

## [54] INSTALLATIONS FOR FORMING AN ELECTROLYTIC COATING

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[58] Field of Search ..... 204/26, 198, 222, 260, 204/261, 272, 273, 285, 287, 297 W, 263, 264

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Primary Examiner—John H. Mack

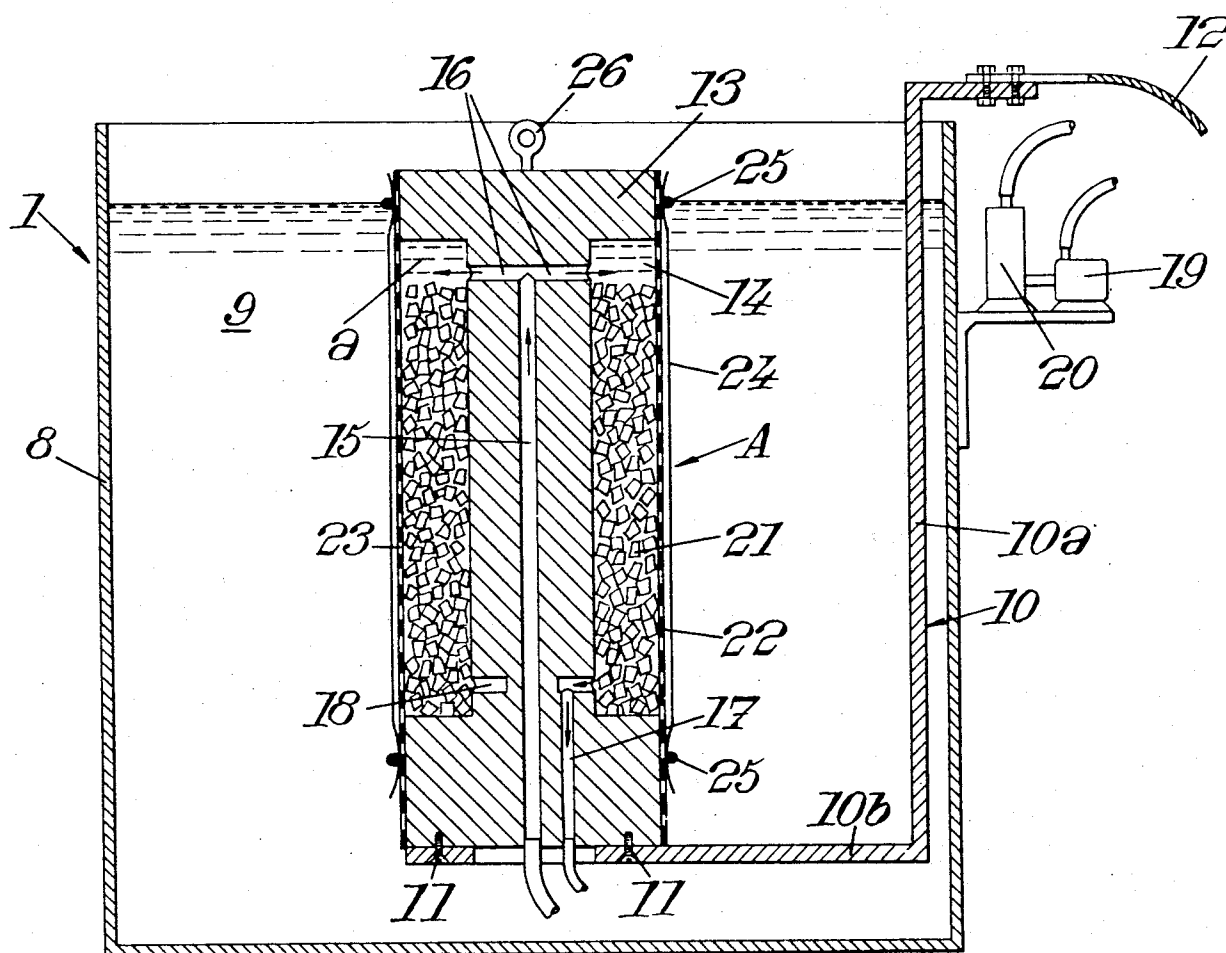
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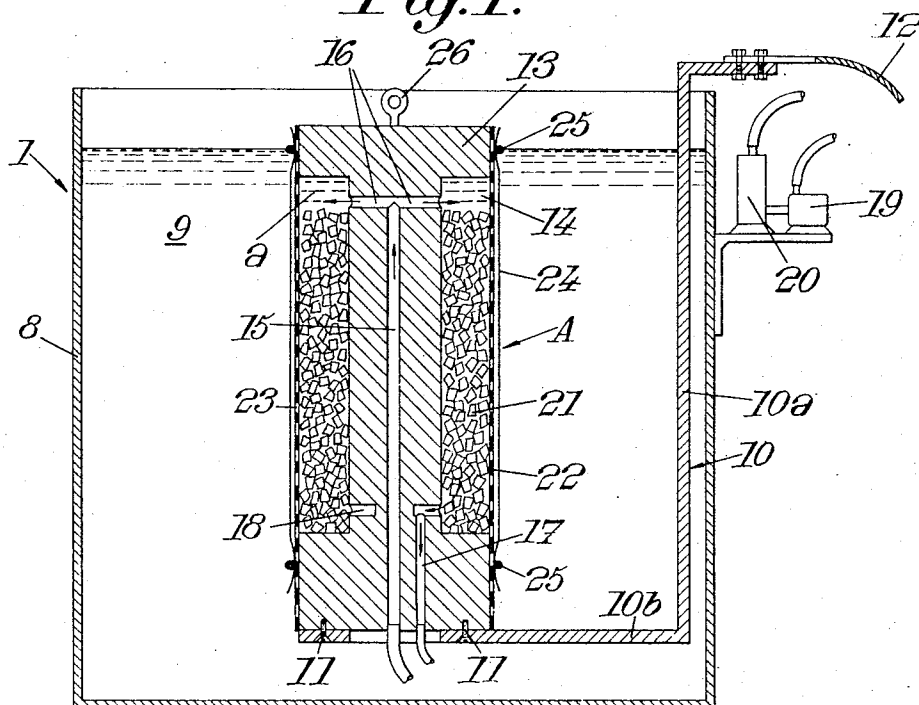
## [57] ABSTRACT

The installation comprises a tank containing a bath of electrolyte, containing particles of silicon carbide, an anode (e.g. of titanium) and a cathode, means for stacking several identical members, enabling the cathode of the installation to be constituted by a stack of members, means for introducing the stack into the bath of the tank and for withdrawing said stack, and an anode comprising a compartment in which are arranged blocks of the metal to be deposited on the members. Means are provided for maintaining the anode in said tank when the cathode is withdrawn and the anode is surrounded by a bag with very fine mesh adapted to retard the entry, into the anode compartment, of said solid particles from the electrolytic bath. The installation further includes means to feed anolyte directly to the anode chamber, independently from the electrolytic bath of the tank. The installation is especially valuable for coating the trochoidal inner walls of rotary piston engine casings.

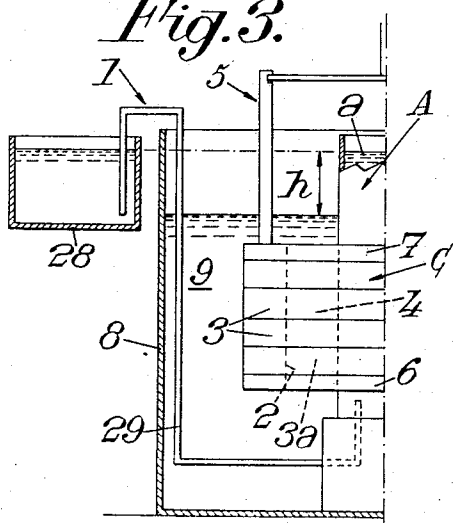
13 Claims, 5 Drawing Figures



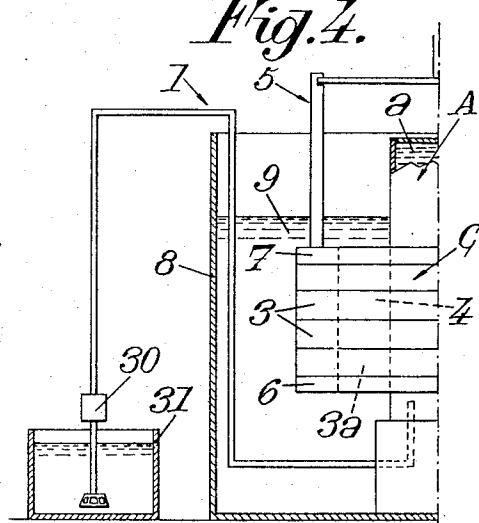
*Fig. 1.*



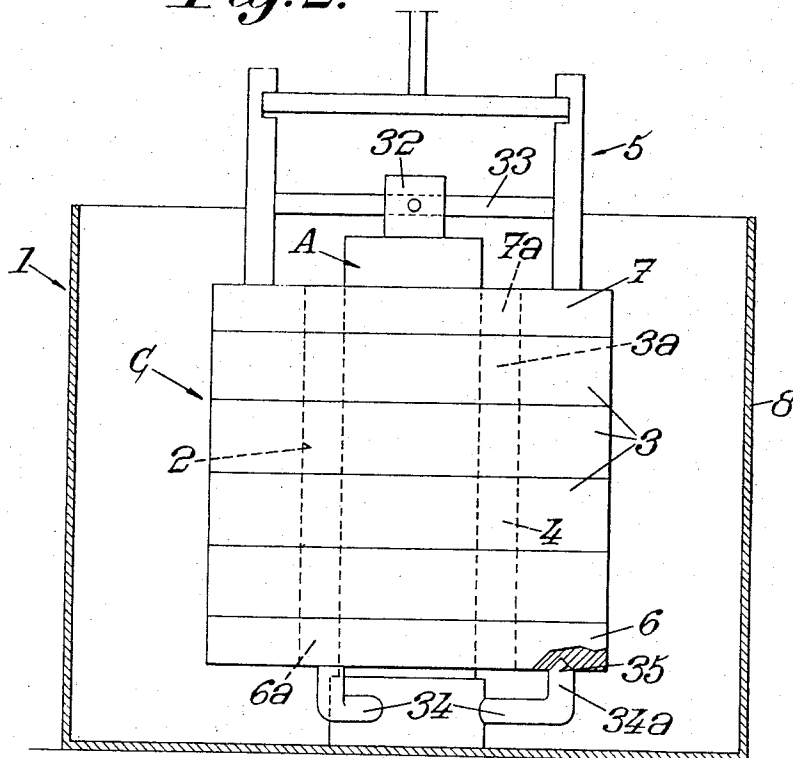
*Fig. 3.*



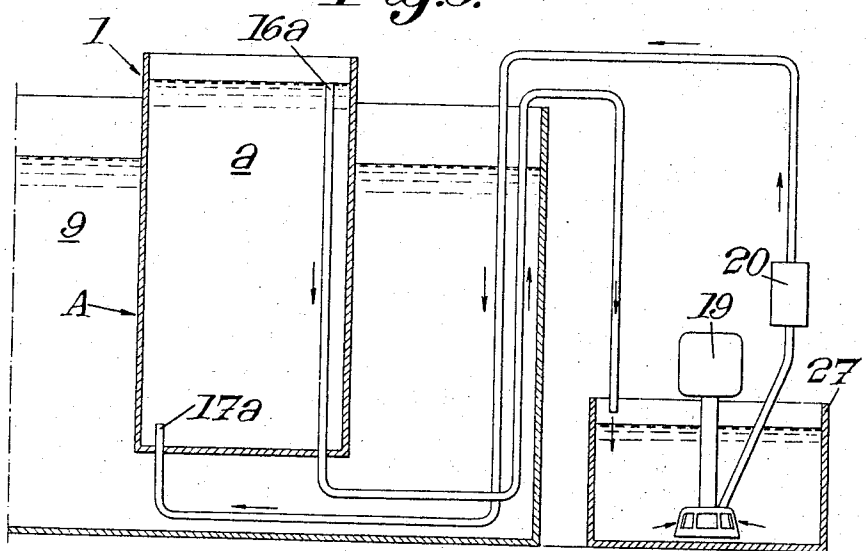
*Fig. 4.*



*Fig. 2.*



*Fig. 5.*



## INSTALLATIONS FOR FORMING AN ELECTROLYTIC COATING

The invention relates to improvements in or to installations for forming an electrolytic coating on the walls of members exposed to frictional forces, comprising:

a tank containing a bath of electrolyte, which bath comprises solid particles of small size, especially particles of silicon carbide,

an anode and a cathode,

means for stacking several identical members, enabling the cathode of the installation to be constituted by a stack of members,

means for introducing the stack into the bath of the tank and to withdraw said stack,

an anode comprising a compartment in which are arranged blocks of the metal to be deposited on the members.

The invention relates more particularly, because it is in this case that its application seems to offer the most advantage, but not exclusively, among these installations, to those for forming an electrolytic coating on the trochoidal inner walls of rotary piston engine casings.

It is a particular object of the invention, to render the abovesaid installations such that they respond better to the various exigencies of practice better than hitherto and particularly such that the yield of these installations is not substantially reduced by the presence of solid particles of small size in the bath of electrolyte.

It is another object of the invention to improve the yield of the installation by enabling reduction in the handling of the anode and by ensuring immersion under current of the members to be coated.

According to the invention, an installation of the previously defined type is characterized by the fact that, on one hand, it comprises means for holding the anode in said tank when the cathode is withdrawn and that, on the other hand, the anode is surrounded by a bag of very fine mesh adapted to retard the entry, into the compartment of the anode, of said solid particles from the electrolytic bath.

Advantageously, the installation comprises means for renewing the anolyte contained in the anodic compartment.

These means for renewing the anolyte may be adapted to establish a circulation of anolyte in the anodic compartment and comprise a pump, a filter, and passages provided in the anode to connect the anodic compartment respectively to aspiration and to delivery from the pump-filter assembly.

In another embodiment, the means for renewing anolyte are adapted to establish a pressure of anolyte in the anodic compartment higher than that of the catholyte.

The invention consists, apart from the features mentioned above, of certain other features which will be more explicitly considered below, with regard to preferred embodiments of the invention which will now be described in more detailed manner, with reference to the accompanying drawings, but which are not to be regarded as in any way limiting.

In the drawings:

FIG. 1 shows diagrammatically, an installation in which the anode is kept immobile with respect to the tank, according to the invention.

FIG. 2 shows, diagrammatically, another embodiment of an installation according to the invention.

FIGS. 3 and 4 show modifications of an embodiment of an installation with an anode fixed in a tank.

FIG. 5 lastly, shows diagrammatically, the filtration circuit of the anolyte.

Referring to the drawings, there can be seen an installation 1 for effecting an electrolytic coating on the trochoidal inner walls 2 (FIG. 2) of casings 3 of rotary piston engines.

The casings 3 are traversed from one side to the other by cavities 3a opening on the lateral surfaces of the casings. The latter are stacked as seen in FIGS. 2, 3, and 4, so that the cavities 3a form an inner housing 4. The stack comprises, for example, four casings, as shown in the drawings, borne by a frame 5 and clamped between a lower base 6 and an upper pressure ring 7. The base 6 and the ring 7 comprise cavities 6a and 7a extending the housing 4 (FIG. 2).

The stacking means for the members 3 comprise therefore the frame 5, the base 6 and the pressure ring 7.

The installation 1 comprises a tank 8 adapted to contain a treatment bath 9 or catholyte.

Means, shown diagrammatically in FIGS. 2 to 4, are provided at the upper portion of the frame 5 to enable the introduction of the stack of casings 3 into the bath 9 and to withdraw said stack after treatment. These means also enable, during treatment, the agitation of the stack of casings 3 for example in a vertical alternate ascending-descending movement.

The installation 1 comprises also an anode A arranged in the tank 8 and adapted to remain there when the cathode is not in said tank, as is the case in FIG. 1.

The anode A is held vertical by fixing means (not shown) resisting any movement of the anode with respect to the tank 8, for example when the cathode C is agitated in the bath 9 during the operation of electrolytic coating.

The electrical connection from the anode A is advantageously ensured by a bent arm 10 preferably of titanium, comprising a substantially vertical portion 10a, neighboring the lateral wall of the tank 8 and a horizontal portion 10b neighboring the bottom of the tank 8 and being extended, radically, towards the central portion of the tank. The anode A is connected mechanically, in dismountable manner, for example by screws 11, to the end of the horizontal portion 10b, the axis of the anode A being substantially coincident with that of the tank 8. A conductor 12 is connected to the arm 10. The cathode C, formed by the stack of casings 3, is lowered into the bath 9 so that the anode A is introduced substantially into the axis of the housing 4 (see FIGS. 2 to 4). The fixing means for the anode A are arranged to enable adjustment of the centering of the anode A with respect to the cathode.

The anode A is constituted by a central body 13 (FIG. 1) of which the cross-section has a contour substantially parallel to that of the cross-section of the inner housing 4 of the cathode C, which has to surround it.

The body 13 comprises a recess or annular compartment 14 extended over the major portion of the length of the body, but not reaching either of the ends of said body.

The central passage 15 is provided in the body 13 and is extended from the lower portion of the latter to the vicinity of the upper end of the recess 14. The passage

15 is connected by two transverse channels 16 to the upper portion of said recess.

The channel 17, parallel to the channel 15, is also provided in the body 13 and is extended from the lower portion of the body to an annular groove 18, into which is opens, situated slightly above the lower end of the recess 14.

The passage 15 is connected, at its lower end, to the delivery from a pump 19, while the passage 17 is connected, through a filter 20, to the aspiration from said pump.

The recess 14 is filled with pieces 21 (having substantially the shape of cubes), of the metal with which it is desired to coat the walls 2. This metal is, for example, nickel.

The body 13 is surrounded, over its whole length, by an expanded sheet 22, preferably of titanium, comprising openings 23 of dimensions less than those of the pieces 21 so that the latter are kept in the recess or anodic compartment 14. The assembly is arranged so that the pieces 21 can be introduced into the recess 14 or extracted from this recess without any dismantling operation.

The sheet 22 is covered over the length of the recess 14 by an anode bag 24 of very fine mesh adapted to control the entry, into the recess 14, of ultrafine particles, such as particles of silicon carbide SiC which the bath 9 contains.

To establish ideas, and by way of example, the said ultra-fine particles are constituted by grains having, for the most part, dimensions equal or less than 1 micron ( $10^{-3}$ mm). The anode bag 24 is clamped in sealed manner against the sheet 22, at its two ends by rings 25. The bag 24 resists an entry of air coming from the pressurized air supply (not shown) serving for the agitation of the bath 9.

A ring 26 is provided at the upper portion of the body 13 to enable manipulation of the anode.

The embodiment of FIG. 1 of an anode A fixed in the tank 8 enables vertical agitation of said anode to be avoided when the cathode C is lowered into and agitated vertically in the bath. This solution also enables the anode to be constituted entirely of titanium, to have a current input fixed through the bottom of the anode and to have fixed passages for the filtration circuit connecting the channels 15, 17 to the filter 20 at the pump 19.

Periodic filtration with a low flow-rate of the anolyte ensures the renewal of the latter and eliminates polarization of the concentration, which polarization has a tendency to be accentuated by reason of the small porosity of the bag 24 which retards diffusion of the electrolyte between the anodic and cathodic compartments. The filtration enables the elimination, progressively with their formation, of anodic muds and particles, such as particles of SiC, with which the electrolyte can be charged, which penetrate into the anode. Such particles, in the absence of filtration, could be deposited on the cubes 21 and adhere firmly thereto thereby forming a screen to the passage of the current.

It will be noted that the continuous renewal of the anolyte during electrolysis is possible but there would possibly result an impoverishment in nickel of the cathodic compartment.

The volume of anolyte being very small, it is convenient to provide, for its renewal, in the filtration circuit, a buffer tank 27 (FIG. 5) of moderate capacity. In FIG.

5, the anode A has only been shown diagrammatically by an envelope containing anolyte *a*. There is provided at the upper portion an overflow orifice 16a and, at the lower portion an inlet channel 17a for the filtered anolyte.

To renew the anolyte, instead of providing a filtration circuit as in FIGS. 1 and 5, there can, as in FIGS. 3 and 4, be provided anolyte under pressure in the anode A with respect to the catholyte contained in the tank 9.

It must be noted that the anodes shown diagrammatically in FIGS. 2 and 5 have a structure similar to that of the anode of FIG. 1 and comprise for example a recess or anodic compartment 14 filled with metallic blocks or pieces 21 and surrounded by a fine mesh bag 24.

According to another embodiment shown in FIG. 3, the anode A is open at its upper portion and communicates with the atmosphere. The level of the anolyte in the anode is at a height *h* above the level of the catholyte. The anode A is supplied with anolyte from a constant level tank 28, through a siphon 29 opening at the lower portion of the anode A.

In the embodiment of FIG. 4, the anode A is closed and the anolyte is kept under a predetermined pressure in the anode by means of a pump 30 supplying the anode with anolyte from a tank 31. The supply of the anode is effected through its lower portion.

In the case of FIGS. 3 and 4, the higher pressure which exists in the anodic compartment facilitates the migration of the anolyte towards the catholyte and hence a slow renewal of the bath in the anodic compartment. By reason of this migration, the passage of particles, such as particles of SiC, contained by the catholyte, towards the inside of the anode, is retarded.

Referring to FIG. 2, there can be seen an installation 1 in which the anode A, which is adapted to remain in the tank 8, comprises at its upper portion, automatic locking means 32 adapted to cooperate with a cross-piece 33 of the frame 5 of the cathode C.

The anode A is provided, at its lower portion, with three radial feet 34 distributed regularly and bent upwardly at a right angle, at their ends 34a.

These feet 34 are adapted to cooperate with housings 35 provided in the base 6, in order to ensure angular positioning and relative centering of the anode A and of the cathode C.

In the embodiment of FIG. 2, the anode A is positioned on the bottom of the tank 8. On the lowering of the cathodic assembly into the tank, into the low position of the assembly, there is produced, on one hand, an anode-cathode centering due to the feet 34 and to the housing 35 and on the other hand, a locking of the anode A, on the cross-piece 33, due to the locking means 32. The cross-piece 33 is insulated electrically from the casings 3 forming the cathode proper.

The anode-cathode assembly thus locked is lifted by some tens of centimeters, about 30 centimeters, then driven with an alternating vertical agitating motion during the operation of electrolytic deposition.

At the end of the operation, the anode-cathode assembly comes back into its low position, the anode is unlocked and remains in the tank 8, while the cathodic assembly is withdrawn vertically from the tank.

The locking means 32 can if necessary serve for establishing the anodic contact for the passage of a current, enabling a progressive current density. In this case, there is provided a flexible auxiliary input (not

shown), of small cross-section, supplying electrical current, at low intensity, to the anode at its lower portion. Thus, immersion of the casings 3 into the bath 9 can be effected under current flow.

The installation according to the invention enables reduction in the handling and movements of the relatively heavy anode, which remains in the tank, and the realization of immersion under current flow of the members to be coated.

The operation of this installation is improved by the fact that the fine mesh bag 24 retards the entry of fine solid particles into the anodic compartment. The deposits of these solid particles on the blocks of metal 21 are reduced.

I claim:

1. Installation for forming an electrolytic coating on the walls of members exposed to frictional forces, especially on the trochoidal inner walls of rotary piston engine casings, said installation comprising:

a tank arranged to contain a bath of electrolyte including solid particles of small size,  
an anode and a cathode,

means for stacking several identical members, enabling the cathode of the installation to be constituted by a stack of members,

means for introducing the stack into the bath of the tank and for withdrawing said stack,

the anode comprising a compartment in which are arranged blocks of a metal to be deposited on the members,

means for maintaining the anode in said tank when the cathode is withdrawn and, surrounding the anode, a bag of very fine mesh adapted to retard the entry, into the anode compartment, of said solid particles from the electrolytic bath, and means for feeding anolyte directly to the anodic compartment, and independently from the electrolytic bath of the tank.

2. Installation according to claim 1, wherein the means for feeding the anolyte are adapted to establish a circulation of anolyte in the anodic compartment and comprise a pump, a filter and passages provided in the anode to connect the anodic compartment respectively to evacuation and to delivery from the pump-filter assembly.

3. Installation according to claim 1, wherein the means for feeding the anolyte are adapted to establish a pressure of anolyte in the anodic compartment greater than that of the catholyte.

4. Installation according to claim 3, wherein the anodic compartment in which the anolyte is located is closed and adapted to be kept under pressure by a feed

pump.

5. Installation according to claim 3, in which the anodic compartment wherein the anolyte is located is open, and comprising means for the supply of the said compartment with anolyte adapted to keep the level of the latter above the level of the electrolyte of the tank.

6. Installation according to claim 1, comprising means for fixing the anode adapted to keep the latter immobile with respect to the tank, especially when the cathode is immersed in the bath and agitated.

7. Installation according to claim 1, wherein the anode comprises automatic locking means adapted to cooperate with a frame supporting the cathode and arranged so as to establish a mechanical connection between said frame and the anode in the course of the operation of electrolytic coating during which the anode and cathode are agitated, said locking means being adapted to be opened when at the end of the coating operation, the assembly of the anode, of the frame and of the cathode being positioned on the bottom of the tank so that only the cathode and its frame are withdrawn from the tank.

8. Installation according to claim 7, wherein the anode comprises at its lower portion radial arms whose ends are adapted to cooperate with housings provided in the lower portion of the frame of the cathode to ensure angular positioning and relative centering of the anode and of the cathode.

9. Installation according to claim 7, comprising a flexible auxiliary current input of small cross-section, at the lower portion of the anode, so that immersion of the cathode can be effected under current flow, and automatic locking means being adapted to establish an anode contact for the passage of a current enabling a progressive current density.

10. Installation according to claim 1, wherein said tank is adapted to contain electrolyte including particles of silicon carbide.

11. Anode for the installation according to claim 1, comprising a central body, provided with a recess in which are adapted to be arranged the blocks of the metal to be deposited on the members, the recess being surrounded by an expanded sheet, said sheet being covered by the bag of fine mesh adapted to retard the entry of fine particles into said recess.

12. Anode according to claim 11, wherein at least one of said central body and said expanded sheet is of titanium.

13. Anode according to claim 11, wherein both said central body and said expanded sheet are of titanium.

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