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(54) OXIDATION DEVICE FOR PLANAR METAL SURFACES, SUCH AS SHEET, FABRIC OR WIRE MESH OF METAL AND TREATMENT APPLICATION METHOD

(57) An oxidation apparatus (1) of planar metal surfaces (2), comprises: a tank (5) within which the planar metal surface (2) being treated is laid; an electrical power supply circuit with the two heads (8, 14) of the electrical power supply of the circuit placed in contact with electrodes with high electrical conductivity; a first planar electrode (6, 7) is placed below the metal surface being treated on a bottom (4) of the aforementioned tank; an electrolyte is placed in the tank to close the electrolytic oxidation circuit; a second electrode is placed sliding and spaced on the planar metal surface (2) under treatment in an immersed position at the level (11) of the electrolyte in the tank (5); and it has the second electrode constituted by a conductive roller (13) placed so as to roll on the planar metal surface (2) being treated, avoiding contact between the cylindrical surface (17) of the roller electrode and the planar metal surface (2) being treated by means of the interposition of a permeable spacer element (18, 30, 37); the permeable spacer element is made of material resistant to the electrolytic action of oxidation and at least placed on one of the two surfaces, the cylindrical one of the roller electrode (13, 17) or the planar metallic one (2) being treated, neither of which must come into contact.

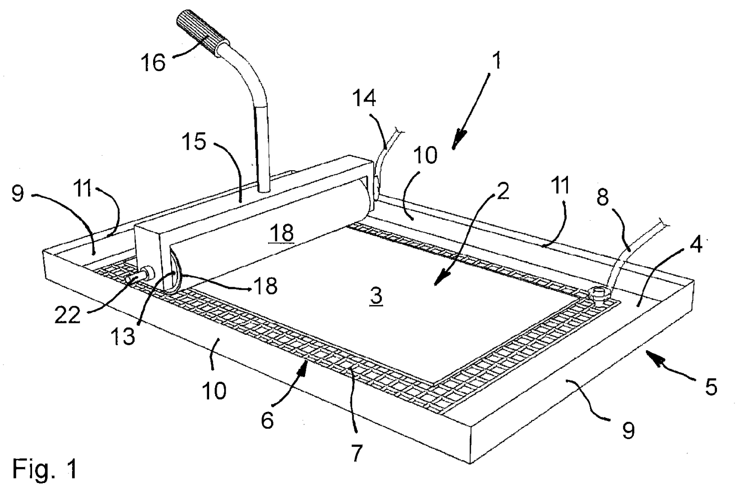

Fig. 1

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Description

Field of application

[0001] The present invention relates to an apparatus for the oxidation of planar metal surfaces, i.e. an apparatus for applying the desired oxidation onto metal surfaces in order to obtain a desired uniform colouring or decoration in limited areas of the surface being treated, so as to obtain graphic shapes and drawings or even lettering on the surface concerned. The method for applying the treatment of the planar, sheet metal, cloth or wire mesh surface is also described.

Background art

[0002] The state of the art comprises generally continuous metal surface oxidation apparatuses wherein the apparatus applies the chemical action, possibly enhanced and accelerated by electrolytic action, of a product acting on the metal of the surface to force the formation of an oxide on the surface itself.

[0003] The metals involved in the aforementioned treatment are those that, in oxidation, generate a stable oxide at the end of the treatment and do not further damage the metal itself over time, hence iron and carbon steel, which are subject to the formation of the unstable oxide constituting the ferrous or ferric oxide, are conveniently excluded, although nothing prevents the treatment of these metals with oxidation, though they can still subsequently rust.

[0004] On the other hand, surface anodising methods are known which apply electrochemical actions to act on the metal constituting the surface and create an oxide layer, albeit of minimal thickness which, although capable of being formed naturally, is obtained in a controlled and very rapid manner by treatment. The application of this treatment takes place mainly using electrodes covered with a layer of insulating fabric, or a buffer impregnated with an electrolytic solution which, if it manages to create an electrolytic cell located between the electrode and the surface being treated, generates noteworthy wear of the electrode as well as the soiling and wear of the insulating fabric, as described in the earlier document US 2015/014173 A1.

[0005] With the setting of the electrolytic etching by means of a soaked buffer, devices are known that carry out general oxidations on the complete surface being treated, or even merely on defined parts thereof, by masking the surface in various ways, i.e. with a printing screen, or application of layers that protect from the action of electrolytic etching, said layers being fixed on the surface being treated and removed at the end of said treatment, leaving a drawing, figures, lettering or even only graphic halos, which decorate the treated surface in the desired way. With buffer oxidation, in addition to the wear and soiling of the insulating fabric, the oxidation action occurs on the metal surface treated unevenly. If the lack of uniformity with the drawings, figures or lettering is not evident, with continuous surface oxidation over the entire metal surface being treated, with the use of the electrolytic buffer oxidation cell it is, conversely, irregular, i.e. its surface is coloured by dark and/or light spots due to the effect of the irregular oxidation of the electrode with the buffer soaked and dragged by its sliding action or by that of the surface being treated with respect to it.

[0006] Known in the art from prior document JP 2003211324 A is a method of surface action engraving on a metal surface in which an electrode conformed to the shape to be engraved on the workpiece is facing, though not in contact with the surface being worked upon. The electrode has a layer of high electrical conductivity in the electrolytic action parts and an insulating mask applied to define the contours of the electrolytic action surface that is to be reproduced on the surface being treated. The electrolytic solution, here a sodium hydroxide solution obtained by dissolving sodium nitrate in water, is forcibly circulated in the space between the electrode and the surface being treated, without any part of the electrode being in contact, but placed at a short distance of less than 1 millimetre from the surface being treated. The treatment takes place in a closed cell into/from which the electrolyte enters and exits and where the advantage for the electrode is that there is little or no wear of the electrode that is covered by the high electrical conductivity layer; hence the limitation of the surface extension of the treatment is given by the limitation of the cell, meaning that this method is not suitable for carrying out oxidations on large surfaces.

[0007] In addition, a method for decorating metal surfaces is also known by arranging a thin spacer screen between an electrode and the metal surface to be decorated in which figures, shapes or lettering are provided and highlighted for electrode attachment mediated by the electrolyte solution. The electrode is equipped with a buffer soaked in an electrolytic solution and is moved in a variable motion over the surface to be treated. A similar embodiment is described in US 2014/03600881 A1.

[0008] However, the procedures described above are unusable for the decoration of large metal surfaces, where it is necessary to oxidise the metal surface in order to give a particular shade to the oxide produced on it, while also managing to limit or reduce to a minimum the wear of the electrode that activates the electrolytic action, since it is necessary to work on large surfaces at the same time and in a short time.

[0009] It is known in the art that the decoration of metal surfaces takes place as mentioned with the electrolytic action mediated by an insulating fabric impregnated with electrolytic solution, which makes the action on discontinuous surfaces very complicated. Indeed, although the electrode and buffer oxidation treatment of discontinuous surfaces, such as wire mesh or wire cloth, is known, the effect of uniformity of oxide colouration on the discontinuous surface is uneven, identical to what occurs for a metal foil or continuous plate surface already described.

[0010] Finally, the presence of surface discontinuities prevents the long life of the buffer in oxidation by the means known in the art that operates by friction, such as the use of the buffer in insulating fabric or electrode in contact with the insulating fabric, or even if carried out with a bath in an electrolytic tank. The treatment is carried out on the entire surface of the grid or metallic cloth, with a limitation on the operation times, the treated surface being much greater than that in the external view of the cloth or grid/metallic mesh which, conversely, is to be decorated and/or coloured with a special uniform oxide on the visible parts from only one side of the grid/mesh or metallic cloth surface.

[0011] This state of the art is subject to considerable improvements with regard to the possibility of making an oxidation apparatus for metal surfaces, which overcomes the aforementioned drawbacks and limitations found in the prior art and which achieves a cheaper and faster way of generating the specific oxidation for the metal being treated, achieving a saving in the costs of application and implementation of what is currently known and allowing high rates of treatment even of discontinuous planar surfaces such as metal meshes or cloths.

[0012] The technical problem, therefore, underlying the present invention is that of making an apparatus that allows application of the electrolytic oxidation of large planar metal surfaces by carrying out the treatment quickly and limiting the wear or damage of the active surfaces of the electrode that applies the treatment to the metal surface, also limiting or reducing to zero the wear of the device interposed between the electrode and the surface being treated.

[0013] An aim inherent in the above technical problem is to produce an apparatus that applies the aforementioned electrolytic action which in turn allows the rapid treatment of large metal surfaces such as metal sheets, cloths or wire meshes in the application of the treatment.

[0014] A corollary to the technical problem described above is the possibility of making the apparatus for applying the electrolytic oxidation treatment with zero electrode wear and that is indifferent to the size of the treated surface.

[0015] Finally, a further part of the above-mentioned technical problem concerns the realisation of rapid electrolytic oxidation treatment of the planar surfaces, in a single operation, both for the complete colouring of the material treated and for achieving a specific decoration.

Summary of the invention

[0016] This technical problem is solved, according to the present invention, by an apparatus for oxidising planar metal surfaces, comprising a tank within which the planar metal surface being treated is laid; a circuit electric power supply; the two electric power supply heads of the circuit are in contact with electrodes, with high electrical conductivity; a first planar electrode is placed below the metal surface being treated on the bottom of the aforementioned tank; an electrolyte is placed in the tank to close the electrolytic oxidation circuit; a second electrode is placed sliding and spaced on the planar metal surface being treated in an immersed position at the level of the electrolyte in the tank; characterised in that it has the second electrode consisting of a conductive roller placed so as to roll on the planar metal surface being treated, avoiding contact between the cylindrical surface of the roller electrode towards the planar metal surface being treated by the interposition of a permeable spacer element; the spacer is made of a material resistant to the electrolytic action of oxidation and is placed on at least one of the two surfaces, either the cylindrical surface of the roller electrode or the planar metal surface being treated, neither of which must not come into contact.

[0017] In addition, a specific form of the spacer element is applied to the cylindrical surface of the roller of the roller electrode and consists of absorbent and insulating material to form a coating sheath covering the cylindrical surface.

[0018] A further improved form of the spacer element is created by a passage printing screen placed, before treatment, on the planar metal surface to be treated, in contact with it, and creating a distance with the thickness of the screen itself between the cylindrical surface of the roller electrode and the planar metal surface being treated.

[0019] In addition, a specific form of application on the planar metal surface under treatment are masks, resistant to electrolytic action, to make decorations, images or lettering on the planar metal surface with the oxidation treatment.

[0020] In one embodiment variant, the passage printing screen features electrolytically resistant masks for creating decorations, images or lettering on the planar metal surface with the oxidation treatment.

[0021] Furthermore, in a preferred embodiment, the passage printing screen with masking, in order to create decorations, images or lettering on its planar metal surface with oxidation treatment, is laid against the planar metal surface under treatment with the masking facing above and in contact with said planar metal surface, while the electrolytic oxidation action of the roller electrode with its cylindrical surface is applied on the upper side of the passage printing screen.

[0022] In a preferred embodiment, the first planar electrode is constituted by a graphite planar plate or graphite mesh placed on the bottom of the tank on which the planar metal surface being treated is laid.

[0023] Furthermore, in a preferred and advantageous embodiment, the roller electrode is made from a cylindrical graphite tube in which an axial metal pin is connected at the ends with the second head of the electrical circuit: the rotational support between the central pin and the graphite tube roller is achieved by a conical turning pair, made of metallic material, close to each end of the roller.

[0024] Finally, a method of applying the electrolytic oxidation action on planar metal surfaces, made by an apparatus defined according to the aforementioned embodiments, is as follows:

- the planar metal surface to be treated is placed in a tank in an electrolyte bath with a level sufficient to cover the planar surface being treated and part of the aforementioned roller electrode;
- the two power supply heads of the circuit are placed one end in contact with the first planar electrode and the second end with the second electrically conductive roller electrode;
- the electrolytic surface oxidation action is applied with unidirectional or bidirectional back-and-forth rotation, rolling the roller electrode on the planar metal surface being treated with a permeable spacer element in between;
- the electrolytic action is activated with either a direct or alternating electric current, generated by the electric power supply circuit;
- the electrolytic action is obtained by rolling the roller electrode on the metal surface being treated, so as to achieve a rapid and uniform distribution of the desired oxidation on the metal surface being treated.

[0025] Further features and advantages of the present invention, in the realisation of an oxidation apparatus of planar metal surfaces, will result from the description, given below, of examples of realisation of the constructive form and some variants, as illustrated above, given by way of example only, with reference to the six attached drawings.

Brief description of the drawings

[0026]

Figure 1 shows a perspective schematic view of the surface electrolytic oxidation apparatus of a planar metal plate arranged in a tank to contain the electrolytic solution and a mesh electrode in contact with the face of the metal plate that must not be decorated and another roller electrode that is rolled over the surface of the plate to carry out the oxidation treatment sought;

- Figure 2 shows a schematic perspective view from another angle of the apparatus of Figure 1, wherein graphic shapes are shown on the surface of the plate to prevent the decoration of the surface under treatment from leaving an impression on the plate at the end of the graphic decoration treatment;
- Figure 3 represents a front perspective schematic view, similar to Figure 2, in which a wall of the tank has been removed to show in view, on a vertical plane, the position of the plate being treated which, in this case, is resting on a lower electrode of the metal plate;
- Figure 4 represents a schematic perspective side view of the apparatus of Figure 1 which a side wall of the tank has been removed to show the position of the roller electrode and the lower mesh electrode;
- Figure 5 represents a schematic sectional view V-V of Figure 4 to show the internal constitution of the roller electrode, which is rolled on the planar surface to be coloured/decorated with electrolytic oxidation;
- Figure 6 shows a schematic perspective view of the electrolytic oxidation apparatus wherein a thin passage printing screen is placed between the roller electrode and the metal surface being treated;
- Figure 7 represents a schematic perspective view of the apparatus of Figure 6 above in which the screen is provided with graphic forms of decoration that prevent the treatment of the underlying metal surface, leaving the desired graphic imprint on the metal surface at the end of the treatment;
- Figure 8 represents a perspective schematic view on the short side of the electrolytic solution containment tank, the front wall having been removed to show the metallic cloth being treated resting on a planar electrode formed by a plate and the roller electrode rolling on the treated surface of the metallic cloth;
- Figure 9 depicts a perspective schematic view from another angle of a planar metal mesh surface which, in addition to being laid on a lower electrode also made of wire mesh, presents graphic decorative forms that prevent the treatment of the underlying mesh metal surface made by the roller electrode rolled on it during the electrolytic oxidation action;
- Figure 10 shows a perspective schematic view of the apparatus of Figure 6 above, analogous to Figure 7, wherein the screen is provided with graphic decorative shapes that prevent treatment of the underlying planar metal surface; these shapes are made on the lower part of the passage printing screen by means of digital ink printing or UV printing, and are placed in contact with said planar metal surface.

Detailed description of some preferred illustrated embodiments

[0027] The Figures show the oxidation apparatus 1 of a metal surface 2 of a planar plate 3, visible in Figure 1; the planar plate being treated is placed on the bottom 4 of a planar tank 5 with a planar electrode 6 interposed, here in the form of a mesh 7; the electrode is connected with a first head 8 of the electrical circuit for activating the electrolytic action. The end 9 and side 10 walls of the planar tank 5 contain an electrolyte with level 11 such as to submerge completely the planar electrode 6, the metal surface 2 being treated and, partly, a roller electrode 12 with a roller 13 which brings the second head 14 of the electrical activation circuit inside the electrolytic solution; the roller is made of metallic or graphite electrical conductive material. The roller electrode 12 is supported in rotation by a frame 15 on which the manual action of the operator acts, with the handle 16; or, more advantageously, the frame 15 is connected to a drive mechanism, not shown, of the frame to bring the roller electrode to roll on the metal surface 2 being treated. A coating 18 with insulating and permeable material, also resistant to electrolytic action, is placed on the cylindrical surface 17 of the roller, visible in Figure 3, with the aim of isolating the cylindrical surface 17 of the roller 13 from the metal surface 2 being treated.

[0028] Figure 2 also shows a mask 19 for making a decoration, lettering or other graphic form on the metal surface 2 being treated that the user wishes to transfer onto the metal surface. Furthermore, in Figures 1, 2 and 4 the planar electrode 6 depicted, in addition to being made of wire mesh 7, can be made of graphite mesh, which is known to be a good electrical conductor and is also resistant to the action of the electrolyte.

[0029] Figure 3 shows the electrolytic oxidation apparatus 1 with a planar electrode 6, consisting of a metal plate 20, placed on the bottom 4 of the tank 5 and in contact with the lower face of the metal surface 2 to allow the electrical contact of the first electrical head 8 of the circuit. In this Figure 3, the metal surface 2 has masking 19 to create, on the metal surface being treated, the graphic shapes that the user intends to transfer onto the metal surface. As well as consisting of a metal plate 20, in this Figure the planar electrode 6 depicted can be made with a graphite plate as a good electrical conductor which is also resistant to the action of the electrolyte.

[0030] Figure 5 shows the axial section of the roller electrode and the rotating support frame with trace V-V. Dimension B, i.e. the active face of the roller electrode 12, is made with a value suitable for the size of the planar tank 5 used, and, in the most convenient size, also reaches 1,550 mm. In this way, the oxidation apparatus performs the processing of planar surfaces with dimensions of 3,000x1,500 millimetres, or even smaller, mainly for samples of 700x400 millimetres using a roller with a size B of 450 mm.

[0031] In the constitution of the roller electrode 12, the roller 13 is rotatably supported on the frame 15 by means of a pin 21 to the ends 22 of which the connection and union cables are connected to the second electrical head 14 of the circuit. The pin 21 crosses the entire roller within a hole 23 with diameter DI and, near the ends 24 of the roller 13, has conical turning pairs 25, each formed by an outer ring 26, keyed to the end housing 24 of the roller 13, and an inner ring 27 keyed and tightened against the taper of the outer ring, on said pin 21, with the thrust of a ring nut 28. To close the end housing 24 of the roller, so as to prevent the electrolyte from re-entering, sealing rings 29 are keyed to said end housing of the roller and in contact with the pin 21 for sealing. Finally, the roller 13 has an outer diameter DE which in operation is maintained below the level 11 of the electrolyte. Figure 5 also shows a coating in insulating and permeable material 18 used for the treatment of metal surfaces with uniform oxidation with or without the use of masking 19. The roller 13 is advantageously made of graphite as a conductive material, while the pin is made of metallic material; finally, the frame 15 is made of insulating material.

[0032] In Figures 6 and 7, the electrolytic oxidation apparatus 1 is made in a modified form with the interposition, between the roller 13 of the roller electrode 12 with the metal surface 2 to be treated, of a passage printing screen 30, which is known to be resistant to the action of the electrolyte while insulating the surface 17 of the roller 13 with respect to said metal surface 2 of the plate 3 depicted. Hence, the oxidation action takes place through the screen, stretched on the metal surface 2 being treated by means of a frame 31 larger than the metal surface itself, also to accommodate the roller 13 of the roller electrode 12 during the treatment. Finally, a mask 32 can be applied to the screen so as to create, on the metal surface being treated, the graphic shapes that the user intends to transfer to the metal surface 2. Furthermore, in the specific design shown in Figure 10, the masking is carried out on the underside of the passage printing screen 37; this means that the lower masking 38 comes into contact with the planar metal surface being treated.

[0033] Finally, Figures 8 and 9 show the oxidation apparatus 1 of metal surfaces wherein the metal surface 2 undergoing treatment is represented by a metal cloth 33 during the treatment with uniform colouration; Figure 9 shows the oxidation apparatus 1 on which a metal surface undergoing treatment is placed, consisting of metal mesh 34 placed on a planar electrode 6 also of metal mesh 35, while masking 36 is done on the metal surface 2 undergoing treatment to highlight the graphic forms, lettering or decorations desired by the user.

[0034] Utilisation of a metal surface oxidation apparatus as described above is as follows.

[0035] The metal surface being treated is placed in an electrolyte containment tank so as to keep the entire metal surface 2 being treated wetted by the electrolyte: the level of the electrolyte 11 in the tank 5 must be higher than the lower cylindrical surface 17 of the roller electrode 12, so as to maintain at all times an electrolyte head on the metal surface 2 being treated. The planar metal surface 2 is in contact with the lower planar electrode 6 and, therefore, is connected with the first head 8 of the electrical circuit for activating the oxidation electrolytic action. The roller 13 of the roller electrode 12 is in electrical contact with the second head 14 of the electrical circuit for activating the aforementioned electrolytic oxidation action. The applied current can be either direct or alternating, depending on the type of metallic surface 2 being treated and the metallic material that, to achieve the required oxidation, requires one or other type of electric current. The interposition of a passage printing screen 30 or of the coating layer in insulating and permeable material 18 allows the surface to avoid direct contact and the formation of high intensity short circuits that would prevent activation of the electrolytic oxidation action.

[0036] The motion of the treatment takes place by rotating the roller electrode 12 on the surface either in an alternating motion or in a one-way motion normal to the axis of rotation of the roller 13. The electrical current applied can be in direct or alternating current with a voltage of between 5 and 25 Volts and a current intensity on the affected surface of the electrode and the underlying metal surface with density commensurate with the size of the surface being treated. In fact, the electrolytic action takes place from the contact line of the cylindrical surface 17 near the metal surface 2 being treated; with a coated roller 18 it can therefore operate from 1.0 to 10.0 A/cm2, whereas with only the rigid surface 17 of the roller 13 it operates at a current density ranging from at least 4.0 to 20.0 A/cm2. The adjustment of the type of current, and its value in voltage and current, is made based on the metal being treated and the desired colouring or density of the final oxidised surface. In addition, in the experiment, processing times of 1 m2 produced in 6 minutes were obtained, with a voltage of 12 Volts, an alternating current of 300 Amperes and using a roller with B = 1550 mm on a plate with a width of 1500 mm. Using a roller of smaller size, for example B = 450 mm, machining times of 1 m2, produced in 3 minutes of work were obtained, with a voltage of 12 Volts and an alternating current of 100 Amperes operating on a plate with a width of 400 mm.

[0037] The material constituting the roller electrode 12 is graphite, which in the most convenient dimension has the roller with an outer diameter DE of 64 mm and an inner diameter of 42 mm, while the electric current passes through the pin 21; only in the turning conical pair 25 does it pass from the pin to the roller which is substantially a graphite tube with the inner and outer diameters in the more advantageous size already mentioned.

[0038] In the use of the graphite roller 13 in the oxidation with a passage printing screen 30, 37, it has been verified that the electrolytic action occurs without appreciable wear on the graphite of the roller, i.e. on the cylindrical surface 17 of the roller, and also, at the same time, does not occur on the surface of the mask of the aforementioned screen. Furthermore, the lower application of the masking 38 on the passage printing screen 37 allows, with said masking, the mask itself to be more resistant, allowing multiple application cycles in succession, even if the same masking 38 is made with a digital printing ink, possibly UV printing.

[0039] The material constituting the pin and the turning pair, such as nickel, titanium and the like, is metallic and corrosion resistant. Furthermore, the turning pair can be made more advantageously of graphite. The planar electrode, whether in a single plate or in a mesh, can be made either of metallic material, advantageously nickel, titanium and similar corrosion-resistant materials, or of graphite in the form of a continuous plate or even of a perforated plate, similar to a mesh, to allow the electrolyte to pass through the holes inside it. The graphite design is preferred as it is cheaper and equally functional.

[0040] The advantages of using the oxidation apparatus of planar metal surfaces, according to the invention, can be summarised as follows.

[0041] In the parts of the apparatus involved, i.e. the roller electrode and, mainly, the metal parts in contact with the metal sheet, metal cloth or metal mesh, which are the most exposed to the action of oxidation, it has been found that the planar electrode, whether it is made of a metal that is obviously different from the metal of the surface being treated, or even of graphite, is not at all subject to wear by the electrolytic action developed. Conversely, the oxidation action was concentrated on the metal surface undergoing treatment so as to achieve high oxidation rates even for large surfaces to be treated. Another very advantageous result over the known art lies in the uniformity of the treatment on the metal surface, be it sheet metal, wire cloth or wire mesh. In fact, the metal surfaces on which the treatment takes place without masking the effect of the uniformity of the current density on the electrode and the constant distance, determined either by the thickness of the coating 18 or by the thickness of the passage printing screen, between the electrode and the metal surface allows, as mentioned, quick achievement of a desired and uniform colouration with the oxidation of the metal surface.

[0042] In addition, a very large advantage, verified in the tests carried out, is the lack of wear of the roller electrode, even if the latter applies currents with high density during the treatment and the working range near the generator of the cylindrical surface of the roller 13 is only a few millimetres, at most 3 if the roller has the active surface 17 directly on it, or 4 mm if the coating 18 of insulating and permeable material is applied to the active surface. In other words, after the tests carried out, none of the electrodes showed signs of wear even after long hours of operation. In addition, the advantage of placing the mask 38 on the passage printing screen 37 in the lower face of the screen itself, in contact with the surface being treated, has been verified: in this arrangement, even a simple digital ink printing, possibly carried out with UV printing, allows the mask to perform its function even for dozens of subsequent treatments. The advantage obtained results from the practicality of the masking (very weak but effective), as it is not applied directly to a plate or surface being worked upon, thus avoiding the known operations of removing the masking applied to the surface being worked upon.

[0043] Moreover, a very useful advantage is obtained in the construction of the tank 5 which contains the electrolyte in non-conductive material, hence no longer subject to electrolytic interactions with the electrolyte itself; in other words, the form of construction of the electrolytic cell does not interact with the planar electrode either in plate or mesh form.

[0044] Finally, the advantage of using a band-coated roller electrode in absorbent and heat-resistant material makes it possible to carry out the treatment even with mechanised handling or robotic means, i.e. already present in devices and therefore not requiring direct human intervention. The simplest form, and of manual application, has allowed the functional and production tests described above, both with the various current densities indicated and with the treatment of the most varied metal surfaces as described. The method of applying the oxidation described with the tank apparatus in forming an electrolytic cell makes it possible to automate fully the execution of the oxidation process.

[0045] Obviously, with regard to an oxidation apparatus of planar metal surfaces described above, in order to satisfy specific and contingent needs a person skilled in the art may make numerous modifications, all however contained within the scope of protection of the present invention, as defined in the following claims. Thus, although the masking described above is more advantageously achieved by digital ink or UV printing, it can, albeit less conveniently, also be achieved by any medium and material that endures to the electrolytic action of oxidation.

Claims

1. An oxidation apparatus (1) of planar metal surfaces, comprising a tank (5) within which the planar metal surface (2) being treated is laid; an electrical power supply circuit with the two heads (8, 14) of the electrical power supply of the circuit placed in contact with electrodes, with high electrical conductivity; a first planar electrode (6, 7) is placed below the metal surface being treated on a bottom (4) of the aforementioned tank; an electrolyte is placed in the tank to close the electrolytic oxidation circuit; a second electrode is placed sliding spaced apart on the planar metal surface (2) being treated in a position immersed at the level (11) of the electrolyte in the tank (5); **characterised in that** it presents the second electrode consisting of a conductive roller (13) placed so as to roll on the planar metal surface (2) being treated, avoiding contact between the cylindrical surface (17) of the roller electrode with the planar metal surface (2) being treated by the interposition of a permeable spacer element (18, 30, 37); the permeable spacer element is made of material resistant to the electrolytic action of oxidation and at least placed on one of the two surfaces, the cylindrical one of the roller electrode (13, 17) or the planar metallic one (2) being treated, neither of which must come into contact.

2. Planar metal surface oxidation apparatus according to claim 1, wherein the spacer element (18) is applied to the cylindrical surface (17) of the roller (13) of the roller electrode (12) and is made of absorbent and insulating material to form a coating sheath of said cylindrical surface.

3. Planar metal surface oxidation apparatus, according to claim 1, wherein the spacer element (30, 37) is made with a passage printing screen positioned before treatment on the planar metal surface (2) to be treated, in contact therewith and to make the spacer with the thickness of the screen itself between said cylindrical surface (17) of the roller electrode (12) and the planar metal surface (2) being treated.

4. Planar metal surface oxidation apparatus, according to claim 2 or 3, wherein masks (19) resistant to electrolytic action are shown on the planar metal surface (2) being treated, to make decorations, images or lettering on the planar metal surface with oxidation treatment.

5. Planar metal surface oxidation apparatus according to claim 3, wherein masks (32, 38) resistant to electrolytic action are shown on the passage printing screen (30, 37) to make decorations, images or lettering on the planar metal surface (2) with oxidation treatment.

6. Planar metal surface oxidation apparatus according to claim 5, wherein the passage printing screen (37) with masks (38), for making decorations, images or lettering on said planar metal surface (2) with the oxidation treatment, is laid against the planar metal surface (2) being treated with the mask (38) facing up and in contact with said planar metal surface, while the electrolytic oxidation action of the roller electrode (12) with its cylindrical surface (17), is applied from the upper side of the passage printing screen.

7. Planar metal surface oxidation apparatus according to one of the preceding claims 1-6, wherein the first planar electrode (6) consists of a graphite planar plate or graphite mesh (7) placed on the bottom (4) of the tank and on which the planar metal surface (2) being treated is placed.

8. Planar metal surface oxidation apparatus according to one of the preceding claims, wherein the roller electrode (12) is made of a cylindrical graphite tube wherein an axial metal pin (21) is connected to the ends (22) with a head (14) of the electrical circuit: the rotating support between the central pin (21) and the graphite tubular roller (13) is made of a conical turning pair (25), in metallic material, close to each end of the roller.

9. A method of applying the electrolytic oxidation action on planar metal surfaces (2), carried out by an apparatus (1) defined according to one of claims 1, 2 or 4, wherein:

   - the planar metal surface (2) to be treated is placed in a tank (5) in an electrolyte bath with a level (11) sufficient to cover the planar surface being treated and part of the aforementioned roller electrode (12);

- the two power supply heads (8, 14) of the circuit are positioned, a first head in contact with the first planar electrode (6, 7) and the second head (14) with the second electrically conductive roller electrode (12);
- the electrolytic surface oxidation action is applied with unidirectional or bidirectional back and forth rotation, rolling the roller electrode (12) on the planar metal surface (2) being treated with a permeable spacer element (18) interposed, consisting of a sheath applied to the cylindrical surface (17) of the electrode roller;
- the electrolytic action is activated with either a direct or alternating electric current, generated by the electric power supply circuit, with a voltage of between 5 and 25 Volts and current between a minimum of 1.0 A/cm2 and a maximum of 20.0 A/cm2, calculated on the surface facing the electrode treatment (12);
- the electrolytic action is achieved by rolling the roller electrode (12) on the metal surface (2) being treated, so as to achieve a rapid uniform distribution of the desired oxidation on the metal surface (2) being treated.

10. A method of applying the electrolytic oxidation action on planar metal surfaces (2), carried out by an apparatus (1) defined according to one of claims 1, 3, 5 or 6, wherein:

- the planar metal surface (2) to be treated is placed in a tank (5) in an electrolyte bath having a level (11) sufficient to cover the planar surface being treated and part of the above-mentioned roller electrode (12);
- the two power supply heads (8, 14) of the circuit are positioned, a first head (8) in contact with the first planar electrode (6, 7) and the second head (14) with the second electrically conductive roller electrode (12);
- the electrolytic surface oxidation action is applied with unidirectional or bidirectional back and forth rotation rolling the roller electrode (12) on the planar metal surface (2) being treated with a permeable spacer element (30, 37) interposed which consists of a printing screen (30, 37) placed on the planar metal surface (2) being treated and in contact with the cylindrical surface (17) of the electrode roller;
- the electrolytic action is activated with either a direct or alternating electric current, generated by the electric power supply circuit, with a voltage of between 5 and 25 Volts and current between a minimum of 1.0 A/cm2 and a maximum of 20.0 A/cm2, calculated on the surface facing the electrode treatment (12);
- the electrolytic action is achieved by rolling the roller electrode (12) on the metal surface (2) being treated, so as to achieve a rapid uniform distribution of the desired oxidation on the metal surface (2) being treated.

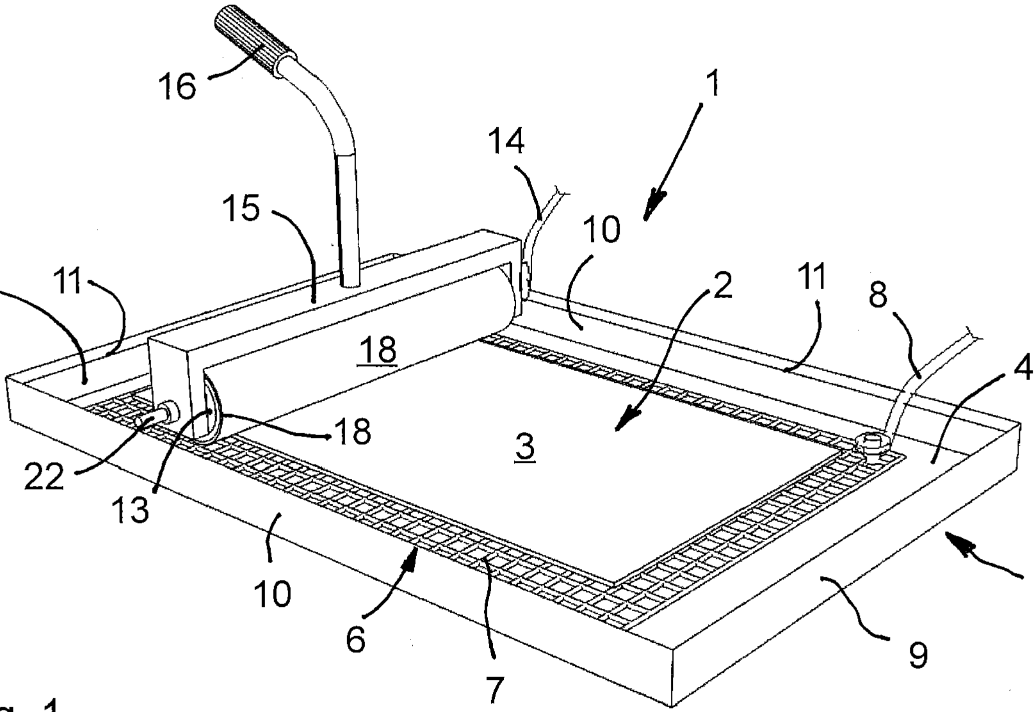
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Fig. 1

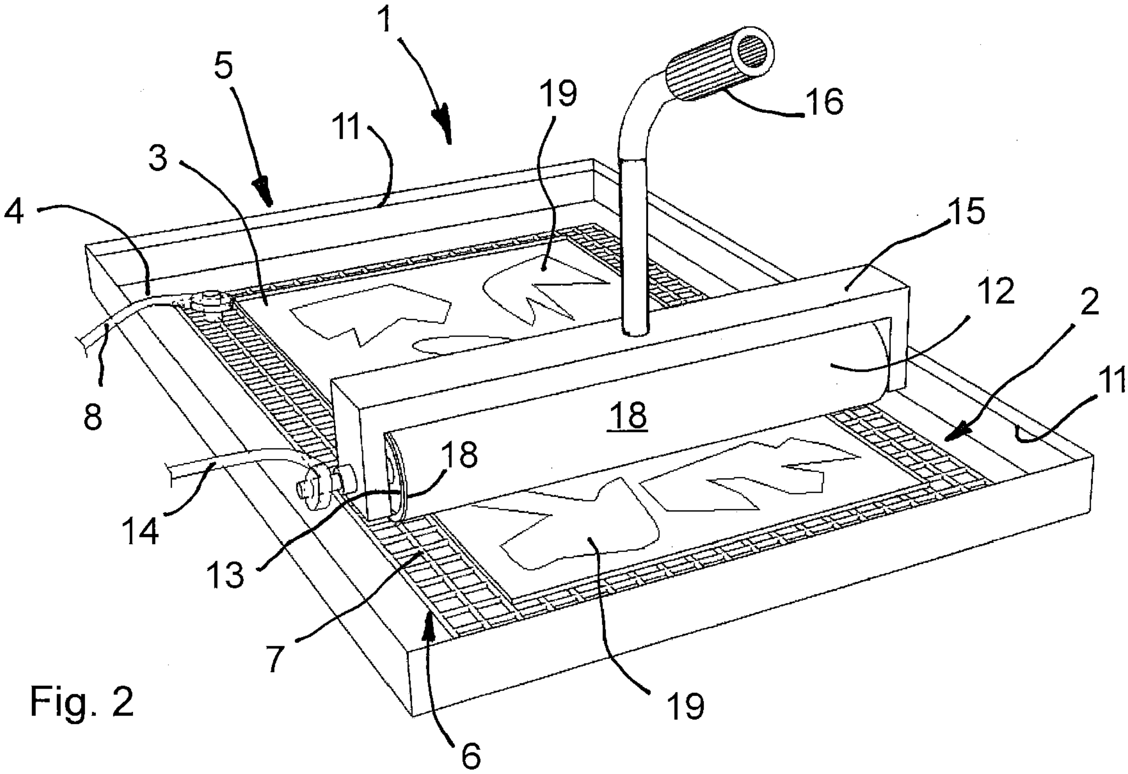
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Fig. 2

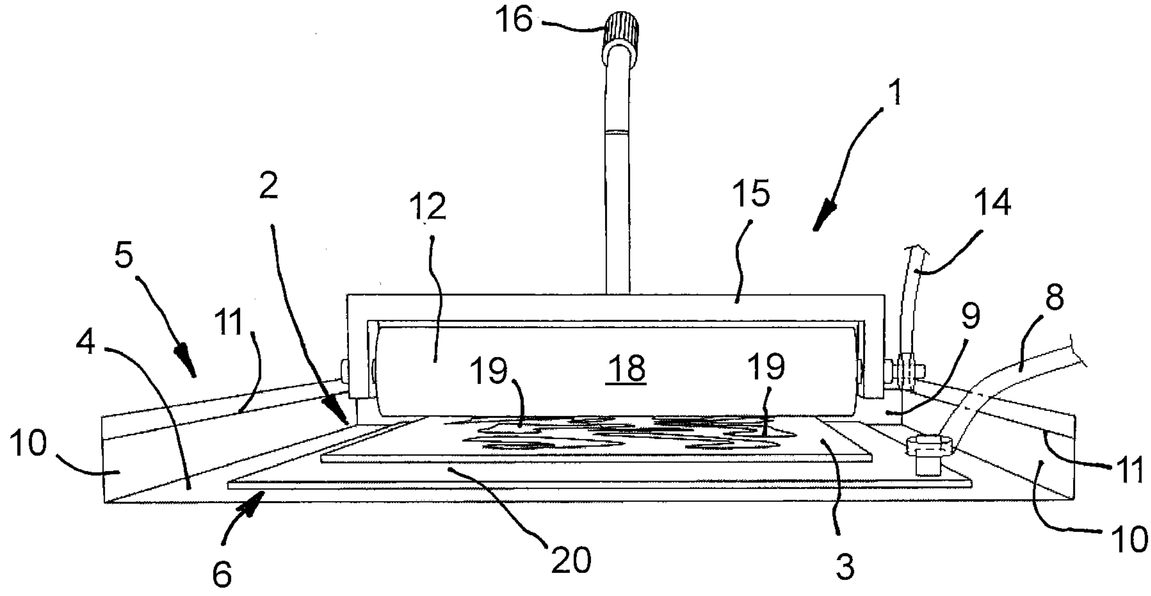
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Fig. 3

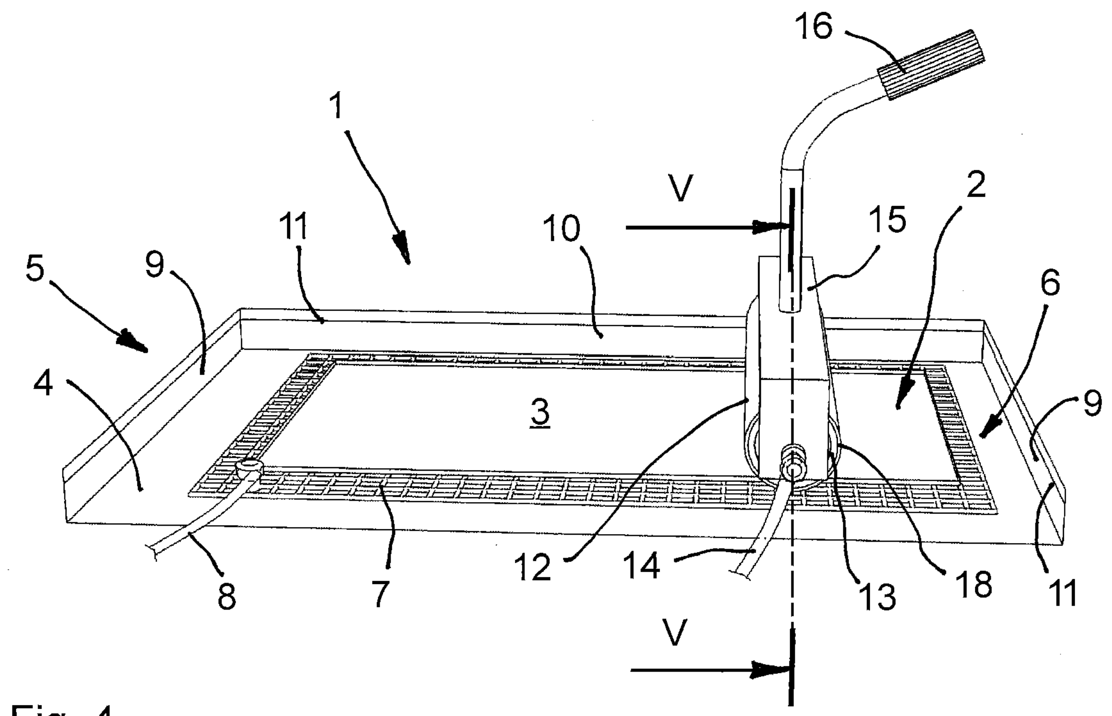
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Fig. 4

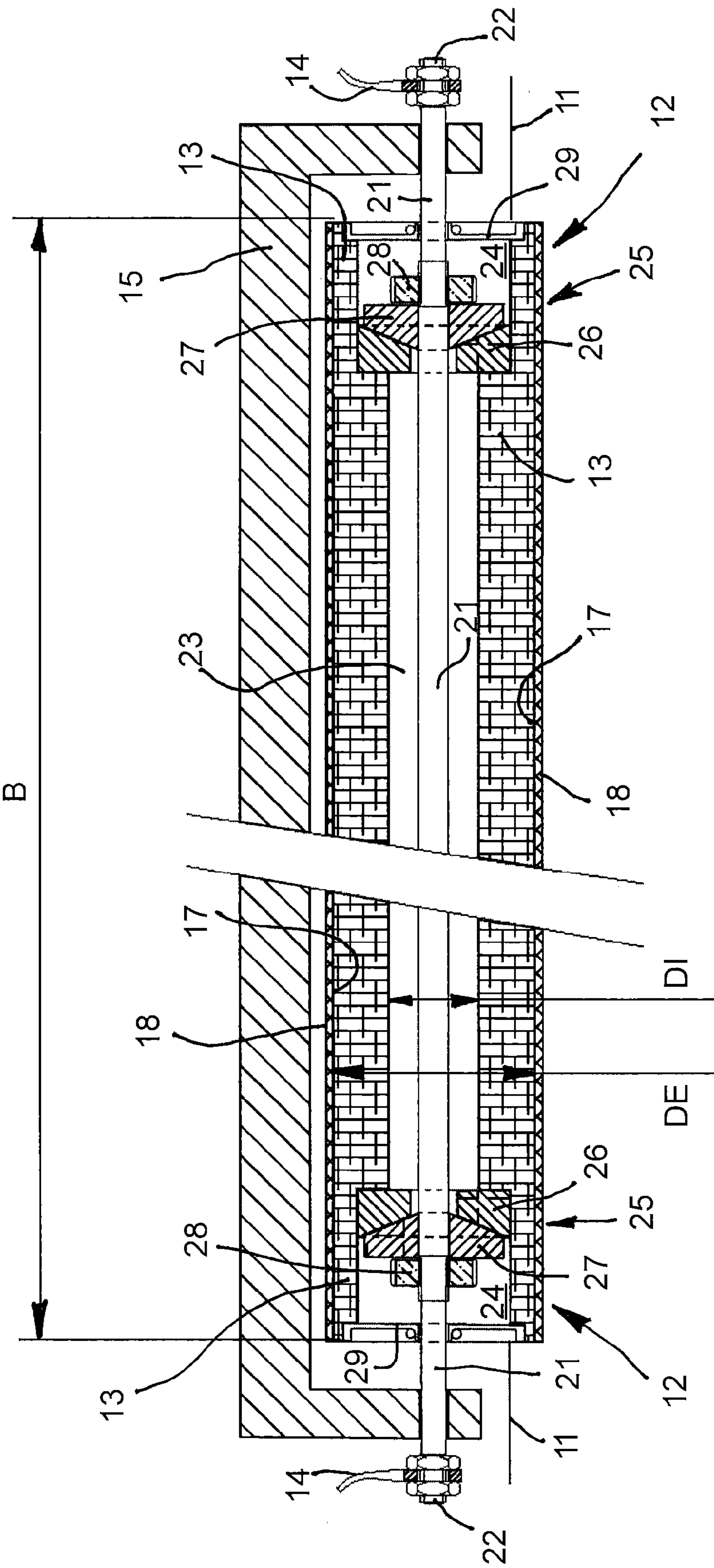

Fig. 5

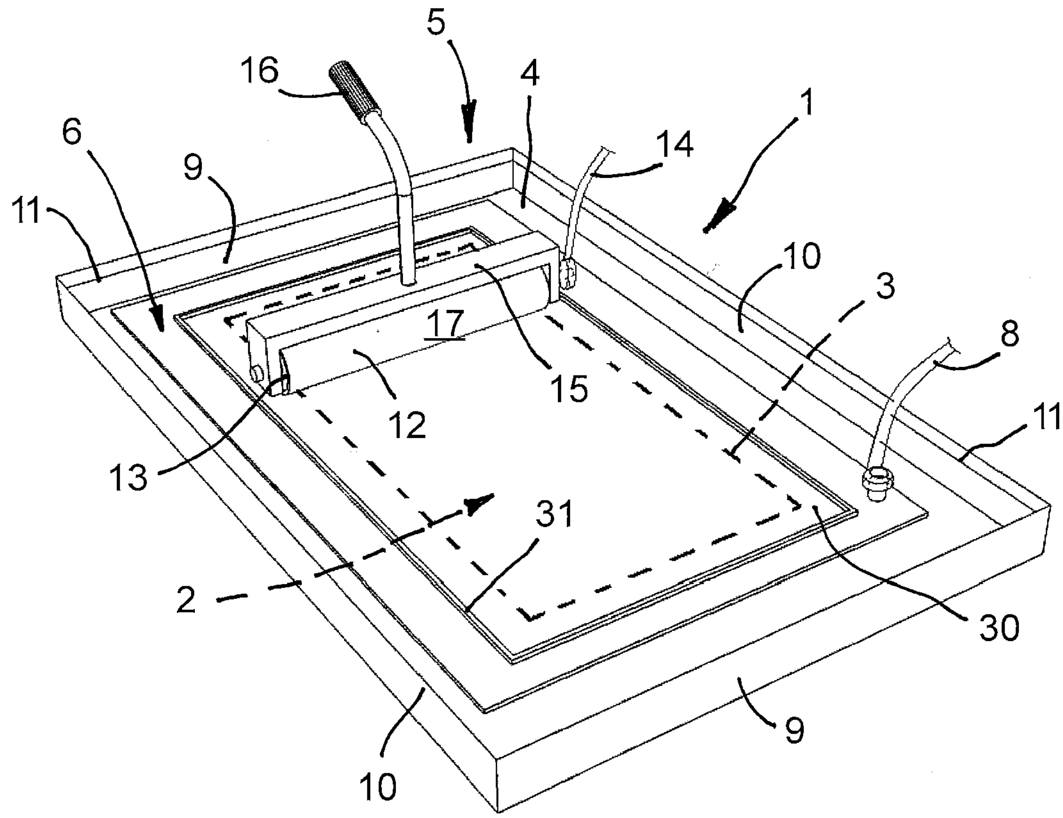
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Fig. 6

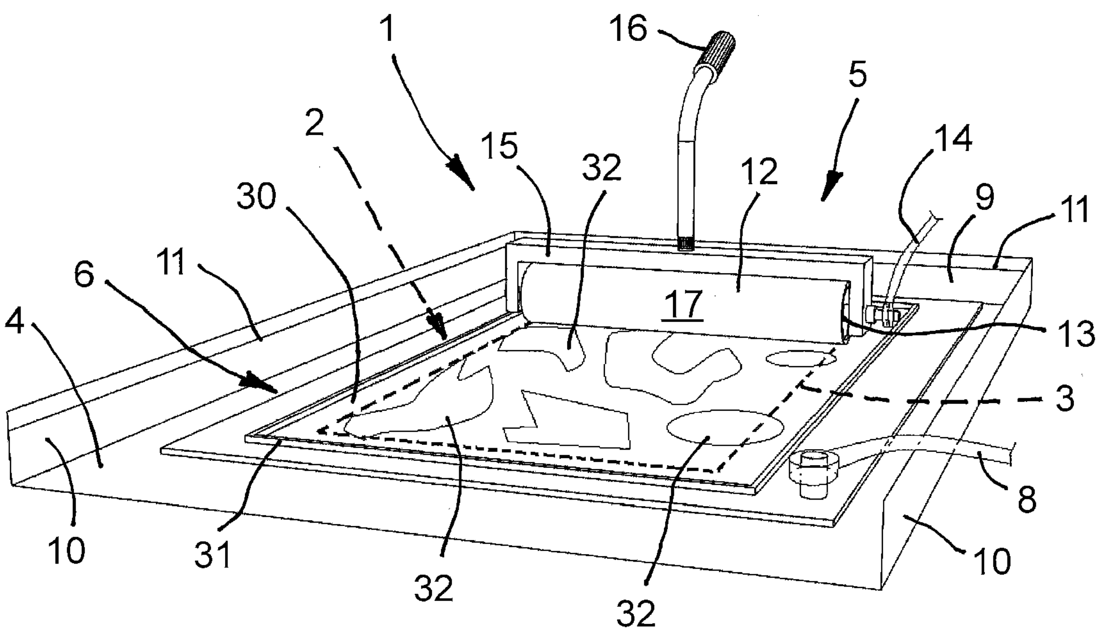
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Fig. 7

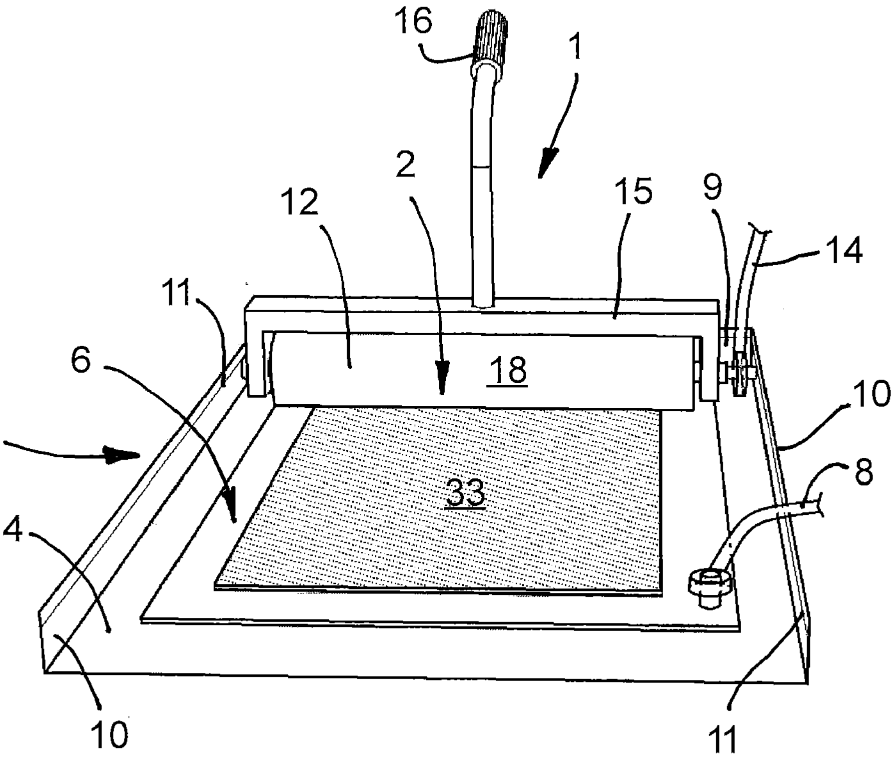
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Fig. 8

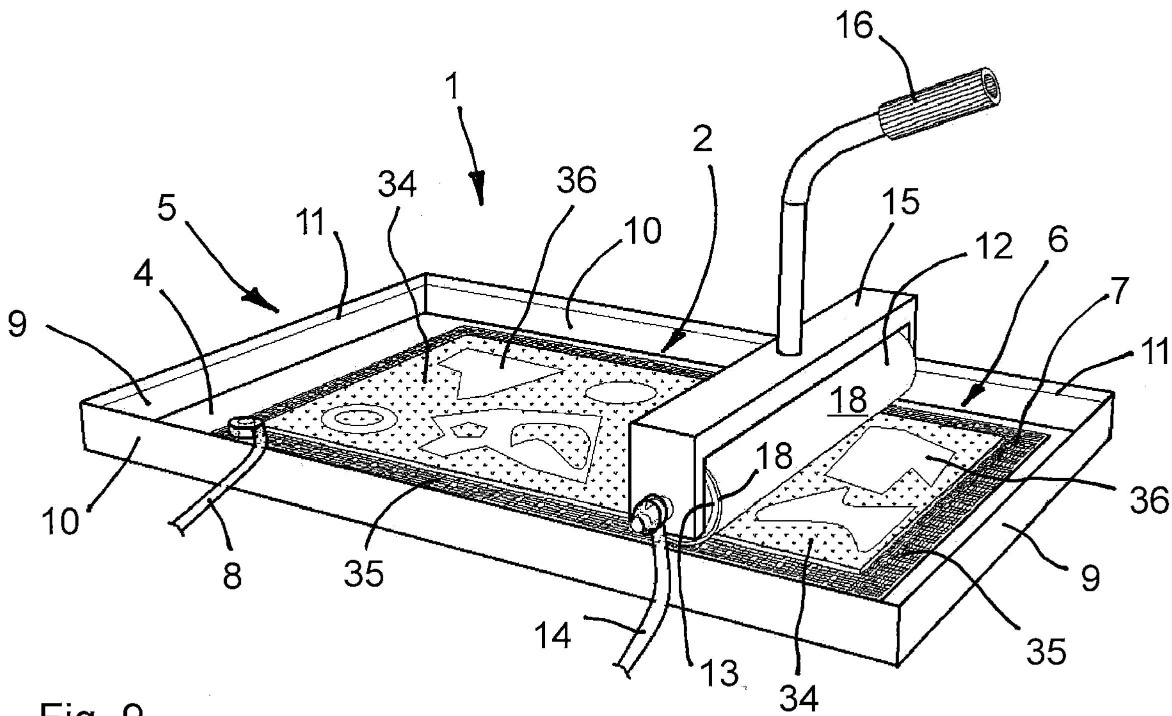
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Fig. 9

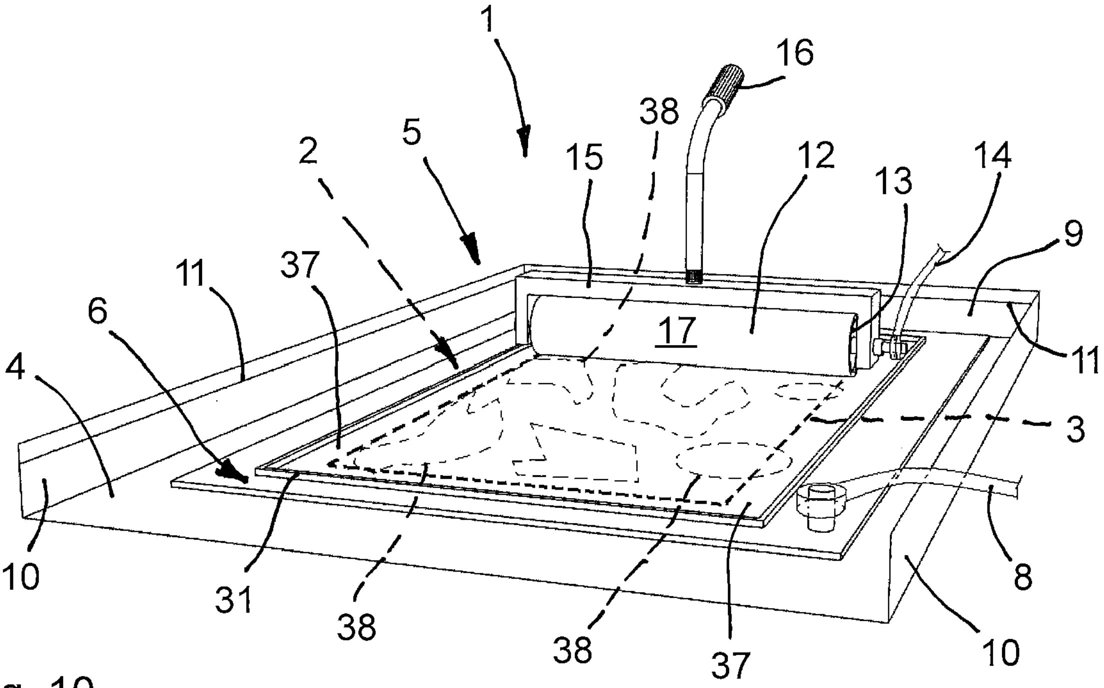

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 21 02 0636

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2 540 602 A (THOMAS FRANK W ET AL) 6 February 1951 (1951-02-06) * column 1, lines 1-5 * * column 6, line 35 - column 8, line 70 * * figure 3 * -----	1-10	INV. C25D11/00 C25D11/02 C25D17/14
A	JP S53 124134 A (SASAKI ICHIROU; AOKI TSUKASA) 30 October 1978 (1978-10-30) * abstract; figure 1 * -----	1-10	
A	DE 103 44 424 A1 (DAIMLER CHRYSLER AG [DE]) 12 May 2005 (2005-05-12) * paragraph [0001] * * paragraphs [0026] - [0028] * * figure 1 * -----	1-10	
A	US 4 569 730 A (KILLER ERIC [CH]) 11 February 1986 (1986-02-11) * column 1, lines 44-55 * * column 2, lines 38-63 * * figure 1 * -----	1-10	TECHNICAL FIELDS SEARCHED (IPC) C25D

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
The Hague	13 May 2022	Crottaz, Olivier

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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13-05-2022

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