ANODISING OF METAL ARTICLES

Filed Dec. 28, 1951

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ANODIZING OF METAL ARTICLES

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Application December 28, 1951, Serial No. 263,810

Claims priority, application Great Britain January 3, 1951

10 Claims. (Cl. 204—58)

The present invention relates to the anodizing of articles having electrically conducting surfaces (such articles being embraced by the short term “metal articles,” even though they are not completely made of metal). The articles may, for example, be made entirely or at least at their surfaces of aluminum, or suitable aluminum or magnesium alloys.

When anodizing metal articles, an electric connection has to be established between the articles and an anode of an electrolytic cell. If a metal wall of the casing of the electrolytic cell is used as anode, and the metal articles to be treated are placed in bulk into the cell so that each article either touches the metal wall of the cell or an adjacent metal article, it will be found that the electric contacts so obtained may not be sufficiently reliable. For example, when anodizing articles, the non-conducting or semi-conducting superficial oxide layer formed during the treatment is liable to affect the electric contacts unless the articles are wired together or are pressed with a considerable force against the casing of the cell and against each other, for example by means of pressure springs or by hydraulic means. It is, however, difficult to provide such or similar means for exerting an adequate pressure on the articles for obtaining a sufficiently good electric contact or it may be inconvenient to wire the articles together, particularly in the case of small and light articles.

It is an object of the invention to overcome these drawbacks.

It is another object to provide a method of anodizing a metal article or articles, which is simple and efficient.

It is a further object to provide an arrangement for anodizing a metal article or articles, which is simple and efficient, and is easy to assemble and to dismantle, for example for the purpose of cleaning.

These and other objects and advantages of the invention will become clear from the following specific description of three embodiments of the invention, when read with reference to the annexed drawings in which:

Fig. 1 is a general, somewhat diagrammatical, view of an arrangement of the invention;

Fig. 2 is a vertical section on a larger scale through one of the electrolytic cells;

Fig. 3 illustrates a modification of the electrolytic cell of Fig. 2; and

Fig. 4 illustrates a further modification.

The present invention consists in a method of anodizing a metal article, wherein the article is introduced into an electrolytic cell, and the electrolytic cell is rotated around an extraneous axis at such a high rotational speed that under the action of a centrifugal force the metal article is forced against an anode of the electrolytic cell, which may be a conducting wall of the cell, so that an extent that sufficiently reliable electric contact is obtained.

A number of metal articles may be introduced into the electrolytic cell, which is rotated around an extraneous axis at such a high rotational speed that under the action of centrifugal forces each metal article is forced against the anode or against an adjacent metal article to such an extent that sufficiently reliable electric contacts are obtained. Before starting the anodizing process, an electric current may be sent through the electrolytic cell in the direction opposite to the direction of the electric current flowing through the cell during anodizing, whereby to remove or prevent superficial oxidation of the article or articles to be treated.

It may easily be achieved that the centrifugal forces are many times greater than the gravitational force or forces acting on the metal article or articles. For example, if an article rotates around an axis at a distance of 9 inches therefrom at a speed of 3,000 rotations per minute, the centrifugal force acting on the article is approximately 2,500 times the weight of the article. If a number of articles are introduced in bulk into the cell, the contact pressure exerted by the centrifugal forces increases in the direction away from the axis of rotation.

This method of treatment has the advantage over applying pressure to the articles by means of pressure springs or hydraulic arrangements in that, in the case of a number of articles, the centrifugal forces act on each article directly and independently of the pressure exerted on an article by an adjacent article, whereby the articles are subjected at least to such directly acting centrifugal forces.

The invention also consists in an arrangement for anodizing a metal article, comprising an electrolytic cell rotatable around an extraneous axis, and means for rotating the electrolytic cell around said axis at such a high rotational speed that under the action of a centrifugal force a metal article introduced into the electrolytic cell is forced against an anode of the electrolytic cell, which may be a conducting wall of the cell, to such an extent that a sufficiently reliable electric contact is obtained. For simultaneously anodizing a number of metal articles, the electrolytic cell may be capable of receiving a number of articles, the cell being in use rotated at such a high rotational speed that under the action of centrifugal forces each of the metal articles introduced into the electrolytic cell is forced against the anode or against an adjacent metal article to such an extent that sufficiently reliable electric contacts are obtained.

Referring now to the drawings, the arrangement of Fig. 1 comprises a shaft 10 rotatably mounted on a base 11 and connected by means of a pulley 12 keyed to the shaft 10, a belt 13 and another pulley 14 to an electric motor 15, which may be fixed by a bracket 16 to any suitable support (not shown). An arm piece 17 is carried by the shaft 10 for rotation therewith. An electrolytic cell generally indicated by reference numeral 20 is pivoted to each end of the arm piece 17.

Each electrolytic cell 20 (see Fig. 2) comprises an outer cylindrical metallic vessel 21 and an inner cylindrical metallic vessel 22, the outer vessel 21 being provided with cooling fins 23 and with means 24 for pivoting the cell 20 to the metallic arm piece 17, the vessels being arranged coaxially. The inner vessel 22 is adapted to receive a suitable electrolyte 25 and an article or articles 26 to be anodized. The inner vessel 22 is electrically connected to the outer vessel 21 by means of a metal screw 27 extending through the bottom of the outer vessel 21 and entering the bottom of the inner vessel 22 without penetrating therethrough, so as not to make direct contact with the electrolyte 25 when contained in the inner vessel; thereby, it is assured that the electric contact between the inner and outer vessels 21 and 22 is made by surfaces not exposed to the anodizing process. A washer 28, which may be made of rubber or the like, ensures that electrolyte which may be split into the space between both vessels 21 and 22 cannot reach the metal screw 27.

A cathode 30 is provided in each cell 20 and is insulated from the inner and outer vessels 21 and 22 by a lid
31 of insulating material which rests on the rim of the inner vessel 22 and is provided with suitable escape holes (not visible in the drawings) for gas liberated. The arm piece 17 is connected to the rotatable shaft 10 which is perpendicular to the arm piece 17 and arranged substantially at the centre thereof, the shaft 10 when rotated by the electric motor 15 rotating the arm piece 17 and therewith the two cells 20. The rotatable shafts 10 and 33 are connected to electric current to the electrolytic cells 20. The slip ring 32 is electrically connected to the rotating shaft 10, while the other slip ring 33 is insulated from the rotatable shaft 10 and electrically connected to the cathode 30 of each cell 20. The first slip ring 32 cooperates with brushes 34 for connection to the positive terminal of an electric direct current supply source (not shown), the other slip ring 33 cooperates with brushes 35 for connection to the negative terminal of the said supply source. In operation, a suitable electrolyte 25 and a metal article or article 26 to be anodized are introduced into the inner vessel 22 of each cell 20, and the slip rings 32 and 33 are connected to the electric supply source, whereby an electric current flows from the positive terminal of the supply source through the brush 34 and through the said first slip ring 32 to the rotatable shaft 10 and through the metal article 26 to the cathode 30, and through the brush 35 to the negative terminal of the supply source. The rotatable shaft 10 is rotated by the electric motor 15 so that under the influence of centrifugal forces the two cells 20 pivot in direction of the arrow A of Fig. 1 from their vertical positions into inclined or nearly horizontal positions (indicated in Fig. 1 in dash-dotted lines at 201 which respect to one of the cells). Each metal article 26 to be treated is thereby subjected to the centrifugal forces set up and is pressed either against a wall of the inner vessel 22 forming the anode of the cell or, in the case of a plurality of metal articles 26 having (as shown) been introduced into the cells 20, against an adjacent metal article 26. The temperature within the cells being kept sufficiently low by the cooling fins 23, which in turn are kept cool by the surrounding air if the cells 20 are rotated with sufficient speed.

By unscrewing the screw 27 the inner vessel 22 may easily be removed from the outer vessel 21 and exchanged against a fresh inner vessel, which is then connected to the outer vessel 21 by means of the screw 27 whereby an inner vessel can be cleaned to remove any oxide skin, which may have been formed during the anodizing of articles, while by means of another inner vessel further articles are being anodized.

Each of the electrolytic cells 20 may be replaced by the electrolytic cell 120 illustrated in Fig. 3. This cell is essentially similar to that shown in Fig. 2. However, the inner vessel 122 of the cell 120 is considerably lower than the outer vessel 121, so that while the articles 26 contained in the inner vessel 122, the electrolyte fills the inner and outer vessels 122 and 121 to establish contact with the cathode 130, which is carried by the lid 131 of insulating material, the lid 131 resting on a shoulder 141 of the outer vessel 121. Moreover, the metal screw 127 is insulated from the outer container 121 by an insulating bushing 146. While in the embodiment of Fig. 2 the washer 28 is only provided as a precaution to prevent electrolyte from reaching the screw 27 if electrolyte is accidentally spilled, the washer 128 of Fig. 3 is essential for preventing the electrolyte 25 from reaching the screw 127, since as shown in Fig. 3 the electrolyte 25 passes around the outside of the inner vessel 122 towards the washer 128. Contact between the electrolyte and the metal screw has to be avoided to prevent the said screw and the complementary screw threads in the bottom of the inner vessel respectively from being anodized, which would detrimentally affect the electric contact between the screw and the inner vessel.

The electrolytic cell 220 of Fig. 4 is similar to that of Fig. 3, but the inner vessel 222 is assumed to be made of insulating material. The inner vessel 222 directly rests on the inner bottom wall of the metallic outer vessel 221, and the screw 232 and the complementary screw threads in the bottom of the outer vessel 221 but does not penetrate therethrough. In this case, the outer metallic vessel 221 is to be connected to the negative terminal of the electric direct current supply source, whereby the upper part of the outer vessel 221 which is in contact with the electrolyte 25 acts as cathode, the anode 2301 extending through the lid 231 of insulating material and terminating at the bottom of the inner vessel 222; the said anode is, of course, to be connected to the positive terminal of the electric direct current supply source. The embodiment of Fig. 4 has the advantage that by using an inner vessel of insulating material and the anode 2301, which is different from the wall of the inner vessel, the active anode surface may be reduced as compared with the embodiment of Fig. 2 or 3 of the cell.

In all the embodiments, a wire 36, 136 or 236 respectively may additionally connect the screw 27, 127 or 227 electrolytic cell with the arm piece 17, 117, 217, to improve the electric connection.

It may happen that a considerable time elapses after the metal article or articles and the electrolyte have been introduced into the cells and before the cells are rotated with the necessary speed. During such an interval the surface of the metal article or articles may become slightly oxidized whereby a high electric resistance is created between the metal articles and one of the electrodes or between a metal article and an adjacent metal article, which would be detrimental for the electrolytic treatment.

With a view to overcoming or, at least, mitigating this drawback, the electric current through the electrolytic cells is initially applied in a sense opposite to that required for the anodizing, whereby to remove or prevent superficial oxidation of the metal article or articles and of the anode of the cell or its wall if acting as the anode, and whereby to clean the metal article or articles prior to the anodizing.

Modifications of the arrangement described are possible. For example more arm pieces than one may be provided on the shaft whereby the number of cells carried by the arm pieces may be increased, and the arm piece or each of the arm pieces may carry a single electrolytic cell only, in which case, a weight is preferably provided at or near that end of the arm piece which does not carry the cell, whereby to balance the arrangement.

In some cases, the direct current supply source may be replaced by an alternating current supply source.

An additional advantage of the invention resides in the fact that the centrifugal forces will accelerate the exhaust of gases liberated around the metal article or articles during their treatment. If, for example, the electrolytic cell 29 assumes in operation the dash-dotted position 201 of Fig. 1, the electrolyte and the metal articles will be urged by the centrifugal forces to the right of Fig. 1, whereas the liberated gases are subjected to a much weaker centrifugal force, which will urge the gases relatively to the electrolyte towards the left and, thus, out of the cell.

This invention is primarily intended to be applied to the anodizing of small and light metal articles. The method and arrangement of the invention is generally reliable and efficient. In exceptional cases, however, the following difficulty may arise: If, for example, metal washers have to be anodized, which are thin but have comparatively large and highly smooth plane surfaces, the washers may lie with their plane surfaces tightly pressed together, so that the electrolyte cannot easily penetrate between such surfaces. Thereby the formation of a uniform oxide layer may be impeded.
In this case means may be provided for preventing the washers to lie flat against each other. For example, spacers may be provided in the inner vessel, or its bottom and, if desired, its walls may be corrugated to ensure that washers adjacent the bottom or the walls do not lie flat against the bottom or the walls but are slightly tilted relative thereto. In most cases, however, if the correct length and shape of the articles will ensure that the difficulty referred to will not arise. For example, nuts, screws, bolts and the like when introduced into the cell in bulk will assume sufficient irregular positions to ensure a uniform anodizing. Tests have shown that the points of electrical contact between the articles or between the articles and the walls of the cell or its anode are in many cases not or hardly perceptible by the unaided normal eye of an observer and can in some cases only be detected by using a magnifying glass.

By rotating the cell or each cell around an extraneous axis the centrifugal forces arising within the cell and acting on different articles will more closely approach the same value throughout the cell than in the case in which the cell would rotate around its own axis. Moreover, the extraneous axis enables the arrangement to be simplified and easily assembled. Another advantage of the rotation around an extraneous axis resides in the fact that on fast acceleration no substantial relative movement between each cell, its electrolyte and the article therein is produced as would be the case in a cell rotating around its own axis. Moreover, if the cells rotate around an extraneous axis it is simpler to balance the arrangement.

It should be clearly understood that the embodiments illustrated in the drawings are given by way of example only. Many modifications, omissions and additions are possible. Without departing from the scope of the invention which is defined in the appended claims.

I claim:

1. A method of anodizing a metal article, comprising the steps of containing an anodic bath in a vessel, introducing the article into the anodic bath, whirling the vessel around an extraneous axis and creating a centrifugal force acting on the metal article, and passing an electric current from an anodic contact element in the vessel through the article and thence through the anodic bath in contact with the article to an anodic contact element in the vessel while holding the article against, and in electric contact with, said anodic contact element by centrifugal force.

2. A method of simultaneously anodizing a plurality of metal articles, comprising the steps of containing an anodic bath in a vessel, introducing the metal articles in bulk into the anodic bath, whirling the vessel around an extraneous axis and creating a centrifugal force acting on the metal articles, passing an electric current from an anodic contact element in the vessel through the said articles and thence through the anodic bath in contact with the articles to a anodic contact element in the vessel while holding at least one of the metal articles against, and in electric contact with, said anodic contact element by centrifugal force, and holding at least one other of said metal articles against, and in electric contact, with an adjacent metal article by centrifugal force.

3. An apparatus for anodizing a plurality of articles, comprising a vessel for an anodic bath having a metallic inner wall, an electrode for the anodic bath in said vessel and electrically insulated from the inner wall of said vessel, means for electrically connecting the electrode to a terminal of an electric supply source, means for electrically connecting the inner wall of the vessel to the terminal of the electric supply source so that the said inner wall forms a second electrode for the anodic bath, a rotatable shaft, means for rotating said shaft, an arm piece keyed at right angles to said shaft, means for pivotally suspending the said vessel from said arm piece with the pivot axis perpendicular to said shaft and to said arm piece, whereby on rotation of the shaft, when in vertical position, the arm piece is horizontal and the vessel is whirled around the shaft and pivots under centrifugal force from its initially vertical position into an inclined position.

4. An apparatus as claimed in claim 3, wherein the vessel comprises a metallic outer vessel, a metallic inner vessel, and means for releasably interconnecting the inner and outer vessels mechanically and electrically.

5. An apparatus as claimed in claim 4, wherein the vessel comprises an inner vessel made of insulating material and an outer metallic vessel, the first electrode forming an anode for the anodic bath and comprising a portion adjacent to, and substantially covering the bottom of the vessel, the inner wall of the outer vessel forming a cathode for the anodic bath.

6. An apparatus as claimed in claim 5, and comprising a lid holding the cathode, the lid resting on the rim of the inner vessel.

7. An apparatus as claimed in claim 4, wherein the outer vessel has a substantially greater height than the inner vessel.

8. An apparatus as claimed in claim 3, wherein the outer wall of the vessel comprises cooling fins.

9. An apparatus as claimed in claim 3, wherein the vessel comprises an anodic bath made of insulating material and an outer metallic vessel, the first electrode forming and anode for the anodic bath and comprising a portion adjacent to, and substantially covering the bottom of the vessel, the inner wall of the outer vessel forming a cathode for the anodic bath.

10. An apparatus for anodizing a plurality of articles, comprising a vessel for an anodic bath in each vessel and electrically insulated from the inner wall of its vessel, means for electrically connecting each electrode to a terminal of an electric supply source, means for electrically connecting each of the inner walls of the vessels to the other terminal of the electric supply source, so that each inner wall forms a second electrode for one of the anodic baths, a rotatable shaft, means for rotating said shaft, an arm piece, a centre portion of said arm piece being keyed at right angles to said shaft, means for pivotally suspending the two vessels from said arm piece, one at each side of said shaft with the pivot axes substantially parallel to each other and perpendicular to said shaft and to said arm piece, whereby on rotation of the shaft, when in vertical position, the arm piece is horizontal and the vessels are whirled around the shaft and pivot under centrifugal forces from their initial vertical positions into inclined positions.

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