

UNITED STATES PATENT OFFICE

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PROTECTING ALUMINUM FROM
CORROSIONJunius D. Edwards, Oakmont, Pa., assignor to
Aluminum Company of America, Pittsburgh,
Pa., a corporation of PennsylvaniaNo Drawing. Application April 29, 1933, Serial
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11 Claims. (Cl. 148—6)

This invention relates to the covering of the surfaces of aluminum and aluminum base alloys, herein collectively designated as aluminum, with a coating capable of resisting the action of cor-
rosive agencies. The invention particularly con-
templates the provision on said aluminum sur-
faces of a corrosion resistant oxide coating.

By various known processes aluminum sur-
faces may be provided with what is generally
termed an "oxide coating". Such a coating is
composed in large part of aluminum oxide. As
stated, the coatings may be produced by various
methods, which methods, with few exceptions,
comprise a reaction, chemical or electro-chemi-
cal, between the aluminum surface and a solu-
tion of a chemically active substance or sub-
stances. The present invention refers to coat-
ings which are produced by these artificial means
and which are adsorptive. It is a further desir-
able characteristic of such coatings that they be
comparatively heavy or thick, but a comparative-
ly thin coating may be satisfactory, especially if
its adsorptive power is high. The very thin film
of oxide naturally forming on aluminum surfaces
is not herein referred to as an oxide coating.

One definite use of these oxide coatings is to
protect the aluminum surfaces against the action
of corrosive agencies. In the performance of this
function the oxide coatings find an important
commercial justification. It is an important ob-
ject of this invention to provide methods whereby
the protection against corrosion offered by these
oxide coatings formed on aluminum surfaces may
be substantially increased and whereby the cor-
rosion resistant quality of the oxide coating may
be so developed that the coated article has an in-
creased useful life. A further object of the in-
vention is the provision of oxide coated aluminum
objects which may be used successfully under se-
vere corrosive conditions.

To these and other ends the invention com-
prises the production of corrosion resistant coat-
ings by forming adsorbent oxide coatings on
aluminum surfaces and thereafter impregnating
said coatings by treating them with a solution of
soluble silicate. The oxide coating is first formed
on the aluminum surface. For instance the
aluminum is made the anode of an electrolytic
cell, the cathode of which may be aluminum,
lead or other suitable metal, with an electrolyte
of sulphuric acid in aqueous solution. External
electrical energy is impressed on the cell with the
result that a layer of oxide is formed on the sur-
face of the aluminum anode. This oxide coating
is adsorptive and may be of varying thickness.
Or the aluminum may be immersed in hot solu-
tion of sodium carbonate and alkali dichromate
for a short period of time with the resulting for-
mation of an adsorptive oxide coating on the sur-
faces thereof. Other methods of forming these

oxide coatings are well known, and may be used,
but I prefer the sulphuric acid method outlined
above.

The aluminum, having been provided with an
adsorptive oxide coating, is preferably washed to
remove residual solutions remaining from the
coating process and is then ready for the second
step of the process, which consists in treating the
oxide coated aluminum surface with a solution
containing soluble silicate. Simple immersion is
the most feasible method of treatment, and in
commercial practice the oxide coated aluminum
is immersed in the solution of soluble silicate, but
other methods of conveying the solution to the
surface will give good results. As a result of
these treatments the soluble silicate is adsorbed
in and on the adsorptive oxide coating. The ox-
ide coated aluminum is then rinsed, if desired,
and thoroughly dried.

A number of soluble silicates are available, but
they vary in their composition and suitability
for my process. The silicate which has a silica
to soda ratio of about 1:1 (i. e., one molecule of
silica to one of soda) is too alkaline for generally
satisfactory use, and even short immersion of
oxide coats in a 5 per cent solution will produce
appreciable attack at room temperature and
rapid attack at boiling temperature. If, however,
the silica to soda ratio is about 2:1 or higher,
satisfactory results can be obtained. With sili-
cate having a ratio of 2:1, the concentration or
the temperature of impregnation should not be
too high if complete attack is to be avoided. For
this reason I prefer to use a silicate solution which
has a silica to soda ratio of about 3:1 or higher,
particularly when a boiling solution is employed.
In using potassium silicate I prefer a silicate hav-
ing about a 4:1 ratio, though silicates of lower
ratio may be used, as in the case of sodium sili-
cate. The ratios given here are approximate,
corresponding generally to the ratios in commer-
cial products. Thus commercial silicates having
ratios of 3.86:1 and 3.25:1 or 2.84:1 would be close
enough to 4:1 or 3:1 for satisfactory use in my
process. The concentration of the solution may
vary within wide limits, from very dilute, such as
a per cent or two upward, but concentrations
around 30 per cent are thick, viscous liquids and
hence are difficult to handle and are adsorbed
slowly. Less trouble is met at 20 per cent, but I
have not observed any advantage in going above
about 5 per cent, which is the preferred strength.

The final product of my process has excep-
tional properties. Its resistance to the action
of corrosive agents, even of a severe character,
is decidedly greater than the resistance of an
oxide coated aluminum which has not been treat-
ed with a solution of soluble silicate in accord-
ance with my invention. The silicate absorbed
in the oxide coating is, despite its soluble nature,

held firmly therein and is leached out only slowly by water as evidenced by the fact that oxide coated aluminum surfaces which have been treated in solutions of soluble silicate held at ordinary temperatures do not lose their highly resistive property under prolonged exposure to the action of spray from a 20 per cent salt solution. For instance a group of aluminum alloy specimens were oxide coated electro-chemically in sulphuric acid solution and a part of the group were then treated with soluble silicate in accordance with my invention. Both the treated and untreated oxide coated specimens were exposed for 52 weeks to the action of a spray of a 20 per cent salt solution. Those specimens treated in accordance with my invention lost only 5.3 per cent, on the average, of their elongation, whereas the oxide coated specimens which were untreated lost, on the average, 16 per cent of their elongation.

Although such results are excellent and superior they can, I have found, be decidedly improved upon when the oxide coated aluminum surface is subjected to certain special treatment.

I have discovered that while highly effective results are obtained when the oxide coated aluminum surface is treated with solutions of soluble silicate held at any temperature there is, nevertheless, a range of temperature through which the treatment is most effective,—namely when the solution of soluble silicate is held at temperatures above about 80° C. and up to and including the boiling temperature of the solution. As the result of such a treatment the soluble silicate is adsorbed in and on the oxide coating and the pores of the coating are apparently closed so that, under the action of weather, moisture and similar agents the removal of any important amount of silicate is practically precluded.

As illustrative of the improved results obtained by practicing my invention at the elevated temperatures aforesaid I may cite the case of duralumin, coated anodically in a sulphuric acid electrolyte and after washing immersed for 30 minutes in a boiling solution of sodium silicate containing about 5 per cent of silicate having a silica to soda ratio of about 3.25:1. The rinsed and dried metal was subjected for 52 weeks to the salt spray test and at the end of that period was practically free from signs of corrosive attack.

This application is a continuation in part of my application for United States Letters Patent, Serial No. 613,789, filed May 26, 1932, and a continuation in part of my application for United States Letters Patent, Serial No. 472,744, filed August 2, 1930.

I claim—

1. In a method of treating aluminum articles to render the surface thereof resistant to prolonged exposure to corrosive influences, forming on the surface of the article an adsorbent oxide coating, and thereafter adsorbing silicate in said coating from a silicate solution, said silicate after adsorption being resistant to solution by washing with water.

2. In a method of treating aluminum articles to render the surface thereof resistant to prolonged exposure to corrosive influences, forming on the surface of the article an adsorbent oxide coating, and thereafter adsorbing silicate in said coating from a silicate solution maintained at

a temperature above about 80° C., said silicate after adsorption being resistant to solution by washing with water.

3. In a method of treating aluminum articles to render the surfaces thereof resistant to prolonged exposure to corrosive influences, forming an adsorbent oxide coating on the surface of the article by anodic oxidation in an electrolyte, and thereafter adsorbing sodium silicate in said coating from a solution of sodium silicate in which the ratio of silica to soda is not less than about 2 to 1.

4. In a method of treating aluminum articles to render the surface thereof resistant to prolonged exposure to corrosive influences, forming on the surface of the article by anodic oxidation in an electrolyte containing sulphuric acid an adsorbent oxide coating, and thereafter adsorbing sodium silicate in said coating from a solution of sodium silicate in which the ratio of silica to soda is not less than about 2 to 1.

5. The method of producing corrosion resistant coatings on aluminum by forming on the surface thereof an adsorbent oxide coating and thereafter treating said coating with a potassium silicate solution in which the ratio of silica to potash is not less than about 2 to 1.

6. In a method of treating aluminum articles to render the surface thereof resistant to prolonged exposure to corrosive influences, forming on the surface of the article by anodic oxidation in an electrolyte containing sulphuric acid an adsorbent oxide coating, and thereafter adsorbing potassium silicate in said coating from a solution in which the ratio of silica to potash is not less than about 2 to 1.

7. The method of producing corrosion resistant coatings on aluminum by forming on the surface thereof an adsorbent oxide coating and thereafter treating said coating with a sodium silicate solution in which the ratio of silica to soda is not less than about 2 to 1, the said solution being maintained during treatment at a temperature above about 80° C.

8. The method of producing corrosion resistant coatings on aluminum by forming on the surface thereof an adsorbent oxide coating and thereafter treating said coating with a sodium silicate solution in which the ratio of silica to soda is not less than about 3 to 1, the said solution being maintained during treatment at a temperature above about 80° C.

9. As a new article of manufacture, an article of metallic aluminum having its surface rendered resistant to prolonged exposure to corrosive influences by the presence on such surface of an adsorbent oxide coating impregnated with a silicate adsorbed and strongly bound therein.

10. As a new article of manufacture, an article of metallic aluminum having its surface rendered resistant to prolonged exposure to corrosive influences by the presence on such surface of an adsorbent oxide coating impregnated with sodium silicate and strongly bound therein.

11. As a new article of manufacture, an article of metallic aluminum having its surface rendered resistant to prolonged exposure to corrosive influences by the presence on such surface of an adsorbent oxide coating impregnated with potassium silicate and strongly bound therein.

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