



(11)

**EP 4 818 377 A1**

(12)

**EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**07.10.2026 Bulletin 2026/41**

(51) International Patent Classification (IPC):  
**C25F 3/16** <sup>(2006.01)</sup> **C25F 7/00** <sup>(2006.01)</sup>

(21) Application number: **24847172.4**

(52) Cooperative Patent Classification (CPC):  
**C25F 7/00; C25F 3/16**

(22) Date of filing: **28.11.2024**

(86) International application number:  
**PCT/ES2024/070750**

(87) International publication number:  
**WO 2025/114631 (05.06.2025 Gazette 2025/23)**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA**  
Designated Validation States:  
**GE KH MA MD TN**

(30) Priority: **28.11.2023 EP 23383221**

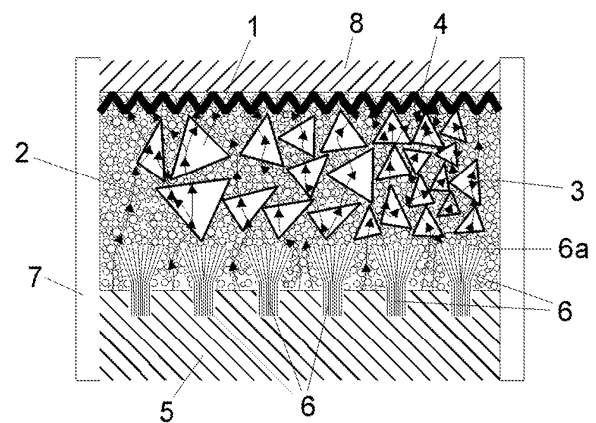
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(54) **METHOD FOR ELECTROPOLISHING METAL PARTS IN FLOATING ELECTRICAL CONTACT AND ELECTROPOLISHING DEVICE FOR CARRYING OUT THE METHOD**

(57) Electropolishing procedure of metal parts in floating electrical contact and electropolishing device to carry out said procedure, comprising: preparation of the parts (1) where they are cleaned; preparation of the electrolytic medium (3); and electropolishing, where the pieces (1) are immersed in the electrolytic medium (3) with an anode (4) and a cathode (5) and electric current (2) is applied; with the pieces (1) submerged floating or submerged (mixed with the electrolyte) and isolated from the cathode (5) by at least one separator (6) with permeable free spaces (6) that allow the electrolytic medium (3) to pass through it to make contact with the cathode (5) and close the circuit when the electric current is applied (2).



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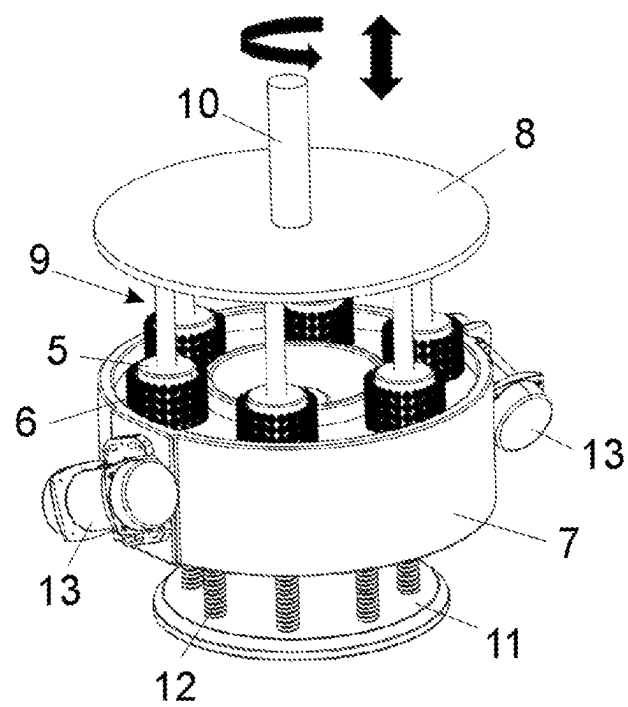


Fig. 2-A

## Description

### PURPOSE OF THE INVENTION

[0001] The invention, as expressed in the statement of this descriptive report, refers to a procedure for electropolishing metal parts in floating electrical contact and electropolishing device to carry out this procedure, providing advantages and characteristics that are described in detail below, which represent an improvement over the current state of the technique.

[0002] The purpose of this invention lies in a procedure for smoothing and polishing metal parts which, based on the electrochemical process of applying an electric current to the part or parts immersed in an electrolytic medium, by contact of the latter with a cathode and an anode, is distinguished mainly in that the parts are incorporated floating in the electrolytic medium, preferably without any restriction i.e. without fastening to avoid clamping marks, and they are isolated from the anode or cathode by means of a separating and insulating element with permeable free spaces that allow the electrolytic medium to close the circuit. The separating and insulating element according to this invention includes, for example, an element with multiple elements, rigid or flexible, in the shape of a tip such as brush-type bristles, a mesh or one or more permeable and insulating fabrics, such as permeable covers or containers.

1. In addition, to improve the polishing effect, the pieces to be polished are removed and turned, for which either the cathode, or the anode, both elements, or even the electrolyte with the pieces themselves are mobile elements, being a second aspect of the invention referring to an electropolishing device designed to carry out this procedure, which, in turn, can adopt different configuration variants to achieve the mentioned motion options.

### FIELD OF APPLICATION OF THE INVENTION

[0003] The field of application of the present invention is framed within the sector of the industry sector dedicated to the polishing of metal parts, particularly focused on the electropolishing systems.

### BACKGROUND OF THE INVENTION

[0004] As is known, electropolishing is a chemical and electrochemical process widely used to improve the surface of metal parts that is essentially based on applying electrical current to the metal part or parts that will be immersed in an electrolytic solution that is put in contact with an anode, for example immersed in the solution to decompose, and with a cathode that is connected to a power supply, which causes the dissolution and controlled removal of small amounts of material and imperfections that may occur on the surface of the part or the

adhesion of dissolved particles of the anode-acting part, for example in galvanizing processes, resulting in a smooth and polished finish.

[0005] There is also a known method of electropolishing by electrolytic means that comprises:

- a set of solid particles comprising a liquid electrolyte inside,
- a quantity of conductive and/or electrolytic solution or water retained in solid particles, and
- a liquid, less conductive than solid particles, non-miscible covering solid particles,

so when a solid particle comes into contact with the piece to be polished, the electrical conductivity between the solid particle and the piece to be polished causes an ion exchange and consequently the polishing of the piece to be polished.

[0006] The problem with this procedure is that the part(s) must be fastened to keep them immersed in the electrolyte medium, so it is inevitable that marks remain in the area of contact of the surface of the part with the clamping, which can be a major inconvenience, especially in small and/or delicate pieces that have to be perfectly polished throughout their surface.

[0007] To avoid these marks, the parts can be incorporated into the electrolyte medium without fastening firmly such as inside an element such as a basket connected to an electrode as described in the Spanish patent P 202030086, ES2831105 A1. In this case, the pieces to be polished are placed in the container where they contact a first electrode connected to the electrical source. This provides an electrical current that flows between the parts and the second electrode through the particles of the medium. The system produces a relative movement of the particles with respect to the pieces to be polished.

[0008] However, this presents the problem of direct contact of the parts with the cathode that provides the current to the electrolyte, for example, when deposited by gravity on the bottom of the container in which they were contained, and with this unwanted marks arise on the surface of them.

[0009] The objective of this invention is, therefore, the development of an improved type of electropolishing procedure that allows to solve this problem and minimize or completely eliminate contact marks by clamping on the surface of the parts, as well as the mass production of these.

### SUMMARY OF THE INVENTION

[0010] The electropolishing procedure of metal parts in floating electrical contact and the electropolishing device to carry out this procedure proposed by the invention are configured as a solution to the objectives mentioned

above.

**[0011]** Specifically, what the invention proposes in some of its aspects, as has been pointed out above, is a galvanic surface treatment procedure, such as electropolishing, to straighten and polish metal pieces that, conventionally based on the application of an electric current to the part or parts submerged in an electrolytic medium, which is put in contact with a cathode and an anode, to generate such current, is characterized in that the pieces are incorporated into the floating electrolyte, preferably without any restriction i.e. without fastening to avoid fixing marks, minimizing or completely eliminating the contact marks by clamping on the surface of the same. These pieces are isolated from simultaneous direct contact with the anode and the cathode by incorporating at least one piece, one or more separating and insulating elements between the anode and the cathode.

**[0012]** In some cases, this suspension medium or separating and insulating element includes permeable free spaces such that allow the electrolytic medium to close the circuit and at the same time define a minimal contact surface with the part to be treated and one of the two electrodes. In some versions of the invention, the minimum contact surface comprises pointed elements or tips.

**[0013]** The expression "parts floating on the electrolyte" should be understood in this document as the parts being at least partially sunk in the middle of the electrolyte by means of a suspension medium. For example, this suspension medium is achieved in some cases thanks to one or more separating and insulating elements with permeable free spaces that allow the electrolytic medium to pass through.

**[0014]** In other examples of the invention, the suspension medium is achieved with DryLyte particles.

**[0015]** Versions comprising these DryLyte particles include the use of conductive solid particles that retain an electrolytic liquid, so that when a solid particle comes into contact with the piece to be polished, the electrical conductivity between the solid particle and the piece to be polished causes an ion exchange and consequently the polishing of the piece:

Solid particles can be ceramic, polymeric, organic, inorganic, of plant origin, etc.

**[0016]** Preferably the conductive particles are ion exchange resin, since in this way they favor ionic conductivity. More preferably, the particles are of cation exchange resin, as this way they are able to capture metal ions extracted in electropolishing processes and maintain the initial properties. In some specific versions, polystyrene polydivinylbenzene sulphonated.

**[0017]** Ion exchange particles with macroporosity are usually called macroporous particles and microporous particles are called gel-like particles. Both types are suitable for use in this invention.

**[0018]** In some cases, these conductive solid particles are found in an environment including a gas, in others in a liquid environment and in some others in a gaseous

environment combination of the two. In some versions of the invention, in order to have a better control over the fluidity and the suspension capacity of the electrolytic medium, a liquid medium can be used. Depending on the rheology and viscosity of the set formed by the piece(s) to be polished, conductive solid particles and liquid, it is possible to control by the ratio between these elements the ability to suspend the pieces and isolate them from one of the two electrodes while allowing them to connect with the other. An increase in the ratio of liquid will promote permeability, decreasing the ability to hold the parts or parts in suspension, while an increase in the proportion of conductive solid particles will have a opposite effect.

**[0019]** In some cases, the added liquid is not significantly conductive in respect of the conductivity of solid particles, which are the ones that mostly guide the ion exchange process. For example, it is possible to use hydrogen carbonated aliphatic chains between 7 - 25 C. In other cases, the liquid used comprises a conductive solution. In some particular versions of the invention, in which we want to guide the ion exchange through the particles and increasing the capacity of transmission of electrical charge between them, the liquid deals with an emulsion between an immiscible conductive and non-conductive solution. This promotes its electrical connection by having greater ease to form conductive meniscus between them, while allowing the modification of the rheology that presents the liquid medium.

**[0020]** The size, rigidity, density and quantity of the solid particles, relative to the one or the pieces to be polished, are parameters to be configured to control the displacement of the piece/s to be polished until touching the anode or cathode, controlling in turn the polishing process. Adjusting the packing factor between solid particles in their corresponding environment considering the qualities of the piece(s) to be polished is an important aspect in order to modify the thrust of solid particles to the parts, controlling in this way their suspension and therefore the contact between them and the electrodes.

**[0021]** This is a factor to consider in order to produce a satisfactory surface treatment. It is important to get the electrical contact time between the parts and one of the two electrodes enough to perform an efficient polishing process and short enough to avoid excessive attacks. Therefore, fluidizing elements or vibrations can be introduced that allow weakening or reinforcing the thrust of the particles that suspend the pieces to be polished in order to control at will the electrical contact between the parts and the electrodes.

**[0022]** The pieces, which in some versions are not fastened by any clamp system or arm, can move freely in the electrolyte, changing the point of electrical contact with the electrolyte and consequently avoiding the clamping marks, even in cases where the suspension medium incorporates such separating and insulating elements.

**[0023]** An advantage of the electropolishing process that is the purpose of the invention is the obtaining of

polished parts with isotropic surfaces that improve the biocompatibility of medical products. Another advantage of the electropolishing process that is the purpose of the invention is the obtaining of mechanically charged components with greater durability and resistance to dynamic fatigue while increasing the lambda factor in the elastohydrodynamic lubrication of the same. In order to achieve a homogeneous result or an isotropic surface, in some versions of the invention, contact elements are designed with the pieces to be polished that, in solidarity with the container, promote their random or non-random orientation within the processing system. The relative movement between the pieces, the medium and the container where they are located can be configured in such a way that this effect is achieved. This contributes to averaging the galvanic effects resulting from its random orientation at will, in such a way that it ends up providing homogeneous or heterogeneous results depending on the application in question.

**[0024]** Another relevant factor for some versions of the invention is the anodic and cathodic surfaces of the electrodes. In some cases, some parts come into contact with the anodic electrode and others are connected to the anode via a connecting train between several parts and the anode. In certain applications, the difference between the ohmic drop between extremes in the situation explained above, requires increasing or decreasing the anodic surface exposed in order to vary the homogeneity, precision and speed of the treatment. Increasing the contact surface generates greater homogeneity and precision. However, under the same conditions, decreasing the contact surface while encouraging parts to be connected between several layers of other parts between them and the anode will increase the speed of treatment of the parts in the most distant part of the anode and will decrease the speed of treatment of the rest of the parts. In some versions of the invention we work with a ratio between the surfaces of the electrodes and the surface of the piece/s to be polished between 100:1 and 1:1, particularly between 50:1 and 1:10, more particularly between 20:1 and 10:1.

**[0025]** For example, a separating and insulating element, in accordance with the present invention, may consist in some versions of one or more bristle-based brushes, or of one or more layers of mesh, or of one or more permeable and insulating fabrics, such as covers or permeable containers.

**[0026]** In any case, preferably, the polishing of the pieces is done by moving, removing and/or turning the pieces, so that the applied current acts uniformly and homogeneously on all the different faces and/or nooks of its surface, for which the procedure contemplates, at least, the following options for action and implementation:

- A first option, in which the cathode presents movement that, in turn, causes the movement and/or flipping of the pieces, while the anode remains static.

- A second option, in which the cathode remains static while the anode is the one that presents the movement that causes the movement and/or flipping of the pieces.

- A third option, in which both the anode and the cathode present movement that causes the movement and/or flipping of the pieces. The movement of the anode and cathode can be simultaneous or alternated.

- A fourth option in which both the anode and the cathode remain static while the electrolytic medium with the pieces in suspension is the one that presents movement that causes their movement and/or turning.

- A fifth option in which the suspension medium, for example, comprising separating and insulating elements with permeable free spaces that allow the electrolytic medium to pass, is the one that presents the movement that causes the movement and/or turning of the suspended parts.

**[0027]** For its part, the electropolishing device that is the purpose of this invention, to carry out the procedure described above comprises, at least, the following elements:

- A container with an electrolytic suspension and with the capacity to incorporate the piece or pieces to be polished submerged and/or floating in said electrolytic medium.
- A piece of metal or other conductive material constituent of the anode that is incorporated into the vessel so that it is submerged in or in contact with the electrolytic suspension.
- A piece of metal or other conductive constituent material of the cathode that is in contact with the electrolytic suspension of the vessel and can be connected to an electrical power source, e.g. a generator, such that, when activated, it closes the circuit with the anode causing the passage of electrical current through the electrolytic medium and with it, the polishing of the parts submerged in it.

**[0028]** Preferably, some versions also include an insulating cap, which covers the container of the electrolytic medium.

**[0029]** In some preferred versions including, for example, in combination with any of the above versions, the device comprises, incorporated between the cathode and the electrolytic medium inside the vessel, a suspension medium or separator of insulating material with permeable free spaces that allow part of that electrolytic medium to pass through to contact the cathode and close

the circuit. In some versions, as for example in combination with any of the above, said suspension or separator medium also presents a configuration based on tips or pointy, sharp, penetrating, incisive or thorny elements; assemblies with protuberances or hooked elements such as Velcro® type, or other irregular shapes, such as a skein-like fabric of tangled threads such as a scrubber-like fabric. This configuration is presented, at least on the surface, in contact with the electrolytic medium, and preferably, at least in the contact area with the parts submerged in that medium.

**[0030]** In a preferred version option, the separator consists of one or more bristle brushes arranged with the base fixed on the cathode and the tips oriented toward the suspension.

**[0031]** In other production options, the suspension or separator medium consists of one or more layers of mesh, or of one or more permeable and insulating fabrics, such as permeable sheaths or containers.

**[0032]** For example, in one version, the means of suspension or separator comprises a sheath, bag or container with holes inside without allowing for escape of the pieces to be polished while allowing the passage of the electrolyte medium from the inside of the bag to the outside of the bag. In this version, the piece can preferably be moved inside the sheath, bag or container. In one or more variants of this version, a non-conductive stirring arm or remover is provided that facilitates the relative movement between the pieces to be polished wrapped in the sheath, bag or container and the electrolytic medium. This bag allows the electrical contact of the parts with the anode.

**[0033]** In a preferred version, the electropolishing device has at least the following variants with different actuation or configuration options.

**[0034]** In a first variant of electropolishing where the cathode shows movement and the anode remains static, the vessel with the electrolytic suspension and the anode is a fixed body that has a ribbed annular configuration on which a carousel of several metal heads rotates, they act as a cathode and are covered with bristle brushes, meshes or permeable surface that fit into the ribbed annular body, so that they are removing the pieces incorporated in it.

**[0035]** In a second variant of electropolishing, where the cathode remains static and the anode shows movement, the vessel with the electrolytic suspension is made up of a fixed tray at the base of which a plurality of bristles or permeable surface is fixed that completely cover it, there is a string of bars that make up the anode that move from one end to another of the tray.

**[0036]** In a third variant of electropolishing, where the anode and the cathode show movement, the vessel with the electrolytic suspension is a rotating drum, preferably arranged horizontally, inside which the anode is fixed to its inner wall,

with a head that defines the cathode that covered with a bristle brush or permeable surface and that, in turn,

preferably rotates through an axis lying inside the drum or is attached in the lower position of the rotating drum.

**[0037]** In a fourth variant of electropolishing, where both the anode and the cathode remain static while the electrolytic medium with the pieces in suspension is the one that presents movement that causes the movement and/or turning of the pieces in suspension.

**[0038]** And a fifth variant of electropolishing, where the suspension medium, for example, comprising separating and insulating elements with permeable free spaces such as to allow the electrolytic medium to pass through, is the one that presents the movement that causes the movement and/or turning of the pieces in suspension.

## DESCRIPTION OF THE DRAWINGS

**[0039]** To complement the description that is being made and in order to help a better understanding of the characteristics of the invention, the present descriptive report is accompanied, as an integral part of it, by a drawing in which, in an illustrative and non-limitative manner, the following has been represented:

Figure 1.- shows a schematic representation in section of an example of an electropolishing device to carry out the procedure that is the purpose of the invention, showing the main parts and elements that it comprises, as well as the disposition thereof;

Figure number 2-A.- shows a schematic view in perspective of an example of producing the electropolishing device of the invention

in a production variant of the same with a cathode that presents movement and a static anode;

Figures number 2-B and 2-C.- show paths seen in elevation and floor from the example of the device shown in Figure 2-A.

Figure number 2-D.- shows a section view of the device, according to cut A-A shown in Figure 2-B;

Figure number 2-E.- shows a sectioned perspective view of the device of the invention, according to the example shown in Figures 2-A to 2-D.

Figures number 3-A and 3-B.- show schematic views in

perspective of an example of the electropolishing device of the invention in a second variant of its realization with the static cathode and the anode endowed with movement, having been represented with the container covered with and without the insulating cap;

Figure 3-C.- shows a floor view of the example of the device shown in Figures 3-A and 3-B;

Figure 3-D.- shows a section view of the device according to the cut B-B shown in Figure 3-C;

Figure 4-A.- shows a schematic view in perspective of another example of the electropolishing device of the invention in a third variant of its realization with the cathode and anode endowed with movement;

Figures 4-B and 4-C.- show both elevation and floor views of the example of the device shown in Figure 4-A;

Figure number 4-D.- shows a section view of the device according to the C-C cut shown in Figure 4-C;

Figures 5-A and 5-B.- show schematic representations in section of another example of the electropolishing device object of the invention, similar to that shown in Figure 1, in this case an example that presents movement and the separating element that isolates the pieces at the top so that gravity is in their favor, specifically an example with translation movement at the anode in Figure 5-A and with translation movement in the cathode in Figure 5-B; and

figure number 5-C.- shows a schematic representation in section of another example of the device of the invention similar to that shown in Figures 5-A and 5-B, in this case with vibratory or turning motion.

Figure 6-A.- shows a schematic view in perspective of an example mechanism of the present invention in a fourth variant of its realization with the cathode and anode endowed with movement;

Figure 6-B.- shows a schematic representation in a cut perspective; and

Figure 6-C.- shows a detailed schematic representation of an elevated cut.

## PREFERENTIAL IMPLEMENTATION OF THE INVENTION

**[0040]** In view of the aforementioned figures, and according to the numbering adopted, we can see in them several examples of non-limiting realization of the electropolishing device of metal parts in floating electrical contact of the invention, which comprises what is described in detail below.

**[0041]** As depicted in Figure 1, this invention includes a galvanic surface treatment procedure of conductive parts (1) in floating electrical contact, comprising the following steps:

Immerse the piece(s) (1) in an electrolytic medium (3) located between an anode (4) and a cathode (5);

apply electrical current (2) flowing between anode (4) and cathode (5) including electrical contact between parts (1) and electrolytic medium (3);

characterized because, the pieces (1) that are immersed in the electrolytic medium (3) floating in it and isolated at least, of the anode (4) or of the cathode (5) by means of a suspension medium or a separator (6) including permeable free spaces (6) that allow the electrolytic medium (3) to pass through it to make contact with the anode (5) and/or the cathode (5) in order to close the circuit when electric current (2) is applied.

**[0042]** In some particular versions, Figure 1 includes a galvanic surface treatment procedure depending on the invention, intended to treat (1) conductive parts by means

of application of electrical current (2) in an electrolytic medium (3) in which they are immersed, comprising at least:

- an electropolishing stage itself, where the pieces (1) are immersed in an electrolytic medium (3), such as an electrolytic suspension, prepared in the previous stage, an anode (4) (negative electrode) is placed, a cathode (5) (positive electrode) is placed and

it applies electrical current (2), for example from an external source (not represented), so that the anode (4) and the cathode are connected to each other (5) by means of the parts (1) and through the electrolytic medium (3), in such a way that the metal ions are dissolved from the surface of the parts and deposited in the medium and in the cathode (5);

**[0043]** Preferably, the electropolishing procedure comprises one of the following stages:

- a previous stage of preparation of the pieces (1), where they are cleaned and degreased to remove residues and potential contaminants from the surface using detergents, solvents or other methods depending on the type of metal and dirt present;
- a stage of preparation of the electrolytic medium (3), where a solution is prepared with the composition and concentration of acids and other chemical components specific to the type of metal to be polished;
- a final stage of rinsing and drying where, after reaching the desired level of polishing, the pieces (1) are removed from the electrolytic medium (3) and rinsed in a neutralizing solution.

**[0044]** And, from this succession of stages, the procedure of this invention comprises an electropolishing stage, where the pieces (1) are immersed in an electrolytic medium (3) floating or submerged in the same, preferably without any fixed clamping and, in addition, the pieces (1) are isolated from the anode (4) or the cathode (5) by at least a suspension medium or a separator (6) with permeable free spaces (6) which let the electrolytic medium pass through it (3) to make contact with the anode (4) or the cathode (5) and close the circuit when the electric current is applied (2).

**[0045]** In addition, preferably at least one suspension medium or a separator (6) isolating the parts (1) from direct contact with the anode (4) or with the cathode (5), is an element having a configuration with a surface of tips, protuberances or roughnesses that determine an area of minimal contact with the pieces (1), preferably tips or any of the other versions of separators described in this document.

**[0046]** In a version option, a suspension medium or separator (6) consists of one or more groups of bristles, and alternatively, by mesh or by one or more permeable and insulating fabrics, such as permeable sheaths or containers.

**[0047]** In any case, preferably, in the electropolishing stage, the parts

(1) are removed and/or flipped to improve the effect and the

electrical current (2) acts uniformly and homogeneously on all the different faces and/or nooks of its surface, for which the main production options are preferably considered:

- by means of the cathode movement (5), while the anode (4) remains static;
- by moving the anode (4), while the cathode (5) remains static; or
- through the movement of both the anode (4) and the cathode (5).
- by the movement of the electrolytic medium (3) with said

pieces (1) submerged in it, while preferably both the anode (4) and the cathode (5) remain static.

- by moving the suspension medium or a separator (6) isolating the pieces (1) from direct contact with the anode (4) or with the cathode (5).

**[0048]** According to Figures 5-A, 5-B and 5-C, we can see how the above

anode movements (4) and/or cathode movements (5) can be translational movements or vibrational or flipping movements. And, in addition, the separating element (6)

can be located on the top, so that the pieces (1) to be polished have gravity in favor.

**[0049]** For its part, the electropolishing device (100, 100', 100'') of this invention, designed to carry out the procedure described above comprises, at least:

- a container (7) suitable to contain the electrolytic suspension (3) and the ability to incorporate, immersed in it, the piece or pieces (1) to be polished;
- a piece of metal or other conductive material constituent of the anode (4) incorporated into the container (7) so that it remains submerged wholly or partially in the electrolytic suspension (3); and
- a piece of metal or other conductive cathode constituent material (5) that is in contact with the electrolytic suspension (3) of the vessel and can be connected to a power supply (not represented).

**[0050]** In addition, this production includes, incorporated between the anode or the

cathode (5) and electrolytic suspension (3) of the vessel (7), a suspension medium or a separator (6) of insulating material, which keep the pieces (1) isolated from direct contact with the anode (4) or with the cathode (5), the suspension medium or the separator (6) present spaces

permeable releases (6) that pass part of the electrolytic suspension (3) to make contact with the anode (4) or the cathode (5) and close the circuit.

**[0051]** Preferably, the electropolishing device (100, 100', 100'')

comprises an insulating cap (8) covering the container (7) with the electrolytic suspension (3).

**[0052]** Preferably, the suspension medium or the separator (6) has a structure based on tips or elements that are pointed, sharp,

penetrating, incisive or thorny; assemblies with protuberances or hooked elements such as Velcro® type, or other irregular forms such as a skein-like fabric of tangled threads such as a scrub-like fabric, at least on their contact surface with the electrolytic suspension (3), which define a minimum contact area with parts (1).

**[0053]** In a version option, the suspension medium or separator (6) consists of bristle groups or brushes, as shown in the figures, or mesh, or one or more permeable and insulating fabrics,

such as sheaths or permeable containers.

**[0054]** According to figures 2-A to 2-E, a first production variant is observed of the electropolishing device

(100) of the invention, where the cathode (5) presents movement and the anode (4)

remains static, the vessel (7) with the electrolytic suspension (3) and the anode (4) includes a fixed body of ribbed annular configuration on which a carousel-shaped structure (9) rotates with several metal heads, acting as a cathode (5), and which are radially arranged hanging from it, where the heads are covered with bristle brushes that fit into the ribbed annular body acting as a medium element of suspension or separator (6)

between the cathode (5) and the pieces (1) incorporated in it submerged in the medium or electrolytic suspension (3).

**[0055]** Preferably, the carousel structure (9) comprises an upper circular base from which the cathode heads hang (5), which, at the same time, defines the insulating cap (8) of the annular container (7) when coupled on it, there is a central axis (8) rotating on this cathode (10) through which the movement is printed to the heads that define the cathode (5) so that they are rotating circularly through the annular channel that defines the vessel (7).

**[0056]** Preferably, the annular container (7) is placed on a support base

(11) supported on a series of springs (12), with provision for both sides and in the central recess of the receptacle (7) cylinders (13) for connection to the power supply to be applied by

electrical current to the assembly and, optionally, the insertion and movement of the electrolytic suspension (3), with the central cylinder (13) also supported on a spring (12).

**[0057]** According to figures 3-A to 3-D, it is seen in a second

variant of the electropolishing device (100') of the invention, where the cathode (5) remains static and the anode (4) is the one that presents movement, the container (7) in which the electrolytic suspension (3) is incorporated where the pieces (1) to be polished are submerged is made up of a fixed tray, for example in an elongated

elliptical, rectangular or similar shape at the base of which the cathode constitutes the background

(5) and in it are fixed, as a means of suspension or separating element (6), a plurality of bristles covering completely said

base, existing at the top of this container (7) in the

form of a tray a string of moving bars that make up the anode (4) and which, attached to a top support (14) move along the tray, from one end of it to the other, to remove the pieces (1).

**[0058]** Preferably, the tray that defines the container (7) has an insulating lid (8) and, similar to the example of the previous variant, the annular container (7) is placed on a support base (11) supported on springs (12), with provision being made on both sides and on the lower part of the same respective cylinders (13) for connection to the power supply that will apply the current and, optionally, for insertion and movement of the electrolytic suspension (3).

**[0059]** On the other hand, according to figures 4-A to 4-D, it is observed in one

third production variant of the device (100") of electropolishing of the invention, where both the anode (4) and the cathode (5) show movement, the vessel (7) with the electrolytic suspension (3) in which the pieces (1) are submerged is a rotating drum, which rotates on its axis, moved, preferably, by a motor (15) coupled to one end of the

drum and that, at the same time, serves as a power source to apply the current, in whose interior said drum incorporates a plate fixed to its interior wall acting as an anode (4), as well as a head that defines the cathode (5) and, in turn, rotates inside the container (7) in the form of a drum through an axis layered (16) to which

it is joined by the opposite end where the insulating cap (8) closes the container (7), this cathode head (5) is covered with a bristle brush or permeable surface that acts as a suspension medium or separator (6) to prevent direct contact with the pieces to be polished (1).

**[0060]** In this case, the container (7) in the shape of a rotating drum is held through an L-shaped structure (17) whose horizontal branch serves as a base and whose vertical branch serves as fixation, through a coupling piece (18) between the shaft of the drum (7) and the motor (15) that moves it.

**[0061]** In the particular case detailed in Figure 6, it is observed that in a fourth variant of the invention, the electropolishing device presents a cup (4) in which the pieces to be polished (2) that come in contact with the cathode electrode (3) are submerged through an electrolytic suspension medium (9) that circulates through holes that prevent the cathode-piece short circuit for dimensional reasons; where these pieces (2) come into direct electrical contact by a cathode (6) and are pushed by it when coupled to means to provide the cathode (3) with movement (1); and where the electrolytic medium of suspension (9) together with the parts are fluidized by a

transmission and vibration system (7) which is optionally connected by the support of the structure (8) through resonators or vibration dampers (5) in order to control efficiently the fluidification provided.

**[0062]** Having sufficiently described the nature of this invention, as well

as the method of putting it into practice, it is not considered necessary to set forth a more extensive explanation so that any expert in the field understands its scope and the advantages derived from it.

## Claims

1. Procedure of galvanic surface treatment of conductive parts (1) in floating electrical contact, comprising the following steps:

Immerse the piece(s) (1) in an electrolytic medium (3) located between an anode (4) and a cathode (5);

apply electrical current (2) flowing between anode (4) and cathode (5) including electrical contact between parts (1) and electrolytic medium (3);

**characterized by** the pieces (1) that are immersed in the electrolytic medium (3) floating in it and isolated at least, from the anode (4) or from the cathode (5) by means of a suspension medium or a separator (6) including permeable free spaces (6) that allow the electrolytic medium (3) to pass through it to make contact with the anode (5) and/or the cathode (5) in order to close the circuit when the electric current is applied (2).

2. Procedure of electropolishing metal parts in floating electrical contact, according to claim 1, **characterized by**

at least one suspension medium or separator (6) that isolates the pieces (1) from direct contact with the anode (4) or the cathode (5), an element that has a configuration with a surface of tips, protuberances or roughnesses that determine an area of minimal contact with the parts (1).

3. Procedure of electropolishing metal parts in floating electrical contact, according to claim 1, **characterized by** at least one means of suspension or separator (6) formed by one or more groups of bristles.

4. Procedure of electropolishing metal parts in floating electrical contact, according to claim 1, **characterized by** at least one suspension medium or separator (6) being a mesh or one or more permeable and insulating fabrics.

5. Electropolishing procedure of metal parts in floating

electric contact, according to claim 1, **characterized by** at least one means of suspension or separator (6) comprising a sheath, bag or container with holes such that the pieces to be polished included in the sheath cannot escape, while the holes of the sheath allow the passage of the electrolyte medium from inside of the bag to outside the bag.

6. Procedure of electropolishing metal parts in floating electrical contact, according to any of the above claims, **characterized by**, in the electropolishing stage, the pieces (1) move and/or turn by moving the cathode (5), while the anode (4) remains static.

7. Procedure of electropolishing metal parts in floating electrical contact, according to any of claims 1 to 5, **characterized by** the fact that, in the electropolishing stage, the pieces (1) are moved and/or turned by the anode movement (4), while the cathode (5) remains static.

8. Electropolishing procedure of metal parts in electric floating contact, according to any of claims 1 to 5, **characterized by**, in the electropolishing stage, the pieces (1) are removed and/or turned by the movement of the anode (4) and the cathode (5).

9. Procedure of electropolishing metal parts in floating electrical contact, according to any of claims 1 to 5, **characterized by**, in the stage of electropolishing, the pieces (1) are moved and/or flipped by the movement of the electrolytic medium (3) with these parts (1) submerged in it, while both the anode (4) and the cathode (5) remain static.

10. Procedure of electropolishing metal parts in floating electrical contact, according to any of claims 1 to 5, **characterized by**, in the electropolishing stage, the pieces (1) are moved and/or turned by means of the movement of the suspension medium or separator (6).

11. Electropolishing device (100, 100', 100'') for electropolishing metal parts in floating electrical contact, including:

- a container (7) suitable to contain the electrolytic suspension (3) and the ability to incorporate, immersed in it, the piece or pieces (1) to be polished;

- a piece of metal or other conductive material constituent of the anode (4) incorporated into the container (7) so that it remains submerged wholly or partially in the electrolytic suspension (3); and

- a piece of metal or other conductive cathode constituent material (5) that is in contact with the electrolytic suspension (3) of the vessel and can

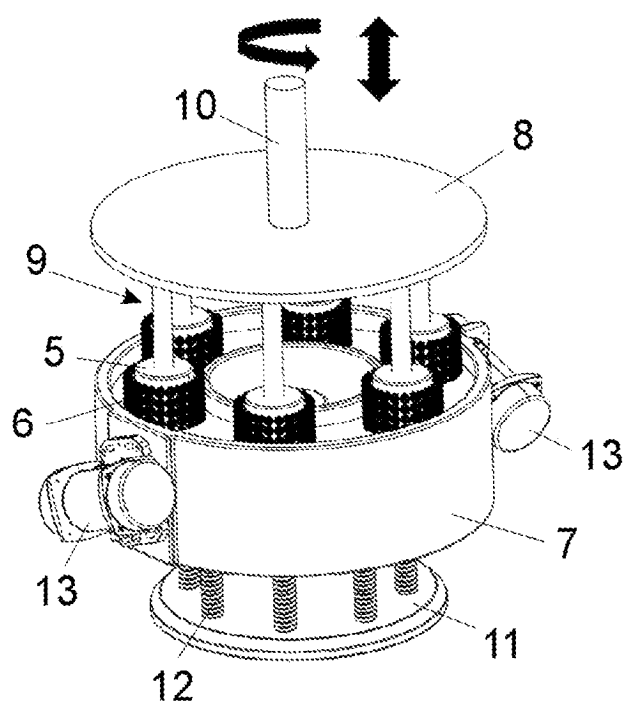
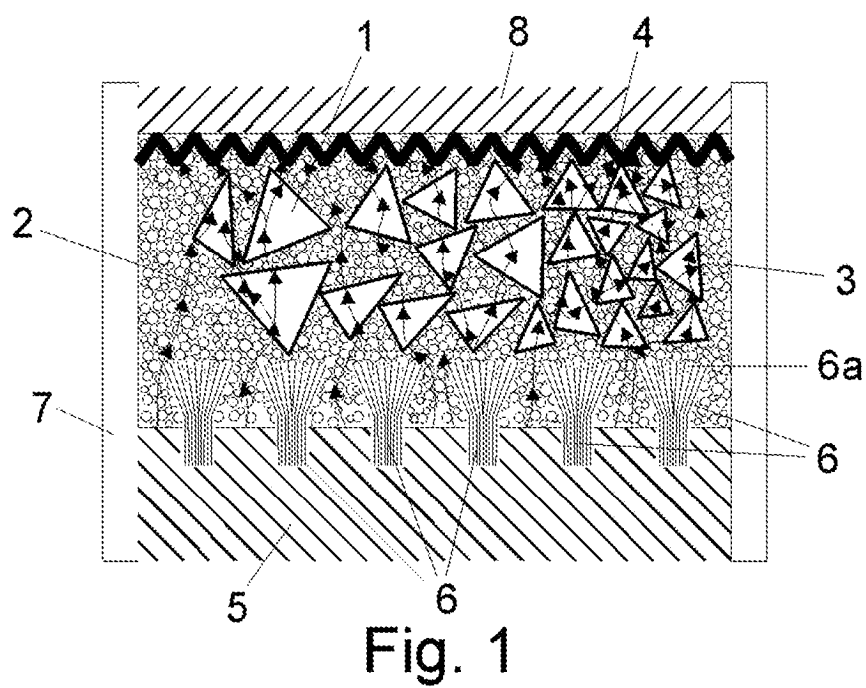
be connected to a power supply,

it is **characterized by**, incorporated between the cathode (5) and the electrolytic suspension (3) of the vessel (7), it also includes one or more separators (6) of insulating material, which keep the parts (1) isolated from direct contact with anode (4) or cathode (5), where the separators (6) have permeable free spaces (6) that allow part of the electrolytic suspension (3) to make contact with the anode (4) or cathode (5) and close the circuit.

12. Electropolishing device, according to claim 10, **characterized by** the separators (6) having a structure with a base of tips, protuberances and other irregular shapes, at least on their contact surface with the electrolytic suspension (3), which define a minimum area of contact with the parts (1).
13. Electropolishing device, according to claim 11, **characterized by** the separator or separators (6) being formed by groups or brushes of bristles, mesh, or by one or more permeable and insulating fabrics.
14. Electropolishing device, according to claim 11, **characterized by** the suspension medium or separator (6) comprising a sheath, bag or container with holes such that the pieces to be polished included in the sheath cannot escape while the holes in the sheath allow the passage of the electrolyte medium from the inside of the bag to the outside of the bag.
15. Electropolishing device, according to any of the claims 10 to 13, **characterized by** a variant of the device (100) where the cathode (5) shows motion and the anode (4) remains static, the vessel (7) with the electrolytic suspension (3) and the anode (4) is a fixed body of ribbed annular configuration on which rotates a carousel-shaped structure (9) with several metal heads, acting as a cathode (5), and which are radially arranged hanging from it, where the heads are covered with bristle brushes that fit into the ribbed annular body acting as a separating element (6) between the cathode (5) and the parts (1) incorporated therein submerged in the electrolytic suspension (3).
16. Electropolishing device, according to any of the claims 10 to 13, **characterized by** the fact that, in a variant of the device (100') where the cathode (5) remains static and the anode (4) shows movement, the vessel (7) in which the suspension incorporates the electrolytic suspension with (3) the pieces (1) to be polished is formed by a fixed tray whose bottom base constitutes the cathode (5) and in it are fixed, as a separating element (6), a plurality of bristles that

completely cover the bottom, existing at the top of the container (7) a string of moving bars that make up the anode (4) and which, attached to a top support (14), they move along the tray, from one end of it to the other, to remove the pieces (1).

17. Electropolishing device, according to any of the claims 10 to 13, **characterized by** a variant of the device (100") where the anode (4) and the cathode (5) show movement, the container (7) with the electrolytic medium (3) in which the pieces (1) to be polished are submerged is a rotating drum, rotates on its axis and whose interior incorporates a plate fixed to its interior wall acting as an anode (4), as well as a head that defines the cathode (5) and that, in turn, rotates inside the container (7) an axis (16) that is attached to the opposite end, with this cathode head (5) covered with a bristle brush that acts as a separator (6) to prevent direct contact with the pieces to be polished (1).



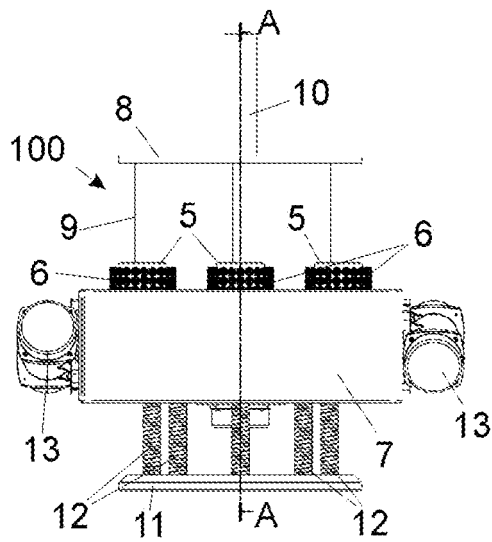


Fig. 2-B

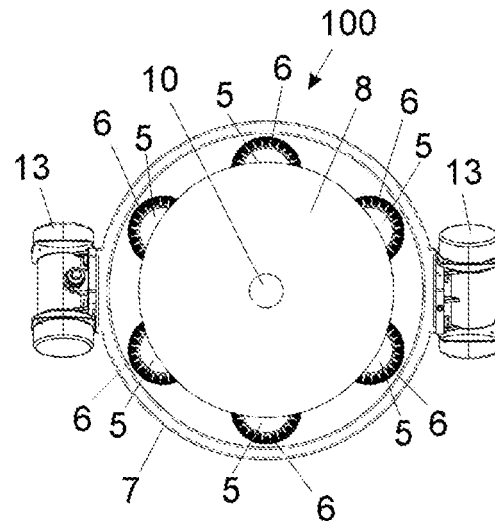


Fig. 2-C

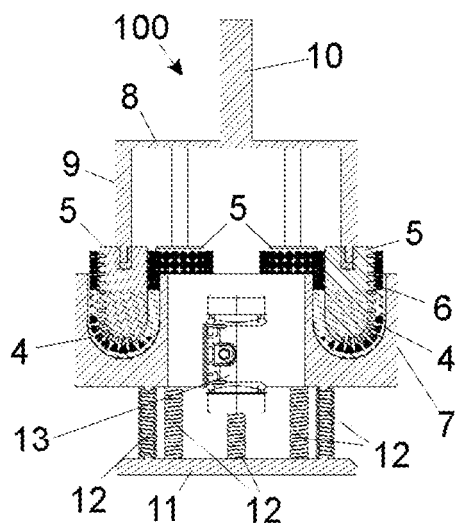


Fig. 2-D

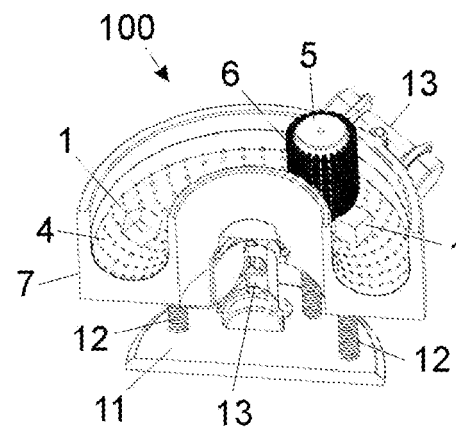


Fig. 2-E

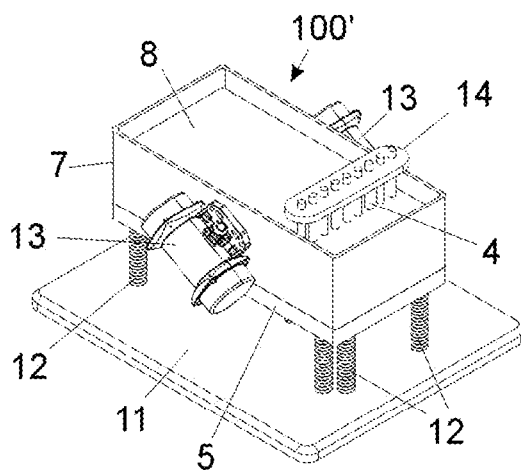


Fig. 3-A

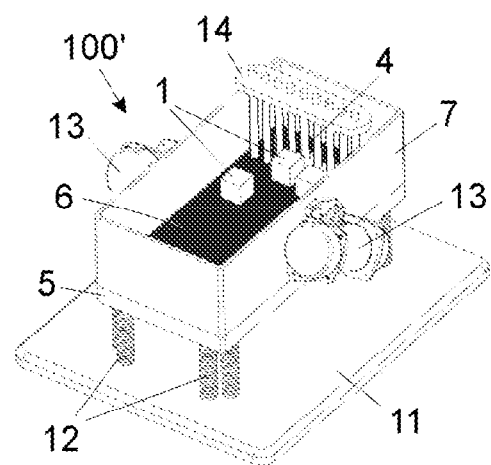


Fig. 3-B

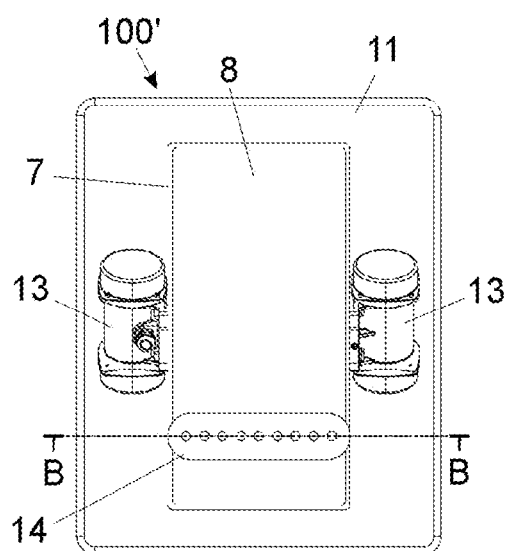


Fig. 3-C

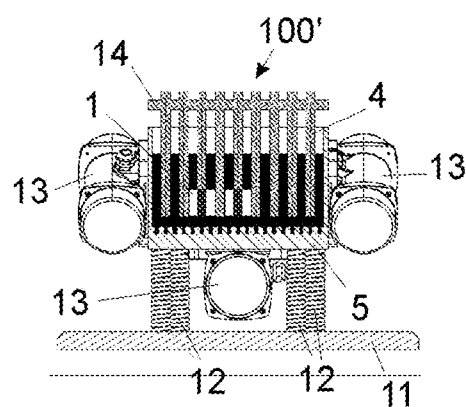
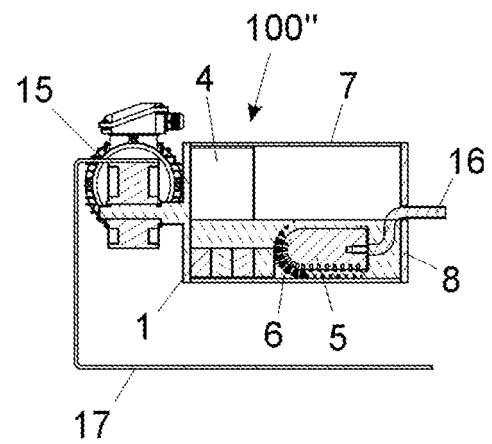
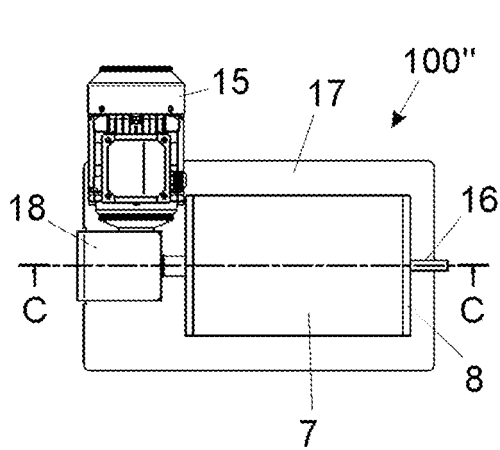
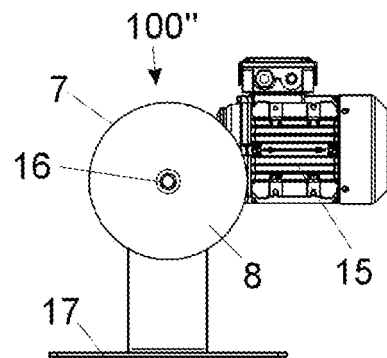
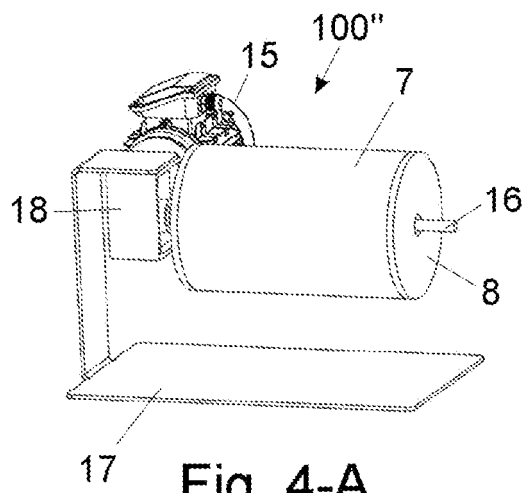


Fig. 3-D



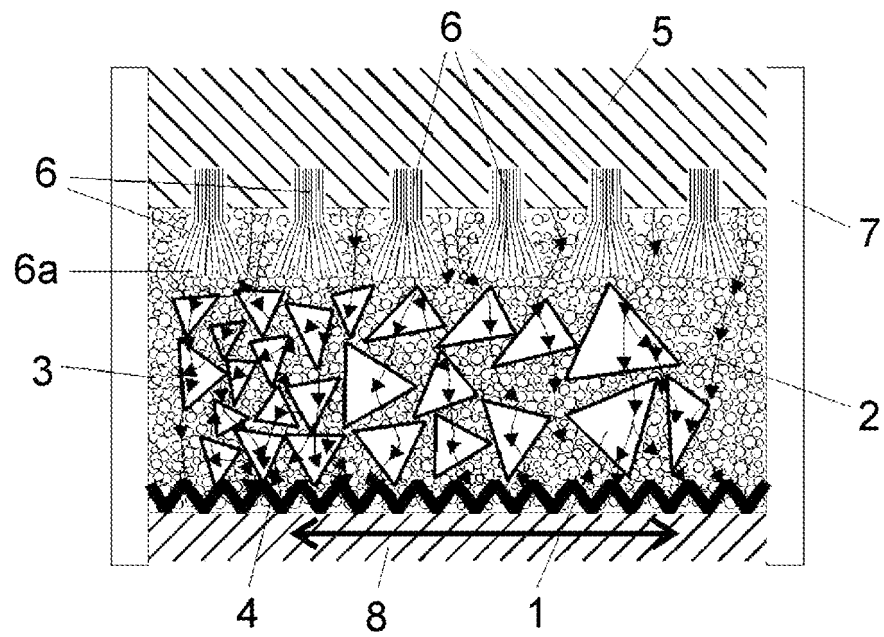


Fig. 5-A

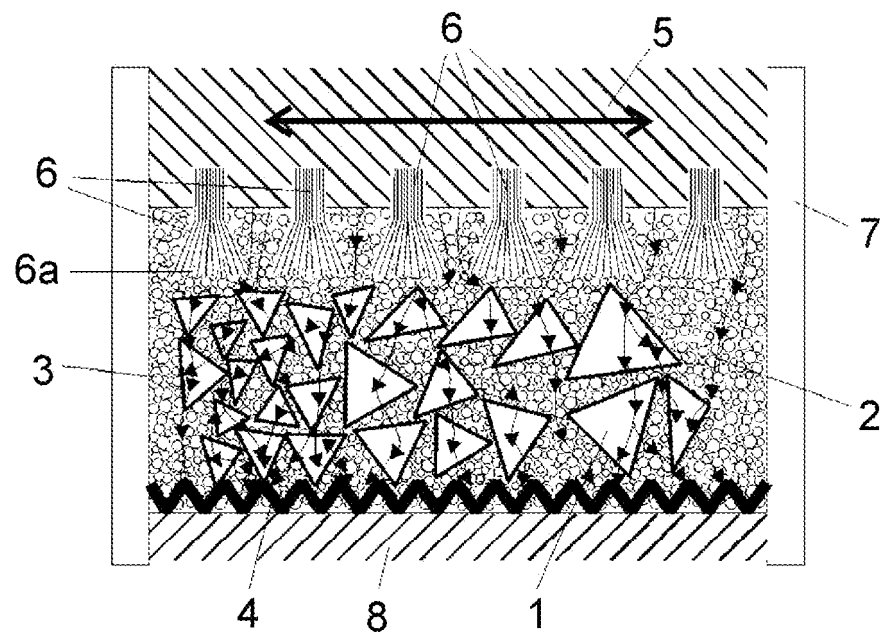


Fig. 5-B

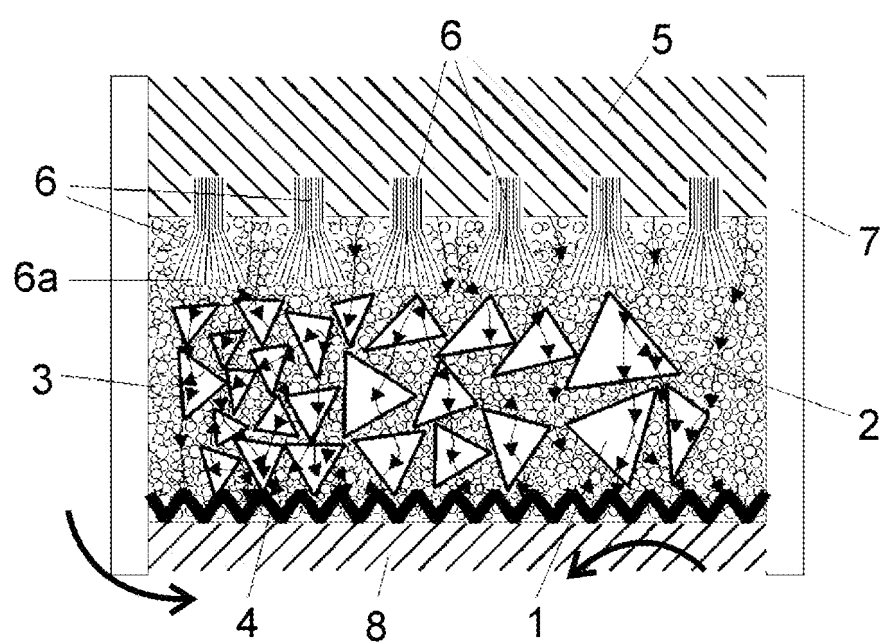


Fig. 5-C

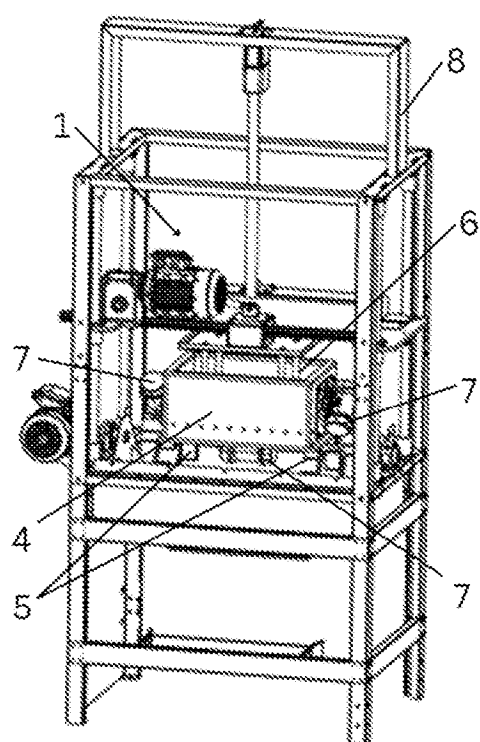


Fig. 6-A

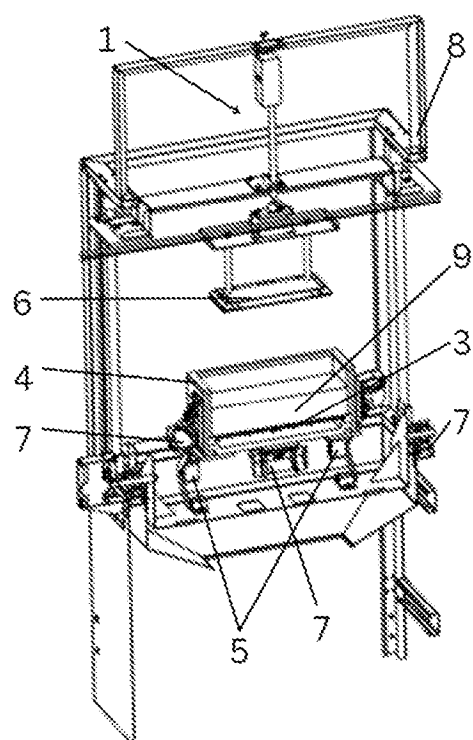


Fig. 6-B

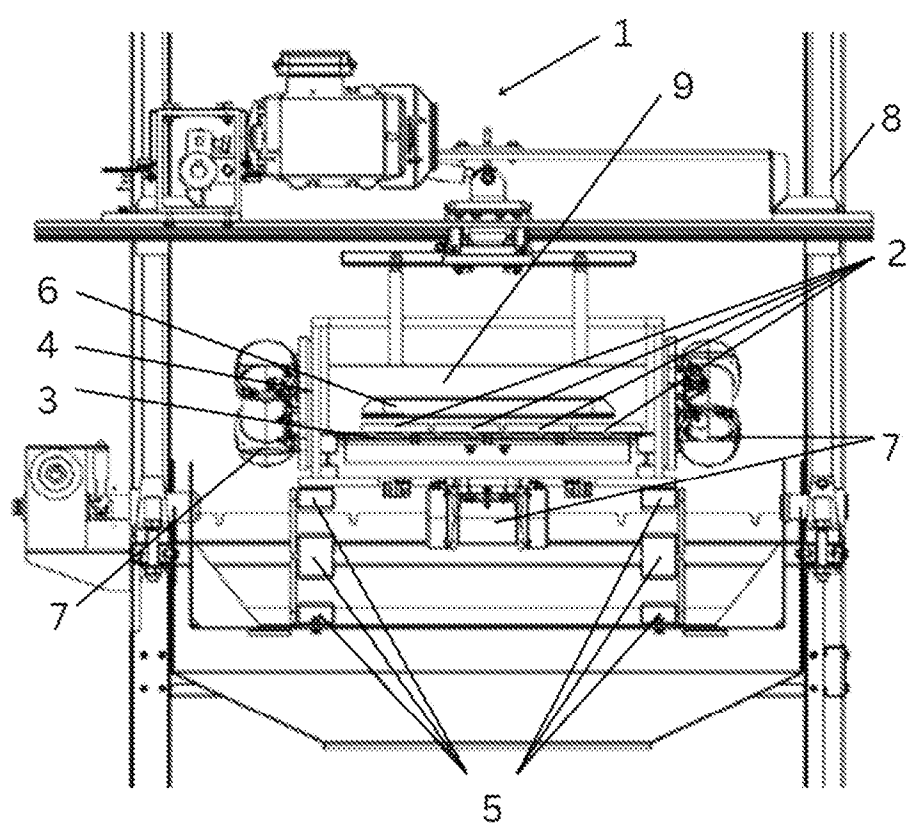


Fig. 6-C

## INTERNATIONAL SEARCH REPORT

International application No

PCT/ES2024/070750

## A. CLASSIFICATION OF SUBJECT MATTER

INV. C25F3/16 C25F7/00  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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Date of the actual completion of the international search

11 April 2025

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

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