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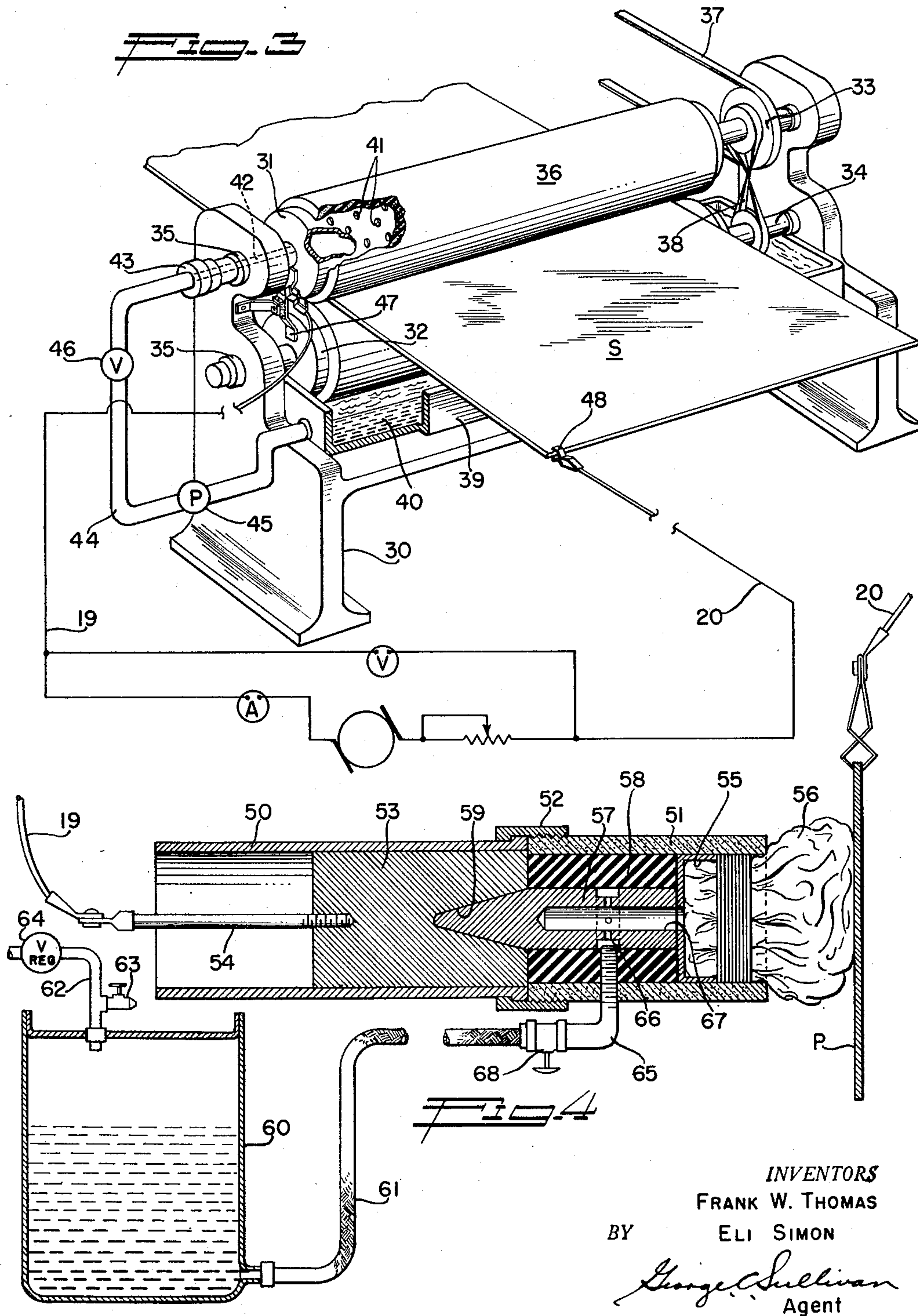
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METHOD AND APPARATUS FOR THE SURFACE TREATMENT OF METALS

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## METHOD AND APPARATUS FOR THE SURFACE TREATMENT OF METALS

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This invention has to do with the surface treatment of metals, and has more particular reference to the anodizing of parts, components, sheets, etc., of aluminum, aluminum alloys, magnesium, magnesium alloys, and other metals.

It is the widespread practice in the aircraft industry, and other industries, to provide or deposit anodic coatings on aluminum and magnesium alloy parts and assemblies to obtain corrosion resistant surfaces and to prepare the surfaces for the increased adhesion of primers, paints and adhesives. The usual procedure is to totally immerse the parts in an appropriate electrolyte and to connect the parts in an electrical circuit so that they form the anode. In the case of large components and assemblies it is necessary to maintain large tanks of electrolyte for their total immersion, and it becomes impractical to anodize extremely large assemblies or to repair the surfaces of previously anodized parts that have become scratched or abraded. Furthermore, the conventional anodizing process is extremely time-consuming, and an anodizing period of about one-half an hour at a current density of one ampere per square foot is usually required with a chromic acid electrolyte to obtain a good corrosion resistant surface on aluminum alloy parts. The prolonged immersion is necessitated because it is impractical to obtain any substantial current density when employing the immersion system. There are many cases where the processing and assembling sequence does not permit the use of the tank or immersion or anodizing procedure.

It is an object of the present invention to provide a method for the anodizing of aluminum alloy, magnesium alloy parts, etc., that is much more rapid than the processes heretofore employed, and which does not require the immersion of the parts in an electrolyte bath. In accordance with the present invention, the surface or surface portions of a part may be provided with an effective anodic deposit in the matter of a few seconds or minutes. The current density obtainable with the present method is many times greater than that which can be provided in the tank or immersion method, and the time required for the production of an effective anodic coating is markedly reduced. In addition, it is unnecessary to handle the parts in order to introduce them into a tank or to remove from a bath at the completion of the operation.

Another object of the invention is to provide an anodizing method that is flexible and capable of employment in many situations where the immersion process is useless, or at least impractical.

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The present method is useful in repairing scratched or abraded anodic films previously applied, in touching up assemblies of anodic parts, in anodizing defined or given portions of assemblies, assemblies having bi-metal parts or non-compatible compounds which cannot be immersed in an electrolyte, and in anodizing one or both surface areas of sheets, etc. The method may be successfully employed to obtain good corrosion resistant films on any surface areas that can be reached with a manually manipulated brush or pad, or by a power driven roller.

Another object of the invention is to provide a method of the character referred to that requires a minimum amount of equipment. The apparatus required may be portable, light in weight, and inexpensive to install and maintain.

Another object of the invention is to provide a simple, practical and inexpensive apparatus for producing or depositing anodic films on parts and assemblies of aluminum, aluminum alloys, magnesium, magnesium alloys, etc. In one embodiment of the invention the equipment consists of a simple brush containing a supply of electrolyte and connected with either a source of D. C. or A. C. power, the brush having an electrolyte supplying means embodied therein or associated therewith so that electrolyte may be supplied to the brush head at will. The brush may be conveniently manipulated by a single workman and employed in a manner similar to a conventional paint brush. The fact that A. C. power may be employed, makes it possible to "plug in" the brush wherever the usual 110 volt A. C. power is available. In another form, the apparatus comprises a pad adapted to be applied to the part to be anodized and saturated with a selected electrolyte. This form of the apparatus provides for the rapid formation of an anodic coating on a substantial surface area, either flat or curved. In still another application of the invention, the apparatus comprises a pair of rollers, either one or both of which carries a pad saturated with a selected electrolyte to treat the surface or surfaces of a sheet, or the like, to be run between the rollers.

Another object of the invention is to provide apparatus or equipment for the anodic coating of metals which is small, compact and portable. The apparatus may be easily moved from place to place, and is immediately readied for use by merely supplying the required quantity of electrolyte and by connecting the applicator or pad with a source of electrical energy.

A further object of the invention is to provide apparatus of the kind referred to that is operable



to form an anodic film or coating much more rapidly than the equipment heretofore employed.

Other objects and features of the invention will be readily understood from the following detailed description of typical preferred forms of the invention wherein reference will be made to the accompanying drawings in which:

Figure 1 illustrates one form of the apparatus showing the applicator in longitudinal cross section and the electrical circuit in a diagrammatic manner;

Figure 2 is a perspective view illustrating another form of the invention in position on a part being treated;

Figure 3 is a more or less diagrammatic perspective view of still another form of the apparatus with the electrical circuit shown in a diagrammatic manner; and

Figure 4 is a view similar to Figure 1 showing still another embodiment of the invention, the piping system being shown in a diagrammatic manner.

It is believed that the method or process of the invention will be best understood following a description of the apparatus. Accordingly, we will first proceed with a detailed description of several preferred forms of the apparatus and will then set forth the method as employed in operating the apparatus, it being understood that the invention is not to be construed as limited to the specific details herein described.

In Figure 1 we have shown a form of the invention embodying a manually manipulatable brush or applicator. The brush comprises an outer shell or tube 10 of a dielectric material that has the required strength and rigidity, and that is resistant to the hot electrolyte. In practice the tube 10 may be formed of Micarta. The tube 10 is proportioned so that it may be readily grasped and held in one hand, and while we have shown a simple cylindrical tube, it is apparent that the member may be externally contoured to more readily fit the hand. The outer end of the tube 10 is open, while its inner end contains the brush 11 to be described below. A liner 12 of metal is secured in the tube 10. The liner is constructed of Dural (a wrought aluminum alloy containing from 3.0 to 4.5% copper, from .4 to 1.0% magnesium, from 0.0 to 0.7% manganese, and the balance aluminum), or like material, that is resistant to the electrolyte and that forms a good electrical conductor. The outer end of the liner 12 may be flush with the end of the tube 10, but the inner end of the liner is spaced some distance from the inner end of the tube so that the liner cannot contact or come in close proximity to the part P being treated or worked upon.

The above mentioned brush 11 is engaged or secured in the inner end of the liner 12, and extends beyond the tube 10 so that it may be moved across the surface of the part being anodized. The invention contemplates the employment of a pad or brush 11 constructed of any selected material that is capable of carrying or becoming saturated with the electrolyte. For example, cotton fiber, porous rubber or sponge rubber may be employed. We prefer to use a pad of glass wool. The shank portion of the pad is tightly wound with wire 13 to be cylindrical in form, and to tightly engage in the sleeve 12. The pad or brush extends outwardly through the tube 10 and flares to have a free exposed active portion overlying the ends of the tube 10. It will be observed that the pad or brush 11 may be easily replaced when worn.

The apparatus of Figure 1 further includes means for drawing or pumping liquid electrolyte into the liner 12 and for forcing the electrolyte out through or into the brush 11. This means also serves to conduct electricity to the sleeve 12 for delivery to the electrolyte in the pad 11. A piston 14 is removably arranged in the liner 12 and is preferably equipped with a series of circumferentially spaced spring-urged balls 15 for riding on the surface of the sleeve to assure an uninterrupted electrical engagement between the piston and sleeve. The balls 15 and their springs are contained in radial sockets in the piston 14, which is metal and a good electrical conductor. An O-ring 16 of synthetic rubber, or similar material, is contained in an annular groove in the piston 14 to maintain a sliding seal between the piston and liner. A piston rod 17 is secured to the piston 14 and extends rearwardly through the liner 12 to normally extend beyond the tubular applicator.

The interior of the liner 12 constitutes a reservoir for containing a sufficient supply of the electrolyte to maintain the pad or brush 11 in a saturated condition for the treatment or anodizing of a considerable surface area of the part or parts to be treated. To fill the reservoir, the pad or brush end of the applicator is immersed in the body of the electrolyte and the piston 14 is moved outwardly so that the electrolyte is drawn into the reservoir. As the applicator is used, the rod 17 is moved inwardly from time to time to force electrolyte into the brush 11 in order to keep the same fully saturated.

The electrical supply system for the applicator of Figure 1 comprises a generator 18, or other suitable source of electrical energy, a lead 19 extending from the generator to the piston rod 17 and a second lead 20 from the generator extending to the part P to be anodized. We have shown a terminal 21 securing the wire 19 to the rod and a releasable clamp 22 on the wire 20 for clamping onto the part P. The circuit arrangement is such that the liner 12 forms the cathode and the part P, the anode. A potentiometer 23 is interposed in the line 20 so that the current density at the point of the anodizing operation may be varied at will. We have also shown an ammeter 24 connected in the lead 19 and a voltmeter 25 connected in a line bridging the generator or power source. While we have shown a generator 18, it is to be understood that any suitable source of D. C. current may be used, and that the lines 19 and 20 may be simply "plugged into" a source of alternating current, such as a conventional 110 volt supply.

In carrying out the process of the invention with the apparatus of Figure 1, the part P, or at least the surface thereof, to be anodized, is thoroughly cleansed of foreign matter. The applicator is supplied with a quantity of the electrolyte as described above, and the wires 19 and 20 are connected with the piston rod 17 and the part P. With the potentiometer 23 adjusted to the selected setting, the operator simply wipes the pad 11 back and forth across the surface of the part. The thickness of the anodic film formed in this manner is a function of the speed and number of brush strokes, the particular electrolyte solution employed, the current intensity and other factors such as the temperature. The potentiometer 18 may be adjusted to obtain any selected current density at the saturated brush 11. In this connection it will be observed that the brush 11 of limited area provides for a highly concen-



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trated action, there being a high current density at the electrolyte in the brush to obtain the rapid formation of an anodic film on the part P. In practice, the current density at the surface of the part P and brush 11 is many times greater than that obtainable with the immersion anodizing method. The voltage and current applied depend upon the electrolyte employed and where the brush is about one inch in diameter we may use from 20 to 200 volts, and from one to fifteen amperes, in accordance with the character of the electrolyte, it being understood that any desired or selected current strength may be used. In a typical preferred case the wires 19 and 20 are connected with the opposite sides of an electrical energy source supplying a voltage of from 20 to 200 volts and a current density of from approximately 180 to approximately 2,750 amperes per square foot. The electrolyte supply to the brush 11 may be a saturated solution of potassium acid sulphate, an aqueous chromic anhydride solution, or any other suitable electrolyte. The number of brush strokes required will depend upon the nature of the part P, the current strength, the electrolyte employed, etc., but in most instances where a D. C. current at approximately 500 amperes per square foot is used, we have found that from fifteen to twenty-five brush strokes will produce a good anodic film. Satisfactory coatings or films are obtained when the electrolyte is a three per cent aqueous solution of chromic acid, and a normal A. C. current supply of about 110 volts is used. When the part to be treated is magnesium or a magnesium alloy, the electrolyte preferably comprises a mixture of tungstate or vanadate salts and chromic acid adjusted to a pH of seven. The applicator may be handled in about the same manner as a conventional paint brush and may be used to engage corners, edges, projections, contoured surfaces, etc. The brush may be stroked across selected surface areas to be treated, leaving other areas of the part untouched. The supply of the electrolyte may be quickly replenished from time to time by simple operation of the piston rod 17 and the applicator, being light in weight and freely manipulatable may be kept in substantially continuous service by the operator.

In Figure 2 we have illustrated another application of the invention. In this case, a mat or pad 20' of fiber glass wool, or cellulose material is provided and a metal screen or sheet 21' is engaged over the pad. The pad 20' is adapted to be arranged on the surface to be treated. We have shown the pad 20' engaged over the surface of the leading edge section 22' of the airplane wing, it being understood that the pad may be formed for application to other parts. The pad may be sufficiently large to cover a substantial area, and is flexible or pliable so as to conform to the contour of the part. The sheet 21' may be considered the cathode and is a metal element in the nature of a wire screen, perforated foil sheet, or a perforated sheet metal member. In the particular case illustrated, the sheet 21' is a perforated plate or sheet metal part. The cathode sheet 21' may be flexible to conform to the pad 20', or may be substantially rigid and shaped to follow the general contour of the part to be treated.

In using the apparatus of Figure 2, the surface of the part 22' is first cleansed and is then brushed with the electrolyte. The mat or pad 20' is either saturated with the electrolyte and then placed on the surface, or is first arranged

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in place on the surface and then saturated with the electrolyte. The shield or cathode sheet 21' is placed over the pad 20' and made to conform thereto. It is desirable to retain the pad 20' in close engagement with the part 22' and this may be accomplished by arranging adhesive tape 23' over the sheet and onto the part 22' as shown, or if desired, wire, straps, or the like, may be employed for this purpose. The above described wire 19 is then secured to the cathode sheet 21' by a clamp 24', and the wire 20 is attached to the part 22' by a similar clamp 25. The assembly is now ready for the anodizing operation. Upon applying current to the circuit 19—20, the anodic coating or film is formed on the surface of the part 22'. An effective coating is provided by applying approximately 20 amperes per square foot of surface being treated at from 10 to 20 volts, using a potassium bisulfate electrolyte, and for a period of from two to ten minutes. It is desirable to supply additional electrolyte to the pad 20 from time to time to prevent the development of local dry spots at the surface of the part 22'. When the pad 20' is formed of fiber glass wool, or the like, the above mentioned electrolytes may be used, but where the pad is of cellulose material a saturated solution of sodium or potassium bisulfate is preferably used because it has no marked degenerative effect upon the cellulose. At the end of the selected treatment period, the electrical circuit is opened and the pad assembly is removed from the part 22'. The surface of the section or part is then flushed or washed with water.

Figure 3 illustrates a form of the invention suitable for the surface treatment of sheets, elongate strips, etc. This device comprises a suitable frame 30 and a pair of rolls 31 and 32. The rolls are horizontally disposed one above the other and have shafts 33 and 34 which are carried in suitable bearings 35 on the frame. Either one or both of the rolls 31 and 32 may form the cathode for the anodizing operation, and are formed of a suitable metal which is resistant to the electrolytes which may be used. Peripheral pads 36 of absorbent or porous material such as sponge rubber or synthetic sponge rubber are provided on the rolls, and the rolls are related so that a sheet S or similar part may be fed between them to be contacted by the pads. It is preferable to drive or rotate the rolls so that the part or sheet being treated may be positively advanced or fed through the rolls. We have shown a belt and pulley drive for the rolls 31 and 32, it being apparent that other forms of drives may be used. The particular drive illustrated includes a belt 37 extending from a power source, not shown, and operating over a pulley on the shaft 33 of the roll 31, and a crossed belt 38 operating over pulleys on the two roll shafts so that both rolls are simultaneously rotated.

The apparatus of Figure 3 further includes means for delivering electrolyte to the sheaths or pads 36 of the rolls 31 and 32. This means is preferably such that electrolyte may be supplied to either one or both of the roll pads. In the case illustrated, the electrolyte supplying means includes a pan or sump 39 arranged in the frame 30 below the roll 32 in a position where the pad 36 of that roll moves through the body of electrolyte 40 contained in the sump. Thus, as the roll 32 rotates, its pad 36 is continuously replenished with the electrolyte. The invention contemplates supplying the electrolyte to the pad 36 of the upper roll 31 either by an external



means such as a spray directed onto the pad, or by an internal means. In the drawings the roll 31 is hollow, and its peripheral wall has a multiplicity of perforations 41 so that electrolyte may be supplied to the interior of the roll for internal delivery to the pad 36. One end portion of the roll shaft 33 has a passage 42 communicating with the interior of the roll and extending to a rotary or swivel coupling 43 on the end of the shaft. A pipe 44 extends from the coupling 43 to the sump 40 or other source of electrolyte. A suitable pump 45 is interposed in the pipe 44 to deliver the electrolyte to the roll 31 and a valve 46 may also be connected in the pipe to control the delivery of the electrolyte.

As mentioned above, the rolls 31 and 32 form the cathodes and spring contacts or brushes 47 are supported by an insulated bracket on the frame 30 to engage adjacent ends of the rolls. The electrical system or circuit of Figure 3 may be identical with that of Figure 1 and corresponding reference numerals are applied to corresponding parts of the two illustrated circuits. The conductor 19 is connected with the brushes 47 and a clamp 48 may be employed to connect the positive line 20 with the part or sheet S.

In carrying out the method with the apparatus of Figure 3, the sump 40 is supplied with a suitable quantity of the electrolyte 40 and the leads 19 and 20 are connected with the brushes 47 and the sheet S respectively. If it is desired to deposit an anodic coating on only one surface of the sheet S, the valve 46 is closed and the pump 45 is cut off. The sheet S is entered between the rolls 31 and 32 and the potentiometer 23 is adjusted to provide the desired current density at the surface of the sheet and the electrolyte carrying pad 36 of roll 32. When the rolls are rotated, the sheet S is drawn between them and the pad 36 of roll 32 moves through the electrolyte 40 to become saturated. The pad of the rotating roll carries the electrolyte into contact with the surface of the sheet S, there being current flow from the cathode roll 32 through the electrolyte in the pad. The area of contact between the rotating pad 36 and the surface of the sheet S is rather limited so that the current density in the electrolyte at the surface of the sheet is concentrated, assuring a rapid anodic film-forming action. The sheet S may be passed between the rolls 31 and 32 several times to build up the anodic film to the desired thickness, the number of passes required depending upon the current strength, the character of the metal in the sheet S, the electrolyte, the temperature, etc. If desired, the speed of rotation of the rollers may be reduced to the extent that a sufficient film or coating may be deposited upon a single run of the part between the rolls. When both surfaces of the sheet S are to be treated, the procedure is the same as just described except that the valve 46 is opened and the pump 45 is operated so that electrolyte is supplied to the pad 36 of the roll 31 as well as to the pad of the roll 32. Following the coating or film forming operation, the surfaces of the sheet S are flushed or washed with water. In some instances it may be desirable to repeat the operations after such washing of the surfaces to build up a more effective anodic coating. The electrolyte employed with the apparatus of Figure 3 will be determined by the character of the sheet S or other parts being treated, and by the character of the pads 36 as described above in connection with Figures 1 and 2.

Figure 4 illustrates an applicator type of de-

vice associated with a remote source of supply of the electrolyte. The applicator includes a hollow or tubular handle 50 of any selected material and a tubular case 51 of Micarta or any other appropriate insulating material secured to the forward end of the handle by a releasable connection 52. A block 53 of metal such as aluminum is secured in the handle 50 and carries a rod 54 which extends rearwardly through the handle for connection with the above described wire 19. The forward end of the case 51 is open to receive the brush or pad.

In this form of the invention the pad assembly is readily removable and replaceable so that the applicator may be equipped with pads of any required size. The pad unit comprises a cup-like member 55 for retaining the root end of the pad 56 of fiber glass wool, cotton fiber, or other selected material. A shank 57 is attached to the cup member 55 and extends rearwardly through a tubular sealing member 58 of rubber, or the like. The sealing member 58 is engaged in the case 51 and bears rearwardly against the block 53 while the cup member 55 seats rearwardly against the sealing member. The brush or pad shank 57 has removable engagement or connection with the block 53. A tapering socket 59 is provided in the forward end of the block, and the rear portion of the brush shank 57 is correspondingly shaped to nest or fit therein. It will be apparent how the brush or pad assembly may be removed and a replacement assembly of the required character and size may be installed.

The means for supplying electrolyte to the applicator is characterized by a remote source of the liquid. As diagrammatically illustrated, this comprises a tank 60 adapted to contain a substantial supply of the electrolyte and a line or hose 61 extending from the tank to the applicator. Pump means or pressure applying means is provided to deliver the electrolyte to the applicator under pressure. In the arrangement illustrated, this comprises an air pressure line 62 discharging into the upper end of the tank 60 and equipped with a release valve 63 and a pressure regulator 64, both of conventional construction. It is to be understood that other forms of pump means, such as a centrifugal pump in the line 61, may be employed to force the electrolyte to the applicator. The line 61, or at least the portion of the line adjacent the applicator, is flexible so as not to interfere with free manipulation of the same. The line 61 connects with a fitting 65, which in turn communicates with an annular groove 66 in the shank 57. The groove 66 communicates by means of spaced radial ports with an axial passage 67 leading out through the shank and member 55 to the root of the pad 56. The fitting 65 is equipped with a valve 68 so that the operator may regulate the feed of the electrolyte to the pad.

The operation of the device shown in Figure 4 is the same as that illustrated in Figure 1, it being understood that the electrical circuit 19—20 is connected with the rod 54 and the part P and is adjusted as above described. In this case the operator may regulate the delivery of electrolyte to the pad 56 as conditions of operation require, and there is no need to otherwise replenish the electrolyte.

While we have referred to the treatment of aluminum, aluminum alloys, magnesium and magnesium alloys, it is to be understood that the invention is not confined to such applications. For example, the method and apparatus may be



used in the treatment of foils of various metals and to treat parts of steel, brass, bronze, etc. Furthermore, in addition to providing corrosion resistant surfaces and surfaces for the application of paints, adhesives, etc., the method and apparatus are adapted to be employed to obtain decorative effects, increase the electrical resistance of foils, sheets, etc., and for other purposes.

Having described only typical forms of the invention, we do not wish to be limited to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art and/or fall within the scope of the following claims.

We claim:

1. The method of forming a corrosion resistant anodic coating on the surface of a metal part which comprises supplying a liquid electrolyte to a porous pad, connecting said part and pad with the opposite sides of an electric energy source which supplies a voltage of from 20 to 200 volts and a current density of from approximately 180 to approximately 2750 amperes per square foot, bringing the surface of said part and the pad into engagement, and moving the pad and part relative to one another while said engagement is maintained and while the part and pad are connected with said energy source to progressively form a corrosion resistant anodic film on said surface.

2. The method of forming a corrosion resistant anodic coating on the surface of a metal part which comprises supplying a liquid electrolyte to a porous pad, connecting said part and pad with the opposite sides of an electric energy source which supplies a voltage of from 20 to 200 volts and a current density of from approximately 180 to approximately 2750 amperes per square foot, bringing the surface of said part and the pad into engagement, moving the electrolyte-containing pad across said surface while maintaining said engagement and while the part and pad are connected with said electrical energy source to progressively form a corrosion resistant anodic film on the surface.

3. The method of forming a corrosion resistant anodic coating on the surface of a part containing metal selected from the group consisting of aluminum and magnesium; said method comprising wetting a liquid-carrying member with an electrolyte, connecting said part and said member with the opposite sides of an electric energy source supplying a voltage of from 20 to 200 volts and a current density of from approximately 180 to approximately 2750 amperes per square foot, and moving the wet member across said surface while the part and member are connected with said electrical energy source to progressively form a corrosion resistant anodic film on said surface.

4. The method of forming a corrosion resistant anodic coating on the surface of an aluminum-containing part which comprises providing a manually manipulable absorbent pad, supplying an electrolyte to the pad, connecting said part and pad with the opposite poles of an electric energy source supplying a voltage of from 20 to 200 volts and a current density of from approximately 180 to approximately 2750 amperes per square foot, engaging the pad with said surface, and moving the pad across the surface while the part and pad remain connected with said elec-

tric energy source to progressively form the anodic coating throughout at least an area of said surface.

5. A device useful in forming anodic films on parts comprising a tubular dielectric member adapted to be grasped and manipulated by the operator, a metal liner in the member, a pad of absorbent material secured in the liner and extending from an end of the member so as to be engaged with the parts being treated, the liner being adapted to contain a supply of electrolyte for wetting the pad, and means for conducting electrical current to the liner and pad.

6. A device useful in forming anodic films on parts comprising a tubular dielectric member adapted to be grasped and manipulated by the operator, a metal liner in the member, a pad of absorbent material secured in the liner and extending from an end of the member so as to be engaged with the parts being treated, the liner being adapted to contain a supply of electrolyte for wetting the pad, a piston operable in the liner to draw electrolyte into the liner and to force electrolyte from the liner into the pad, and means for conducting electrical current to the liner and pad.

7. A device useful in forming anodic films on parts comprising a tubular dielectric member adapted to be grasped and manipulated by the operator, a metal liner in the member, a pad of absorbent material secured in the liner and extending from an end of the member so as to be engaged with the parts being treated, the liner being adapted to contain a supply of electrolyte for wetting the pad, a metal piston operable in the liner to force electrolyte therefrom into the pad, a rod on the piston for operating the same, and means connected with the rod for supplying electrical current to liner and pad.

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