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(54) **POWDER COATING (ELECTROSTATIC PAINTING) PLANT FOR TREATING NON ELECTRICALLY CONDUCTIVE BRAKE PADS**

PULVERBESCHICHTUNGSANLAGE (ELEKTROSTATISCHE LACKIERUNG) ZUR BEHANDLUNG VON NICHT ELEKTRISCH LEITFÄHIGEN BREMSBELÄGEN

INSTALLATION DE POWDRAGE (PEINTURE ÉLECTROSTATIQUE) POUR LE TRAITEMENT DE PLAQUETTES DE FREIN NON CONDUCTRICES D'ÉLECTRICITÉ

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**EP 3 485 984 B1**

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**Description**Technical field

**[0001]** The present invention relates to a plant for powder coating non electrically conductive brake pads made with NAO ("Non Asbestos Organic" i.e. asbestos-free organic friction) friction materials.

State of the art

**[0002]** Friction materials utilized as the lining in drum brake shoes of drum brakes and in the brake pads in automobile disk brakes and other devices (for example in clutch plates) are manufactured with a compound (mixture) comprising a fibrous or fiber material, an organic binder (usually a phenolic synthetic resin) and a bulk or "filler". Instead of asbestos as the fiber material, which has been legally banned as a substance dangerous to the environment, mixtures of other organic and inorganic materials are utilized, such as rock wool, aramid and carbon fibers, metal fibers or powder such as copper, tin, iron, aluminum, and other metals or metal alloys such as bronze or brass. EP1227262 for example, indicates the use of a friction material of the above described type containing approximately 10% copper fibers by volume, between 0.1 and 15% tin and/or tin sulfide by volume, and between 4 and 9% bronze fibers by volume.

**[0003]** NAO compounds, due to their composition, have an electric conductivity not sufficient to ensure a good painting thereof; things are even worse if the copper is eliminated (due to environment care compounds without copper are more and more requested).

**[0004]** Even though in brake pads the compound is manufactured as a plaque or pad assembled on a metal plate in order to form the actual brake pad, painting brake pads made with non electrically conductive materials presents numerous problems. In particular, it is presently impossible to utilize currently used powder coating plants built to coat/paint brake pads that are electrically conductive.

**[0005]** More generally it is also known that in order to powder coating (a painting technology requiring use of electrostatic charges) non electrically conductive elements such as for example mechanical components manufactured with plastic polymers, a conductive primer is applied to the surface of the non conductive element to be painted. However, conductive primers are based on organic solvents which are noxious and dangerous to the environment.

**[0006]** Attempts to powder coat brake pads made with non conductive compounds have not been successful up to now; this is because, when at all possible, (thanks to the presence of the metal base support for the plaque in a non conductive compound), the preparation, finish, and thickness are not satisfactory: brake pads manufactured using this method are therefore unable to pass standard corrosion tests. JPS6061078 and WO92/15404 do not

solve these problems.

**[0007]** The only alternative available therefore is the use of other coating technologies, which are however more expensive and require large specially devised plants that call for an unacceptable investment considering present manufacturing volumes.

Summary of the invention

**[0008]** The object of the present invention is to provide a powder coating plant for treating non electrically conductive brake pads, and in particular NAO brake pads, which will lead to optimal application, coverage and surface finishing, comparable to that which can be achieved with plants that are currently in use and that have been designed for treating electrically conductive brake pads manufactured using metal containing compounds; all of this while utilizing presently existing plants with minimal modifications and without the use of conductive primers.

**[0009]** The invention therefore relates to a powder coating plant for treating non electrically conductive brake pads, as defined in claim 1.

**[0010]** According to a main aspect of the invention, upstream of an electrostatically charged painting powder coating/deposition station and of a baking station used to melt and polymerize the coating powder in order to form a coating layer on the surface to be coated of the non conductive brake pads, a pre-treatment station is present in order to make the brake pads to be coated temporarily electrically conductive by uniformly wetting the same by adsorption and/or deposition of poorly mineralized water, on at least the aforementioned surface to be coated with an amount that is sufficient to produce a measurable weight increase in the non conductive brake pads, which will then cause said elements to become electrically conductive. The adsorbed and/or deposited water is subsequently eliminated within the baking station.

**[0011]** Within the scope of the present invention, "poorly mineralized water" or "low mineral content water" shall be understood to be water which is devoid of ions which would be potentially chemically reactive with iron compounds and that has a dry residue and an electric conductivity which are quantitatively comparable to those of bottled water.

**[0012]** In particular, according to an aspect of the invention, the water to be utilized according to the invention and in the plant to implement it must possess a chemical composition devoid of ions which would be potentially chemically reactive with iron compounds and such that the water possesses a value of the specific electrical conductivity measured at 20°C comprised between 1 and 5,000  $\mu\text{S}/\text{cm}$  and preferably comprised between 10 and 700  $\mu\text{S}/\text{cm}$  [in the Metric System "S" is the symbol for Siemens].

**[0013]** Furthermore, according to the applicant's technician's findings the water must be adsorbed and/or deposited on each non electrically conductive brake pad to

be made conductive in an amount that will cause a weight increase in each electrically non conductive element of between 0.15% and 0.30%.

**[0014]** In this manner the electric resistance of brake pads manufactured, with asbestos-free organic friction compounds changes from an order of magnitude of 1,000,000 MΩ (Mega Ohm) before pre-treatment, to values around 0.011 MΩ after pre-treatment, and then back to pre-treatment values at the end of the baking phase, which is commonly carried out in a tunnel oven. Hence pre-treated brake pads can be coated by means of traditional powder coating methods by depositing the coating powder electrostatically by means of the same steps already in use for brake pads manufactured with electrically conductive compounds.

**[0015]** According to the invention, the pre-treatment station comprises a motorized roller rack for tidily conveying the non electrically conductive brake pads; a plurality of nozzles for delivery high pressure jets of low mineral content water towards the non electrically conductive brake pads, said nozzles being suitable for creating a mist all around the non electrically conductive brake pads; at least one supply pump for the nozzles; and an extraction hood facing the nozzles.

**[0016]** In a preferred embodiment, the pre-treatment station further comprises a superheated steam generator operating with a low mineral content water, for instance well water; a plurality of delivery nozzles for a superheated steam towards the non electrically conductive elements; an air/steam mixing means suitable for producing an air/steam flow with an air steam ratio of between 15 and 30 m<sup>3</sup>/kg aimed at the non electrically conductive elements, when the elements are located on a transport mechanism upstream of the electrostatic powder coating station; and cooling means where the non electrically conductive elements are driven by the transport mechanism downstream of the air/steam mixing means and immediately upstream of the electrostatic powder coating station.

**[0017]** According to the first embodiment, the entire pre-treatment station laid out along its longitudinal axis, that is to say in the direction of advancement of the brake pads to be coated, occupies overall a section of only 45 mm (equal to the length of the motorized roller rack), implements the pre-treatment stage in only 10 seconds, and with negligible power consumption (about 1 KW).

**[0018]** In particular these results are obtained by means of two constructive features: on one hand the nozzles are aligned in line to one another underneath the motorized roller rack, so that their jets are aimed from below upwards at a predetermined vertical distance from the motorized roller rack, leaving an empty space, possibly adjustable, between the rack and the nozzles; and on the other hand the extraction hood is defined by a tubular element provided with a straight collection slit facing the nozzles in the same direction of alignment as the nozzles themselves. As a matter of fact, it has been found that when these two constructive features are present at

the same time, they have a synergistic effect that permits regulation of the amount of poorly mineralized water deposited on the brake pad and that wets the compound to be treated with an extremely high degree of precision.

5 This is of the essence in order to achieve the desired electrical conductivity without soaking too much the brake pads.

**[0019]** An additional advantage of the system according to the invention is that it is capable of coating both, 10 NAO asbestos-free organic brake pads and low steel metallic brake pads by simply turning off the pre-treatment station. It is therefore possible to alternate from one type of compound to the other on the same production line without performing any modifications.

15 **[0020]** Finally, the plant of the invention is completely environmentally friendly.

#### Brief description of the drawings

20 **[0021]** Additional features and advantages of the present invention will be apparent from the following description of the two non limiting embodiments thereof given exclusively for exemplification purposes with respect to the enclosed drawings, where:

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- Figure 1 depicts a schematic lateral elevation view, partially in a longitudinal cross-section, of a powder coating plant implemented according to the invention;
  - 30 - Figure 2 depicts an enlarged scale schematic view in cross-section of a component in the plant in figure 1;
  - Figure 3 depicts an enlarged scale perspective view of a second component of the plant in figure 1;
  - 35 - Figure 4 depicts a schematic lateral elevation view, partially in a longitudinal cross-section, of a second embodiment of the powder coating plant implemented according to the invention; and
  - Figures 5 and 6 depict two charts displaying the weight and electrical conductivity variation of asbestos-free organic friction compound brake pads treated according to the method of the invention.
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#### Detailed description

45 **[0022]** With reference to figure 1, is depicted a powder coating plant, overall indicated with reference number 1, for painting non electrically conductive elements 2 as brake pads manufactured with asbestos-free organic friction compounds, known in the art and therefore not shown in detail but only illustrated as blocks.

**[0023]** Said type of brake pads are initially manufactured by molding the compound at a temperature of between 130 and 200°C in order to create a plaque or pad, which are subsequently cured by thermal treatment, assembled onto an iron metal support, and finally painted together with the support.

55 **[0024]** NAO brake pad compounds obtained in this

manner however, using previously existing technologies, cannot be powder coated but only spray painted, with all the associated issues, including protection of the environment, that this implies.

**[0025]** According to the invention, on the contrary, the powder coating plant 1 is utilized, which in general comprises a pre-treatment station 3, where non electrically conductive elements 2 consisting in brake pads are made to be temporarily electrically conductive in the manner that will be described hereinafter and are therefore "transformed" into electrically conductive elements, specifically brake pads 2b, a station 4, of a type known in the art and therefore illustrated only schematically, where coating powders 5 are applied electrostatically onto elements 2b, a melting and polymerization station 6 for the coating powders 5, preferably defined by a baking oven of the tunnel type known in the art and therefore illustrated only schematically for simplicity, and at least one transport mechanism 7 suitable for tidily transporting non electrically conductive elements 2 to be coated in series along stations 3, 4, and 6, in order to traverse the same and finally produce non electrically conductive elements 2 provided with at least one surface 8 to be coated (which may extend to the entire external surface of elements 2 or to part only thereof as the case may be), a coating layer 9 made of the coating powders 5 melted and polymerized in oven 6 at the temperature common for powder coating processes (in general around 200-220°C).

**[0026]** In the depicted non limiting example, plant 1 comprises a transport device 7 traversing stations 4 and 6, and which places the coated elements 2 onto a table 10, and a second device 7 supplying elements 2 to station 3, located upstream of stations 4 and 6.

**[0027]** Hereinafter the terms "upstream" and "downstream" are understood as referring to the direction of advancement D of non electrically conductive brake pads 2 along plant 1, and more specifically stations 3, 4, and 6, indicated by the arrows in figure 1.

**[0028]** According to the invention, pre-treatment station 3 comprises a means 11 for depositing and/or adsorbing poorly mineralized water onto at least the surface 8 to be coated of the non electrically conductive elements or brake pads 2, and preferably on each entire non electrically conductive element 2, in order to cause a measurable weight increase in the non electrically conductive elements 2, corresponding to an amount of low mineral content water retained on the same (at least in correspondence with the surface 8) thus causing said elements 2 to temporarily electrically conduct, "transforming them" into elements 2b.

**[0029]** As previously stated, "poorly mineralized water" is to be understood as water having a composition devoid of ions that would be potentially chemically reactive with iron compounds (which constitute the support for the asbestos-free organic friction compound of brake pads 2), and hence devoid of ions such as Cl<sup>-</sup>, and having an amount of dry residue and an electric conductivity quantitatively comparable to those of the bottled water. The

poorly mineralized water that may be used in plant 1 according to the invention must nonetheless possess a chemical composition such that it has a specific conductivity measured at 20°C comprised between 1 and 5,000 μS/cm and preferably between 10 and 700 μS/cm.

**[0030]** Furthermore, still according to the invention, melting and polymerization station 6 for coating powders 5 must be suitable not only for melting and polymerizing powders 5, but also for eliminating at least part (in fact substantially all) of the water previously adsorbed and or deposited onto non electrically conductive elements 2. Taking into account that station 6 comprises a tunnel oven known within the art where temperatures in the range of 200°C are reached, this last characteristic is built-in. Nonetheless, said characteristic is necessary within the scope of the invention, and hence precludes the use of melting and polymerization stations where there is no certainty of eliminating the water retained upon/within the elements 2.

**[0031]** According to the embodiment illustrated in figure 1, pre-treatment station 3 of plant 1 comprises in combination: a rack 12 comprising a plurality of, for example four, motorized rollers 13 displaced each from the other in direction D along which the non electrically conductive elements 2 are transported tidily in line during processing; a plurality of nozzles 14 supplying high pressure jets 15 of poorly mineralized water (as previously defined, for example well water) towards the non electrically conductive elements 2 found on the rack 12; at least one pump 16 supplying (at a pressure greater than 60 bar and preferably equal to 70 bar) the low mineral content water (contained in a tank not illustrated for simplicity or obtained directly from a well or other natural sources) to nozzles 14; and an extraction hood 17 facing the supply nozzles 14 and provided with a suction fan 18 that collect the environment air together with most of the water supplied by the nozzles 14, so as to prevent water dripping onto the elements 2 after the jets 15 have passed through the rack 12 (through the spacing between the rollers 13) and "wetting" the elements 2 found on the rollers 13.

**[0032]** In particular, the nozzles 14 supply jets 15 that expand in a cone pattern dispersing the water in the air thanks to the drop in pressure at the nozzle, creating in the process a mist (a very fine uniform dispersion of water micro droplets in air) all around the non electrically conductive elements 2 traversing on rollers 13, around the rollers 13 themselves, and in general around the entire volume between the nozzles 14 and hood 17, which wets and deposits a conductive film onto the insulating surface of the elements 2, and where excess water is subsequently aspirated by the hood 17 by means of the suction fan 18, which forces the water into a discharge pipe 19. Being a simple mixture of water and air, the mist aspirated by the hood 17 may be discharged directly into the environment, or treated in order to at least partially recycle the water.

**[0033]** According to the illustrated preferred embodiment, the supply nozzles 14 (see figure 3) are aligned

and spaced along the direction L (figure 3), perpendicular to the transport direction D of the non electrically conductive elements 2 along the plant 1 in general, and on the motorized rollers 13 rack 12 in particular. Direction L is specifically perpendicular to direction D.

**[0034]** In the illustrated example, nozzles 14 are placed under the motorized rollers 13 of rack 12, in order to aim the jets 15 from below upwards; moreover, according to an important aspect of the invention, the nozzles 14 are spaced apart vertically from the motorized rollers 13 of rack 12 by a fixed amount i.e. a predetermined distance T, so that between the rack 12 of motorized rollers 13 and the nozzles 14 there is an empty space, indicated by the letter S in figure 3.

**[0035]** Preferably, station 3 in plant 1 also comprises a means 20 for varying in an adjustable manner the predetermined distance T, which is illustrated schematically only in figure 3 as holes 20b and as a hydraulic or pneumatic piston 20c (any other type of actuator is suitable). According to the non limiting illustration in figure 3, the rollers 13 are each attached to a gear 21, which is rotated by means of a gear transmission 23 driven by a motor 24 common to all four rollers 13, which therefore rotate synchronously. Rollers 13, transmission 23, and motor 24, together with all the remaining rack 12 parts are supported by a frame 25 which is part of the support structure of the plant 1, not illustrated for sake of simplicity.

**[0036]** Frame 25 also comprises upright supports 26 eventually provided with holes 20b spaced apart to one another in the vertical direction; for example, on the upright supports 26 (only one of which is shown for simplicity in figure 3, however it is clear that at least two are necessary, one on each side of rack 12) slides a C section beam 27. The beam 27 provides support for a pipe 28 laid out along direction L, which further bears upwards the nozzles 14. The nozzles 14 are arranged in a line within a pair of bulkheads 29 also connected to beam 27, the top border of which defines the distance T of the nozzles 14 from the rollers 13. Beam 27 may be activated automatically by actuation means 20c, or displaced manually while system 1 is not operating, and fixed in a new position by inserting specially devised fixing pins or cleats (known in the art and not illustrated for simplicity) into holes 20b.

**[0037]** While possessing the above described characteristics, extraction hood 17 is not only constructed as illustrated schematically in figure 1, but is instead implemented as an extraction hood 17b depicted in figure 2.

**[0038]** Extraction hood 17b is defined by a tubular element 30 facing nozzles 14 below, provided with a straight longitudinal aspiration slit 31 running along the direction L of nozzles 14. Said straight slit 31 is defined along its length by two V bent edges/rims 32 bending back into tubular element 30 so as to define inside and at the bottom of said tubular element a water collection suction trap, from which suction trap 33 the collected water (which is thus prevented from falling back towards elements 2) is then removed by the suction fan 18 by

means of suction. For this purpose, suction fan 18 is arranged to face directly opposite slit 31.

**[0039]** In this manner, the mist created by nozzles 14, thanks to the empty space S between them and rollers 13, in which jets 15 can be dispersed precisely forming the cited mist, is extracted by hood 17b through slit 31, causing it to travel around elements 2 and rack 12. Subsequently, the water droplets suspended in the air in order to form said mist, are extracted by hood 17b together with the air where they are suspended; a large portion of the water finds its way directly into drain 19; the water droplets that are not directed to drain 19 lose velocity within pipe 30, which operates as a form of cyclone, and are collected into suction trap 33, without falling onto elements 2, also thanks to the presence of the bent edges 32.

**[0040]** Therefore, elements 2 being transported upon rack 12 receive a controlled amount of water, which they are able to covalently retain, consequently slightly increasing their weight. System 1, and in particular the elements comprising station 3, is/are sized to cause an increase in weight of elements 2 traversing station 3 of between 0.15% and 0.30%.

**[0041]** With respect to figure 4, where similar or identical details to those described previously are indicated with the same reference numbers for simplicity, a plant 1b is depicted corresponding to a possible variation of plant 1 according to the invention, previously described.

**[0042]** Plant 1b differs from plant 1 in that in addition to pre-treatment station 3 a pre-treatment station 3b is added again for the purpose of uniformly wetting in a controlled manner at least the surface 8 to be coated, and preferably each entire non electrically conductive element consisting in a brake pad 2 by adsorption and/or deposition of poorly mineralized water which is covalently retained on elements 2, but in a different manner.

**[0043]** Pre-treatment station 3b comprises: a superheated steam generator 35 that receives a flow of low mineral content water F, as defined previously, and heats it in order to create a flow of steam V at approximately 200°C; a plurality of nozzles 38 supplying such steam to non electrically conductive elements 2; and steam/air mixing means 37 suitable for creating a flow of air/steam with a steam ratio of between 15 and 30 m<sup>3</sup>/kg directed towards non electrically conductive elements 2, when these are located on transport device 7.

**[0044]** According to the non limiting example shown, plant 1b comprises three separate transport devices 7, a first device to load elements 2 into station 3b, a second device 7 included as an integral component of station 3b, on which elements 2 are found when struck by the air/steam flow, and a third device 7 traversing stations 4 and 6 to deposit the coated elements 2 onto table 10. Nozzles 38 (as is the case for all of station 3b) are obviously located upstream of electrostatic application station 4 of coating powders 5, and are arranged in an analogous scheme to that of nozzles 14, but positioned so as to operate above elements 2 and above transport

mechanism 7 on which elements 2 are placed tidily e.g. in series while traversing station 3b.

**[0045]** Station 3b further comprises a cooling means 40 for elements 2b located immediately upstream of powder coating station 4. Elements 2b are simply the non conductive elements 2 that retain the poorly mineralized water supplied by said controlled air/steam flow and which therefore form a covalent bond (also for system 1 described previously) directly above elements 2, which thus become electrically conductive elements 2b.

**[0046]** In the depicted non limiting embodiment, air/steam mixing means 37 and cooling means 40 are defined by two adjacent sections 390 and 391 of a tunnel hood 39 arranged above transport mechanism 7 comprised in station 3b at a predetermined distance T2 from transport mechanism 7 and from a suction fan/aspirator 392 assembled on tunnel hood 39 which aspirates air from the environment into tunnel hood 39 through a slit or gap 393 defined by the distance or empty space T2 between the top surface of transport mechanism 7 on which elements 2/2b are placed and the bottom border of tunnel hood 39; said air, together with a large portion of the steam supplied by nozzles 38, which are arranged inside tunnel hood 39 within section 390 distal from coating station 4, is eliminated by means of a drain 394. Section 391 of tunnel hood 39 is instead next to station 4 and is found immediately downstream of nozzles 38 and immediately upstream of electrostatic powder coating 5 application station 4.

**[0047]** Within section 390 the steam V supplied by nozzles 38 is mixed with part of the environmental air aspirated through gap 393 within hood 39, where the flow of air/steam formed in this manner is directed towards fan 392 and hits elements 2, depositing an amount of poorly mineralized water onto the same, which adheres to surface 8 by means of covalent bonds, "transforming" non conductive elements 2 into conductive elements 2b. In section 391, the remaining environmental air aspirated into tunnel hood 39 by fan 392 hits electrically conductive elements 2b, thus eliminating potential excess water and cooling them (elements 2/2b are in fact heated in section 390 as a result of the heat content of steam V to a temperature not suitable for carrying out the electrostatic powder coating 5 deposition).

**[0048]** On the basis of the above description, it is clear that both plants 1 and 1b are suitable for implementing a method for powder coating of electrically non conductive brake pads 2, comprising: a pre-treatment phase, where non electrically conductive elements 2 are made to electrically conduct on at least one of a surface 8 thereof to be coated, giving rise to temporarily conductive elements 2b; a deposition phase where coating/painting powder 5 is applied by means of an electrostatic field to surface 8 to be coated; and a baking phase, where coating powder 5 previously applied on elements 2b is melted and polymerized in order to create a coating layer 9 on surface 8 to be coated.

**[0049]** Instead of performing the deposition by spray-

ing using solvents and a conductive primer as in the prior art, the pre-treatment phase consists in uniformly wetting at least surface 8 to be coated, and preferably each entire non electrically conductive element 2, by adsorption and/or deposition of water, preferably poorly mineralized water, as defined previously, in order to produce a measurable weight increase in the non electrically conductive elements 2, which causes said elements 2 to temporarily conduct electrically, giving rise to elements 2b.

**[0050]** The water retained by the non electrically conductive elements 2 in order to create elements 2b, which differ from elements 2 precisely because of the presence of water, preferably low mineral content water, adhered by means of covalent bonds to at least surface 8, is subsequently at least partially eliminated (preferably substantially completely removed) during the baking phase.

**[0051]** The poorly mineralized water retained by elements 2 by means of covalent bonds during the pre-treatment phase must possess a chemical composition such that the specific conductivity of such water measured at 20°C is to be comprised between 1 and 5,000  $\mu\text{S}/\text{CM}$  and preferably between 10 and 700  $\mu\text{S}/\text{cm}$ . Furthermore, the pre-treatment phase is carried out so that each non electrically conductive element 2 retains such an amount of water (adsorbed and/or deposited) as to cause an increase in weight in each non electrically conductive element 2 of between 0.15% and 0.30%.

**[0052]** By means of plant 1b, the pre-treatment phase is performed producing, starting from said poorly mineralized water, superheated steam at least 200°C, mixing a flow V of said superheated steam with at least a proportion of an air flow A aspirated inside tunnel hood 39 from the exterior in order to generate at nozzles 38 housed in section 390 of tunnel hood 39 a flow of air/steam in a ratio of between 15 and 30  $\text{m}^3/\text{kg}$ , and directing said steam/air flow by means of suction fan 392 located in section 391 of tunnel hood 39, and therefore placed next to coating station 4 downstream of nozzles 38, onto the non electrically conductive elements 2, arranged tidily, e.g. in line on a conveyor belt (mechanism 7). Said pre-treatment phase is immediately followed by a cooling phase of non electrically conductive elements 2 and made electrically conductive (elements 2b) because of the poorly mineralized water retained with covalent bonds. Said cooling phase is carried out before depositing the painting powder 5, in section 391 of the tunnel hood 39, arranged downstream of section 390 where the nozzles 38 are located.

**[0053]** On the other hand, by means of plant 1 the pre-treatment phase is carried out by spraying high pressure poorly mineralized water jets 15 onto the non electrically conductive elements 2 in order to create a mist around said elements, while extracting the mist through extraction hood 17/17b.

**[0054]** In this case, jets 15 of said poorly mineralized water are aimed at non electrically conductive elements 2 consisting in brake pads from below, while the elements 2 are moving on the motorized roller rack 12, above which

the extraction hood 17 is located.

**[0055]** The effects of the pre-treatment method according to the invention were tested experimentally on a set of samples. A plurality of brake pads of a type known in the art were produced, utilizing however asbestos-free organic friction compound.

**[0056]** Some of the brake pads were treated by means of the above described station 3b with the steam/air mixture and subsequent cooling, measuring their weight before the treatment, after coming into contact with the air/steam mixture (wet pads) in section 390 of tunnel hood 39, after cooling in section 391 of tunnel hood 39, and after baking in tunnel oven 6, at the same temperature utilized for traditionally painted pads. The results obtained with the samples are displayed in figure 5. As it can be immediately seen, the charts depicting the change in weight of the various samples are completely consistent as a trend, and display an increase in weight for wet pads, which diminishes after the cooling phase, and which substantially disappears at the end of the baking phase, proving that the water retained by the brake pads after supplying the steam/air mixture is eliminated in the powder coated (painted) pads. Similarly, the continuous line chart displays the weight variation trend for a coated pad: as it can be seen, the weigh of the pad after cooling remains constant, since the weight of the water lost is equivalent to the weight of the coating (coating powder 5) deposited and baked in stations 4 and 6.

**[0057]** Further brake pads were treated in station 3 described previously, displaying the same weight variation trend.

**[0058]** Finally the mean of the weight increase/decrease measurements and electrical resistance for the "blank" (not coated) brake pads before water treatment, after treatment, at the exit of tunnel hood 39, and at the exit of oven 6 are shown. The results obtained are shown in the charts in figure 6. As it can be seen, in the "wet" state the non conductive brake pads become conductive, showing mean electrical resistance values between 0.01 and 0.02 Mega Ohm, against a mean electrical resistance values of non treated pads (not wet) and after baking in oven 6 of approximately 1,000,000 Mega Ohm.

**[0059]** Since stations 4 and 6 are identical to those of traditional powder coating plants devised for treating brake pads obtained with conductive compounds (containing metal), it is clear that plants 1 and 1b can be derived from already existing plants, by simply adding station 3/3b in series. Furthermore, by simply activating/deactivating stations 3 and 3b, plants 1 and 1b are suitable for treating brake pads obtained from both conductive compounds, and non conductive compounds.

**[0060]** Therefore the aims of the invention are fully met.

## Claims

1. A plant (1;1b) for powder coating of electrically non-conductive brake pads (2) assembled onto an iron

metal support, comprising a pre-treating station (3;3b), in which the electrically non-conductive brake pads are made temporarily electrically conductive (2b), a coating station (4) for electrostatic applying painting powders (5), a station (6) for melting and polymerizing the painting powders (5), preferably defined by a tunnel shaped baking oven, and at least one conveyor device (7) adapted to make the electrically non-conductive brake pads (2) assembled onto an iron metal support to be painted move along said stations (3;3b,4,6); wherein the pre-treating station (3;3b) comprises means (11) for making water to be retained on at least one surface (8) to be painted of said electrically non-conductive brake pads (2) and, preferably, on each said entire electrically non-conductive brake pad, to such an extent to produce a measurable increase of weight in the electrically non-conductive brake pads, which makes such brake pads electrically conductive (2b); said painting powder melting and polymerizing station (6) being further configured to eliminate by evaporation at least part of the water previously retained on the electrically non-conductive brake pads (2); **characterized in that, in combination:**

- i)- the pre-treating station (3;3b) comprises a source of low mineral content water, having a specific conductivity comprised between 1 and 5,000  $\mu\text{S}/\text{cm}$ , and preferably between 10 and 700  $\mu\text{S}/\text{cm}$ , measured at 20°C;
- ii)- the pre-treating station further comprising: a motorized rolling rack (12) having powered rollers (13) on which the electrically non-conductive brake pads (2) transit tidily; a plurality of nozzles (14) for supplying high pressure jets (15) of said low mineral content water towards the electrically non-conductive brake pads (2), said nozzles (14) being adapted to create a mist all-around said electrically non-conductive brake pads; at least one feeding pump (16) for said nozzles; and a suction hood (17;17b) arranged facing said nozzles (14);
- iii)- the said nozzles (14) being arranged underneath said motorized roller rack (12) at a predetermined vertical gap (T) from the powered roller rack (12), so that
- iv)- an empty space (S) is delimited between the rack and said nozzles; and
- v)- said nozzles address said jets (15) of said low mineral content water onto the electrically non-conductive brake pads (2) from the bottom upwards while the brake pads (2) move upon the powered rolls (13),
- vi)- said suction hood (17;17b) being arranged over the motorized roller rack (12).

2. A plant (1b) according to claim 1, **characterized in that** the pre-treating station (3b) comprises in com-

bination: an over-heated steam generator (35) starting from said low mineral content water; a plurality of delivery nozzles (38) for said flow of over-heated steam (V) toward said electrically non-conductive brake pads; air/steam mixing means (37) adapted to produce towards said electrically non-conductive brake pads (2), when they are placed upon said at least one conveyor device (7), an air/steam flow with an air/steam ratio comprised from 15 to 30 m3/kg; and cooling means (391;392) through which said electrically non-conductive brake pads are guided by said at least one conveyor device (7), downstream of said air/steam mixing means (37) and immediately upstream of the painting powder coating station (4).

3. A plant according to claim 1, **characterized in that**, in combination:

vi)- said nozzles (14) are arranged aligned side by side with an aligning direction (L) transversal to a forward direction (D) of the electrically non-conductive brake pads on said powered roll rack (12);

vii)- the supply nozzles (14) and the at least one feeding pump (16) are adapted to generate said pressurized low mineral content water jets (15) at a pressure of at least 60 bar;

viii)- the suction hood (17b) is defined by a tubular element (30) provided towards the nozzles with a rectilinear through suction slot (31) arranged parallel to the aligning direction (L) of the nozzles.

4. A plant according to claim 3, **characterized in that** it comprises means (20) for adjustably varying said predetermined vertical gap (T); and **in that** said rectilinear slot (31) is longitudinally delimited by a pair of V-folded edges (32) folded towards the inside of the tubular element so as to delimit within and under the same a water collecting suction trap (33).

### Patentansprüche

1. Werksanlage (1; 1b) zur Pulverbeschichtung von elektrisch nicht leitenden Bremsbelägen (2), die auf einem Eisenmetallträger montiert sind, umfassend eine Vorbehandlungsstation (3; 3b), in der die elektrisch nicht leitenden Bremsbeläge vorübergehend elektrisch leitend gemacht werden (2b), eine Beschichtungsstation (4) zum elektrostatischen Auftragen von Lackierungspulvern (5), eine Station (6), zum Schmelzen und Polymerisieren der Lackierungspulver (5) die vorzugsweise durch einen tunnelförmigen Backofen definiert ist, und zumindest eine Fördereinrichtung (7), die ausgelegt ist, um die elektrisch nicht leitenden Bremsbeläge (2), die auf einem Eisenmetallträger montiert und zu lackieren

sind, entlang der Stationen (3; 3b, 4, 6) zu bewegen; wobei die Vorbehandlungsstation (3; 3b) Mittel (11) umfasst, um Wasser, das auf zumindest einer zu lackierenden Oberfläche (8) der elektrisch nicht leitenden Bremsbeläge (2) und vorzugsweise auf jedem gesamten elektrisch nicht leitenden Bremsbelag derart zurückzuhalten, dass eine messbare Gewichtszunahme in den elektrisch nicht leitenden Bremsbelägen erzeugt wird, die solche Bremsbeläge elektrisch leitend macht (2b); wobei die Lackierungspulverschmelz- und Polymerisationsstation (6) ferner so konfiguriert ist, dass sie durch Verdampfung zumindest einen Teil des zuvor auf den elektrisch nicht leitenden Bremsbelägen (2) zurückgehaltenen Wassers eliminiert; **dadurch gekennzeichnet, dass in Kombination:**

i)- die Vorbehandlungsstation (3; 3b) eine Quelle für Wasser mit niedrigem Mineralgehalt mit einer spezifischen Leitfähigkeit zwischen 1 und 5000 pmS/cm und vorzugsweise zwischen 10 und 700 pmS/cm, gemessen bei 20 °C, umfasst;

ii)- wobei die Vorbehandlungsstation ferner umfasst: einen motorisierten Rollträger (12) mit angetriebenen Rollen (13), auf denen die elektrisch nicht leitenden Bremsbeläge (2) geordnet laufen; eine Vielzahl von Düsen (14) zum Zuführen von Hochdruckstrahlen (15) des Wassers mit niedrigem Mineralgehalt zu den elektrisch nicht leitenden Bremsbelägen (2), wobei die Düsen (14) ausgelegt sind, um die gesamten elektrisch nicht leitenden Bremsbeläge herum einen Nebel zu erzeugen; zumindest eine Förderpumpe (16) für die Düsen; und eine Absaughaube (17; 17b), die den Düsen (14) zugewandt angeordnet sind;

iii)- wobei die Düsen (14) unterhalb des motorisierten Rollträgers (12) in einem vorbestimmten vertikalen Abstand (T) von dem angetriebenen Rollträger (12) angeordnet sind, sodass iv)- ein Leerraum (S) zwischen dem Träger und den Düsen abgegrenzt ist; und

v)- die Düsen die Strahlen (15) des Wassers mit niedrigem Mineralgehalt auf die elektrisch nicht leitenden Bremsbeläge (2) von unten nach oben richten, während sich die Bremsbeläge (2) auf den angetriebenen Rollen (13) bewegen, vi)- die Absaughaube (17; 17b) über dem motorisierten Rollträger (12) angeordnet ist.

2. Werksanlage (1b) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vorbehandlungsstation (3b) in Kombination umfasst: einen Generator (35) für überhitzten Dampf, der von dem Wasser mit niedrigem Mineralgehalt ausgeht; eine Vielzahl von Abgabedüsen (38) für den Strom von überhitztem Dampf (V) in Richtung der elektrisch nicht leitenden Bremsbeläge; Luft/Dampf-Mischmittel (37), die aus-



gelegt sind, um einen Luft/Dampf-Strom mit einem Luft/Dampf-Verhältnis von 15 bis 30 m<sup>3</sup>/kg in Richtung der elektrisch nicht leitenden Bremsbeläge (2) zu produzieren, wenn diese auf der zumindest einen Fördereinrichtung (7) platziert sind; und Kühlmittel (391; 392), durch die die elektrisch nicht leitenden Bremsbeläge durch die zumindest eine Fördereinrichtung (7) geführt werden, stromabwärts der Luft/Dampf-Mischmittel (37) und unmittelbar stromaufwärts der Lackierungspulverbeschichtungsstation (4).

**3. Werksanlage nach Anspruch 1, dadurch gekennzeichnet, dass** in Kombination:

vi) - die Düsen (14) nebeneinander ausgerichtet angeordnet sind, mit einer Ausrichtungsrichtung (L) quer zu einer Vorwärtsrichtung (D) der elektrisch nicht leitenden Bremsbeläge auf dem angetriebenen Rollenträger (12);

vii) - die Zufuhrdüsen (14) und die zumindest eine Förderpumpe (16) ausgelegt sind, um die unter Druck stehenden Strahlen (15) von Wasser mit niedrigem Mineralgehalt bei einem Druck von zumindest 60 bar zu erzeugen;

viii) - die Absaughaube (17b) durch ein rohrförmiges Element (30) definiert ist, das in Richtung der Düsen mit einem geradlinigen Durchgangsabsaugschlitz (31) versehen ist, der parallel zur Ausrichtungsrichtung (L) der Düsen angeordnet ist.

**4. Werksanlage nach Anspruch 3, dadurch gekennzeichnet, dass** sie Mittel (20) zum einstellbaren Verändern des vorbestimmten vertikalen Abstands (T) umfasst, und dass der geradlinige Schlitz (31) in Längsrichtung durch ein Paar V-förmig gefalteter Ränder (32) begrenzt ist, die in Richtung des Inneren des rohrförmigen Elements gefaltet sind, um innerhalb und unter diesen eine Wassersammelsaugfalle (33) zu begrenzen.

**Revendications**

1. Usine (1 ; 1b) pour le revêtement en poudre de plaquettes de frein (2) électriquement non conductrices assemblées sur un support métallique en fer, comprenant une station de prétraitement (3 ; 3b), dans laquelle les plaquettes de frein électriquement non conductrices sont rendues temporairement électriquement conductrices (2b), une station de revêtement (4) pour l'application électrostatique de poudres de peinture (5), une station (6) pour la fonte et la polymérisation des poudres de peinture (5), définie de préférence par un four de cuisson en forme de tunnel, et au moins un dispositif transporteur (7) adapté de sorte que les plaquettes de frein électri-

quement non conductrices (2) assemblées sur un support métallique en fer à peindre se déplacent le long desdites stations (3 ; 3b, 4, 6) ; dans lequel la station de prétraitement (3 ; 3b) comprend un moyen (11) pour retenir l'eau sur au moins une surface (8) à peindre desdites plaquettes de frein électriquement non conductrices (2) et, de préférence, sur chacune desdites plaquettes de frein électriquement non conductrices de l'électricité entières, dans une telle mesure que cela produit une augmentation mesurable de poids dans les plaquettes de frein électriquement non conductrices, qui rend de telles plaquettes de frein électriquement conductrices (2b) ; ladite station de fusion et de polymérisation de poudre de peinture (6) étant en outre configurée pour éliminer par évaporation au moins une partie de l'eau précédemment retenue sur les plaquettes de frein électriquement non conductrices (2) ; **caractérisée en ce que, en combinaison :**

i)- la station de prétraitement (3 ; 3b) comprend une source d'eau à faible teneur en minéraux, ayant une conductivité spécifique comprise entre 1 et 5 000 pS/cm, et de préférence entre 10 et 700 pS/cm, mesurée à 20 °C ;

ii)- la station de prétraitement comprenant en outre : un portoir roulant motorisé (12) ayant des rouleaux motorisés (13) sur lesquels les plaquettes de frein électriquement non conductrices (2) transitent de manière régulière ; une pluralité de buses (14) pour fournir des jets haute pression (15) de ladite eau à faible teneur en minéraux vers les plaquettes de frein électriquement non conductrices (2), lesdites buses (14) étant adaptées pour créer un brouillard tout autour desdites plaquettes de frein électriquement non conductrices ; au moins une pompe d'alimentation (16) pour lesdites buses ; et une hotte d'aspiration (17 ; 17b) disposés en face desdites buses (14) ;

iii)- lesdites buses (14) étant disposées sous ledit portoir à rouleaux motorisés (12) à un espace vertical prédéterminé (T) du portoir à rouleaux motorisés (12), de sorte que

iv)- un espace vide (S) est délimité entre le portoir et lesdites buses ; et

v)- lesdites buses adressent lesdits jets (15) de ladite eau à faible teneur en minéraux sur les plaquettes de frein (2) électriquement non conductrices, du bas vers le haut, tandis que les plaquettes de frein (2) se déplacent sur les rouleaux motorisés (13),

vi)- ladite hotte aspirante (17 ; 17b) étant disposée au-dessus du portoir à rouleaux motorisés (12).

2. Usine (1b) selon la revendication 1 **caractérisée en ce que** la station de prétraitement (3b) comprend en

combinaison : un générateur de vapeur surchauffée (35) à partir de ladite eau à faible teneur en minéraux ; une pluralité de buses de distribution (38) pour ledit écoulement de vapeur surchauffée (V) vers lesdites plaquettes de frein électriquement non conductrices ; des moyens de mélange air/vapeur (37) adaptés pour produire vers lesdites plaquettes de frein électriquement non conductrices (2), lorsqu'ils sont placés sur ledit au moins un dispositif transporteur (7), un flux d'air/vapeur avec un rapport air/vapeur compris entre 15 et 30 m<sup>3</sup>/kg ; et des moyens de refroidissement (391 ; 392) à travers lesquels lesdites plaquettes de frein électriquement non conductrices sont guidées par ledit au moins un dispositif transporteur (7), en aval desdits moyens de mélange air/vapeur (37) et immédiatement en amont de la station de revêtement de peinture en poudre (4).

3. Usine selon la revendication 1, **caractérisée en ce que**, en combinaison :

- vi) - lesdites buses (14) sont disposées alignées côte à côte avec une direction d'alignement (L) transversale à une direction avant (D) des plaquettes de frein électriquement non conductrices sur ledit portoir à rouleaux motorisés (12) ;
- vii) - les buses d'alimentation (14) et l'au moins une pompe d'alimentation (16) sont adaptées pour générer lesdits jets d'eau à faible teneur en minéraux sous pression (15) à une pression d'au moins 60 bars ;
- viii) - la hotte d'aspiration (17b) est définie par un élément tubulaire (30) fourni vers les buses avec une fente d'aspiration rectiligne (31) disposée parallèlement à la direction d'alignement (L) des buses.

4. Usine selon la revendication 3, **caractérisée en ce qu'elle** comprend des moyens (20) pour faire varier de manière réglable ledit espace vertical prédéterminé (T) ; et **en ce que** ladite fente rectiligne (31) est délimitée longitudinalement par une paire de bords pliés en V (32) pliés vers l'intérieur de l'élément tubulaire de manière à délimiter à l'intérieur et sous celui-ci un piège d'aspiration de collecte d'eau (33).

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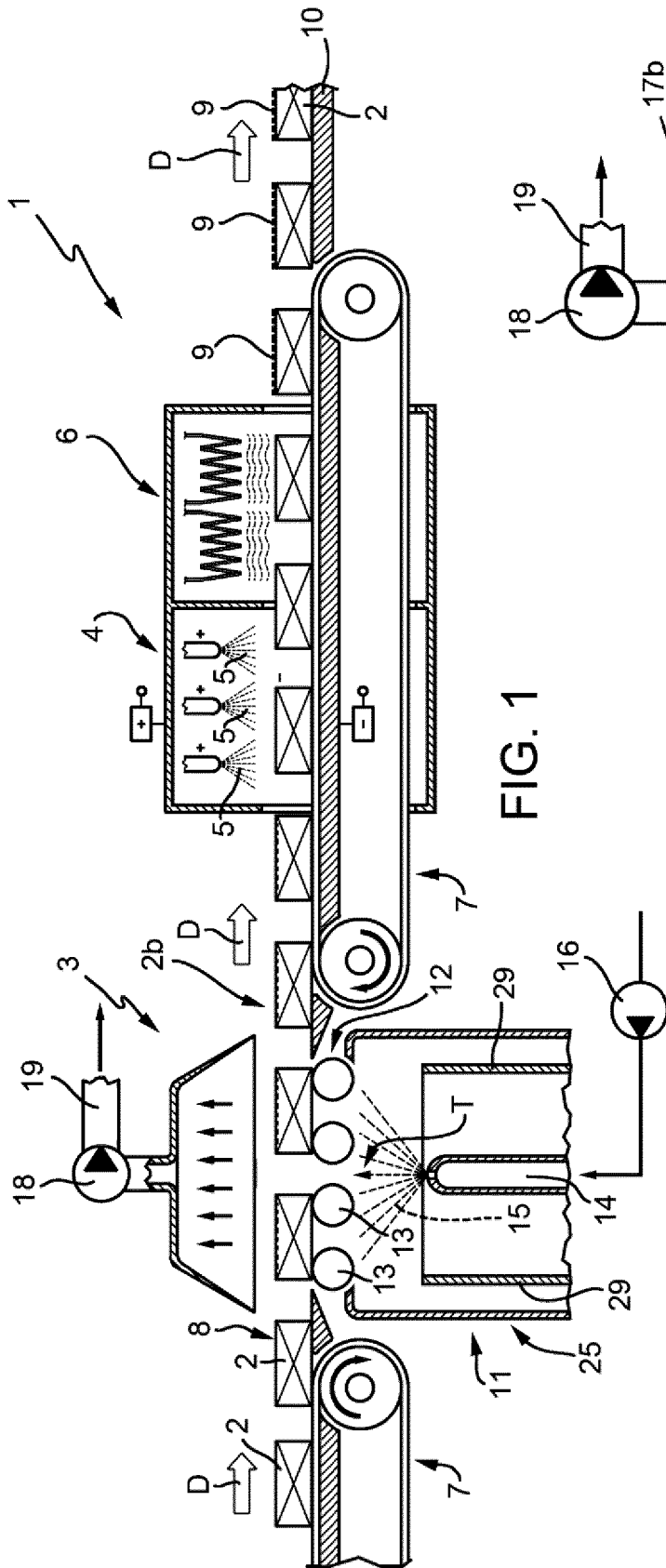


FIG. 1

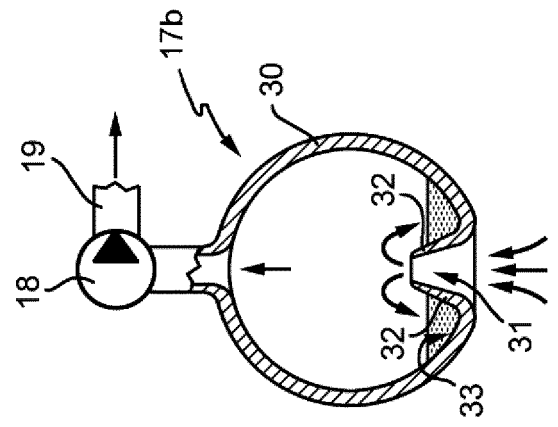


FIG. 2

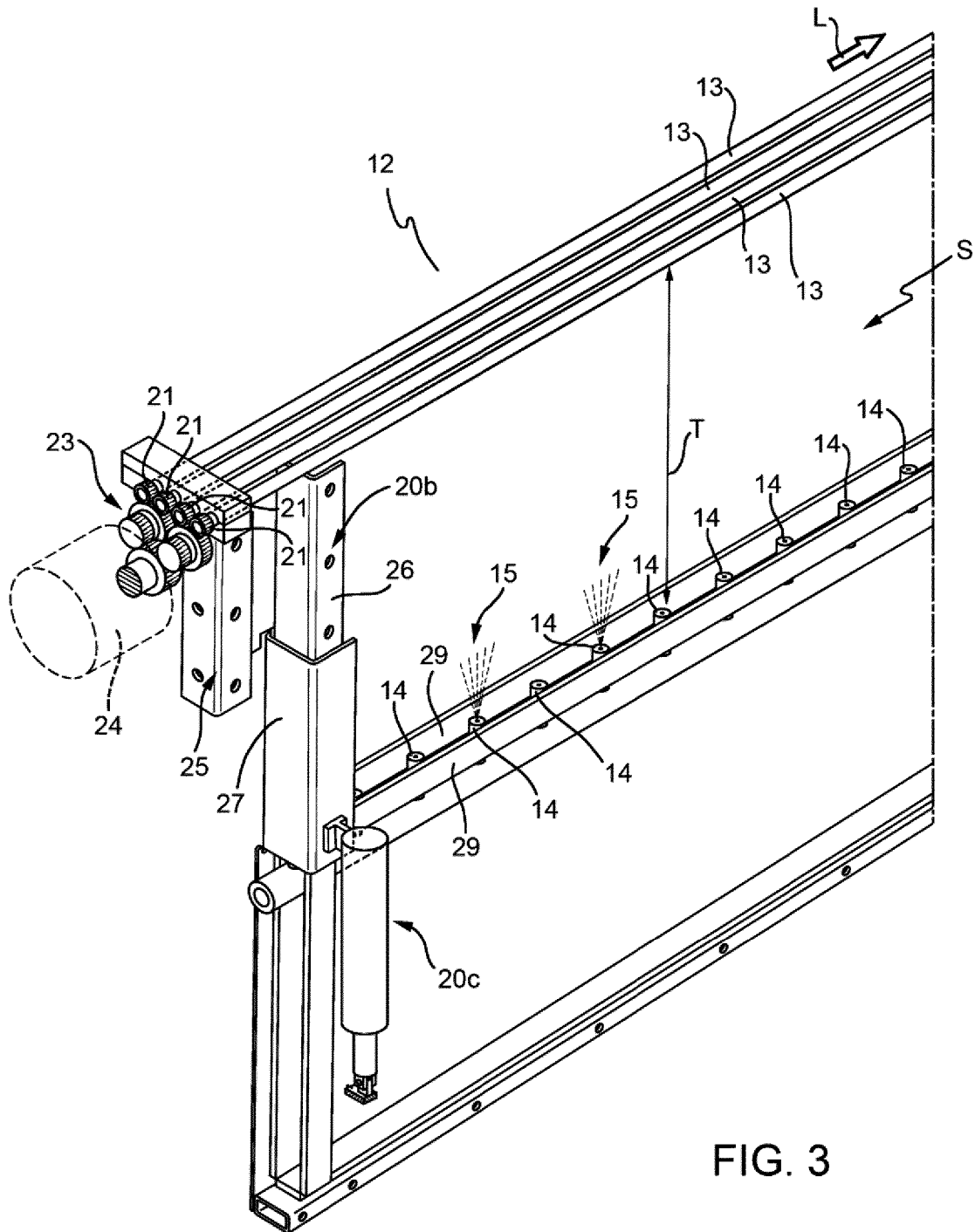


FIG. 3

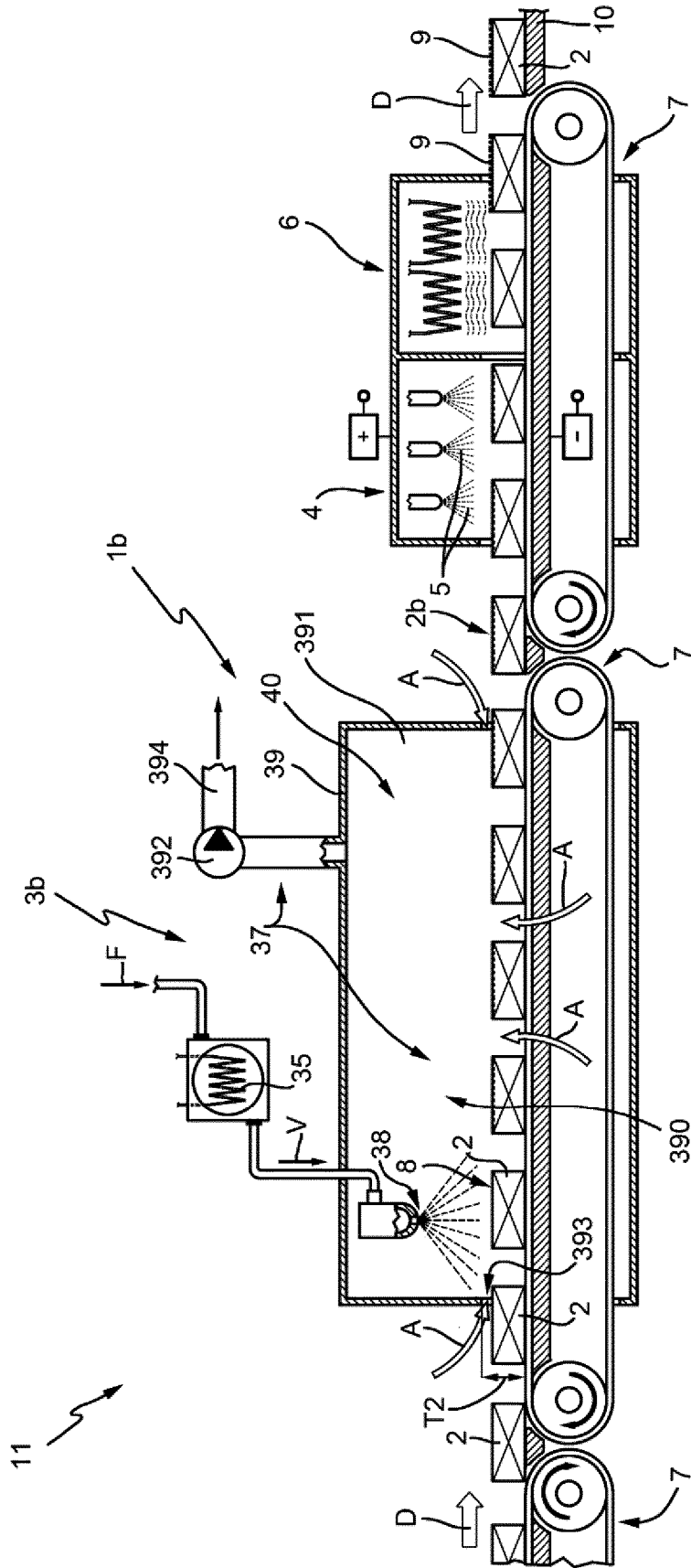


FIG. 4

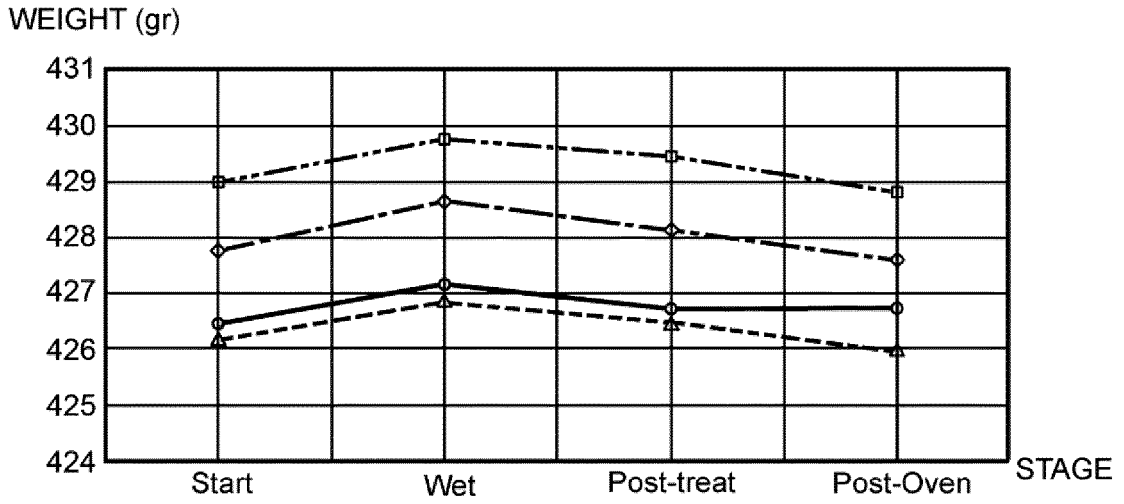


FIG. 5

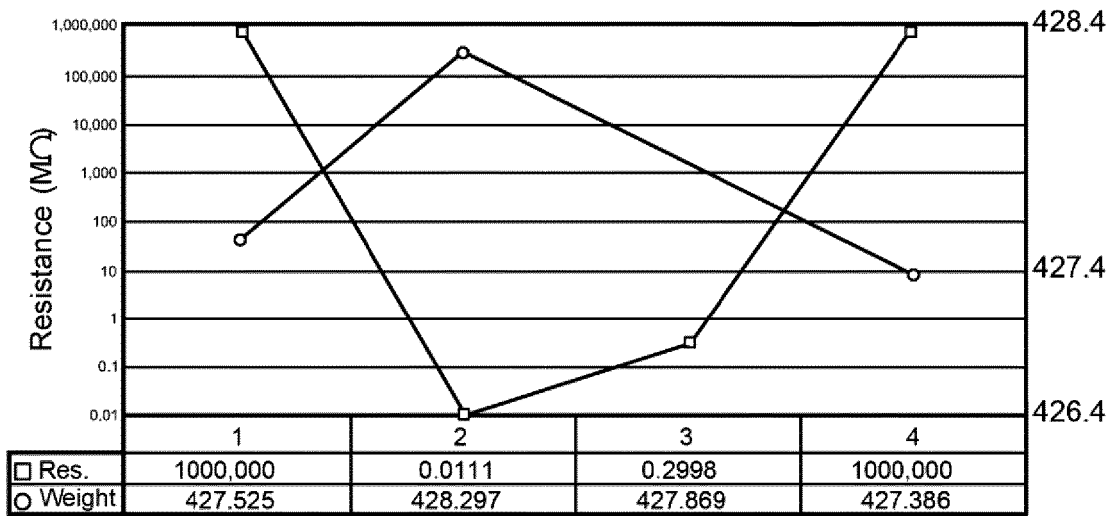


FIG. 6

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- EP 1227262 A [0002]
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