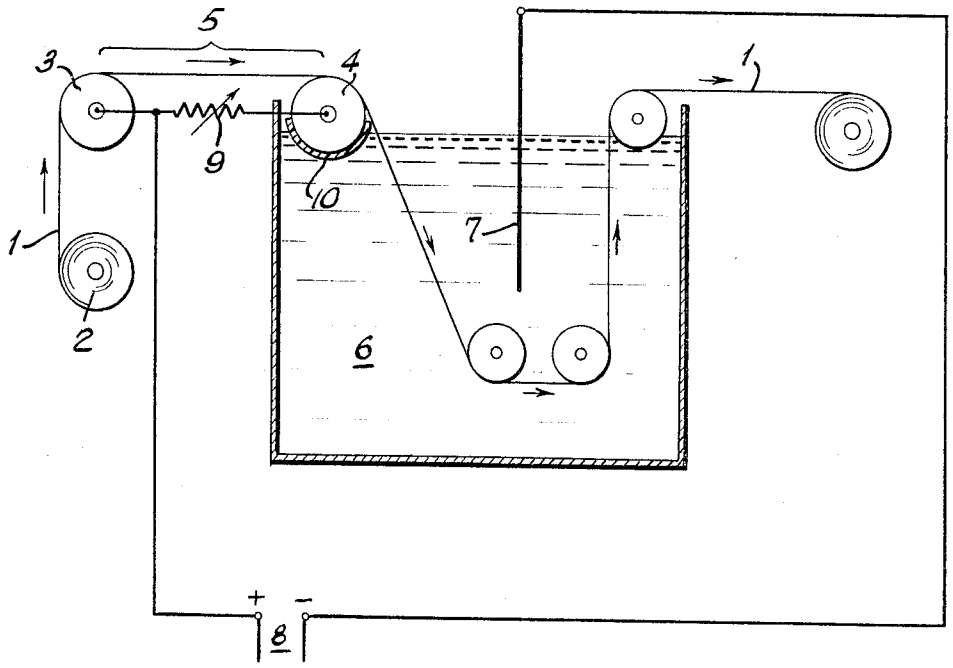
Sept. 6, 1966 W. POST 3,271,287

APPARATUS FOR ANNEALING AND ELECTROLYTICALLY TREATING METALLIC STRIP

Filed Nov. 27, 1962



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United States Patent Office

3,271,287

Patented Sept. 6, 1966

3,271,287

APPARATUS FOR ANNEALING AND ELECTROLYTICALLY TREATING METALLIC STRIP

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Filed Nov. 27, 1962, Ser. No. 240,372
Claims priority, application Switzerland, Nov. 28, 1961, 13,827/61
3 Claims. (Cl. 204—210)

The invention relates to process and an apparatus for annealing and electrolytic treatment of continuous lengths of metal, such as strips or wires, and especially to annealing and electrolytic etching of aluminium foil for electrolytic capacitors.

In the production of electrolytic capacitors the electrode foil is usually etched in order to increase its surface area. Before etching the foil is annealed, on the one hand to soften the foil after rolling, and on the other hand to volatilise lubricants and hence degrease the foil. This annealing is commonly effected in a separate operation in annealing furnaces of various kinds.

According to the present invention annealing is effected by electrical resistance heating apart of the travelling length of metal, and electroyltic treatment is combined with it in one apparatus and in one working operation, by using sufficient of the current flowing through the electrolytic treatment bath for annealing. The whole or part of the current flowing through the electrolytic treatment bath can be used according to the extent of annealing desired. The process is particularly suitable for the combined annealing and electrolytic etching of a continuous length of aluminium foil, which is passed through an electrolytic etching bath and is subjected before entering this bath to sufficient of the current flowing through the bath to anneal it. By combining annealing and electrolytic treatment in this way treatment processes, for example in the production of roughened aluminium foils for electrolytic capacitors, can be substantially shortened and simplified. In particular, there is no need for a separate annealing operation, and annealing furnaces are dispensed with.

A suitable apparatus for carrying out this process comprises an electrolytic treatment tank, means for passing a continuous length of metal through it, spaced electrical contact points for the metal defining between them an annealing zone, and a variable resistance connecting the points. The annealing zone and the variable resistance are connected together in parallel in series with the electrolytic treatment bath, and in operation the proportion of current which flows through the annealing zone is controlled by the variable resistance.

The accompanying drawing shows schematically the preferred apparatus for annealing and electrolytic etching aluminium foil by the process according to the invention.

An aluminium foil **1** is unrolled from a supply roll **2**, and is passed over contact rollers **3** and **4**, which act as electrical contact points and define between them an annealing zone **5**, and then into an etching bath **6**. The contact rollers may be made from copper or brass. An electrode **7** dips into the etching bath. Current flows from a current source **8** via the electrode **7** through the bath **6** to the metal foil **1** and back to the current source **8** via the

contact rollers **3** and **4**. The whole of the current supplied by the current source **8** is used for the etching.

For annealing the foil only a part of the current flowing through the foil in the etching bath may be necessary. The higher the annealing temperature, the greater must be the current flowing through the annealing zone **5**. For controlling the current flowing through the foil the contact rollers **3** and **4** are connected through a variable resistance **9** in parallel with the annealing zone **5**. The remaining current flows through the variable resistance **9**. If the whole of the current used for etching is also necessary for annealing, the resistance **9** may be disconnected, and then the contact roller **4** serves only as a guide roller. Thus the annealing current can be adjusted as desired without it being necessary to alter the etching current. It is of course always necessary that the current fed to the electrolytic treatment bath should be greater than or equal to the current necessary for annealing.

In known apparatus for the electrolytic treatment of metal strip in which there is a current-supply roller before the electrolytic tank there may be said to be an annealing zone in the strip between the contact roller and the surface of the liquid in the tank. This annealing can not however be controlled, and the contact roller is therefore arranged as near as possible to the surface of the liquid so that annealing is reduced to a minimum. This uncontrollable annealing is preferably also avoided in the apparatus according to the invention by arranging one contact roller immediately at the surface of the liquid. In the drawing the roller **4** is separated from the electrolyte by an electrically insulating screen **10**, for example of an insulating synthetic resin. The heat of the annealed foil is given up to the etching bath **6**, which as is customary is at an elevated temperature, and can if necessary be cooled.

The annealing zone **5** can be exposed to the atmosphere or can be surrounded by a screening tunnel through which an inert gas is passed. Further treatment baths can be installed after the etching bath **6**.

In a similar manner other metal strips or wires can be annealed and subjected to an electrolytic treatment such as etching or pickling.

The following example illustrates the treatment of aluminium foil by the present process:

A 50 mm. wide and 0.09 mm. thick aluminium foil having a purity of 99.99% was annealed by feeding it with a speed of 50 cm./min. through the apparatus illustrated in the accompanying drawing and was etched in an aqueous solution of 10% sodium chloride and 3% hydrochloric acid at 70–80° C. The total current flowing through the apparatus and used for the etching amounted to 220 amps. The resistance **9** was so adjusted that a partial current of 180 amps flowed through the annealing zone **5**. The latter was 700 mm. long. In this way the aluminium foil was heated to a temperature of 350° C. By increasing the annealing current to 200 amps the temperature in the annealing zone rose to 450° C.

What is claimed is:

1. An apparatus for treating metal, comprising an electrolytic treatment tank for containing an electrolyte for the electrolytic treatment of the metal, means for continuously advancing a continuous length of metal lengthwise through the electrolyte in said tank, two electrical contact points at the entrance side of said electrolytic

tank in electrical contact with said metal and spaced therealong to define an annealing zone therebetween, and an incomplete electric circuit comprising a source of electric current having two terminals of opposite polarity, an electrode dipping into said electrolyte, an electrical connection between one of said terminals and said electrode, an electrical connection between the other terminal and the contact point furthest from the entrance side of the tank, and a variable resistance between said contact points in parallel with the section of the metal between said contact points while said metal is extending between said contact points, said circuit being completed by the continuous length of metal passing over the two electrical contact points and through the electrolyte.

2. An apparatus according to claim **1** in which one of the contact points is an electrically conductive roller adapted to be arranged at the surface of the liquid in the

tank and separated from the liquid by an electrically insulating screen.

3. An apparatus according to claim **1** in which the annealing zone is surrounded by a screening tunnel through which an inert gas may be passed.

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