April 16, 1974 A. R. GOODKIN 3,804,732

ANODIZING PROCESS

Filed July 19, 1971

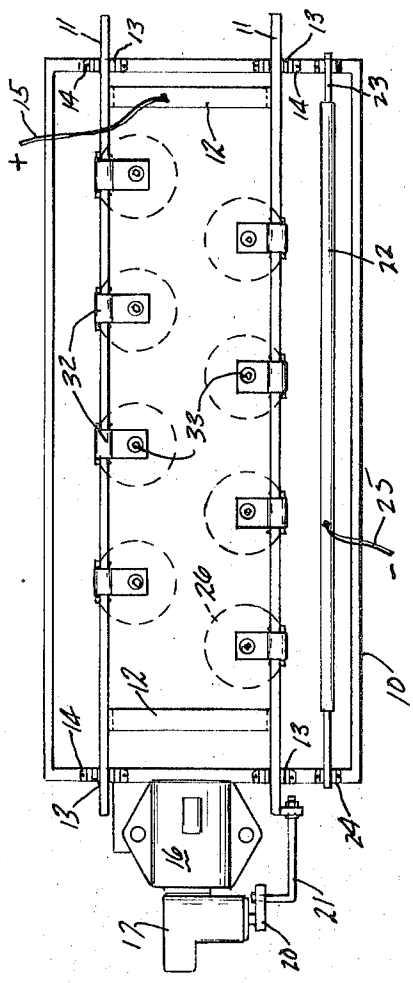


FIG - 3

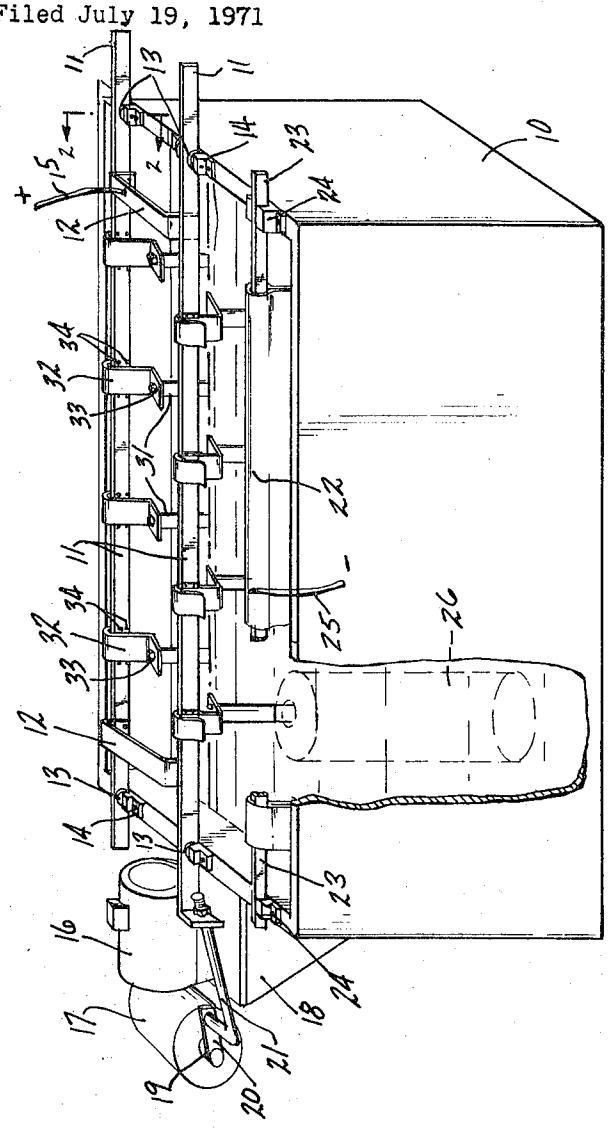


FIG - 1

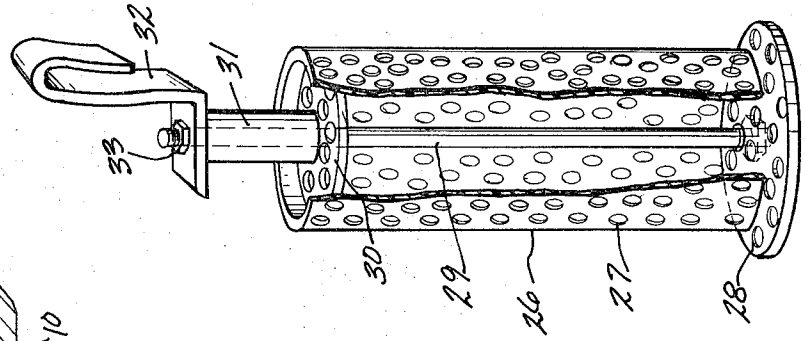


FIG - 4

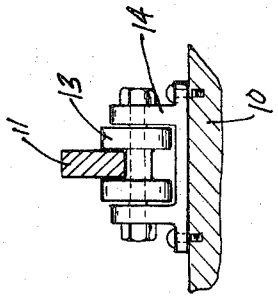


FIG - 2

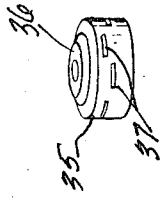


FIG - 5

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United States Patent Office 3,804,732 Patented Apr. 16, 1974

3,804,732

ANODIZING PROCESS

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Filed July 19, 1971, Ser. No. 163,610
Int. Cl. B01d 3/34
U.S. Cl. 204—58 4 Claims

ABSTRACT OF THE DISCLOSURE

Novel process for the bulk anodizing of small metal articles, wherein the articles, grouped in spaced containers suspended from an anode bar or from a plurality of anode bars, are continually reciprocated through the electrolyte bath during treatment. The bath, preferably a 15% to 20% by weight aqueous solution of sulfuric acid, is maintained at below ordinary room temperatures, preferably at 55° to 60° F. Anodized coatings of increased uniformity are thus obtained, and the useful life of the solution is extended about tenfold, as compared with procedures of the prior art.

BRACKGROUND OF THE INVENTION

Field

This invention relates to anodizing processes wherein the surface of articles of metal, such as aluminum, is electrochemically oxidized so as to improve the appearance and the resistance to corrosion. In particular, this invention is directed to an improved process for the bulk anodizing of articles in groups, each group consisting of a large number of articles, whereby each article is provided with a porous oxidized surface capable of readily and uniformly absorbing dyes.

Description of the prior art

Anodizing processes have been known and used extensively during past decades, and many procedural variations, for example with respect to electrolyte composition, the control of variables such as amperage and voltage, and particular mechanical handling methods and apparatus, have been reported in numerous technical publications and patents. However, bulk anodizing procedures which have been used or described have continued to be deficient in certain respects. In particular, it has not been possible in practice consistently and economically to accomplish substantial uniformity in the anodized coatings over the surface of each article. This has resulted in excessive extents of rejection of improperly anodized parts, characterized by anodized layers of varied thickness or absorptive properties or even by the presence of void areas, practically free of the desired oxidized layer, particularly as evident after dyeing.

Such defects resulted from factors which have been corrected in the present process. These factors included the retention of gas bubbles over portions of the articles; the existence of temperature and concentration gradients within groups of articles, which arose despite thorough mixing of the main bath; and the non-exposure to the bath of those article portions which remained in contact with each other throughout the treatment.

SUMMARY OF THE INVENTION

In accordance with this invention, a bulk anodizing process is provided wherein each group of metal articles is placed in an individual container which is suspended from an anode bar, the articles being thereby connected anodically, and the said group is repeatedly caused to move through the bath in one direction, stop, and the move in the opposite direction during the anodizing treatment. Preferably, the bath is a 15% to 20% by weight aqueous solution of sulfuric acid maintained at 55° to 60° F.

The objects of the invention have included mainly the reduction or substantial elimination of disadvantageous features of bulk anodizing processes of the prior art, such as the formation of non-uniform anodized areas and the presence of areas of slight or essentially no anodizing, responsible for excessive extents of rejection.

Such objectives have been accomplished in accordance with this invention through the provision of the continual reciprocating movement of the articles through the solution. The dislodging and removal of gas bubbles, such as of air or oxygen, from the articles is brought about by the frequent cyclic percolation of the bath in turn in opposite directions through the articles in each group. Likewise, such percolation acts to prevent temperature and concentration gradients within each group of articles. Furthermore, the exposure to the bath of article surfaces which would otherwise remain in contact is effected by displacements or rocking of the articles during the repeated cycles of travel in one direction, stopping, and then travel in the reverse direction. Another object has been the enhancement of the above advantages by maintaining the electrolyte bath at a somewhat reduced temperature.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying figures of the drawing are diagrammatic illustrations of the bulk anodizing process of this invention.

FIG. 1 is a perspective view of anodizing apparatus used in a preferred embodiment in accordance with the invention.

FIG. 2 is an enlarged sectional view along the line 2—2 of FIG. 1.

FIG. 3 is a top view of the apparatus of FIG. 1.

FIG. 4 is a perspective view of an assembled anodizing basket and associated parts, as utilized in the embodiment shown in FIG. 1.

FIG. 5 is a perspective view of a perforated metal cup, typical of articles which may be anodized in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing, which represents diagrammatically the apparatus used in a preferred embodiment in accordance with the invention, the electrolyte solution, preferably a 15% to 20% by weight aqueous solution of sulfuric acid, is contained in tank **10**, which may conveniently be twelve feet in length and three feet in width and depth. A pair of connected anode bars **11** of copper, about fourteen feet long, three inches high, and a half inch thick, are provided just above the top of the tank and lengthwise thereof. The anode bars are rigidly connected near the ends by a pair of copper cross members **12**, securely fastened or welded to the anode bars. Each bar rests in rolling engagement on a grooved roll **13**, for example of suitable insulating plastic such as nylon or "Teflon," at each end of the tank, each roll being rotatably mounted in a housing **14** fastened to the tank, details being most clearly shown in FIG. 2. Anode bars **10** are connected through lead wire **15** to a suitable power source, not shown. An electric motor **16** and gear box **17**, associated therewith, are located on a stand **18**, mounted at a convenient height at one end of the tank. A low power motor, for example, one and a quarter horse power, is adequate.

Actuation of the motor **16** causes the rotation of the gear box axle **19** and of crank arm **20**, which is securely fastened to axle **19**, and thus effects the reciprocating movement of drive rod **21**, the latter being rotatably con-

nected to crank arm **20**. Drive rod **21** is operatively connected to the anode bars **11** and causes them to move forward and backward in unison and in simple harmonic motion on grooved rolls **13**. The length of travel is adjustable according to the relative placement of the rotatable connection of drive rod **21** to crank arm **20**, and may conveniently be set at one to two feet.

A cathode **22**, for example of lead sheet, is suspended in the bath near one side of tank **10** and parallel thereto, being fastened to a copper bar **23**, the ends of which rest in grooves in an insulating block **24** at each end of the tank. The anodizing circuit is completed through a cathode connecting wire **25**. The electrolyte solution is thoroughly mixed during the anodizing operation by conventional air agitation or mechanical means, not shown. Preferably, the bath is maintained at a temperature somewhat below normal room temperatures, within the range of about 50° to 65° F., preferably at 55° to 60° F. by means of cooling coils immersed in the bath, not shown, through which a refrigerant fluid is circulated under thermostatic control.

The articles to be anodized in bulk are contained in basket assemblies **26**, as shown in FIG. 4. The container consists of a perforated cylinder **27** of plastic, having dimensions for example of two feet in length and nine inches in diameter, seated on a perforated bottom disc **28** of aluminum, somewhat larger in diameter than the plastic cylinder. A rod **29** of titanium, three-fourths inch in diameter and threaded at both ends, is inserted through a central opening in the disc **28** and is held in place by a nut. While the rod is held in a central position, the cylinder is filled with the articles to be anodized, usually numbered in the hundreds, and they are caused to form a rather compact column, but with spaces and channels between the contacting articles, by vibration or tapping, and the perforated top disc **30** of aluminum, somewhat smaller in diameter than the cylinder interior, is inserted in place over the column of articles within the container. The assembly is completed by placing the tubular spacer **31** of aluminum, then aluminum clip **32**, and finally nut **33** over the protruding end of rod **29**, and tightening the nut. Each assembled container with its charge of articles to be anodized, the latter not being shown in the drawing, is clipped to an anode bar **11** at one of the desired positions provided thereon, between two rows of bolt heads **34** or in a suitable recess, so as to avoid displacement of the clips along the bars during the reciprocating motion of the anode bars and of the containers in the bath. The clip positions along the bars are staggered relative to one another in order to permit the maximum utilization of the available tank volume. The articles are all made anodic through direct electrical contact with the adjacent articles, with closure discs **28** and **30** and with rod **29**, and then through clip **32** to anode bar **11**. The container assemblies are immersed in the electrolyte bath to above spacer **31**, and usually to somewhat above nut **33**.

An article, typical of those effectively treated by the bulk anodizing process of the invention, is shown in a diagrammatic perspective view in FIG. 5. This consists of an aluminum cup **35**, three-fourths inch in diameter and three-eights inch in depth, provided with an open end, a base having a central perforated protruding portion **36**, and with indentations **37** in the side wall.

When the anode bars have been loaded with the charged and assembled containers, and with the bath at a temperature of 55° to 60° F. and under agitation, the reciprocating movement of the anode bars and associated containers is initiated by actuating the motor, and the anodizing circuit is closed. The rate of movement is at a predetermined desired value, for example at ten cycles per minute, that is a total travel of 20 to 40 feet in both directions per minute. The anodization is carried out at a voltage of 12 to 15 volts for a suitable period, for example thirty minutes. Usually a slight decrease in voltage occurs during the treatment; for example, the potential may drop from 15.0 volts initially to 14.75 volts at the end of a thirty minute anodizing period.

The reciprocating movement of the contained articles through the bath during treatment effects the substanial avoidance of deficient and nonuniform anodic coatings on the article surfaces. This advantageous result is attained through a number of functions which are accomplished simultaneously in the inexpensive and uncomplicated process of this invention. During each passage of the containers through the bath, electrolyte solution percolates between and through the articles, displacing partly depleted and superheated solution for restoration in the main bath to the normal desired conditions of temperature and concentration. At the same time, such flow assists in the removal of gas bubbles from the article surfaces which otherwise would prevent anodizing action on the areas covered thereby. The dislodging and removal of gas bubbles is also aided by the mechanical action and inertial forces occurring during the reciprocation and the momentary stops between reversals of direction. A significant factor promoting uniform anodization is that the articles in the contained columns are caused to undergo small displacements or rocking during the repeated back-and-forth travel, which results in the exposure to the electrolytic action of article surfaces which would remain blocked in the absence of such movement. Also, the additional mixing of the bath by the continual movement of the containers improves the maintenance of the bath at the desired operating temperature and concentration.

Following the anodizing treatment, the contained articles are allowed to drain and are thoroughly washed with water. Treatment in a dye solution may then be carried out, followed by a suitable sealing step, when a colored product is desired.

Anodized articles, clear or dyed, prepare in accordance with the above embodiment, display an attractive uniform appearance, the surfaces being substantially free of uncoated areas, streaks, or different shadings. Rejected articles, having such blemishes, amount to less than 1%, as contrasted with rejection rates of about 10% to 15% when the anodization is carried out without reciprocation of the articles and at 70° to 80° F. Operation of the anodizing process with reciprocation of the articles as described in the above example, except that the bath is kept at 70° to 80° F., results in a rejection rate of about 3% to 6%.

A further singificant advantage of the process of this invention is an eight- to ten-fold increase in the useful life of the electrolyte solution, as compared with prior art practice, as exemplified by use for six months rather than for three weeks.

The provision of a plurality of connected anode bars each carrying contained groups of articles to be anodized is also advantageous in significantly increasing the production capacity and, at the same time, in effecting more thorogh agitation of the bath. At times, it may prove particulary advantageous to use three or four anode bars, connected together in parallel arrangement, in each tank for operations generally in accordance with the above example.

The reciprocating motion feature of this invention will in most cases readily be applied by operating the method essentially as set forth in the preferred embodiment. However, variations may be beneficial at times, provided that one adheres to the principle of causing the articles to move repeatedly in opposite directions with a stop at each reversal. Thus, instead of the horizontal back-and-forth motion, the articles may be caused to travel up and down in the bath with a stop at each reversal of direction. In a further example, each contained group of articles may be made to rotate repeatedly, first clockwise and then counterclockwise, with a stop at each reversal, and with the cycle continuing throughout the anodization process.

The advantages of this invention are likewise available with the use of other known electrolyte solutions, for

example, phosphoric acid, oxalic acid, and chromic acid, or of sulfuric acid with the addition of one or more of these, or of electrolyte solutions including ingredients for accomplishing special desired effects, such as, for example, wetting agents or sequestering agents. Other variations known to those skilled in the art may likewise be incorporated in the present bulk anodizing process without departing from the spirit and purposes of the invention.

What is claimed is:

1. A process of bulk anodizing aluminum articles, of the type in which a plurality of said articles are enclosed as a group in at least one perforated container immersed in an anodizing electrolyte solution, said solution having a cathode in contact therewith, each said container being suspended from an anode bar, and said articles being electrically connected to said bar, wherein the improvement comprises the steps of:

causing the said container and the said articles associated therewith to move through the said solution, then come to a stop, and then move in a reverse direction, the said movements being for a distance of about one to two feet in each direction, thereby completing a cycle, during which said solution percolates cyclically in opposite directions through each group of articles, thus acting to prevent temperature and concentration gradients in said solution within each group and to remove gas bubbles from said articles, and continually repeating the said cycle of reverse movements and a stop before each reversal at a rate of substantially ten cycles per minute throughout the anodizing treatment.

2. A process according to claim 1, wherein each of a plurality of said anode bars supports a plurality of said containers, said bars being united in parallel arrangement.

3. A process according to claim 1, wherein said solution is a 15% to 20% by weight aqueous sulfuric acid solution maintained at a temperature of 55° to 60° F.

4. A process according to claim 1, wherein the said movements are in simple harmonic motion in a horizontal direction.

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FREDERICK C. EDMUNDSON, Primary Examiner

U.S. Cl. X.R.

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