APPARATUS FOR CARRYING OUT ELECTROLYTIC TREATMENTS ON THE ENTIRE SURFACE
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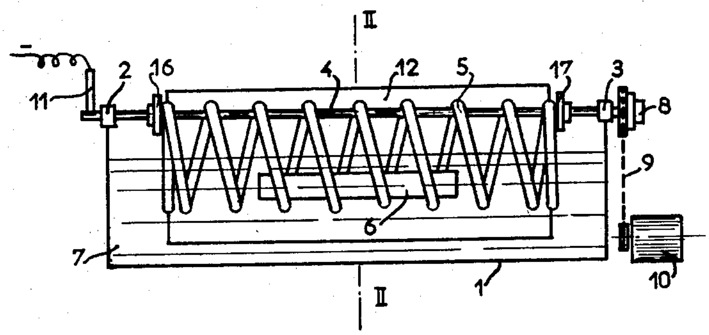

Fig.1

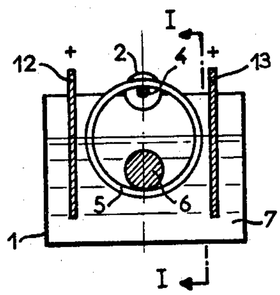

Fig.2

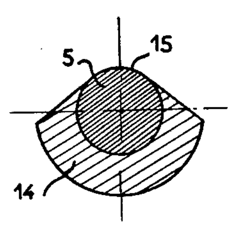

Fig.3

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APPARATUS FOR CARRYING OUT ELECTROLYTIC TREATMENTS ON THE ENTIRE SURFACE

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The present invention relates to a process for carrying out electrolytic treatments on the entire surface of metallic objects or parts, or of non-metallic parts having a surface which is conductive of electricity.

The invention may be advantageously utilized for the nickel plating of uranium bars used in atomic piles.

The invention permits the electrolytic production of continuous coatings over the entire surface of such parts.

This invention also provides a process for carrying out chemical non-electrolytic treatments on metallic and non-metallic surfaces.

Devices for carrying out these processes are also included in the invention and also the parts or objects treated according to these processes and with such devices and the coatings thus obtained.

It is known that electrolytic treatments are usually effected on conductive metallic parts or on parts of which the surface has been rendered conductive if the constituent material of the parts is not conductive.

The parts to be treated (work-pieces) are connected to one of the poles of a source of direct or alternating current and are then immersed in an electrolytic bath so as to constitute one of the electrodes thereof, the other pole of the source of current being connected to one or several electrodes placed in the same electrolytic bath as the work-pieces, but not in contact with them.

By means of direct current, there are thus effected electrolytic degreasing treatments, the work-pieces constituting the cathode of alkaline baths, and electrolytic pickling treatments, the work-pieces then constituting in general the anodes of the baths, which are most often acid. Electrolytic plating is also carried out by placing the work-pieces in appropriate baths as the cathode which baths include among their constituents one or several salts of metal compounds (or salts or compound of the metals themselves in the case of alloys) which it is desired to deposit.

Also with alternating or direct current, anodic oxidation treatments can be effected on the surfaces of metals such as aluminium, the work-pieces placed in the acid baths constituting either of the electrodes when utilising alternating current, or the anode when utilising direct current.

The work-pieces are usually fixed in mountings or attached by means of wires, these mounting or wires supporting them and supplying the electric current required. The treatments effected on the work-pieces by this means only act on the parts immersed in the baths. If the work-pieces are immersed entirely, the treatments do not act on the points of attachment for the pieces. When the work-pieces are to be treated over their entire surface, it is necessary to apply a first electrolytic deposit on a portion of the surface, to stop the treatment and then to attach the pieces at points already treated and to carry out a second deposition in the same bath to cover this time a portion of the first deposit and the piece itself at the point of attachment or on the portion not immersed during the first operation. This procedure leads to results which are often unfavourable because of the preparation of the surface to be treated before the second deposit

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before acting at the same time both on the base metal and on the first deposit; these preparations for two different metals are very often contradictory, so that there is a risk of having poor adherence of the second deposit to the first or to the base metal which is not covered during the first operation. Also the series of treatments, comprising the two deposits, gives irregularities of thickness and various faults originating from the different positions of the work-pieces in the bath for each of the two operations.

This process, which necessitates supplementary manipulations and more numerous fixing means, is thus difficult in every way and often leads to unsatisfactory results.

A process known as "drum treatment" can be employed for the electrolytic covering of the entire surface of metallic work-pieces; it consists of placing these work-pieces in a non-conductive receptacle of generally cylindrical form; this receptacle may be water-tight and in that case contains the electrolytic bath, or it may be pierced with numerous holes and in that case is immersed totally or partly in a tank containing the electrolytic bath; contacts provided in the drum are connected to a source of electric current such that the work-pieces, lying loose in the bottom of the drum, and immersed in the bath, constitute one of the electrodes: the other electrode or electrodes are fixed and immersed in the same bath. The drum is made to rotate so as to maintain the work-pieces under continual displacement. During this operation, they receive a current which is sent to them via the various contacts and is transmitted from one work-piece to any other.

Since the collection of work-pieces is at the bottom of the drum, those which at any one moment are on top receive the desired treatment. Because of the movement of the drum, the work-pieces are turned over and all reach the surface at certain instants and are then treated. The operation lasts for the necessary time for the work-pieces to be given equivalent treatment. This process can only be employed in the case of work-pieces of small dimensions and of shapes which can roll one over another.

Non-electrolytic chemical treatments of work-pieces are generally effected over their whole surface and generally take place in a bath of a reactive liquid; the region of the work-pieces to be treated which is in contact with the fixing or supporting means does not allow treatment to be effected homogeneously over their entire surface.

According to one aspect of the present invention, a process is provided for carrying out electrolytic or chemical treatments on the entire surface of a work-piece which is substantially a solid of revolution in one dimension in which at least one work-piece is disposed inside a coil spring of elongated form on which it rests freely, the sole electrical contact with the work-piece being the spring, and at least the part of the spring containing the work-piece is immersed in a bath for effecting the treatment to be carried out, the work-piece being subjected to a continuous rotation for maintaining it in contact with the spring by rotating the spring about its own axis of revolution.

According to another aspect of the invention, an apparatus is provided for carrying out electrolytic or chemical treatments on the entire surface of a work-piece which is substantially a solid of revolution in one direction which comprises a treatment receptacle for containing a treatment bath, a substantially horizontal spring of cylindrical form which can be at least partially immersed in the bath, and a substantially horizontal, rotatable support passing inside the spring and supporting it freely over all its length.

The process is particularly applicable to the treatment of solid or hollow bars, rods or spindles, the length of which is greater than the diameter. It can be utilised for all electrical or chemical treatments of such work-pieces and particularly for electrolytic plating, anodic oxidation, degreasing, pickling, polishing, brightening, and similar treatments as well as for chemical treatments of the kind mentioned above. It is utilisable for all coverings or treatments currently employed in treating metallic and other work-pieces; in the case of electrolytic treatment, the work-piece to be treated must be conductive; in other cases, it may be conductive or not. The process of the invention can be used particularly to provide a nickel plating free from discontinuity on the uranium bars utilised in nuclear reactors.

The spring used in accordance with the present process should have at least one generatrix permanently in the horizontal position, the other generatrices being necessarily at a level higher than that first mentioned. The spring should be provided with elastic properties in its transverse direction; it can be a spring of customary form, for example approximately helicoidal. Means, comprising for example a motor, are provided for imparting a rotatory movement to the spring which imparts it to the work-piece; this rests freely and constantly in contact during the rotation on the lower part of the spring, that is to say its lower horizontal generatrix; the situation of the work-piece is determined entirely by the action of its own weight.

At least that part of the spring containing the work-piece is immersed in the treatment bath. The means for rotation may suitably comprise a motor and a rod driven by the motor; the rod supports the spring along the entire length of the upper generatrix of the inside surface of the spring. This arrangement requires the part of the spring containing the work-piece to have cylindrical shape; the rod rests at its two extremities on bearings, rollers or other equivalent means allowing it to rotate freely.

If the treatment envisaged is an electrolytic treatment, the spring must be constituted by a conductive wire, for example a metallic wire, and preferably should be covered by an insulating material so that instead of the passage of electric current occurring over the entire surface of the wire, this passage occurs only at the part of the internal surface of the spring in contact with the support rod and the work-piece to be treated; the current to be applied to the work-piece is led to the support rod via the bearings or rollers or by sliding contacts, whence it passes into the spring and from the spring into the work-piece. The assembly constituted as just described is located in a treatment vessel in such a manner that the work-piece is immersed in the bath which also contains the electrodes necessary for completing the electric circuit. The lower part of the spring and the work-piece are immersed so that the upper part of the spring and the support rod are above the bath. Rotation of the assembly permits all the surface of the work-piece to be treated without discontinuity, the points of contact being continually varied without interruption of the current. This device is completed by collars, which can be of plastics material, which are fixed on the rod at the two ends of the spring; they serve to limit its axial displacement. A mechanical system (comprising for example pulleys and belts) or an electrical system (constituted for example by a rheostat or a variable transformer) is also provided to adjust the speed of rotation of the support and to adjust the speeds of rotation of all the parts of the assembly—rod, spring and work-piece.

When the work-piece is substantially cylindrical, it undergoes a regular rotary movement so long as its length is greater than the internal diameter of the spring so that it does not become located across it. The piece should be prevented from leaving the spring at one or other of the ends thereof; this may be attained by various means such as by attaching abutments of a suitable diameter to the support rod, which abutments can be the collars for arresting the spring and which are then made of sufficient diameter, or by placing fixed abutments in the bath at the ends of the spring, which abutments can simply be the ends of the vessel or by utilising a cylindrical helicoidal spring containing the work-piece in its central portion (the greater part of its length) but having coils of smaller diameters than those in the central portion. In this last case, the weight of the work-piece causes the spring, due to its elastic properties, to take up an inwardly curved shape in its lower immersed part which constitutes a kind of pocket in which the work-piece remains and from which it cannot be displaced merely by the rotary movement to which it is subjected.

The present invention can also be utilised if it is desired to carry out a series of chemical and/or electrochemical treatments which must be applied in a certain order one after the other. The work-piece can then be taken out of a spring located in a given bath corresponding to a given treatment and put into another spring in the bath corresponding to the following treatment. Alternatively, a support, spring and work-piece and, if required, rotation means, can together constitute a movable entity. In this case, the pieces can be placed in the spring before beginning the treatments and can be successively transported from one bath to another by transfer of this entity in order to carry out degreasing, pickling, washing, electrolytic plating and so forth.

The length and diameter of the spring, the number of turns and the diameter of the wire employed are determined as a function of the length, diameter and weight of the work-pieces.

In the case of an electrolytic treatment, the spring should advantageously be sufficiently flexible to ensure good electrical contact between all its coils and the work-piece and the support rod which supplies the current; the spring should be able to provide the work-piece with the current of the necessary intensity for the treatment envisaged without its being liable to heating which would make it lose its mechanical properties, destroy the insulation or upset the treatment. In general, the interior diameter of the spring should be sufficient to ensure the immersion of the piece, while remaining below the length of the latter when it is of cylindrical form. The length of the spring should in principle be greater than the length of this piece.

In certain cases, several work-pieces can be treated in the same spring, these pieces being placed one after the other on the lower generatrix of the spring; several pieces can be placed side by side in the direction of their length inside the spring.

In order that the invention may be fully understood, one preferred embodiment is described below by way of non-limitative example of the device according to the invention, in conjunction with the accompanying drawings, in which:

FIG. 1 shows a diagrammatic section, along I—I of FIG. 2, of a device according to the invention;

FIG. 2 shows a diagrammatic section, along II—II of FIG. 1, of the same device;

FIG. 3 shows a transverse section of the spring of the same device.

As shown in FIGS. 1 and 2, a treatment vessel **1** is provided at its upper part with two bearings **2** and **3** in which a nickel steel rod **4** is mounted which serves to support a helicoidal spring **5**. The work-piece **6** to be treated is supported by the spring **5** and is immersed in a treatment bath **7**. The rod **4** is rotated by a motor **10** through the intermediary of a pulley **8** and a belt **9**. The support **4** comprises two collars **16** and **17** maintaining the helicoidal spring **5** in place during its rotation.

This device as just described can be utilised to effect a chemical treatment; additional components are required for carrying out electrolytic treatment, the treatment bath **7** then being an electrolytic bath. These additional components are as follows: a sliding contact **11** supplies the current, through the intermediary of the rod 4 and the spring 5, to the work-piece 6 which constitutes the cathode; two anodes 12 and 13 constituted by two nickel plates are provided and are shown in section in FIG. 2 on either side, for providing return of the current.

In order to ensure good electrical contact between the various parts in rotation, the spring 5 is surrounded as shown in FIG. 3 with an insulating cover 14 which prevents the passage of electric current over any of the surface of the wire constituting the spring 5 except for the part 15 at the interior surface of the spring in contact with the rod 4 and the bar 6 to be treated.

Example

The description which follows of the nickel plating of the entire surface of certain uranium bars utilised in nuclear reactors is given in order to enable the process of the invention to be understood.

The bars of uranium to be treated had a length of 300 mm., a diameter of 25 mm. and a weight of about 3 kg., and were subjected firstly to various surface preparative treatments and appropriate washings and were then placed in a helicoidal and cylindrical spring mounted on a receptacle containing a nickel plating bath. The spring was made of a nickel steel wire of 2 mm. diameter; it had a length of 380 mm., an internal diameter of 100 mm., and comprised 14 spirals spaced on average at 30 mm., the last turn at each of the ends of the spring being circular so that the end of the wire was applied against the penultimate coil to avoid any catching of the spring during operation. The partial insulating cover was of polyvinyl chloride.

The spring was supported by a support rod of nickel steel of about 10 mm. diameter; it rotated at a speed of about 60 turns per minute.

The assembly formed by the support rod and the spring was connected to a source of direct current so as to constitute a cathode; electrical contact with the uranium bar was thus affected. This uranium bar was immersed in the nickel plating bath; the current intensity was regulated as a function of the composition and characteristics of the bath. When the desired thickness of the nickel covering had been obtained, the operation was stopped and the bar was removed from inside the spring and washed. It was then found to be covered over the whole of its surface with a layer of nickel without discontinuity and of good regular thickness, better than that which can be obtained by any other electrolytic process.

What we claim is:

1. Apparatus for electrolytic treatment of the surface of an electrically conductive work piece, the work piece being substantially a solid of revolution about one axis, comprising a container containing an electrolytic bath including salts of metal compounds to be deposited, an electrically conducting substantially helicoidal coil for containing and for supporting the work piece, the part of said coil containing the work piece being immersed in said bath, a horizontal cylindrical member projecting through and supporting said coil, means for imparting rotation to said member about its longitudinal axis, the coefficients of friction between said coil and said member and between said coil and the work piece imparting rotation to said coil and to the work piece, means for limiting the axial displacement of said coil along said member, at least one electrode immersed in the bath and means for applying an electric voltage between said coil and said electrode, the interior surface of said coil being electrically conducting and constituting an electrode, said support being electrically conducting and being connected to said electric voltage supply means and insulation on the exterior surface of said coil.

2. Apparatus as described in claim 1 in which said coil is metal wire and said insulation extends over the exterior surface of said wire.

3. Apparatus as described in claim 1 including abutments at the extremities of said coil for preventing movement of the work piece out of said coil.

4. Apparatus as described in claim 3 including end coils for said coil of smaller diameter than said coil, said end coils constituting said abutments.

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