

Sept. 8, 1970

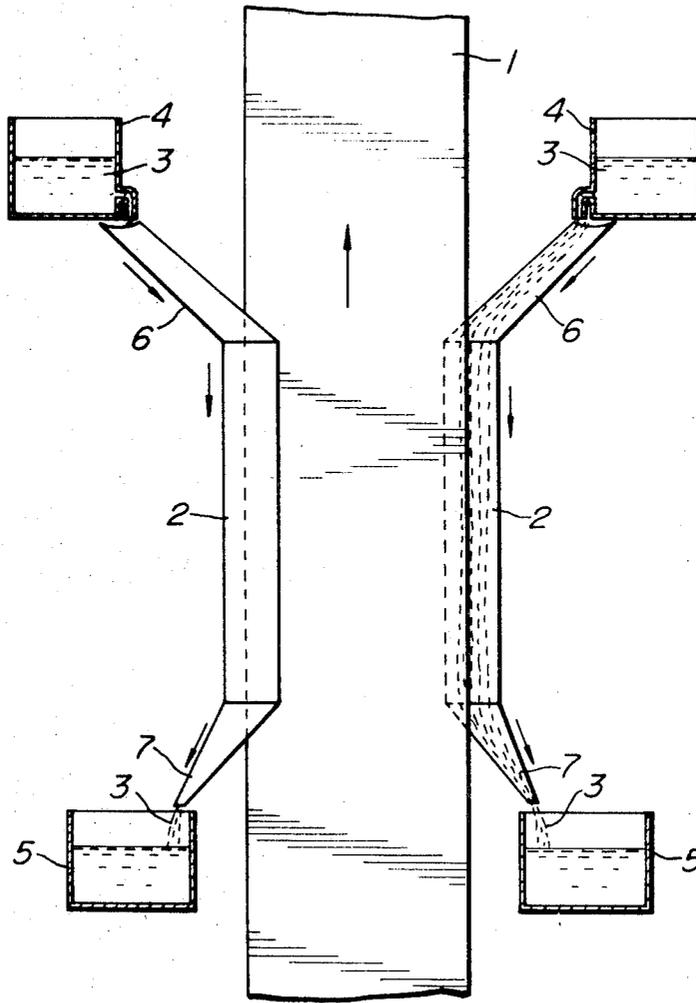
TAKASHI SUZUKI  
METHOD OF CONTINUOUSLY TREATING THE SURFACES OF THE EDGE  
PORTIONS OF METAL SHEETS

3,527,678

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2 Sheets-Sheet 1

FIG. 1



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FIG. 2

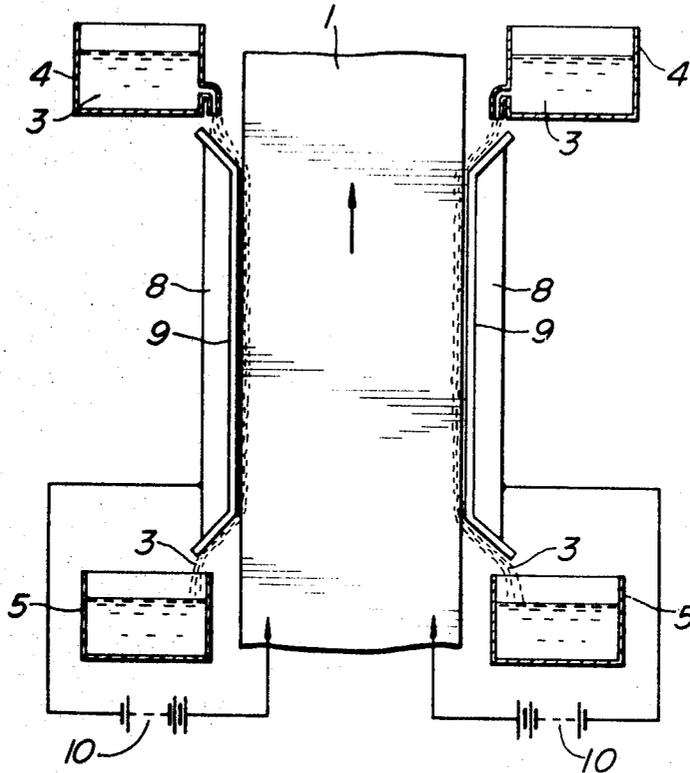


FIG. 3

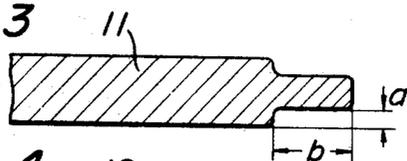
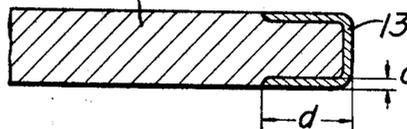


FIG. 4



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3,527,678

**METHOD OF CONTINUOUSLY TREATING THE SURFACES OF THE EDGE PORTIONS OF METAL SHEETS**

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2 Claims

**ABSTRACT OF THE DISCLOSURE**

A method of continuously treating the surfaces of the edge portions of a metal sheet such as aluminum foil, by moving the metal sheet longitudinally thereof, while having its edge portions immersed in a surface treating liquid flowing down on the confronting surfaces of a pair of vertically positioned wall structures.

The present invention relates to a method of treating the surfaces of the edge portions of a metal sheet continuously. The term "metal sheet" as used herein refers to a long foil or strip of a metal, such as iron, copper, aluminum, tin or nickel, or an alloy thereof. The term "edge portions" as used herein refers to the edges and areas in the vicinity thereof at the opposite sides of a metal foil or a metal strip specified above. The surface treatment which is achieved by the method of this invention includes such surface treatment as cleaning, etching, polishing, formation, coating, coloring, plating or anodic oxidation, which is operated using a liquid surface treatment compound.

In treating the surfaces of the edge portions only of a metal sheet selectively, there have been employed two methods, namely one is the method in which the surfaces of a metal sheet are masked with a substance which is unsusceptible to the action of the surface treating compound used, except for the edge portions which are to be subjected to a surface treatment. Another is the method in which a metal sheet is wound tightly into a coil shape so that a surface treating liquid may not be allowed to penetrate through the interspace between adjacent layers of metal sheet and is subjected to a surface treatment in that state. However, the former method is disadvantageous in that the operations of masking the metal sheet with a substance of the type described and removing said substance after completion of the surface treatment, are extremely laborious, whereas the latter method has the drawback that it is of great difficulty to avoid completely the penetration of the surface treating liquid through the interspace between adjacent layers of the metal sheet.

It is the object of the present invention to provide a method which enables the surface treatment of the edge portions of a metal sheet to be carried out continuously without masking or winding the metal sheet as described above, and which obviates the drawbacks of the conventional methods entirely.

Namely, according to the present invention, there is provided a method of continuously treating the surface of the edge portions of a metal sheet, characterized by moving the metal sheet in a longitudinal direction thereof while having its edge portions immersed in a surface treating liquid flowing down on the confronting surfaces of wall structures being held vertically.

In order that the present invention may be more clearly understood, reference will now be made to the accompanying drawings which illustrate the present invention by way of example and in which:

FIG. 1 is a schematic view illustrating an embodiment of the apparatus used for practicing the method of this invention;

FIG. 2 is a schematic view of another embodiment of the apparatus, showing the mechanical and electrical arrangement thereof; and

FIGS. 3 and 4 respectively are fragmentary cross sections of metal sheets showing the edge portions which have been treated by the method of this invention.

Referring to FIG. 1, reference numeral 1 designates a sheet of such metal as aluminum and 2 designates a pair of wall structures which are each made of a material, e.g. polypropylene, which is unsusceptible to the corrosive action of a surface treating liquid 3 used, and which are held vertically in opposed relation to each other. The surface treating liquid 3, e.g. an aqueous solution of caustic soda or aqueous solution of oxalic acid, contained in storage tanks 4, flows down on the confronting surfaces of the vertical wall structures 2 slowly in the direction of arrows at a constant rate and is accumulated in respective storage tanks 5. Guide members 6 and 7 are provided between the storage tanks 4 and the vertical wall structure 2 and between the vertical wall structures 2 and the storage tanks 5, respectively, for guiding the surface treating liquid flowing therebetween.

Now, when the metal sheet 1 is moved upwardly in the direction of arrow, with the edge portions thereof immersed in the surface treating liquid 3 flowing down on the confronting surfaces of the wall structures 2, the sheet 1 is subjected to surface treatment at the edge portions by the surface treating liquid 3. In this case, although a slight amount of the surface treating liquid remains on those portions of the sheet which have passed through the flows of surface treating liquid, the amount is so small that such liquid is substantially not capable of effecting surface treatment. Accordingly, the surface treatment is essentially effected only during the passage through the surface treating liquid flowing down on the surfaces of the wall structures. Thus, it will be appreciated that, by maintaining the travelling speed of the sheet of metal 1 constant, the period of contact between the edge portions of the sheet 1 and the surface treating liquid 3 becomes constant and thereby uniform surface treatment can be obtained over the entire length of the edge portions of said sheet. The surface treating liquid 3 remaining on the edge portions may be removed by washing said edge portions with water or heating the same.

During operation, it is preferable for the edge portions of the sheet 1 to be slightly spaced from the corresponding surfaces of the wall structures 2. However, if such is difficult, the edge portions of the web may be held in light contact with the wall structures 2 in such a degree as not to damage the edge portions. Where the angle of contact of the surface treating liquid 3 with respect to the sheet 1 is relatively large, the surface treating liquid 3 may be separated from the sheet by means of the guide members 7 connected to the respective wall structures. On the other hand, where the angle of contact is small or the sheet 1 is moved downwardly, it is necessary to provide liquid removing scraper consisting, for example, of rubber. The surface treating liquid 3 accumulated in the storage tanks 5 may be recirculated to the storage tanks 4 for reuse.

The surface of each wall structure 2 must be macroscopically flat in a vertical direction but may be curved or ridged in a horizontal direction so as to control the flow direction of the surface treating liquid 3. It is also possible to change the flow rate of the surface treating liquid by supplying the liquid through wall provided with pores or by sucking the liquid, flowing down on the surface of the wall, outwardly through said hole.

The method of the present invention is applicable to any and all surface treatments of metals using a liquid sur-

face treating compound. The surface treatments of this type include cleaning, etching, polishing, formation, coating, coloring, plating and anodic oxidation. Of these surface treatments, electrochemical treatments, such as plating, anodic oxidation and electrolytic polishing, require an opposite electrode to be provided. In this case, the wall structures are each composed of an inner wall consisting of an electrically insulating porous material and an outer wall providing the opposite electrode, and the surface treating liquid acts as an electrolyte. An embodiment of the apparatus for carrying out such electrochemical treatments is illustrated in FIG. 2.

Referring to FIG. 2, wherein the same reference numerals indicate similar parts in FIG. 1, the metal sheet 1 is caused to move upwardly and the surface treating liquid 3 flows from the storage tanks 4 to the storage tanks 5. Each of opposed wall structures 8 is composed of an opposite electrode and a thin layer 9 of a porous insulating material which is provided on said electrode for contact with the corresponding edge portion of the sheet 1 with a small interspace therebetween, the surface of said thin layer 9 being held vertically. A power source 10 is provided to impress a predetermined voltage across the opposite electrode of each wall structure 8 and the metal sheet 1, with its positive electrode connected to said metal sheet.

In operating the apparatus of the arrangement described, the surface treating liquid 3 in the storage tanks 4 is flown down on the surfaces of the wall structures 8, as in the case of apparatus shown in FIG. 1, while the sheet of metal 1 is moved upwardly with its edge portions immersed in the flows of surface treating liquid, and thereby anodic oxidation of said edge portions can be accomplished.

Although the apparatus shown in FIGS. 1 and 2 described above, are arranged such that both edge portions of the sheet of metal be subjected to a surface treatment concurrently, it is obviously possible to arrange so as to carry out the surface treatment of only one edge portion of said sheet.

Now, the method of the present invention will be described more specifically by way of specific examples wherein said method was applied for the surface treatment of the edge portion of an aluminum sheet.

A 15% aqueous solution of caustic soda was flown on the surface of a vertically positioned wall structure at a constant rate, which wall structure consisted of a flat plate of polypropylene and had a height of 300 mm. A sheet of aluminum of 0.2 mm. in thickness and 99.4% in purity was moved upwardly at the rate of 500 mm. per minute while having its edge portion held in contact with the flow of aqueous solution of caustic soda. The edge portion of the sheet of aluminum thus treated had the cross sectional configuration shown in FIG. 3, wherein reference numeral 11 designates the sheet of aluminum, the distance  $a$  being 0.05 to 0.06 mm. and the distance  $b$  being 2 to 2.5 mm.

In another example, an anodic oxidation was conducted according to the method of this invention, using a wall structure which was composed of a vinylidene chloride net (Saran net in trade name) adhered to the surface of a plane carbon electrode. A 10% aqueous solution of oxalic acid was flown down on the vertical surface of the wall structure (300 mm. in height) at the normal temperature at the rate of 1.5 litres per minute and a sheet of aluminum of 0.2 mm. in thickness was moved upwardly at the rate of 100 mm. per minute, while having its edge portion held in contact with the flow of said aqueous solution of oxalic acid. During the operation, 20 volt

direct current was impressed across the carbon electrode and the sheet of aluminum, with the latter being on the positive side. The cross sectional configuration of the edge portion of the sheet treated by the anodic oxidation, is shown in FIG. 4, wherein reference numeral 12 designates the sheet of material and 13 designates the oxide film formed at the edge portion of said sheet, which had a film thickness  $c$  of about  $2\mu$  and a width  $d$  of about 3 mm.

As will be clearly understood from the foregoing description, it is possible according to the present invention to conduct a surface treatment of the both opposite edge portions of a metal sheet simultaneously continuously by moving said metal sheet with only the edge portions thereof immersed in a surface treating liquid. In addition, since the surface treatment can be accomplished without causing any damage to the surface of the central portion of the metal sheet, the method of this invention can be used for an extremely wide range of applications, such as for the removal of burr or ruggedness from the edge portion of a metal sheet, for the removal of a scale accumulated at the edge portion of a metal sheet, for the reinforcement of the edge portion of a metal sheet by the anodic formation and for the production of a metal sheet having colored edges, and thus is of great industrial advantage.

I claim:

1. A method of continuously treating the surfaces of edge portions alone of a metal strip characterized by treating the surfaces of edge portions of a metal strip by immersion in a surface treating liquid flowing down on confronting surfaces of vertically positioned wall structures while moving the metal strip longitudinally thereof, said metal strip being disposed such that its width is substantially normal to said surfaces of said wall structures and said edge portions are parallel to and adjacent said surfaces of said wall structures so that only the edge portions of the metal strip are immersed in said surface treating liquid.

2. A method of continuously treating the surfaces of edge portions alone of a metal strip characterized by treating the edge portions of said metal strip by immersion in an electrolyte solution flowing down on confronting surfaces of vertically positioned wall structures adapted to cause an electrolyte solution to move therealong while moving the metal strip longitudinally thereof, said metal strip being disposed such that its width is substantially normal to said surfaces of said wall structures and said edge portions are parallel to and adjacent said surfaces of said wall structures so that only the edge portions of the metal strip are immersed in said electrolyte solution, and passing a current between each of opposite electrodes disposed on the inner side of each of said wall structures and said metal strip through said electrolyte solution.

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