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(54) GALVANIC PLATING MODULE OF A HORIZONTAL GALVANIC PLATING LINE FOR GALVANIC METAL DEPOSITION ON A SUBSTRATE

(57) The present invention is related to galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate; wherein said galvanic plating module comprises an inlet area, a plating device, and an outlet area, wherein the inlet area is arranged on one side of the plating device while the outlet area is arranged subsequently on the other side of the plating device in a transport direction of the substrate; wherein the plating device comprises an inlet side, an outlet side, an upper part and/or a lower part, and at least one first transport element for simultaneously transporting and electrically contacting the substrate during its transportation at a transport level in transport direction; and wherein the inlet area and/or the outlet area of the galvanic plating module comprises at least a second transport element for transporting the substrate during its transportation at a transport level in transport direction, wherein the galvanic plating module comprises further at least two substrate guiding elements being in conjunction with said plating device and said second transport element, wherein said substrate guiding elements are arranged between said plating device and said second transport element below and/or above the transport level of the substrate.

Further, the present invention is generally directed to a kit for a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate. The invention also relates to a method for adapting a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate by making use of such a kit.

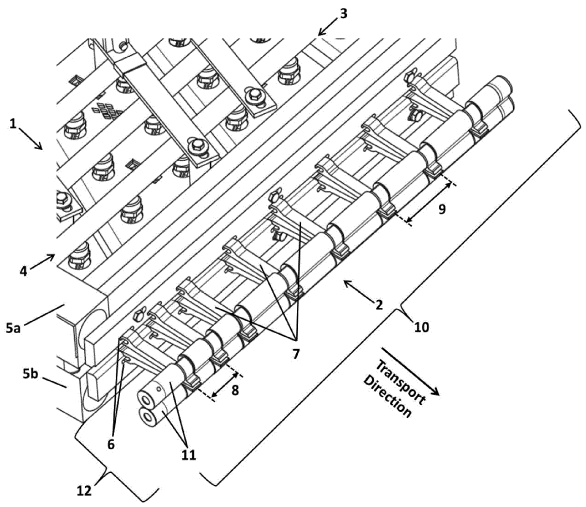

Figure 1

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Description

Field of the Invention

[0001] The present invention relates to a galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate. The invention further relates to a kit for a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate. The invention also relates to a method for adapting a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate by making use of such a kit.

Background of the Invention

[0002] There have been known a plurality of different transport systems in the past for transporting a substrate through a galvanic plating module of a horizontal galvanic plating line for metal, in particular copper, deposition by a galvanic process. Herein, a galvanic plating module is commonly subdivided in three different areas, namely an inlet area, a plating device and an outlet area. The inlet area and the outlet area are herein areas, wherein the substrate will only be transported through without electrically contacting them during their transportation. Inside of the plating device of the galvanic plating module instead, the respective substrates will be transported and simultaneously electrically contacted by other transport elements, such as a series of subsequently arranged clamps.

[0003] Known transport systems for the inlet area and the outlet area of such a galvanic plating module comprises commonly a plurality of different transport elements below and/or above the transport level of a substrate. This can be exemplarily a classical roll having the same constant diameter in axial direction, which is perpendicular to the transport direction of the substrates; or a wheel axis comprising a roll with constant diameter in axial direction having additional circular discs arranged spaced apart from each other on the surface of said roll. Such wheel axis have been successfully proven to be a suitable alternative for the above-mentioned classical rolls as transport elements for forwarding the respective substrates inside of these areas of a galvanic plating module.

[0004] Therefore, it has been already attempted in the past to solely make use of these common transport elements for forwarding a substrate from a transport element arranged in the inlet area of a galvanic plating module to the inlet side of the plating device; or from the outlet side of a plating device of a galvanic plating module to the next subsequently arranged transport element being arranged in the outlet area of the respective galvanic plating module.

[0005] However, with both types of the above-cited transport elements, there had been solely successfully transported relatively thick and rigid substrates in the past.

[0006] A severe disadvantage of these transport elements is the continuous physical contact between the rolls or wheel axis and the substrates. In case of sensitive surfaces, pattern plating or even in panel plating, there are requirements to reduce said physical contact, for instance to avoid contacting of photo resist covered surface areas of the substrates or to avoid damages of fine conductive structures or conductive patterns on said surfaces. A further disadvantage can be the unintentional particle contamination on the surface of these substrates by said rolls or wheel axis caused by surface abrasion of the respective transport element. These above-cited disadvantageous are even more generated, if a transport element having an extensive area, such as a metal sheet or steel plate, is used.

[0007] Especially, the fact that the demands of the industry are changing more and more to systems being able to transport substrates, whose thickness, stiffness and rigidity are more and more decreasing while at the same time the flexibility is more and more increasing, generates new problems such as threading for ensuring a safe transport of these flexible substrates.

[0008] These new demands prevent the possibility to work without additional transport elements in the inlet area and the outlet area close to the respective inlet side or outlet side of the plating device of the galvanic plating module. Even when the industry of course always attempts to reduce the distance between the last transport element being arranged in the inlet area in front of the inlet side of the plating device; or between the outlet side of the plating device and the first transport element subsequently arranged in the outlet area of the galvanic plating module, there will be always a distance in between.

[0009] This is especially a severe problem, if the transport element for simultaneously transporting and electrically contacting the substrate inside of the plating device is a series of clamps. They are commonly installed in prior art plating devices in form of an enclosed circle as a continuous loop system, wherein each clamp is returning to the inlet side of the plating device after having arrived at the outlet side of the plating device. Herein, each clamp clamps at least a part of a substrate at the inlet side of the plating device, transporting and electrically contacting the substrate during its transportation through said plating device. After having arrived at the outlet side of the plating device, the clamp opens and releases thereby the substrate. Afterwards, said clamp is running on the backside (herein referred as contact side of the plating device) back to the inlet side of the plating device to clamp there another substrate.

[0010] Conclusively, if such a continuous loop of clamps is used, there is always an intermediate space in between the inlet side and the outlet side of the plating device and the closest adjacently arranged transport element of the inlet area or the outlet area inside of the galvanic plating module, namely at least the space required for the movement of one clamp inside of said con-

tinuous clamp loop.

[0011] This serious problem of somehow "bridging" said intermediate space has not yet been solved successfully.

Objective of the present Invention

[0012] In view of the prior art, it was thus an object of the present invention to provide a galvanic plating module comprising substrate guiding elements, which shall not exhibit the aforementioned shortcomings of the known prior art galvanic plating modules.

[0013] In particular, it was an object of the present invention to provide a galvanic plating module, wherein a safe transport of substrates between a plating device and adjacent transport element(s) in the inlet and/or the outlet area of such a galvanic plating module can be ensured without the risk that the substrates will thread into or around said transport elements.

[0014] Furthermore, it has been an object of the present invention to avoid that substrates, in particular flexible substrates, will be misguided outside of the transport level during their forwarding from a plating device to an outlet area or from the inlet area to a plating device inside of such a galvanic plating module.

[0015] Furthermore, it was an object to provide a solution for forwarding substrates comprising at least sensitive surface parts without mechanically or physically damaging them by the surface of the substrate guiding elements. Additionally, it was especially an object of the present invention to provide a kit for an already installed galvanic plating module.

Summary of the Invention

[0016] These objects and also further objects which are not stated explicitly but are immediately derivable or discernible from the connections discussed herein by way of introduction are achieved by a galvanic plating module having all features of claim 1. Appropriate modifications to the inventive galvanic plating module are protected in dependent claims 2 to 13. Further, claim 14 comprises a kit for a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate. Furthermore, claim 15 comprises a method for adapting a galvanic plating module by making use of such a kit.

[0017] The present invention accordingly provides a galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate; wherein said galvanic plating module comprises an inlet area, a plating device, and an outlet area, wherein the inlet area is arranged on one side of the plating device while the outlet area is arranged subsequently on the other side of the plating device in a transport direction of the substrate; wherein the plating device comprises an inlet side, an outlet side, an upper part and/or a lower part, and at least one first transport element for simultaneously transporting and electrically contacting the substrate during its transportation at a transport level in transport direction; and wherein the inlet area and/or the outlet area of the galvanic plating module comprises at least a second transport element for transporting the substrate during its transportation at a transport level in transport direction, characterized in that the galvanic plating module comprises further at least two substrate guiding elements being in conjunction with said plating device and said second transport element, wherein said substrate guiding elements are arranged between said plating device and said second transport element below and/or above the transport level of the substrate.

[0018] It is thus possible in an unforeseeable manner to provide a galvanic plating module comprising substrate guiding elements, which does not exhibit the aforementioned shortcomings of the known prior art galvanic plating modules.

[0019] In particular, it is now possible to provide a galvanic plating module, wherein a safe transport of substrates between a plating device and adjacent transport element(s) (herein defined as second transport elements) in the inlet and/or the outlet area of such a galvanic plating module can be ensured without the risk that the substrates will thread into or around said transport elements.

[0020] Furthermore, it can now be avoided that substrates, in particular flexible substrates, will be misguided outside of the transport level during their forwarding from a plating device to an outlet area or from the inlet area to a plating device inside of such a galvanic plating module.

[0021] Furthermore, it is possible to provide a solution for forwarding substrates comprising at least sensitive surface parts without mechanically or physically damaging them by the surface of the substrate guiding elements.

[0022] Additionally, it is possible to provide a kit for an already installed galvanic plating module.

Brief Description of the Figures

[0023] For a more complete understanding of the present invention, reference is made to the following Detailed Description of the Invention considered in conjunction with the accompanying figures, in which:

Fig. 1 shows a schematic perspective side view of a part of a galvanic plating module of a preferred embodiment of the present invention;

Fig. 2 shows a schematic side view of a part of a galvanic plating module of the preferred embodiment of the present invention shown in Fig. 1;

Fig. 3 shows a schematic cut out of the side view of a part of a galvanic plating module of the preferred embodiment shown in Fig. 2; and

Fig. 4 shows a schematic top view of a part of a

galvanic plating module of the preferred embodiment of the present invention shown in Fig. 1.

Detailed Description of the Invention

[0024] As used herein, the term "galvanic metal", when applied to a horizontal galvanic plating device for galvanic metal deposition on a substrate in accordance with the present invention, refers to metals which are known to be suitable for such a horizontal deposition method. Such galvanic metals comprise gold, nickel, and copper, preferably copper.

[0025] As used herein, the term "being in conjunction" refers in its broadest sense to any kind of suitable connection of the substrate guiding elements between the plating device of the galvanic plating module and the second transport element(s). This comprises a detachably or permanently fixed connection. Herein, a detachable connection is preferred due to its character of being the more flexible possibility compared to a permanently fixed connection.

[0026] A substrate can be round, preferably circular, or angular, preferably polyangular, such as rectangular, quadratic or triangular, or a mixture of round and angular structure elements, such as semicircular. Such a substrate can have a diameter ranging from 50 mm to 1000 mm, preferably from 100 mm to 700 mm, and more preferably from 120 mm to 500 mm, in case of a round structure; or a side length ranging from 10 mm to 1000 mm, preferably from 25 mm to 700 mm, and more preferably from 50 mm to 500 mm, in case of an angular, preferably polyangular, structure. The substrate can be a printed circuit board, a printed circuit foil, a semiconductor wafer, a solar cell, a photoelectric cell or a monitor cell. The transport level of the substrate is preferably constant during its transportation through the different modules of a horizontal galvanic plating line.

[0027] As used herein, the term "galvanic plating module", when applied in accordance with the present invention, refers to a module for metal deposition making use of current (galvanic process). The material of the galvanic plating module has to be made of a non-metallic material, preferably made of a polymeric material, or more preferably made of polyvinylchloride (PVC), polyethylene (PE), polyethylene terephthalate (PET), polytetrafluoroethylene (PTFE, Teflon) or polypropylene (PP), at least there, where the surface of the galvanic plating module is or can become into contact with the electrolyte. If such a part of the galvanic plating module is made of a metallic material, it will lead to disadvantageous plating out of galvanic metal out of the electrolyte on the surface of said part(s) of the galvanic plating module.

[0028] As used herein, the term "inlet side", when applied in accordance with the present invention, refers to said side of the plating device directed to the inlet area of the plating device. The inlet side comprises further an inlet opening for enabling a horizontal transport of substrates into the plating device. If an upper part and a lower part of the plating device are present, said inlet opening is arranged between said upper and lower part of the plating device. The same applies vice versa for the term "outlet side" of the plating device, wherein the outlet side is directed to the outlet area of the plating device. The outlet side comprises further an outlet opening for enabling a horizontal transport of substrates out of the plating device.

[0029] As used herein, the term "upper part", when applied in accordance with the present invention, refers to a part of the plating device being arranged above the transport level of the substrate, wherein said upper part comprises at least one electrolyte conduit for inserting electrolyte fluid into the plating device and at least an insoluble anode. This upper part of the plating device serves the purpose of plating a galvanic metal on the upper surface of the respective substrate during its transportation through said plating device. The same applies vice versa for the term "lower part" of the plating device for plating a galvanic metal on the lower side of the respective substrate during its transportation through said plating device. If both parts are present, a galvanic metal deposition on both sides of the substrate can be executed.

[0030] The liquid level of the electrolyte is at least high enough that the upper surface of the substrate is always covered by the electrolyte. Preferably, the liquid level of the electrolyte is at least higher than the lower edge of the upper part of the plating device of the galvanic plating module. The substrate guiding elements of the present invention support the transport of substrates from a second transport element of an inlet area of the galvanic plating module to the inlet side of the plating device; or from the outlet side of the plating device to a second transport element of the outlet area of a galvanic plating module. Herein, the substrates are always in a "wet state", meaning that the respective level of the electrolyte is at least higher than the upper surface of said substrates during their transportation through the galvanic plating module.

[0031] As used herein, the term "substrate guiding element", when applied to a galvanic plating module in accordance with the present invention, refers to any kind of suitable device element, which can be used for supporting the transport of a substrate from a second transport element of an inlet area of the galvanic plating module to the inlet side of the plating device; or from the outlet side of the plating device to a second transport element of the outlet area of a galvanic plating module. Herein, the substrate guiding element shall be suitable to fulfill the technical requirement to provide minimized contact to the surface of the substrate. This is especially required if the substrate comprises sensitive surface area parts, which can be easily damaged by too much physical contact between the respective substrate guiding element and the substrate during its transport. The present invention is therefore explicitly not directed on extensive area device elements (such as a steel plate or a metal sheet)

for forwarding a substrate from a second transport element of an inlet area of the galvanic plating module to the inlet side of the plating device; or from the outlet side of the plating device to a second transport element of the outlet area of a galvanic plating module.

[0032] The total surface directed to the substrate of all substrate guiding elements arranged below (in case there are substrate guiding elements) the transport level is ranging from 1 to 60 %, preferably from 3 to 45 %, and more preferably from 5 to 35 %, of the total area between the plating device and the adjacently arranged second transport element(s).

[0033] The total surface directed to the substrate of all substrate guiding elements arranged above (in case there are substrate guiding elements) the transport level is ranging from 1 to 60 %, preferably from 3 to 45 %, and more preferably from 5 to 35 %, of the total area between the plating device and the adjacently arranged second transport element(s).

[0034] Said total area between the plating device and the adjacently arranged second transport element(s) is limited on two opposite sides by the entire width of the plating device (clearly to be determined by the contact side of the plating device and the side opposite to the contact side of the plating device) and by the distance between the plating device and the adjacently arranged second transport element(s).

[0035] The total number of substrate guiding elements arranged below (in case there are substrate guiding elements) the transport level is ranging from 2 to 20, preferably from 4 to 15, more preferably from 5 to 12.

[0036] The total number of substrate guiding elements arranged above (in case there are substrate guiding elements) the transport level is ranging from 2 to 10, preferably from 4 to 9, more preferably from 5 to 8.

[0037] The first transport element of the plating device can be any kind of transport element which can ensure a safe handling, transportation and electrically contacting of the respective substrate(s) during its transportation through the plating device.

[0038] It is preferred that the first transport element for simultaneously transporting and electrically contacting the substrate inside of the plating device is a series of clamps. They are installed in such a way to form an enclosed circle as a continuous loop system, wherein each clamp is returning to the inlet side of the plating device after having arrived at the outlet side of the plating device. Herein, each clamp clamps at least a part of a substrate at the inlet side of the plating device, transporting and electrically contacting the substrate during its transportation through said plating device. After having arrived at the outlet side of the plating device, the clamp opens and releases thereby the substrate. Afterwards, said clamp is running on the backside (herein referred as contact side of the plating device) back to the inlet side of the plating device to clamp there another substrate.

[0039] Conclusively, in case of making use of such a continuous loop of clamps, there is always an intermediate space in between the inlet side and the outlet side of the plating device and the closest adjacently arranged second transport element of the inlet area or the outlet area inside of the galvanic plating module, namely at least the space required for the movement of one clamp inside of said continuous clamp loop.

[0040] In one embodiment, the inlet area and/or the outlet area comprises at least two second transport elements, wherein said second transport elements comprise rollers and/or wheel axes, which are arranged in a row at least below the transport level of the substrate; wherein at least two substrate guiding elements are in conjunction with the second transport elements of the inlet area and with the upper part and/or lower part of the plating device; and/or wherein at least two substrate guiding elements are in conjunction with the second transport elements of the outlet area and with the upper part and/or lower part of the plating device.

[0041] In a preferred embodiment thereof, at least one of the second transport elements is a roller having at least one circular groove.

[0042] It is generally preferred that at least 50%, more preferably at least 75%, and most preferred at least 90 %, of the second transport elements are rollers having each such a circular groove.

[0043] It is further generally preferred that at least 50%, more preferred at least 75%, and most preferred at least 90 %, of the second transport elements are rollers having a circular groove for each substrate guiding element provided between the plating device and the adjacently arranged second transport elements in the inlet area and/or in the outlet area of the galvanic plating module.

[0044] It is further generally preferred that at least the first, preferably at least the first two, more preferably at least the first three, and most preferably at least the first five, second transport elements arranged next to the inlet side and/or to the outlet side of the plating device is/are roller(s) having such a circular groove.

[0045] In an even more preferred embodiment thereof, at least one of the two substrate guiding elements comprise a hook-shaped end, wherein said hook-shaped end is hooked into the circular groove of said at least one roller having said circular groove; or hooked into the space between two discs of a wheel axis.

[0046] This offers an additional advantage compared to the other inventive substrate guiding elements, which are only running close to the front of a second transport element. There could still be the risk, even when it has been already further minimized by making use of an inventive substrate guiding element without such a hook shaped end, that the substrate can be crushed or at least damaged by threading around the second transport element or by being misguided downwards or upwards outside of the transport level. The use of such a preferred substrate guiding element comprising a hook-shaped end completely vanish this residual risk of crushing or at least damaging a substrate by threading.

[0047] It is generally (also in other herein cited embod-

iments of the present invention) preferred that substrate guiding elements having such a hook-shaped end can even hook into a plurality of second transport elements in order to bridge even more transport pathway of the substrate to further enhance the safe transport of them.

[0048] It is further generally preferred that at least 50%, more preferably at least 75%, and most preferred at least 90 %, of the substrate guiding elements comprise a hook-shaped end, wherein said hook-shaped end is hooked into a circular groove of a second transport element being a roller having such a circular groove; or hooked into the space between two discs of a wheel axis.

[0049] It is further generally preferred that at least 50%, more preferably at least 75%, and most preferred at least 90 %, of the substrate guiding elements comprise a hook-shaped end, wherein all hook-shaped ends are hooked into an individual respective circular groove of the same second transport element being a roller having such a number of individual circular grooves.

[0050] In one embodiment, the inlet area and/or the outlet area comprises at least a pair of second transport elements, wherein such a pair of second transport elements consists of one second transport element arranged below the transport level of the substrate and another second transport element oppositely arranged above the transport level of the substrate, wherein said two second transport elements of such a pair are driven in opposite directions against each other.

[0051] Herein, of course, both second transport elements of such a pair are driven in transport direction of the substrate to support the entering of the substrate into the outlet area of the galvanic plating module (pair is subsequently arranged to the outlet side of the plating device) or to support the leaving of the substrate out of the inlet area of the galvanic plating module into the plating device (pair is arranged in front of the inlet side of the plating device). This offers the advantage to further minimize the risk of threading a flexible substrate around a second transport element or of misguiding a flexible substrate downwards or upwards outside of the transport level.

[0052] In preferred embodiment thereof, at least one of the two second transport elements of such a pair of second transport elements of the inlet area and/or the outlet area is adjustable in height perpendicular to the transport direction and the transport level of the substrate.

[0053] This offers the advantage that the pair of second transport elements can be adjusted to any substrate thickness in order to ensure a safe transport. Herein, at least one roller can then be adjusted in height perpendicular to the transport direction, namely the upper roller upwards and/or the lower roller downwards.

[0054] In one embodiment, the plating device comprises at least a recess at its inlet side and/or its outlet side, wherein at least one substrate guiding element is detachably connected to the plating device by inserting one end of at least one substrate guiding element into said recess.

[0055] Such a recess offers generally the advantage that it can equalize a possible thermal expansion of the substrate guiding element caused by the temperature applied in the liquid. The required recess can be provided exemplarily by milling it out from the outer surface of the plating device, such as from the outer surface of the upper and/or lower part of the plating device. Alternatively, it can be provided by additionally mounting at least a fastening element, preferably at least a fastening rail, at the inlet side and/or at the outlet side of the plating device.

[0056] In one embodiment, the galvanic plating module comprises a plurality of substrate guiding elements being in conjunction with the plating device and the second transport elements of the inlet area and/or the outlet area, wherein the plurality of substrate guiding elements are arranged in a row between said plating device and said second transport elements of the inlet area and/or the outlet area below and/or above the transport level of the substrate.

[0057] The use of a plurality of substrate guiding elements instead of just two can be advantageous for adapting the number of substrate guiding elements applied in dependence to the total width of the substrate, which has to be processed. On the one hand there is a demand of the industry to minimize the physical contact of such substrate guiding elements to the lower and/or the upper surface of the substrates in order to avoid damaging of sensitive surface parts and particle contamination caused by abrasion. However, on the other hand there is the need of supporting the transport of substrates between a plating device and an adjacently arranged second transport element by these substrate guiding elements in order to ensure a safe transport of the substrates, which become in our days thinner and thinner and thereby more and more flexible.

[0058] In a preferred embodiment thereof, the plurality of substrate guiding elements are arranged at irregular intervals below and/or above the transport level of the substrate.

[0059] This can be advantageous if several different sizes of substrates have to be regularly processed. A distribution of substrate guiding elements in accordance with required substrate sizes can help to install most preferably one single arrangement of substrate guiding elements having one specific consequence of irregular intervals, which can successfully process all required substrate sizes at customer's site.

[0060] In another preferred embodiment thereof, the plurality of substrate guiding elements are arranged over the entire width of the plating device.

[0061] This ensures that even a substrate of maximum size can be processed and transported safely.

[0062] In a further preferred embodiment thereof, the galvanic plating module comprises a plurality of substrate guiding elements, which are arranged in a row between the outlet side of the plating device and the second transport elements of the outlet area below and above the transport level of the substrate; wherein each substrate guiding element arranged below the transport level is op-

positely arranged to a respective substrate guiding element arranged above the transport level thereby forming a pair of substrate guiding elements; wherein the distance between such two individual substrate guiding elements of a pair of substrate guiding elements is, preferably linearly, decreasing from the outlet side of the plating device to the subsequently arranged second transport element(s) of the outlet area of the galvanic plating module.

[0063] This ensures that substrates having sensitive surface parts on both sides can be processed and forwarded safely. It helps especially to enter the substrates into the adjacently arranged inlet area and/or outlet area of a galvanic plating module without the risk that the substrate will be crushed or at least damaged by threading around the second transport element or by being misguided downwards or upwards outside of the transport level.

[0064] In another further preferred embodiment thereof, the galvanic plating module comprises a plurality of substrate guiding elements, which are arranged in a row between the inlet side of the plating device and the second transport elements of the inlet area below and above the transport level of the substrate; wherein each substrate guiding element arranged below the transport level is oppositely arranged to a respective substrate guiding element arranged above the transport level thereby forming a pair of substrate guiding elements; wherein the distance between such two individual substrate guiding elements of a pair of substrate guiding elements is constant or, preferably linearly, decreasing from the second transport element(s) of the inlet area of the galvanic plating module to the subsequently arranged inlet side of the plating device.

[0065] This ensures that substrates having sensitive surface parts on both sides can be processed and forwarded safely. It helps especially to enter the substrates into the plating device without the risk that the substrate will be crushed or at least damaged by threading around the first transport element or by being misguided downwards or upwards outside of the transport level.

[0066] In general, it is advantageous if the substrate guiding elements are composed of a non-metallic material, preferably a polymeric material, such as polyethylene or polypropylene.

[0067] If said substrate guiding elements are made of a metal, it would lead to undesired plating out of the galvanic metal ions of the liquid on the surface of said substrate guiding elements.

[0068] Further, the object of the present invention is also solved by a kit for, especially for adapting, a galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate comprising an inlet area, at least one second transport element, a plating device, and an outlet area, wherein the plating device comprises an upper part and/or a lower part, wherein the kit comprises at least two substrate guiding elements for providing a conjunction between the plating device and the adjacently arranged at least one second transport element of the inlet area and/or the outlet area by detachably or permanently fixing the respective substrate guiding elements below and/or above the transport level of the substrate between the plating device and the at least second transport elements; and wherein said kit preferably further comprises at least a fastening element, preferably at least a fastening rail, for being fixed at the upper part and/or the lower part of the plating device.

[0069] Such a kit offers the remarkable advantage that not only new galvanic plating modules can be sold to customer's, but also that already installed galvanic plating modules at customer's sites can be modified by making use of such a kit. Thereby, even "old" existing horizontal galvanic plating modules can be brought into conformity with the new demands of the industry to handle and forward new thin and flexible substrates safely from a plating device to an adjacently arranged second transport element or vice versa.

[0070] Furthermore, the object of the present invention is also solved by a method for adapting a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate, comprising the following method steps:

i) providing a galvanic plating module comprising an inlet area, a plating device, and an outlet area, wherein the inlet area is arranged on one side of the plating device while the outlet area is arranged subsequently on the other side of the plating device in transport direction of the substrate;
wherein the plating device comprises an inlet side, an outlet side, an upper part and/or a lower part, and at least one first transport element for simultaneously transporting and electrically contacting the substrate during its transportation at a transport level in transport direction;
and wherein the inlet area and/or the outlet area of the galvanic plating module comprises at least a second transport element for transporting the substrate during its transportation at a transport level in transport direction;

ii) providing such an inventive kit;

iii) optionally fixing the fastening element, preferably the fastening rail, of said inventive kit at the upper part and/or the lower part of the plating device;

iv) detachably or permanently fixing of the at least two substrate guiding elements of said kit between the plating device and the second transport elements below and/or above the transport level of the substrate.

[0071] The present invention thus addresses the problem of ensuring a safe, damaging free transport of substrates, in particular of flexible and/or sensitive sub-

strates, between a plating device and an adjacently arranged inlet area and/or outlet area of the galvanic plating module.

[0072] The following non-limiting examples are provided to illustrate an embodiment of the present invention and to facilitate understanding of the invention, but are not intended to limit the scope of the invention, which is defined by the claims appended hereto.

[0073] Turning now to the Figures, Figure 1 shows a schematic perspective side view of a part of a galvanic plating module of a preferred embodiment of the present invention.

[0074] Herein, there is shown a part of a plating device 1, and a part of an outlet area 12, wherein the outlet area 12 is arranged subsequently to the plating device 1 in transport direction of the substrate.

[0075] Figure 1 further shows an outlet side 2, a contact side 3, a side opposite to the contact side 4, an upper part 5a and a lower part 5b of the plating device 1 of the galvanic plating module.

[0076] The first transport element being suitable for simultaneously transporting and electrically contacting a substrate during its transportation at a transport level in transport direction through said plating device 1 is not shown. Preferably, it is a series of clamps.

[0077] The plating device 1 is only partially shown in Figure 1 in order to allow a better explanation of the present invention based on the transport of a substrate from the outlet side 2 of a plating device 1 to the subsequently arranged adjacent second transport elements 11 of the outlet area 12 of the galvanic plating module.

[0078] However, the outlet area of the galvanic plating module is also not shown entirely in Figure 1 for illustration purposes. There are only shown two second transport elements 11, which are arranged at the outlet side 2 of the plating device 1 in the subsequently arranged outlet area 12.

[0079] These two second transport elements 11 are in this preferred embodiment of the present invention rollers having a plurality of circular grooves. Said two second transport elements 11 are arranged as a pair of second transport elements 11 in the outlet area 12, wherein said pair consists of one second transport element 11 arranged below the transport level of the substrate and another second transport element 11 oppositely arranged above the transport level of the substrate.

[0080] The galvanic plating module shown in Figure 1 additionally comprises a plurality of substrate guiding elements 7 being in conjunction with said plating device 1 and said second transport elements 11 of the outlet area 12, wherein the plurality of substrate guiding elements 7 are arranged in a row between said plating device 1 and said second transport elements 11 of the outlet area 12 below and above the transport level of the substrate.

[0081] Herein, each substrate guiding element 7 arranged below the transport level is oppositely arranged to a respective substrate guiding element 7 arranged above the transport level thereby forming a pair of substrate guiding elements 7; wherein the distance between such two individual substrate guiding elements 7 of a pair of substrate guiding elements 7 is linearly decreasing from the outlet side 2 of the plating device 1 to the subsequently arranged second transport elements 11 (from which only two second transport elements 11 are shown for illustration purposes) of the outlet area 12 of the galvanic plating module.

[0082] Herein, the plating device 1 comprises a recess 6 for each substrate guiding element 7 at its outlet side 2, wherein each substrate guiding element 7 is detachably connected to the plating device 1 by inserting one end of each substrate guiding element 7 into one respective recess 6.

[0083] Thereby, all substrate guiding elements 7 are in conjunction with the second transport elements 11 of the outlet area 12 on the one end and with the upper part 5a or the lower part 5b of the plating device 1 on the other end.

[0084] Herein, all substrate guiding elements 7 comprise a hook-shaped end, wherein said hook-shaped ends are hooked into the respective circular groove of the respective roller (second transport element 11) of the outlet area 12.

[0085] Herein, the plurality of substrate guiding elements 7 is arranged over the entire width 10 of the plating device 1.

[0086] Herein, all substrate guiding elements 7 are composed of a non-metallic polymeric material.

[0087] Herein, the plurality of substrate guiding elements 7 is arranged at irregular intervals below and above the transport level of the substrate. In the preferred embodiment shown in Figure 1, there are two different distances between the individual substrate guiding elements 7. The first distance 8 shown between some substrate guiding elements is smaller than the second distance 9 shown between the other substrate guiding elements.

[0088] Figure 2 shows a schematic side view of a part of a galvanic plating module of the preferred embodiment of the present invention shown in Figure 1.

[0089] Herein, the two second transport elements 11 shown in the outlet area 12 of the galvanic plating module are now even better recognizable as a pair of second transport elements 11 at the outlet side 2 of the plating device 1. Herein said pair of second transport elements 11 consists of one second transport element 11 arranged below the transport level of the substrate and another second transport element 11 oppositely arranged above the transport level of the substrate.

[0090] From the plurality of substrate guiding elements 7 being in conjunction with the upper part 5a and the lower part 5b of the plating device 1, solely one pair of substrate guiding elements 7 is shown, wherein one substrate guiding element 7 is arranged below the transport level and another substrate guiding element 7 is oppositely arranged above the transport level.

[0091] The electrolyte level (also called herein liquid

level of the electrolyte) 13 shown in Figure 2 is higher than the lower edge of the upper part 5a of the plating device 1 of the galvanic plating module.

[0092] Figure 2 is in particular suitable to facilitate the understanding that in said preferred embodiment of the present invention, the distance between such two individual substrate guiding elements 7 of a pair of substrate guiding elements 7 is linearly decreasing from the outlet side 2 of the plating device 1 to the subsequently arranged second transport elements 11 of the outlet area 12 of the galvanic plating module.

[0093] Figure 3 shows a schematic cut out of the side view of a part of a galvanic plating module of the preferred embodiment shown in Figure 2.

[0094] Herein, the two second transport elements 11 shown of the outlet area 12 of the galvanic plating module are now even better recognizable as a pair of second transport elements 11 at the outlet side 2 of the plating device 1. Herein said pair of second transport elements 11 consists of one second transport element 11 arranged below the transport level of the substrate and another second transport element 11 oppositely arranged above the transport level of the substrate.

[0095] It is especially now to recognize in this cut out of Figure 2 that the upper part 5a and the lower part 5b of the plating device 1 comprises a recess 6 for each substrate guiding element 7 at the outlet side 2 directed to the subsequently arranged adjacent outlet area 12 of the galvanic plating module. Herein, each substrate guiding element 7 is detachably connected to the plating device 1 by inserting one end of each substrate guiding element 7 into one recess 6.

[0096] Herein, it is recognizable that the substrate guiding elements 7 shown comprise each a hook-shaped end, which is hooked into the respective circular groove of the respective roller (second transport element 11) of the outlet area 12. Again, the electrolyte level (also called herein liquid level of the electrolyte) 13 shown in Figure 3 is higher than the lower edge of the upper part 5a of the plating device 1 of the galvanic plating module.

[0097] Figure 4 shows a schematic top view of a part of a galvanic plating module of the preferred embodiment of the present invention shown in Figure 1.

[0098] Herein, the galvanic plating module of Figure 1 comprising a plating device 1 and an outlet area 12, which are arranged adjacent to each other, is shown again as schematic top view. Said top view shall allow an even better recognition of the different distances 8 and 9 between the individual pairs of substrate guiding elements 7 over the entire width 10 of the plating device 1.

[0099] Figure 4 shows also (as Figure 1) the outlet side 2, the upper part 5a of the plating device 1, the contact side 3, and the side opposite to the contact side 4 of the plating device 1.

[0100] Again, all substrate guiding elements 7 are in conjunction with the second transport elements 11 of the outlet area of the galvanic plating module on the one end and with the upper part 5a and lower part 5b of the plating device 1, on the other end. Caused by the top view, only the upper part 5a of the plating device 1 is recognizable.

[0101] While the principles of the invention have been explained in relation to certain particular embodiments, and are provided for purposes of illustration, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims. The scope of the invention is limited only by the scope of the appended claims.

Reference signs

[0102]

1	Plating device of the galvanic plating module
2	Outlet side of the plating device
3	Contact side of the plating device
4	Side opposite to the contact side of the plating device
5a	Upper part of the plating device
5b	Lower part of the plating device
6	Recesses of the upper and lower parts of the plating device
7	Substrate guiding element
8	First distance between substrate guiding elements
9	Second distance between substrate guiding elements
10	Entire width of the plating device perpendicular to the transport direction at the transport level of the galvanic plating module
11	Second transport element of the galvanic plating module
12	Outlet area of the galvanic plating module
13	Electrolyte level

Claims

1. Galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate;
wherein said galvanic plating module comprises an

inlet area, a plating device (1), and an outlet area (12), wherein the inlet area is arranged on one side of the plating device (1) while the outlet area (12) is arranged subsequently on the other side of the plating device (1) in a transport direction of the substrate; wherein the plating device (1) comprises an inlet side, an outlet side (2), an upper part (5a) and/or a lower part (5b), and at least one first transport element for simultaneously transporting and electrically contacting the substrate during its transportation at a transport level in transport direction;
and wherein the inlet area and/or the outlet area (12) of the galvanic plating module comprises at least a second transport element (11) for transporting the substrate during its transportation at a transport level in transport direction, **characterized in that**
the galvanic plating module comprises further at least two substrate guiding elements (7) being in conjunction with said plating device (1) and said second transport element (11), wherein said substrate guiding elements (7) are arranged between said plating device (1) and said second transport element (11) below and/or above the transport level of the substrate.

2. Galvanic plating module according to claim 1 **characterized in that** the inlet area and/or the outlet area (12) comprises at least two second transport elements (11), wherein said second transport elements (11) comprise rollers and/or wheel axes, which are arranged in a row at least below the transport level of the substrate; wherein at least two substrate guiding elements (7) are in conjunction with the second transport elements (11) of the inlet area and with the upper part (5a) and/or lower part (5b) of the plating device (1);
and/or wherein at least two substrate guiding elements (7) are in conjunction with the second transport elements (11) of the outlet area and with the upper part (5a) and/or lower part (5b) of the plating device (1).

3. Galvanic plating module according to claim 2 **characterized in that** at least one of the second transport elements (11) is a roller having at least one circular groove.

4. Galvanic plating module according to claim 3 **characterized in that** at least one of the two substrate guiding elements (7) comprise a hook-shaped end, wherein said hook-shaped end is hooked into the circular groove of said at least one roller having said circular groove; or hooked into the space between two discs of a wheel axis.

5. Galvanic plating module according to one of the preceding claims **characterized in that** the inlet area and/or the outlet area (12) comprises at least a pair of second transport elements (11), wherein such a pair of second transport elements (11) consists of one second transport element (11) arranged below the transport level of the substrate and another second transport element (11) oppositely arranged above the transport level of the substrate, wherein said two second transport elements (11) of such a pair are driven in opposite directions against each other.

6. Galvanic plating module according to claim 5 **characterized in that** at least one of the two second transport elements (11) of such a pair of second transport elements (11) of the inlet area and/or the outlet area (12) is adjustable in height perpendicular to the transport direction and the transport level of the substrate.

7. Galvanic plating module according to one of the preceding claims **characterized in that** the plating device (1) comprises at least a recess (6) at its inlet side and/or its outlet side (2), wherein at least one substrate guiding element (7) is detachably connected to the plating device (1) by inserting one end of at least one substrate guiding element (7) into said recess (6).

8. Galvanic plating module according to one of the preceding claims **characterized in that** the galvanic plating module comprises a plurality of substrate guiding elements (7) being in conjunction with the plating device (1) and the second transport elements (11) of the inlet area and/or the outlet area (12), wherein the plurality of substrate guiding elements (7) are arranged in a row between said plating device (1) and said second transport elements (11) of the inlet area and/or the outlet area (12) below and/or above the transport level of the substrate.

9. Galvanic plating module according to claim 8 **characterized in that** the plurality of substrate guiding elements (7) are arranged at irregular intervals below and/or above the transport level of the substrate.

10. Galvanic plating module according to claim 8 or 9 **characterized in that** the plurality of substrate guiding elements (7) are arranged over the entire width (10) of the plating device (1).

11. Galvanic plating module according to one of claims 8 to 10 **characterized in that** the galvanic plating module comprises a plurality of substrate guiding elements (7), which are arranged in a row between the outlet side (2) of the plating device (1) and the second transport elements (11) of the outlet area (12) below and above the transport level of the substrate;
wherein each substrate guiding element (7) ar-

ranged below the transport level is oppositely arranged to a respective substrate guiding element (7) arranged above the transport level thereby forming a pair of substrate guiding elements (7);
wherein the distance between such two individual substrate guiding elements (7) of a pair of substrate guiding elements (7) is, preferably linearly, decreasing from the outlet side (2) of the plating device (1) to the subsequently arranged second transport element(s) (11) of the outlet area (12) of the galvanic plating module.

12. Galvanic plating module according to one of claims 8 to 11 **characterized in that** the galvanic plating module comprises a plurality of substrate guiding elements (7), which are arranged in a row between the inlet side of the plating device (1) and the second transport elements (11) of the inlet area below and above the transport level of the substrate;
wherein each substrate guiding element (7) arranged below the transport level is oppositely arranged to a respective substrate guiding element (7) arranged above the transport level thereby forming a pair of substrate guiding elements (7);
wherein the distance between such two individual substrate guiding elements (7) of a pair of substrate guiding elements (7) is constant or, preferably linearly, decreasing from the second transport element(s) (11) of the inlet area of the galvanic plating module to the subsequently arranged inlet side of the plating device (1).

13. Galvanic plating module according to one of the preceding claims **characterized in that** the substrate guiding elements (7) are composed of a non-metallic material, preferably a polymeric material, such as polyethylene or polypropylene.

14. Kit for a galvanic plating module of a horizontal galvanic plating line for galvanic metal, preferably copper, deposition on a substrate comprising an inlet area, at least one second transport element, a plating device (1), and an outlet area (12), wherein the plating device (1) comprises an upper part (5a) and/or a lower part (5b), wherein the kit comprises at least two substrate guiding elements (7) for providing a conjunction between the plating device (1) and the adjacently arranged at least one second transport element (11) of the inlet area and/or the outlet area (12) by detachably or permanently fixing the respective substrate guiding elements (7) below and/or above the transport level of the substrate between the plating device (1) and the at least second transport elements (11); and wherein said kit preferably further comprises at least a fastening element, preferably at least a fastening rail, for being fixed at the upper part (5a) and/or the lower part (5b) of the plating device (1).

15. Method for adapting a galvanic plating module for galvanic metal, preferably copper, deposition on a substrate, comprising the following method steps:

i) providing a galvanic plating module comprising an inlet area, a plating device (1), and an outlet area (12), wherein the inlet area is arranged on one side of the plating device (1) while the outlet area (12) is arranged subsequently on the other side of the plating device (1) in transport direction of the substrate;
wherein the plating device (1) comprises an inlet side, an outlet side (2), an upper part (5a) and/or a lower part (5b), and at least one first transport element for simultaneously transporting and electrically contacting the substrate during its transportation at a transport level in transport direction;
and wherein the inlet area and/or the outlet area (12) of the galvanic plating module comprises at least a second transport element (11) for transporting the substrate during its transportation at a transport level in transport direction;
ii) providing a kit according to claim 14;
iii) optionally fixing the fastening element, preferably the fastening rail, of the kit according to claim 14 at the upper part (5a) and/or the lower part (5b) of the plating device (1);
iv) detachably or permanently fixing of the at least two substrate guiding elements (7) of said kit between the plating device (1) and the second transport elements (11) below and/or above the transport level of the substrate.

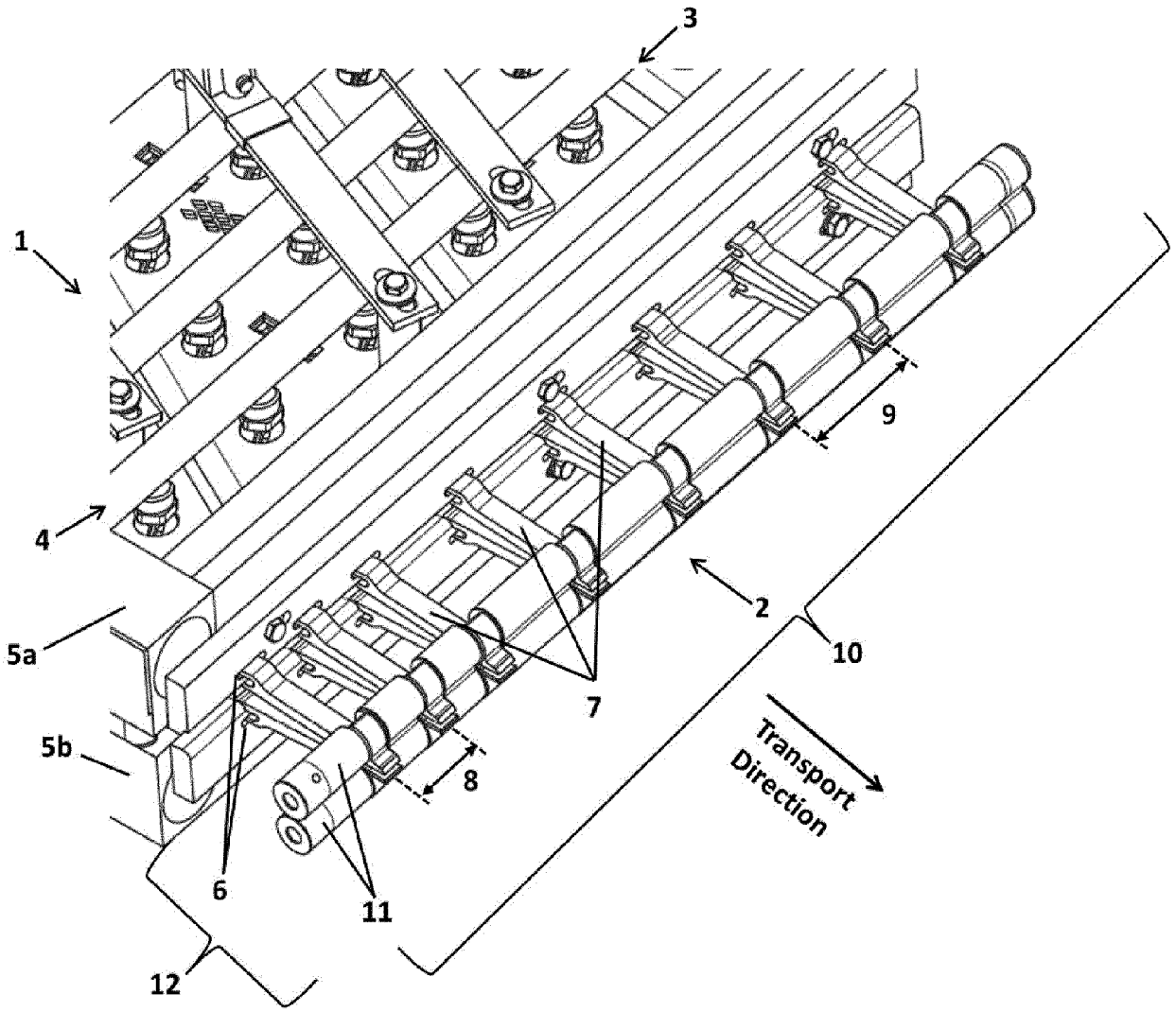

Figure 1

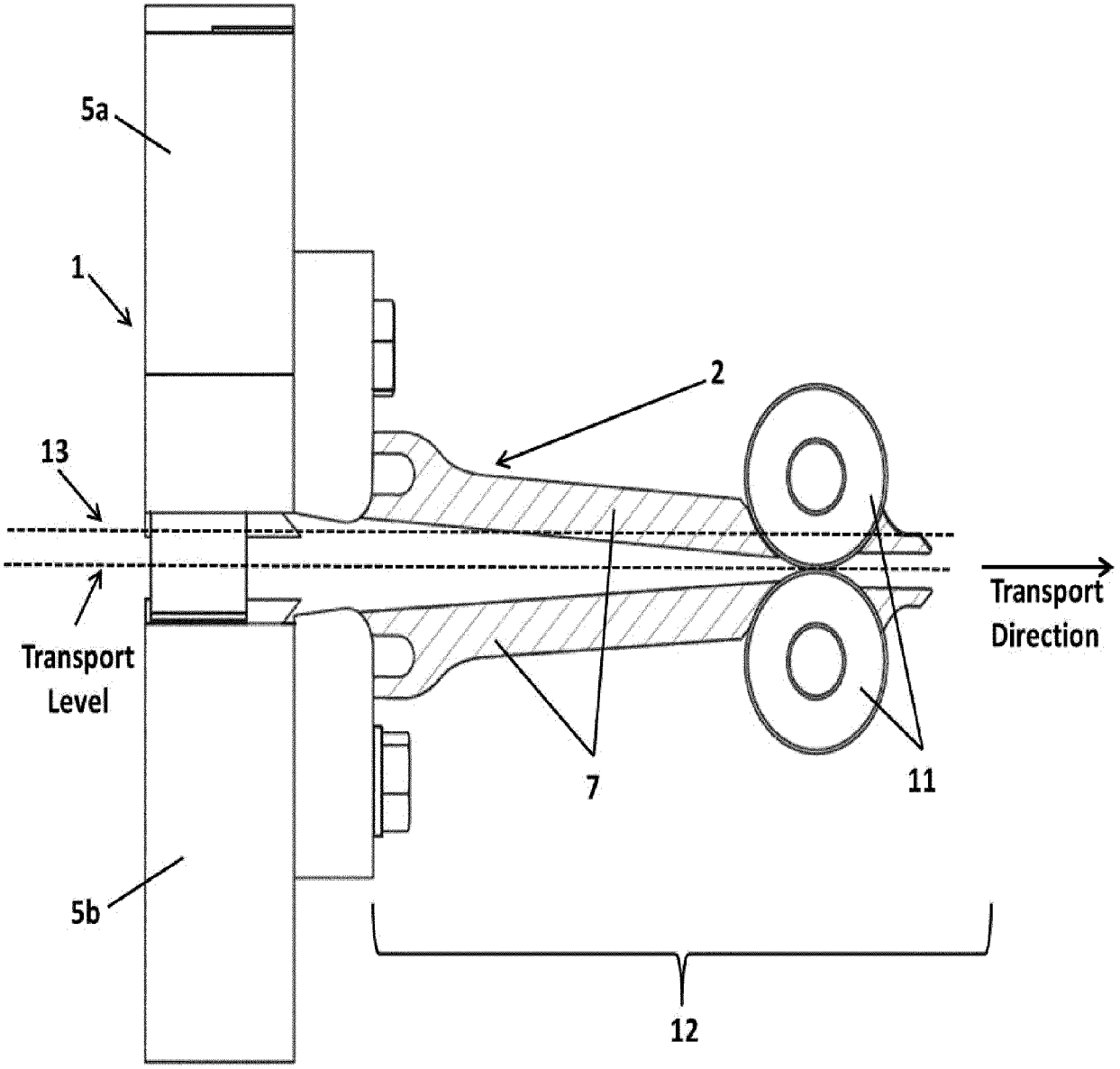

Figure 2

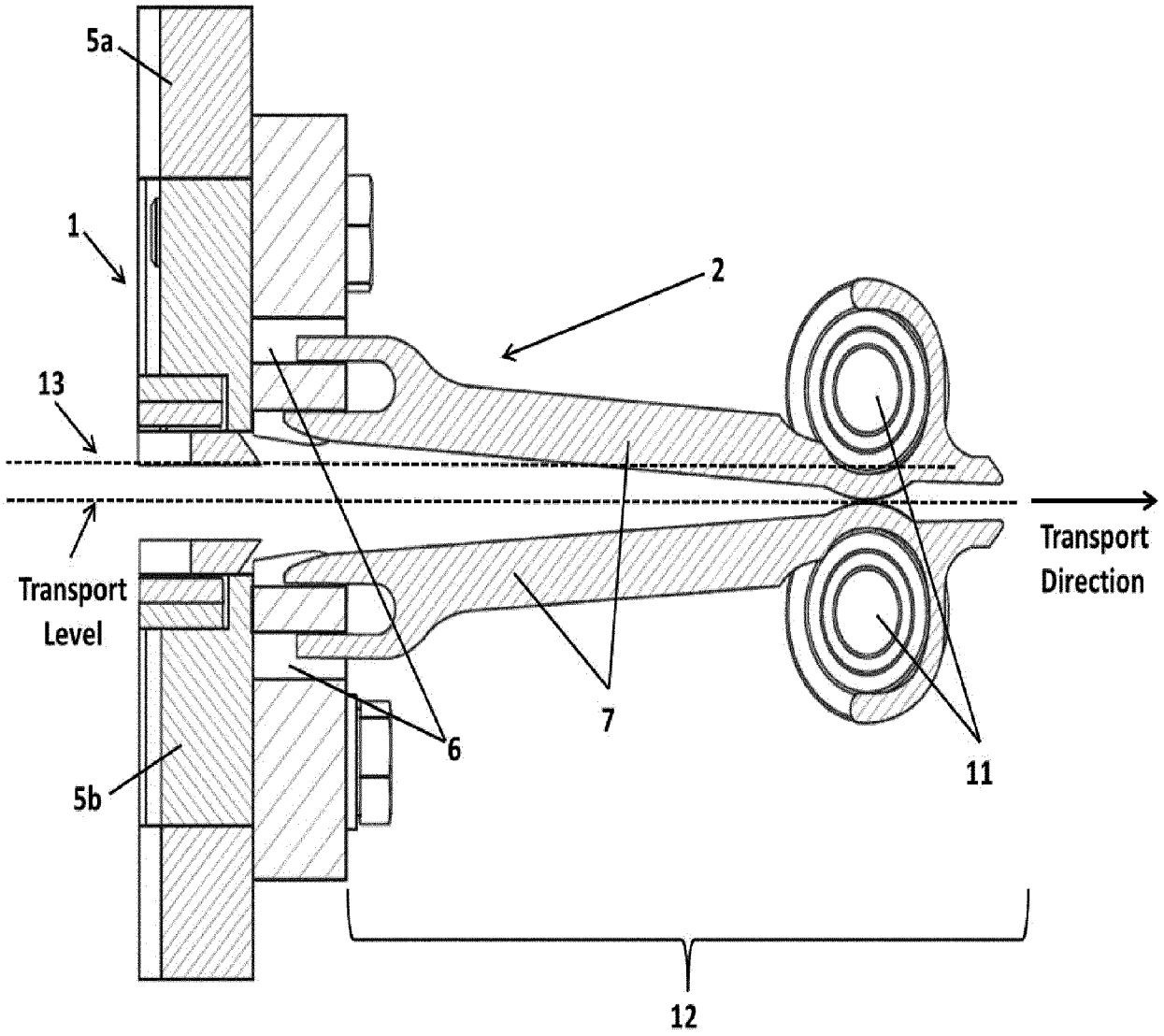

Figure 3

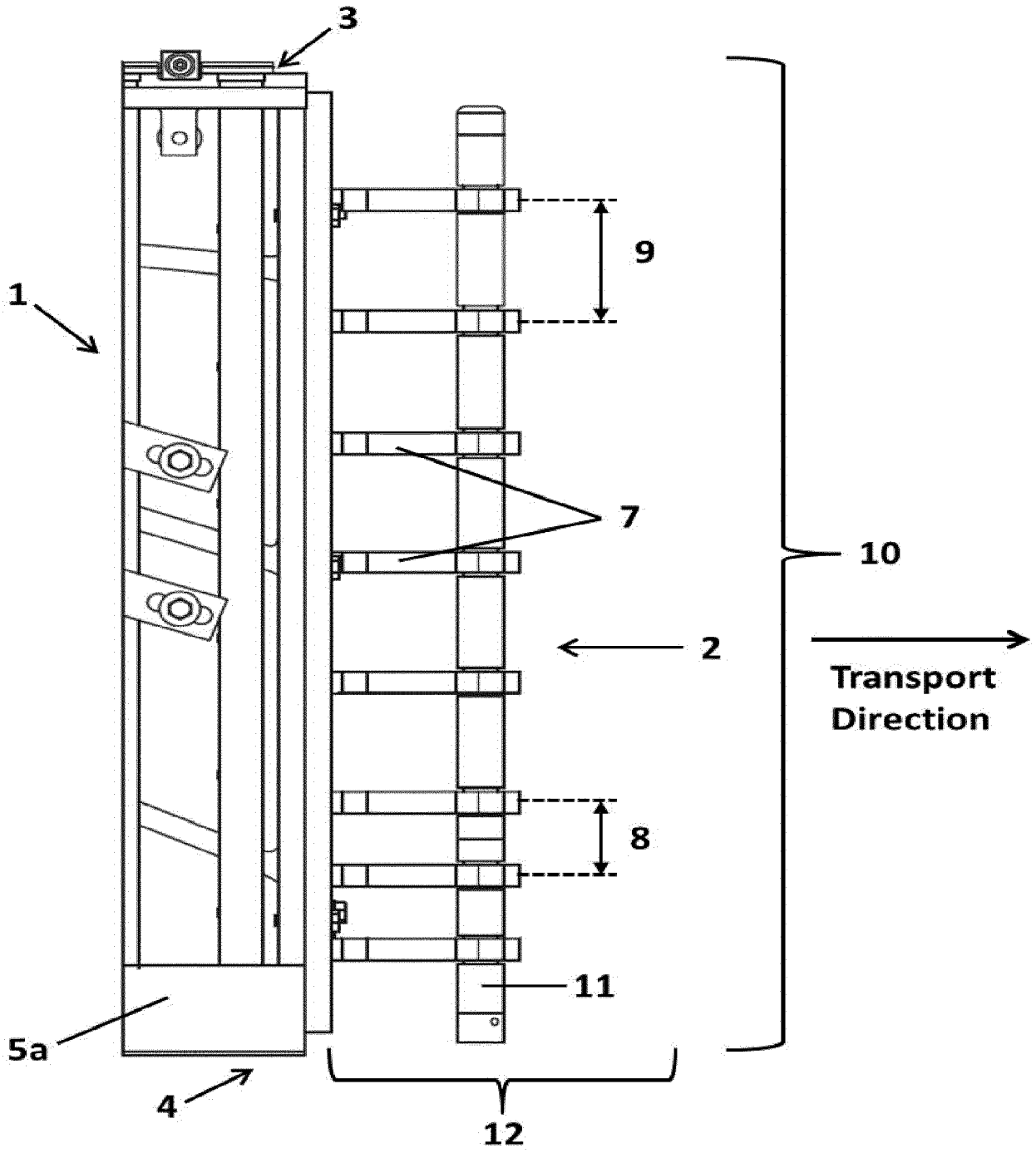

Figure 4

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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 1278

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 September 2017	Le Hervet, Morgan

CATEGORY OF CITED DOCUMENTS

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