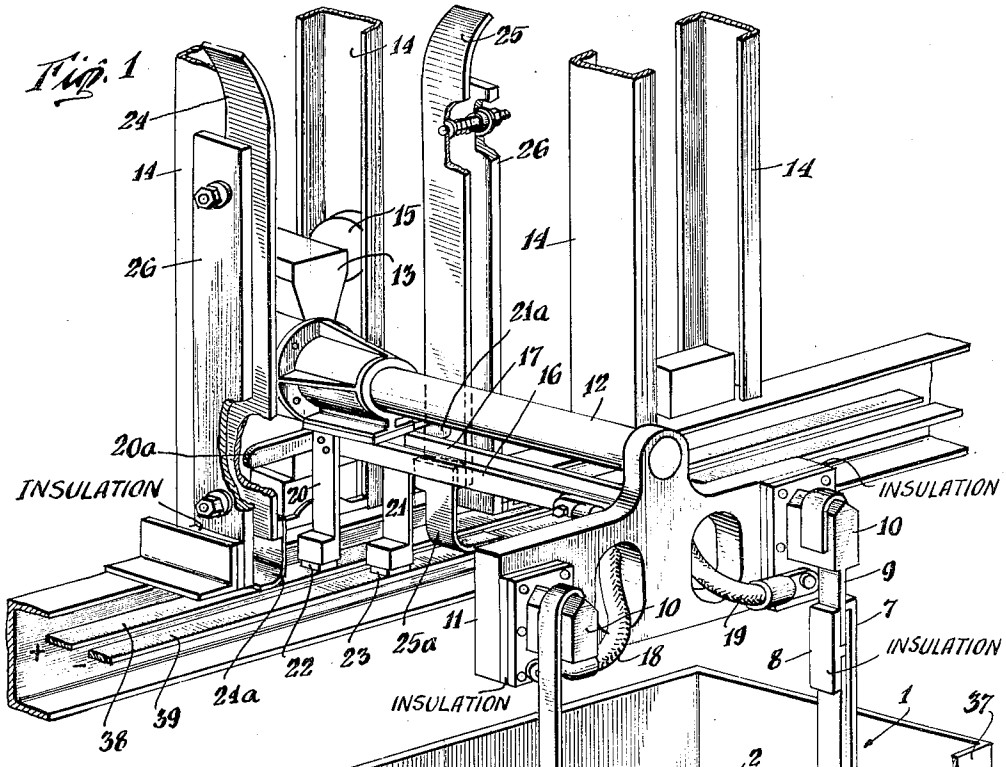
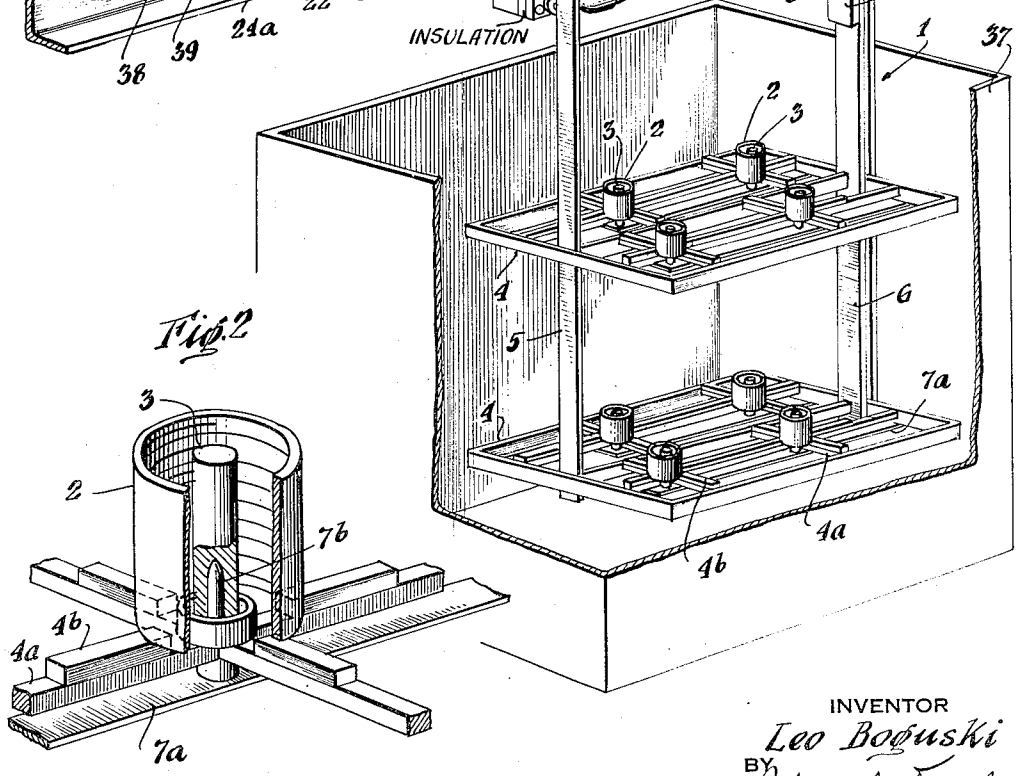


Fig. 2



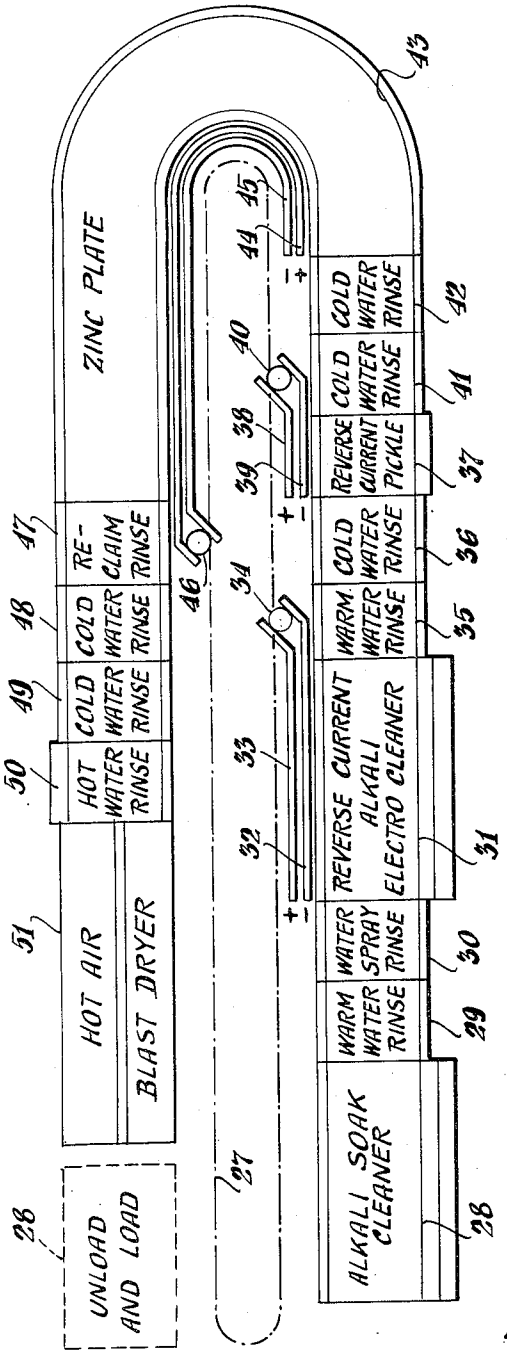
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Fig. 3



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PROCESS AND APPARATUS FOR REVERSE CURRENT PROTECTION OF ANODES IN ELECTROPICKLING

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Application August 29, 1952, Serial No. 307,122

2 Claims. (Cl. 204—34)

The present invention relates to electroplating processes and especially to the preparation of articles for electroplating.

Articles to be electroplated are commonly prepared for the electroplating process by cleaning and pickling. The typical cleaning process involves the immersion of the articles in an alkaline solution, which dissolves grease, dirt and other foreign materials which may be clinging to the articles. The articles being plated commonly serve as cathodes in the electroplating process itself, but in the cleaning process, it is common to send current through the articles in the reverse direction so that they then serve as anodes. When such a current is employed in the cleaning step, it is called an electrocleaning process. Such an electrocleaning process tends to produce an oxide film on the surface of the articles to be electroplated, which film must be removed prior to the electroplating process. The production of this oxide film in the electrocleaning step is not objectionable, however, since more or less oxide film is present in any event, and the oxide film added in the electrocleaning step can be readily removed in the following step which is utilized to remove the natural oxide film.

The oxide film removing process is commonly termed "pickling." It is accompanied by immersing the articles to be electroplated in an acid solution. It has been suggested to pass current through the articles and the solution during the pickling process, in which case the process is called electropickling. Many electropickling processes have been proposed, utilizing current flowing in one direction or the other. Electropickling with the articles as cathodes is more common, since it prevents oxidization of the articles.

In typical electroplating processes, the articles to be plated are moved successively through the cleaning and pickling baths and then into the electroplating bath, with suitable intervening rinses after each bath. In such conventional processes, the anode remains in the electroplating bath at all times. In certain other electroplating processes, with which the present invention is concerned, the consumable anode structures move with the articles to be plated, successively through the cleaning and pickling baths. Such movement of the anode structures is usually employed in cases where the plated articles are of unusual shape, and an anode of correspondingly unusual shape must be used to electroplate the articles successfully. For example, such an arrangement has been used where it is desired to electroplate the inside surfaces of threaded steel pipe couplings with zinc.

A process of the type described, wherein the anodes are carried along with the articles to be plated, requires the use of a complex rack structure for supporting the articles and the anodes so that the articles will be physically close to but electrically insulated from the anodes. A suitable rack structure, appropriate for use with threaded pipe couplings, is shown and claimed in the

copending application of G. A. Shepard and R. C. Avellone, Serial No. 313,264, filed October 6, 1952.

When such a rack structure is used in an electroplating process, two difficulties are presented which are not encountered in more conventional processes. One such difficulty is that the acid in the pickling bath attacks the anode structure which is carried on the rack with the articles, so that the anode material is wasted and the life of the anode is correspondingly shortened. Another difficulty is that those parts of the racks which are metallic and electrically connected to the articles are plated in the electroplating bath along with the articles. As the racks repeatedly move through the plating apparatus, these platings on the racks tend to build up to objectionable thicknesses.

It is an objection of the present invention to provide an electroplating process of the type described in which the building up of plated deposits on the racks is prevented.

Another object is to provide an electroplating process of the type described in which the solution of the anode material by the acid in the pickling bath is prevented.

These objects of the invention are attained by modifying the pickling step of the electroplating process to send a reverse current flow through the pickling solution, utilizing as anodes the articles to be plated and the electrically associated parts of the rack, and utilizing as cathodes the consumable electrodes which normally serve as anodes. This modification of the pickling step substantially prevents the corrosion of the anode material by the acid, and also is effective to strip from the racks the material which was plated thereon during their previous immersion in the electroplating bath.

Other objects and advantages of the invention will become apparent from a consideration of the appended specification, taken together with the accompanying drawings, in which;

Fig. 1 is a fragmentary perspective view showing a rack for supporting articles in electroplating apparatus of the type concerned in the present invention;

Fig. 2 is a fragmentary perspective view on an enlarged scale, showing a detail of the rack of Fig. 1; and,

Fig. 3 is a diagrammatic plan view showing electroplating apparatus including an arrangement of tanks and other operating stations in which the process of the present invention may be carried out and through which the rack of Fig. 1 is moved by a suitable conveyor mechanism.

Referring to Figs. 1 and 2, there is generally indicated at **1** a rack supporting a number of articles **2** to be electroplated. These articles are shown as internally threaded steel pipe couplings which are to be plated on their insides. The rack **1** also supports a number of anodes **3**, for example, zinc shown as vertical rods concentric with the couplings. Only a few of the articles **2** and anodes **3** are shown in the drawing, to avoid confusing the illustration. The rack **1** includes two vertically spaced trays **4** which are mounted on a pair of uprights **5** and **6**.

Each tray **4** is in the form of a rectangular frame having a grid of cross-bars **4***a*. The uprights **5** and **6**, trays **4** and cross-bars **4***a* are covered with rubber or other electrical insulating material which is not attacked appreciably by the solutions in which the rack is immersed.

On the top of each cross-bar **4***a* is mounted a contact bar **4***b*. The contact bars **4***b* are cut away adjacent the intersections of the cross-bars **4***a*. The contact bars **4***b* are not insulatingly covered, and are electrically connected to the cross-bars **4***a*. The articles **2** to be plated are placed on the contact bars **4***b*.

The upright **5** serves as a bus bar for conveying electrical current through the trays **4** to the articles **2**. The

upright 6 is paralleled by a bus bar 7 which is connected electrically to a suitable arrangement of conductor bars 7a which extend beneath the intersections of the cross-bars 4a. At each such intersection, the conductor bar 7a is electrically connected to an upstanding post 7b which is supported by but electrically insulated from the cross-bars 4a. The upper end of each post 7b is formed to receive and support an anode 3. The rack structure illustrated is shown in detail and claimed in the copending application of G. A. Shepard and R. C. Avellone, Serial No. 313,264, previously mentioned.

The upper end of upright 6 is mechanically supported through an electrical insulator 8 on a bus bar 9 which is electrically connected to the bus bar 7. The upright 5 and the bus bar 9 have their upper ends bent over so that they are supported on a pair of electrically conductive lugs or brackets 10 insulatingly mounted on a frame 11 carried at the end of an arm 12. The brackets 10 are shown in detail and claimed in the application of Shepard and Avellone, mentioned above. The opposite end of arm 12 is mounted on a carriage 13 which is movable vertically between a pair of tracks 14, which are of channel-shaped cross-section with their open sides facing each other. The carriage 14 is provided with rollers 15 which move within the tracks 14 and are guided thereby.

A pair of bus bars 16 and 17 are also mounted on the carriage 13 and extend parallel to the arm 12. The outer ends of bus bars 16 and 17 are connected respectively through cables 18 and 19 to the lugs 10 which support the upright 5 and bus bar 9. At their ends adjacent the carriage 13, the bus bars 16 and 17 are connected to downwardly depending bus bars 20 and 21 respectively, which carry at their lower ends brushes 22 and 23, riding respectively on stationary bus bars 38 and 39. The polarity of the bus bars indicated in the drawing is the reverse polarity, i. e., such that the anodes 3 are negative and the articles 2 positive.

The rack 1 is shown as being lowered within a tank 37 which may be filled with a suitable solution for treating the articles 2 electrolytically.

The apparatus shown in Fig. 1 forms one unit of a continuous conveyor mechanism. The carriage 13 may be moved vertically along the tracks 14 to lift the rack 1 out of the tank 37. After the rack 1 is so lifted, the conveyor mechanism including tracks 14 is moved horizontally to bring the rack 1 over another tank, similar to tank 37, containing a different treating solution. Another set of tracks 14 is shown at the right hand side of Fig. 1. It should be understood that the conveyor includes a number of sets of tracks 14, each with its own carriage 13, and all moving together horizontally.

The bus bars 20 and 21 are respectively provided with lateral extensions 20a and 21a. These extensions cooperate with vertically extending auxiliary contacts 24 and 25, respectively, which are yieldably mounted on but electrically insulated from fixed supports 26. The auxiliary contacts 24 and 25 are connected through yieldable extensions 24a and 25a to the stationary bus bars 38 and 39.

The purpose of the auxiliary contacts 24 and 25 is to connect the anodes 3 and articles 2 to a source of electric current as they move downwardly into or upwardly out of an acid electropickling bath contained in the tank 37. The anodes are thereby protected from attack by the acid in the bath at all times while they are in contact with the acid bath, as explained below.

Fig. 3 shows a plan view of a conveyor mechanism and a succession of tanks through which the racks 1 supporting the articles 2 to be electroplated and the anodes 3 are successively moved. The conveyor mechanism including the carriages 13 and racks 1, moves counterclockwise around an endless path shown diagrammatically by a broken line 27. At a station indicated by the dotted line frame 28, the racks 1 are loaded with articles to be electroplated. After the racks 1 are loaded at the station 28, they are moved over a tank 28 containing a cleaning solution. The cleaning process taking place in tank 28 is not electrolytic. The particular solution used may be any suitable conventional alkaline cleaning solution. After the tank 28, the racks are moved into a tank 29, containing a warm water rinse, followed by another tank 30 containing a water spray rinse.

The conveyor mechanism moves intermittently. Each time that a rack is carried by the conveyor from one tank to another, the rack is elevated by the carriage 13 so as to clear the end of the first tank before it is moved horizontally by the conveyor. As soon as the rack is positioned above the succeeding tank, the carriage 13 is operated to lower the rack into the new tank.

After leaving the rinsing tank 30, the racks are moved into a tank 31 where they are subjected to a reverse current electrocleaning process. In other words, the anodes 3 are connected to a negative bus bar 32, while the articles being cleaned are connected to a positive bus bar 33. The solution employed in the tank 31 may be any suitable alkaline electrocleaning solution. The bus bars 32 and 33 may be supplied with electrical energy from any suitable source such as a generator 34.

After leaving the electrocleaning tank 31, the racks pass through a warm water rinse tank 35 and a cold water rinse tank 36. They then enter a reverse current pickling tank 37. When the racks are in the pickling tank, the anodes are connected to a negative bus bar 38 and the articles to be cleaned are connected to a positive bus bar 39. The bus bars 38 and 39 are supplied with electrical energy from a generator 40. The solution employed in the reverse current pickling tank may be sulfuric acid of suitable concentration.

After leaving the reverse current pickling tank 37, the racks 1 pass through two separate cold water rinse tanks 41 and 42 and then enter an elongated zinc plating tank 43. The zinc plating tank contains a suitable electrolytic solution for plating the articles 2 with zinc. While the racks 1 are in the zinc plating tank 43, the anodes are connected to a positive bus bar 44 and the articles to be plated are connected to a negative bus bar 45. The bus bars 44 and 45 are supplied with electrical energy by a generator 46.

After leaving the zinc plating tank 43, the racks pass through a reclaim rinsing tank 47, to successive cold water rinsing tanks 48 and 49 and a hot water rinsing tank 50. They then pass through a hot air blast dryer 51 and then back to the station 28 where the articles plated are unloaded from the racks and new articles to be plated are placed on the racks.

The articles move through the apparatus only once, but the racks and the anodes move through the apparatus cyclically, so that the several steps of the process are cyclically repeated as to the racks and anodes.

The racks 1 or at least certain metallic parts thereof which are electrically associated with the articles 2, acquire a plating of zinc while in the tank 43. In the rack structure illustrated, the parts so affected are the contact bars 4b. While it is possible to cover most of the rack structure with protective material to prevent such plating, it is highly desirable to leave part of the rack surface uncovered, so that the articles to be plated can be connected to the source of electricity simply by placing the articles on such uncovered surfaces. Furthermore, it is desirable to make the area of the exposed surface substantially larger than the contacting area of the articles, so that the placing of the articles on the racks will not be critical, and also so that the racks can support articles of different sizes. This zinc plating is stripped off the metallic parts of the racks by the action of the reverse current in the pickling tank 37. The solution in that tank thereby acquires an increasing concentration of zinc ions which may even result in some plating of zinc on the anodes 3. Even if no plating takes place, the zinc in that solution may be reclaimed by suitable treatment of the solution. The energization of the zinc anodes 3 with reverse polarity in that

tank also tends to reduce the corrosion of those anodes by the sulfuric acid.

As explained above, the use of the auxiliary contacts **24** and **25** protects the anodes **3** from corrosion by the acid throughout the time when they are in contact therewith. When the rack **1** is fully immersed in the electropickling bath, the auxiliary contacts **24** and **25** are paralleled by the brushes **22** and **23**, whose current carrying capacity is higher. Consequently, the contacts **24** and **25** are fully active only during the lowering and raising of the rack **1** into and out of tank **37**. Since this represents only a small portion of the total time of immersion of the rack **1** in tank **37**, the contacts **24** and **25** and their related parts may be omitted without unduly affecting the operation of the process. In the present specification and claims, it is sometimes stated that in the electropickling step, the reverse current flows "concurrently with" the immersion of the rack in the pickling bath. This language is intended to define the electroplating step of the process generically, whether or not the auxiliary contacts **24** and **25** are used.

Although the rack **1** moves horizontally through some of the longer tanks, as for example, the plating tank **43**, it does not move horizontally in the pickling tank **37**. It is lowered vertically into that tank from a position wherein all the parts are above the auxiliary contacts. After a predetermined time, the pickling process is terminated by raising the rack and its associated parts far enough to clear the upper ends of the auxiliary contacts **24** and **25** before moving horizontally.

In one installation of plating apparatus, where the invention was employed in connection with the zinc plating of internally threaded steel pipe couplings on their inside surfaces, the solutions employed in the various treating tanks were as follows:

In the soaking cleaning tank **28**, a solution containing 5 to 10 ounces per gallon of the following composition:

	Per cent
Sodium meta silicate	60
Soda ash	20
Tetra sodium phosphate	4.75
Rosin	10
Caustic soda	5
Wetting agent	25

In the reverse current electrocleaning tank **31**, 5 to 10 ounces per gallon of the following composition:

	Percent
Fused sodium ortho silicate	87.5
Soda ash	12.5

In the reverse current pickling tank **37**, a sulfuric acid solution containing 4 to 7% by weight of sulfuric acid. Although this is the preferred range of acid concentration, solutions of from 1% to 10% by weight of acid may be used.

The solution in the zinc plating tank **43** contained from 350 to 530 grams per liter of zinc sulfate ($ZnSO_4 \cdot 7H_2O$) and 20 to 30 grams per liter of ammonium sulfate. The pH value of the solution was maintained between 3.5 and 5.0.

The invention is also applicable to other electroplating procedures, for example, processes employing anodes formed of tin or alloys of zinc and tin. Modification of the electroplating solution would be necessary to correspond to the change in the anode material, in accordance with the principles well-known by those skilled in the electroplating art. It will also be understood that other cleaning and pickling solutions may be employed where desired in accordance with the knowledge and practice of the art, the procedure relative to the pickling bath being thus applicable to solutions of various acids which may be used in such baths.

I claim:

1. Process for electroplating metal articles comprising the steps of: placing said articles on an electrically conductive rack in positions adjacent consumable electrodes supported on but electrically insulated from said rack; immersing said rack with the consumable electrodes and articles thereon in a pickling bath including an acid effective to remove oxide films from said articles, which acid normally attacks said consumable electrodes; concurrently with said immersion conducting a direct electric current through said rack, said articles, said bath and said consumable electrodes with said articles serving as anodes and said electrodes as cathodes, said reverse current being effective to inhibit corrosion of the electrodes by the acid and to strip from the rack material plated thereon during a preceding plating step; withdrawing the rack with the electrodes and articles thereon from the pickling bath and immersing it in a plating bath; conducting a direct electric current through said consumable electrodes, said plating bath, said articles and said rack with said electrodes serving as anodes and said articles as cathodes, said electrodes being electrolytically consumed in said plating bath as a plate is deposited on the articles and on the rack; and withdrawing the rack from the plating bath and unloading the articles therefrom.

2. Process for electroplating zinc on steel articles comprising the steps of: placing said articles on an electrically conductive rack in positions adjacent zinc electrodes supported on but electrically insulated from said rack; immersing said rack with the electrodes and articles thereon in a pickling bath including sulfuric acid to remove oxide films from said articles, which acid normally attacks said electrodes; concurrently with said immersion conducting a direct electric current through said rack, said articles, said bath and said electrodes with said articles serving as anodes and said electrodes as cathodes, said reverse current being effective to inhibit corrosion of the zinc electrodes by the sulfuric acid and to strip from the rack zinc plated thereon during a preceding plating step; withdrawing the rack with the electrodes and articles thereon from the pickling bath and immersing it in a plating bath including zinc sulfate; conducting a direct electric current through said electrodes, said plating bath, said articles and said rack with said electrodes serving as anodes and said articles as cathodes, said electrodes being electrolytically consumed in said plating bath as a zinc plate is deposited on the articles and on the rack; and withdrawing the rack from the plating bath and unloading the articles therefrom.

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