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(54) **BROCHETTE SYSTEM AND METHOD FOR METAL PLATING**

(57) A method of metal plating components includes placing a component and a spacer on a brochette, placing the brochette with the component and the spacer on a structure, and placing the structure with the brochette into a metal plating tank having a metal plating solution such that the component is submersed in the metal plating solution. The spacer is configured to mask a portion of the least one component and the component and the spacer are arranged on the brochette such that the spacer prevents the portion of the component from being contacted by the metal plating solution. The method also includes metal plating a surface of the component submersed in the metal plating solution, removing the structure with the brochette from the metal plating solution, drying the component on the brochette, and removing the dried component and the spacer from the brochette. Metal plating systems are also provided.

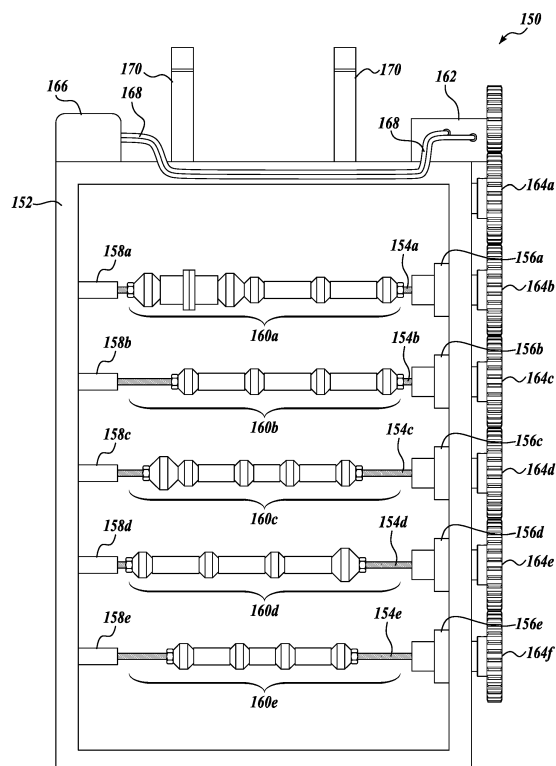


FIG. 5

Description

BACKGROUND

[0001] Metal plating is a process of depositing a metallic material on a surface of an object. Metal plating can change the characteristics of the surface of the object, such as increasing corrosion resistance, increasing surface hardness, increasing or decreasing surface friction, increasing or decreasing surface adhesiveness, increasing aesthetic value, and the like. Many methods have been developed for metal plating, including electroplating and electroless plating. In electroplating, a substrate is provided with an ionic metal and electrons are supplied to cause a film of non-ionic metal to form on the substrate. In electroless plating, the substrate is placed in an aqueous solution where several simultaneous reactions occur without the use of external electrical power to cause a layer of metal to form on the substrate.

[0002] Existing metal plating processes are time-consuming and hazardous. Some existing metal plating processes require significant amounts of manual labor for preparation of components to be plated and for finishing the plated components. The preparation and finishing of these components in the existing metal plating processes require manual work by a technician on each component, taking large amounts of time for the labor and exposing the technician to hazardous materials used during the preparation and finishing of the components.

SUMMARY

[0003] Various examples of the present disclosure provide methods of metal plating that address, among other things, the extraneous manual labor and harmful solutions needed in the finishing process of the prior art metal plating techniques.

[0004] In one embodiment, a method of metal plating components includes placing at least one component and at least one spacer on a brochette, placing the brochette with the at least one component and the at least one spacer on a structure, and placing the structure with the brochette into a metal plating tank having a metal plating solution such that the at least one component is submersed in the metal plating solution. The at least one spacer is configured to mask a portion of the least one component. The at least one component and the at least one spacer are arranged on the brochette such that the at least one spacer prevents the portion of the at least one component from being contacted by the metal plating solution. The method further includes metal plating at least one surface of the at least one component submersed in the metal plating solution, removing the structure with the brochette from the metal plating solution, drying the at least one component on the brochette, and removing the dried at least one component and the at least one spacer from the brochette.

[0005] In one example, the method further includes

placing the structure with the brochette into a cleaning tank having a cleaning solution such that the at least one component is submersed in the cleaning solution before placing the structure into the metal plating tank. In another example, the at least one component and the at least one spacer are arranged on the brochette such that the at least one spacer prevents the portion of the at least one component from being contacted by the cleaning solution.

[0006] In another example, the method further includes rotating the brochette with the at least one component while the at least one component is submersed in the metal plating solution. In another example, the structure comprises a brochette rotation system configured to rotate the brochette with the at least one component while the at least one component is submersed in the metal plating solution.

[0007] In another example, the method further includes providing an electrical charge to the at least one component while the at least one component is submersed in the metal plating solution. In another example, the structure comprises at least one support hook configured to be placed on a support structure above the metal plating tank while the at least one component is submersed in the metal plating solution. In another example, providing the electrical charge to the at least one component comprises providing the electrical charge from the support structure to the structure via the at least one support hook, from the structure to the brochette via a contact point between the structure and the brochette, and from the brochette to the at least one component.

[0008] In another example, placing the at least one component and the at least one spacer on the brochette comprises placing the at least one component and the at least one spacer between fasteners on the brochette. In another example, the method further includes applying a compressive force to the at least one component and the at least one spacer on the brochette between the fasteners.

[0009] In another example, placing the at least one component and the at least one spacer on the brochette comprises placing the brochette through a bore of the at least one component and a bore of the at least one spacer. In another example, placing the at least one component and the at least one spacer on the brochette further comprises placing a conical section of the spacer into the bore of the at least one component.

[0010] In another example, the at least one component comprises a plurality of components. In another example, two of the plurality of components have one or more of different sizes or different shapes. In another example, the plurality of components comprises a first component having a first surface and a second component having a second surface. In another example, placing the at least one component and the at least one spacer on the brochette comprises placing the first component and the second component on the brochette with the first surface facing the second surface. In another example, the place-

ment of the first component and the second component on the brochette with the first surface facing the second surface is configured to prevent the first surface and the second surface from being contacted by the metal plating solution while the first and second components are sub-

[0011] In another embodiment, a system for holding at least one component during a metal plating process includes a brochette configured to have the at least one component placed thereon, at least one spacer configured to be placed on the brochette and to mask a portion of the least one component, and a structure configured to hold the brochette with the at least one component and the at least one spacer. The at least one spacer is configured to be arranged on the brochette such that, when the structure with the brochette is placed into a metal plating tank having a metal plating solution such that the at least one component is submersed in the metal plating solution, the at least one spacer prevents the portion of the at least one component from being contacted by the metal plating solution.

[0012] In one example, the system further includes a brochette rotation system configured to rotate the brochette with the at least one component while the at least one component is submersed in the metal plating solution. In another example, the system further includes fasteners configured to exert a compressive force on the at least one component and the at least one spacer on the brochette when the at least one component and the at least one spacer are located between the fasteners on the brochette.

[0013] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

DESCRIPTION OF THE DRAWINGS

[0014] The foregoing aspects and many of the attendant advantages of the disclosed subject matter will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 depicts an existing metal plating process for plating a component;

FIGURES 2A and 2B depict a front view and a side cross-sectional view, respectively, of an embodiment of a component suitable for plating by one embodiment of a metal plating process;

FIGURES 3A and 3B depict a front view and a side cross-sectional view, respectively, of another embodiment of a component suitable for plating by one embodiment of a metal plating process;

FIGURES 4A and 4B depict a side view and a per-

spective view, respectively, of an embodiment of a spacer usable to hold and mask components in one embodiment of a metal plating system;

FIGURE 5 depicts an embodiment of a metal plating system for plating one or more components using spacers, such as, for example, the spacers depicted in FIGURES 4A and 4B;

FIGURES 6A and 6B depict a side view and a cross-sectional view, respectively, of an embodiment of a brochette with various embodiments of the components installed thereon using spacers, such as, for example, the spacers depicted in FIGURES 4A and 4B;

FIGURES 7A to 7F depict one representative embodiment of a process for metal plating components using a metal plating system, such as, for example, the system depicted in FIGURE 5; and

FIGURE 8 depicts an embodiment of a metal plating process for plating a plurality of components in accordance with an aspect of the present disclosure.

DETAILED DESCRIPTION

[0015] Embodiments of systems and methods are disclosed herein for metal plating using a brochette to hold components and spacers. In some embodiments, the spacers hold the components to the brochette and mask portions of the components during the metal plating process. The systems and methods disclosed herein for metal plating provide advantages over existing metal plating processes.

[0016] One existing metal plating process 100 for plating a component (e.g., a bushing) is depicted in FIGURE 1. At block 102, the component is masked to cover a surface of the component that will not be plated. The component, for example, can include a through bore defining an interior bore surface. In one example, masking the component includes placing a masking material (e.g., masking tape) over the interior bore surface. At block 104, the component is blast cleaned to prepare the unmasked surfaces of the component that will be plated. At block 106, the component is prepared with a wire. In one example, a wire is fed through a bore in the component such that the wire touches only the masked portions of the component. At block 108, the component is metal plated and dried. In one example, the component is held by the wire during the metal plating and drying process and passes electrical current to the component during the plating process.

[0017] After the component has dried, the wire is then removed from the component and the component is unmasked at block 110. In one example, uninstalling the wire includes removing the wire from a bore in the component. In another example, unmasking the component includes removing masking tape from the component. At block 112, the unmasked component is cleaned. Cleaning the unmasked component includes removing adhesive left on the component by the masking tape. In some

examples, cleaning the unmasked component also includes removing metal plating from the surface that was not to be plated (e.g., when a gap existed in the masking tape during the plating process). At block 114, the metal plating on the component is brushed and polished. In some instances, the brushing and polishing is necessitated by the presence of defects in the metal plating, such as contaminants, air pockets, and the like. After the brushing and polishing, the metal plating process 100 of the component is completed and the component is ready to be used.

[0018] The metal plating process 100 depicted in FIGURE 1 has a number of deficiencies. In one example, the metal plating process 100 requires a significant amount of manual labor for each component. Each component is individually masked and cleaned prior to plating, individually plated and dried, and individually cleaned, brushed, and polished after being plated. In another example, the possibility for failure of the process is high due to the amount of manual labor required for each component. The masking process is susceptible to human error in applying the masking material (e.g., masking tape). The dipping of a component using a wire results in non-homogenous metal plating on the component. Pores can also form in the metal plating due to the presence of contaminants or air pockets formed during the plating process. The amount of manual labor can further increase the risk of exposure of a technician to hazardous materials used in the metal plating process 100, including cleaning agents used to clean the component before plating, solvents used to clean excess adhesive from the masked areas on the component, polish used to polish the plated regions of the component, and the like.

[0019] Embodiments of metal plating processes, systems, and apparatuses are described herein that address some of the deficiencies of the metal plating process 100 depicted in FIGURE 1. Specifically, embodiments of the metal plating processes, systems, and apparatuses described herein are capable of achieving one or more of the following: metal plating multiple components at one time, increasing homogeneity of metal plating applied to components, reducing the number of defective components by reducing the opportunity for human error in the metal plating process.

[0020] FIGURES 2A and 2B illustrate an embodiment of a component 120 suitable for plating in a metal plating process. The component 120 includes a bore 122. The component 120 also includes outer surfaces 124a-d that are to be plated in a metal plating process and an outer surface 128 that is not to be plated during the metal plating process. The bore 122 of the component 120 includes an inner bore surface 126 that is also not to be plated during the metal plating process. In some examples, the component 120 is made from a metal or metal alloy, such as iron, steel, and the like. As can be seen in FIGURE 2B, the bore 122 runs through the component 120 from the outer surface 124a to the outer surface 128, and thus, can be referred to as a through bore.

[0021] FIGURES 3A and 3B illustrate an embodiment of a component 130 for plating in a metal plating process. The component 130 includes a bore 132. The component 130 also includes an outer surface 134 that is to be plated in a metal plating process. The bore 132 of the component 130 includes an inner surface 136 that is not to be plated during the metal plating process. In some examples, the component 130 is made from a metal or metal alloy, such as iron, steel, and the like. As can be seen in FIGURE 3B, the bore 132 runs through the component 130 from one side to the other to give the component 130 a tube-like structure.

[0022] The embodiments of components 120 and 130 are just two examples of components that can be plated in metal plating processes of the present disclosure described below. However, any number of other components can be metal plated in one or more of these metal plating processes. Such components may take any number of forms, shapes and sizes, and such components may have any number of features, such as bores, countersinks, surfaces, ridges, and the like. Various embodiments of metal plating systems and methods are described herein using the examples of the components 120 and 130. However, it should be understood that embodiments of the metal plating systems and methods described herein can be used with any type of component or combination of components.

[0023] Referring now to FIGURES 4A and 4B there is depicted an embodiment of a spacer 140. The spacer 140 is suitable for holding and masking one or more components in one representative embodiment of a metal plating system described below, for example, in FIGURE 5. The spacer 140 includes two opposing conical sections 142a-b. The conical sections 142a-b extend from a central portion 144 to respective ends 146a-b of the spacer 140. The spacer 140 also includes a through bore 148 extending between the ends 146a-b of the spacer 140. Various dimensions of the spacer 140 (e.g., a diameter of the central portion 144, a slope of the conical sections 142a-b, a diameter of the ends 146a-b, a diameter of the bore 148, a distance between the ends 146a-b, etc.) may be selected based on one or more dimensions of components (e.g., a diameter of the bore 122 in component 120, a diameter of the bore 132 in component 130, etc.). In some embodiments, the spacer 140 is made from a material, such as stainless steel, that does not adhere well to metal plating. In these embodiments, the spacer 140 can be used in a metal plating process, cleaned to remove any metal plating residue after the metal plating process, and used in a subsequent metal plating process. In other embodiments, the spacer 140 is made from a material, such as silicone, plastic, etc., that adhere to metal plating. In these embodiments, the spacer 140 can be used in a metal plating process and then discarded.

[0024] FIGURE 5 depicts an embodiment of a metal plating system 150 for metal plating a plurality of components, such as, for example, components 120, 130, etc., using spacers, such as, for example, spacers 140,

in accordance with an aspect of the present disclosure. The system 150 includes a structure 152 configured to hold a number of brochettes 154a-e. The brochettes 154a-e include first ends 156a-e, respectively, and second ends 158a-e, respectively. Each of the first ends 156a-e and second ends 158a-e is configured to be placed in the structure 152 such that the brochettes 154a-e are held by the structure 152 and permitted to rotate. In some embodiments, one or more of the first ends 156a-e and second ends 158a-e are configured to make an electrical connection with the structure 152 when the brochettes 154a-e are placed in the structure 152.

[0025] The brochettes 154a-e are configured to carry a plurality of components, shown as components 160a-e, respectively. In one embodiment, one or more of the brochettes 154a-e carries components 160a-e having different shapes or sizes. As described in greater detail below with respect to FIGURES 6A and 6B, in one embodiment, the components 160a-e are held on the brochettes 154a-e using spacers 140 that are configured to mask portions of the components 160a-e that are not to be plated during the metal plating process.

[0026] The system 150 also includes a brochette rotation system configured to rotate one or more of the brochettes either individually or at the same time. In one embodiment, the brochette rotation system includes a source of motion 162 and a transmission comprising a plurality of motion transfer mechanisms 164a-f. In the embodiment shown in FIGURE 5, the source of motion 162 includes a motor, such as a turbine, configured to produce a rotary driving force. In one embodiment, the motor is driven by pressurized air that is provided via a valve 166 and air lines 168. In other embodiments, the source of motion 162 may include but is not limited to a hydraulic-powered rotation mechanism, a manual rotation mechanism (e.g., a rotating handle), an electrical motor, or any other means for producing a rotary driving force. In the embodiment shown in FIGURE 5, the motion transfer mechanisms 164a-f include gears that are configured to be rotationally driven by the source of motion 162. In other embodiments, the source of motion 162 may produce a linear output that causes rotation of the gears via a transmission device, such as a rack and pinion system, a Scottish yoke, among others.

[0027] Rotation of the motion transfer mechanisms 164a-f causes the brochettes 154a-e to rotate via direct or indirect coupling. In one embodiment the first ends 156a-e of the brochettes 154a-e are configured to be coupled to the motion transfer mechanisms 164a-f such that rotation of the motion transfer mechanisms 164a-f causes the brochettes 154a-e to rotate. In other embodiments, motion transfer mechanisms 164a-f in the brochette rotation system are replaced by another motion transfer mechanism or mechanisms, such as a chain and sprocket system, a rack and pinion system, and the like. In the case of the rack and pinion system, the source of motion 162 may generate linear motion to drive the rack and the pinion or pinions convert the linear motion of the

rack to rotary motion of the brochettes 154a-e.

[0028] In some embodiments, the system 150 includes additional features, such as support hooks 170. In use, the support hooks 170 in one example are placed on a support structure over a tank (e.g., a cleaning solution tank or a metal plating solution tank) such that the brochettes 154a-e are suspended in the tank. In this example, when the brochettes 154a-e are suspended in a tank containing solution, the source of motion 162 can be operated to rotate the brochettes 154a-e and the components 160a-e via an associated transmission, such as the motion transfer mechanisms 164a-f, within the solution contained in the tank. In some embodiments, the support hooks 170 are made of an electrically-conductive material that conducts electricity from a support structure over a tank to the brochettes 154a-e to provide an electrical charge during the metal plating process.

[0029] Referring now to FIGURES 6A and 6B, side and cross-sectional views of an embodiment of the brochette 154a is depicted with components 120, 120', 130, and 130' installed thereon using spacers 140 and 140', in accordance with an aspect of the present disclosure. In this embodiment, the brochette 154a includes a threaded rod with first end 156a and second end 158a. From left to right in the depiction shown in FIGURES 6A and 6B, the following components are installed on the brochette 154a: a fastener 180, the spacer 140 through the bore 148, the component 120 through the bore 122, component 120' through the bore 122', the spacer 140 through the bore 148, the spacer 140' through the bore 148', the component 130 through the bore 132, the spacer 140' through the bore 148', the component 130' through the bore 132', the spacer 140' through the bore 148', and the fastener 180'.

[0030] The spacers 140 in some embodiments are configured to engage the bores 122 and 122' of the components 120 and 120'. The spacers 140' are configured to engage the bores 132 and 132' of the components 130 and 130'. The spacers 140 and 140' are also configured to mask the bores 122, 122', 132, and 132' as the components are supported by the brochette 154. In one embodiment, the fasteners 180 and 180' are configured to engage the threads on the brochette and to exert a compressive force against the components 120, 120', 130, and 130' and the spacer 140 and 140'. The combination of the configuration of the spacers 140 and 140' to mask the bores 122, 122', 132, and 132' and the compressive force exerted by the fasteners 180 and 180' prevents a solution (e.g., cleaning solution, metal plating solution, etc.) from entering the bores 122, 122', 132, and 132' and contacting the inner bore surfaces 126, 126', 136, and 136' of the components 120, 120', 130, and 130' when the brochette 154a is submersed in the solution. This arrangement allows for such solution to contact and/or plate the outer surfaces 124a-d, 124a'-d', 134, and 134' of the components 120, 120', 130, and 130' when the brochette 154a is submersed in the solution but prevents plating at the location of inner bore surfaces.

[0031] In the embodiment shown in FIGURES 6A and 6B, there is no spacer between the component 120 and the component 120'. The component 120 and the component 120' are placed on the brochette 154 with outer surfaces 128 and 128' facing each other. In this embodiment, the outer surfaces 128 and 128' are not to be plated during a metal plating process. With the outer surfaces 128 and 128' facing each other, the compressive force exerted by the fasteners 180 and 180' prevents a solution from contacting the outer surfaces 128 and 128' or entering the bores 122 and 122' when the brochette 154a is submersed in the solution. The arrangement shown in FIGURES 6A and 6B allows the brochette 154a to be submersed in metal plating solution during a metal plating process without plating the inner surfaces 126, 126', 136, and 136' of the components 120, 120', 130, and 130' and the outer surfaces 128 and 128' of the components 120 and 120'. No masking material, such as masking tape, is required to mask any portion of the components 120, 120', 130, and 130'.

[0032] In the embodiment shown in FIGURES 6A and 6B, there are two spacers 140 and 140' between the component 120' and the component 130. In some embodiments, the use of two spacers between components enables components of different sizes and/or shapes, such as the component 120' and the component 130, to be placed on the same brochette. This ability increases the number of components that can be held on a brochette during a single metal plating process.

[0033] One representative process for metal plating components using a metal plating system, such as, for example, the system shown in FIGURE 5, will now be described with reference to FIGURES 7A to 7F. In FIGURE 7A, components 202 and spacers 204 are installed on a brochette 200. The spacers 204 are configured to mask portions of the components 202 that are not to be plated during the plating process. In some examples, the components 202 and/or the spacers 204 have different sizes and/or shapes. In these examples, at least some of the spacers 204 have different sizes or shapes to mask the portions of the components 202 that are not to be plated. In FIGURE 7B, the brochette 200 with the installed components 202 and spacers 204 is placed into a structure 206. The structure 206 includes a brochette rotation system 208 configured to selectively rotate the brochette 200 and, optionally, other brochettes placed in the structure 206.

[0034] An assembly composed of the structure 206 and the brochette 200 is then placed in a cleaning solution tank 210 that holds cleaning solution 212, as shown in FIGURE 7C. As shown in FIGURE 7C, the brochette 200, the components 202, and the spacers 204 are submersed in the cleaning solution 212. The spacers 204 are configured to mask portions of the components 202 such that the portions of the components 202 are not contacted by the cleaning solution 212 when the brochette 200, the components 202, and the spacers 204 are submersed in the cleaning solution 212. In one em-

bodiment, the components 202 and the spacers 204 are located on the brochette 200 between fasteners that exert a compressive force to prevent the portions of the components 202 from being contacted by the cleaning solution 212.

[0035] As shown in FIGURE 7C, the structure 206 includes support hooks 213 that are configured to be placed on a support structure 214 (e.g., a bar or a pipe) located above the cleaning solution tank 210. In one embodiment, the support structure 214 is located at a position above the cleaning solution tank 210 such that all of the brochettes on the structure 206 are submersed in the cleaning solution 212 when the support hooks 213 of the structure 206 are placed on the support structure 214. In one embodiment, the cleaning solution 212 is configured to remove contaminants and debris from surfaces of the components 202 that will be plated. The cleaning solution in one embodiment is capable of removing contaminants and debris from surfaces of the components 202 that will be plated without movement of the components 202 in the cleaning solution 212. In this embodiment, the brochette 200 is not rotated by the brochette rotation system 208 while the brochette 200 is submersed in the cleaning solution 212.

[0036] After the components 202 have been cleaned in the cleaning solution 212, the components 202 are ready to be plated. FIGURE 7D illustrates the structure 206 supporting the brochette 200 placed in a metal plating tank 216 that holds a metal plating solution 218. As shown in FIGURE 7D, the brochette 200, the components 202, and the spacers 204 are submersed in the metal plating solution 218. The spacers 204 are configured to mask portions of the components 202 such that the portions of the components 202 are not contacted by the metal plating solution 218 when the brochette 200, the components 202, and the spacers 204 are submersed in the metal plating solution 218. In one embodiment, the components 202 and the spacers 204 are located on the brochette 200 between fasteners that exert a compressive force to prevent the portions of the components 202 from being contacted by the metal plating solution 218.

[0037] As shown in FIGURE 7D, the support hooks 213 on the structure 206 are configured to be placed on a support structure 220 (e.g., a bar or a pipe) located above the metal plating solution tank 216. In one embodiment, the support structure 220 is located at a position above the metal plating solution tank 216 such that all of the brochettes on the structure 206 are submersed in the metal plating solution 218 when the support hooks 213 of the structure 206 are placed on the support structure 220. The metal plating solution 218 is configured to plate surfaces of the components 202. In one embodiment, the components 202 are plated by the metal plating solution 218 in response to an electrical charge being provided to the components 202. In one embodiment, the support hooks 213 are electrically conductive and an electrical charge is provided to the components 202 from

the support structure 220 to the components 202 via the support hooks 213, the structure 206, and the brochette 200. In this and other embodiments, portions of the structure 206 can be covered by a dielectric material, electrical insulation, etc., as long as an electrical conductive path between the support hooks and the brochette is not interrupted.

[0038] In one embodiment, the brochette rotation system 208 is configured to rotate the brochette 200 while the brochette 200 is submersed in the metal plating solution 218. In some embodiments, rotating the brochette 200 while the brochette 200 is submersed in the metal plating solution 218 results in more even metal plating on the components 202 than if the brochette 200 remained stationary. In one embodiment, pressurized air can be advantageously used to power the brochette rotation system 208 because pressurized air will not harm the metal plating solution 218 if pressurized air is inadvertently released into the metal plating solution 218. In addition, powering the brochette rotation system 208 with an electrical motor may introduce an electrical charge into the metal plating solution 218 that causes uneven application of metal plating to the components 202. However, while an electric motor may not be the preferred source of motion in the brochette rotation system 208, an electric motor may be used in the brochette rotation system 208 as a source of motion.

[0039] After the components 202 have been metal plated, as shown in FIGURE 7D, the structure 206 is removed from the metal plating tank 216 and the components 202 are dried. The components may be left on the brochette 200 during the drying process, either with the brochette 200 placed in the structure or with the brochette 200 removed from the structure. After the components 202 are dried, the components 202 and the spacers 204 can be removed from the brochette 200, as shown in FIGURE 7E. In one example, removing the components 202 and the spacers 204 from the brochette 200 includes loosening fasteners from the brochette 200 and sliding the components 202 and the spacers 204 off of the brochette 200.

[0040] FIGURE 7F depicts the components 202 and the spacers 204 removed from the brochette 200. In some embodiments, the components 202 removed from the brochette 200 are plated on the surfaces that were to be plated and not plated on the surfaces that were not to be plated. In some embodiments, the components 202 do not require post-plating cleaning because no adhesive masking materials were used to mask the components 202. In embodiments that employed brochette rotation during plating, polishing may also be avoided as rotation of the components 202 during the plating in FIGURE 7D can result in plating that does not need to be polished.

[0041] FIGURE 8 depicts an embodiment of a metal plating process 230 in accordance with an aspect of the present disclosure. At block 232, components are installed on a brochette using spacers that are configured to mask a portion of the components. In some embodiments, the components have different sizes and/or

shapes. In some embodiments, the spacers have different sizes and/or shapes. In some embodiments, the components and the spacers are installed on the brochette between fasteners that are configured to exert a compressive force on the components and spacers. One example of installing components on a brochette is depicted in FIGURE 7A.

[0042] At block 234, the components are cleaned. In some embodiments, the components are cleaned by submersing the brochette with the components and spacers in a cleaning solution. The components and spacers are installed on the brochette such that portions of the components that will not be plated are not exposed to the cleaning solution. In one example, the cleaning solution is an electrolytic cleaning solution. One example of cleaning components on a brochette is depicted in FIGURE 7C.

[0043] At block 236, the cleaned components are metal plated and dried. In some embodiments, the components are cleaned by submersing the brochette with the components and spacers in a metal plating solution. The components and spacers are installed on the brochette such that portions of the components that will not be plated are not exposed to the metal plating solution. In one example, the metal plating solution is an aqueous solution with cadmium for cadmium plating. In some embodiments, the components are metal plated by passing an electrical charge to the components while the components are submersed in the metal plating solution. In some embodiments, the brochette with the components is rotated by a brochette rotation system while the components are submersed in the metal plating solution. One example of metal plating components on a brochette is depicted in FIGURE 7D.

[0044] At block 237, the plated and dried components and the spacers are uninstalled (e.g., removed) from the brochette. In one example, the metal plating process is complete when the plated and dried components are removed from the brochette. In this example, no polishing or adhesive cleaning is required after the plated and dried components are removed from the brochette. One example of uninstalling components from a brochette is depicted in FIGURE 7E.

[0045] The method 230 depicted in FIGURE 8 has a number of advantages over the method 100 depicted in FIGURE 1, some of which will now be explained. In one example, the brochette used in the method 230 can hold a larger number of components than the wires used in the method 100, resulting in greater volume of components plated in each metal plating process. In another example, the method 230 eliminates the time and expense of masking components that is done in the method 100. In another example, the method 230 eliminates the time and expense of unmasking the components in method 100, as well as the risk to technicians from using a solvent to remove adhesive left on the component from the masking tape in the method 100. In another example, the rotation of the brochette while in the metal plating

solution 218 results in more even metal plating on the components than the wire dipping process used in the method 100. Such even metal plating from the method 230, in some embodiments, eliminates the time and expense of brushing and polishing done in method 100, as well as the risk to technicians from using a polish to polish the component in the method 100. In another example, the brochette and spacers used in the method 230 allow for treatment of components of different sizes on the same brochette at the same time. In another example, the success rate of plating components (i.e., the percentage of components that are plated without a defect) is greater using the method 230 than the method 100. The method 230 may have other advantages over the method 100 not explicitly discussed herein.

[0046] It should be noted that for purposes of this disclosure, terminology such as "upper," "lower," "vertical," "horizontal," "inwardly," "outwardly," "inner," "outer," "front," "rear," etc., should be construed as descriptive and not limiting the scope of the claimed subject matter. Further, the use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless limited otherwise, the terms "connected," "coupled," and "mounted" and variations thereof herein are used broadly and encompass direct and indirect connections, couplings, and mountings.

[0047] The principles, representative embodiments, and modes of operation of the present disclosure have been described in the foregoing description. However, aspects of the present disclosure which are intended to be protected are not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. It will be appreciated that variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present disclosure. Accordingly, it is expressly intended that all such variations, changes, and equivalents fall within the spirit and scope of the present disclosure, as claimed.

Claims

1. A method of metal plating components, comprising:

placing at least one component and at least one spacer on a brochette, wherein the at least one spacer is configured to mask a portion of the least one component;

placing the brochette with the at least one component and the at least one spacer on a structure;

placing the structure with the brochette into a metal plating tank having a metal plating solution such that the at least one component is submersed in the metal plating solution, wherein the

at least one component and the at least one spacer are arranged on the brochette such that the at least one spacer prevents the portion of the at least one component from being contacted by the metal plating solution;
metal plating at least one surface of the at least one component submersed in the metal plating solution; and
removing the structure with the brochette from the metal plating solution.

2. The method according to Claim 1, further comprising:

drying the at least one component on the brochette; and
removing the dried at least one component and the at least one spacer from the brochette.

3. The method according to Claim 1 or 2, further comprising:

placing the structure with the brochette into a cleaning tank having a cleaning solution such that the at least one component is submersed in the cleaning solution before placing the structure into the metal plating tank.

4. The method according to Claim 3, wherein the at least one component and the at least one spacer are arranged on the brochette such that the at least one spacer prevents the portion of the at least one component from being contacted by the cleaning solution.

5. The method according to any one of the preceding claims, further comprising:

rotating the brochette with the at least one component while the at least one component is submersed in the metal plating solution.

6. The method according to any one of the preceding claims, further comprising:

providing an electrical charge to the at least one component while the at least one component is submersed in the metal plating solution via the at least one support interface, from the structure to the brochette via a contact point between the structure and the brochette, and from the brochette to the at least one component.

7. The method according to any one of the preceding claims, wherein placing the at least one component and the at least one spacer on the brochette comprises placing the at least one component and the at least one spacer between fasteners on the bro-

chette.

8. The method according to Claim 7, further comprising:

applying a compressive force to the at least one component and the at least one spacer on the brochette between the fasteners.

9. The method according to any one of Claims 1 to 6, wherein placing the at least one component and the at least one spacer on the brochette comprises placing the brochette through a bore of the at least one component and a bore of the at least one spacer; and placing a conical section of the spacer into the bore of the at least one component.

10. The method according to any one of the preceding claims, wherein the at least one component comprises a plurality of components, and wherein the plurality of components comprises a first component having a first surface and a second component having a second surface.

11. The method according to Claim 10, wherein placing the at least one component and the at least one spacer on the brochette comprises placing the first component and the second component on the brochette with the first surface facing the second surface.

12. The method according to Claim 11, wherein the placement of the first component and the second component on the brochette with the first surface facing the second surface is configured to prevent the first surface and the second surface from being contacted by the metal plating solution while the first and second components are submersed in the metal plating solution.

13. A system according to holding at least one component during a metal plating process, wherein a portion of the at least one component is not to be plated during the metal plating process, the system comprising:

a brochette configured to have the at least one component placed thereon;
at least one spacer configured to be placed on the brochette and to mask the portion of the least one component; and
a structure configured to hold the brochette with the at least one component and the at least one spacer;
wherein the at least one spacer is configured to be arranged on the brochette such that, when the structure with the brochette is placed into a metal plating tank having a metal plating solution

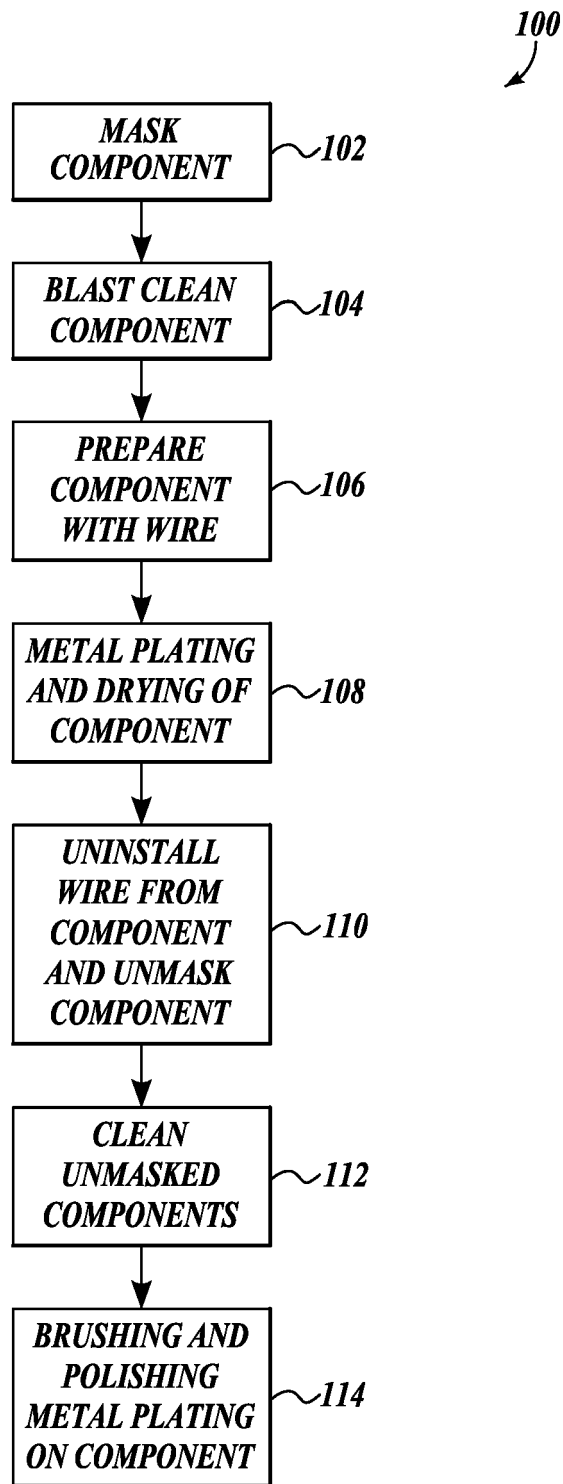
such that the at least one component is submersed in the metal plating solution, the at least one spacer prevents the portion of the at least one component from being contacted by the metal plating solution.

14. The system according to Claim 13, further comprising:

a brochette rotation system configured to rotate the brochette with the at least one component while the at least one component is submersed in the metal plating solution.

15. The system according to Claim 13 or 14, further comprising:

fasteners configured to exert a compressive force on the at least one component and the at least one spacer on the brochette when the at least one component and the at least one spacer are located between the fasteners on the brochette.

**FIG. 1**

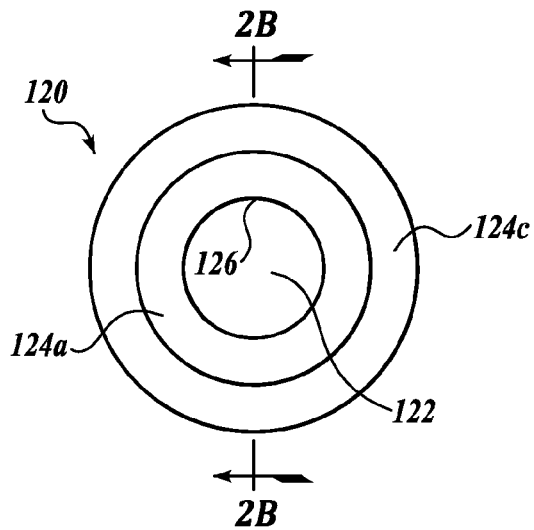


FIG. 2A

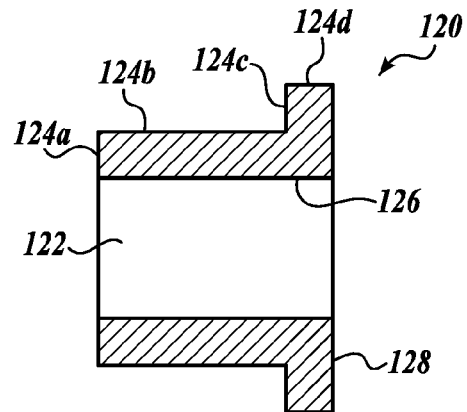


FIG. 2B

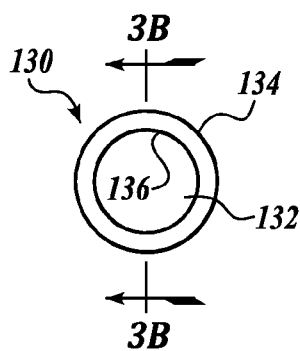


FIG. 3A

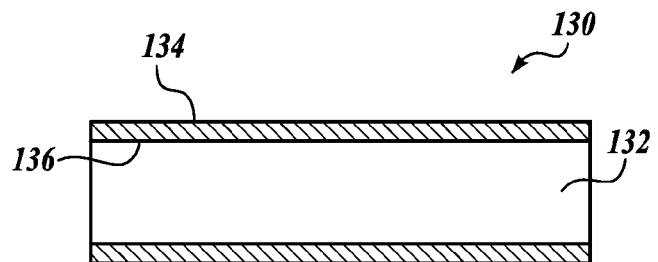


FIG. 3B

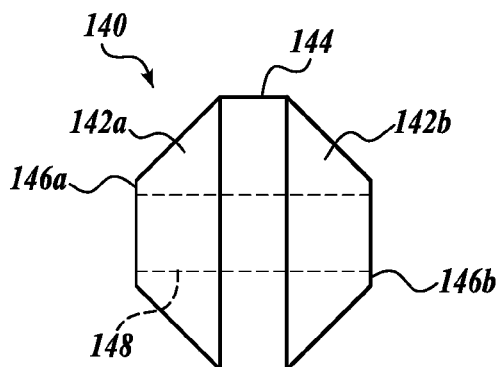


FIG. 4A

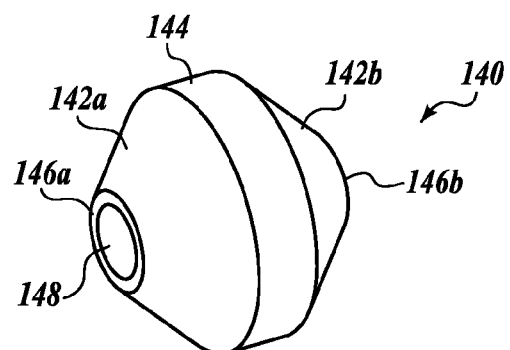


FIG. 4B

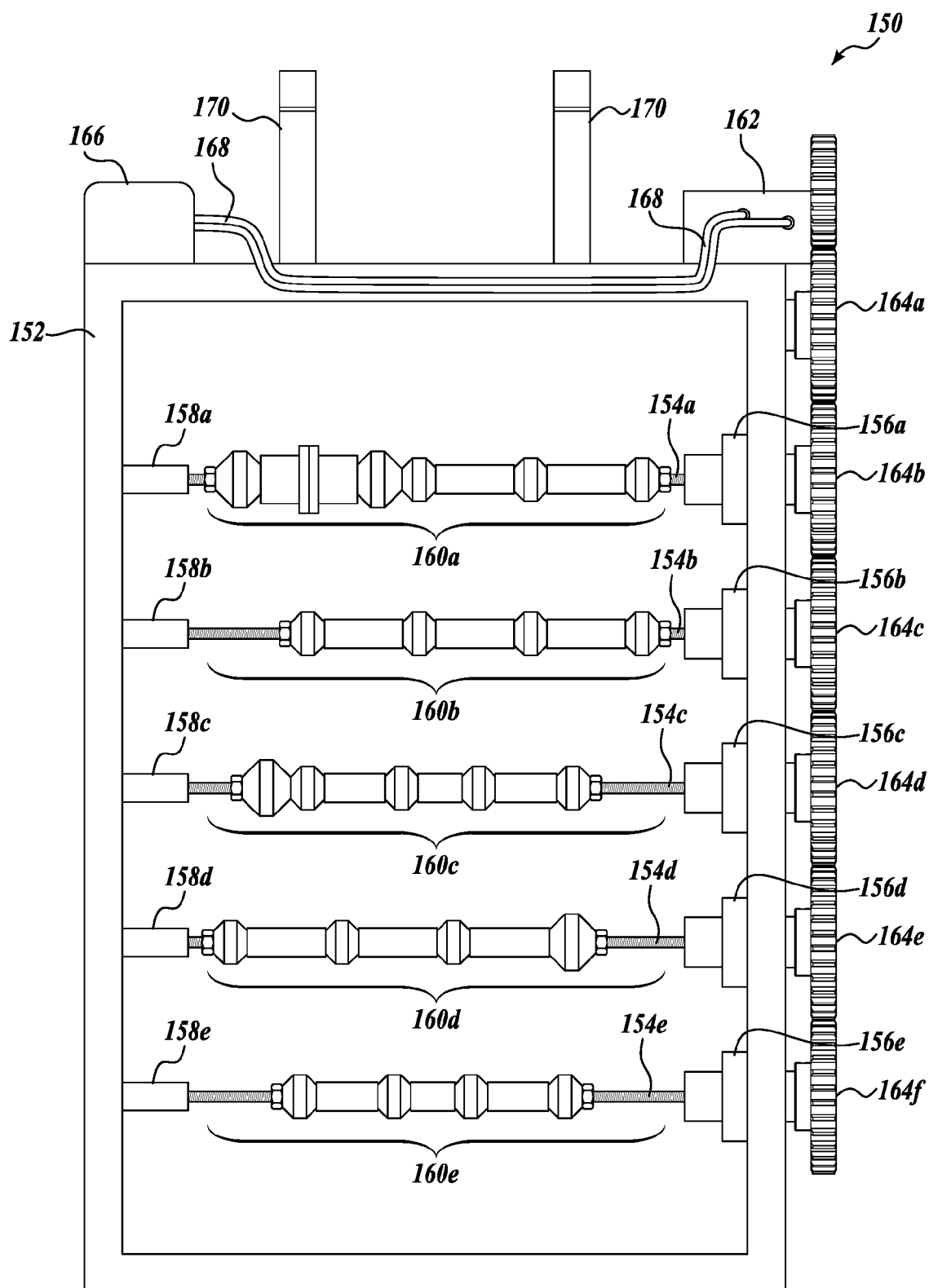


FIG. 5

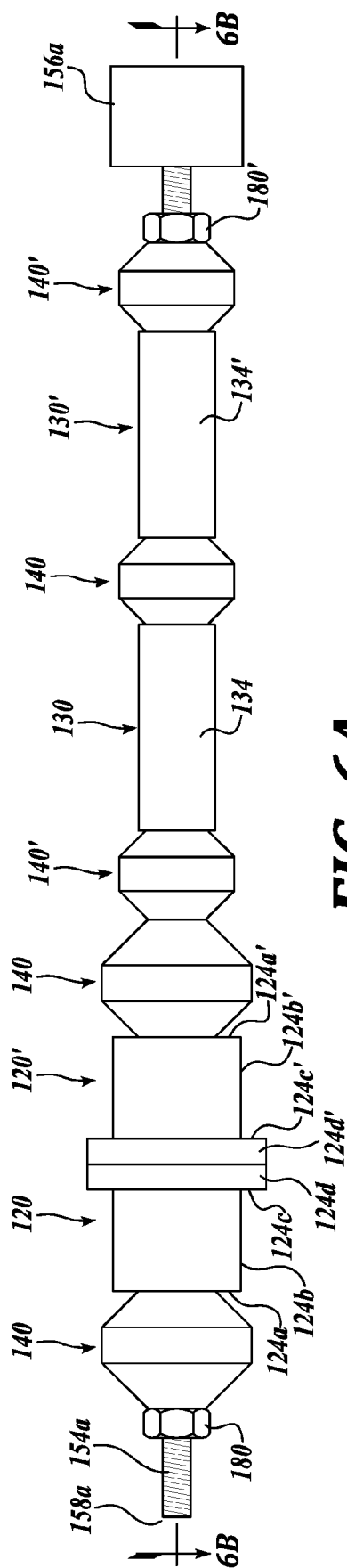


FIG. 6A

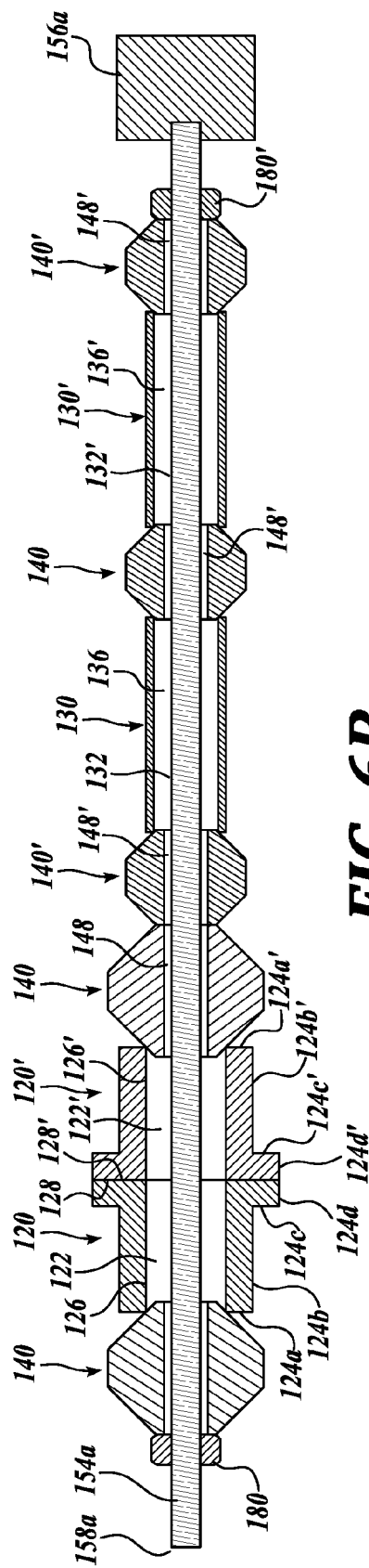


FIG. 6B

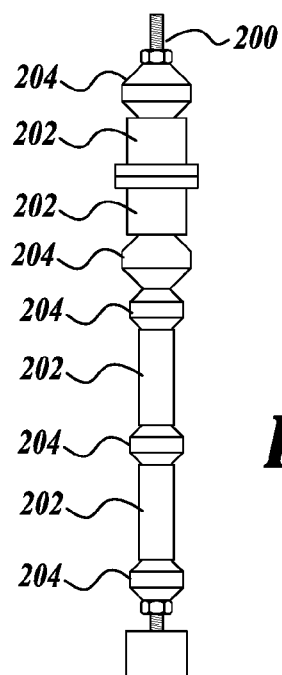


FIG. 7A

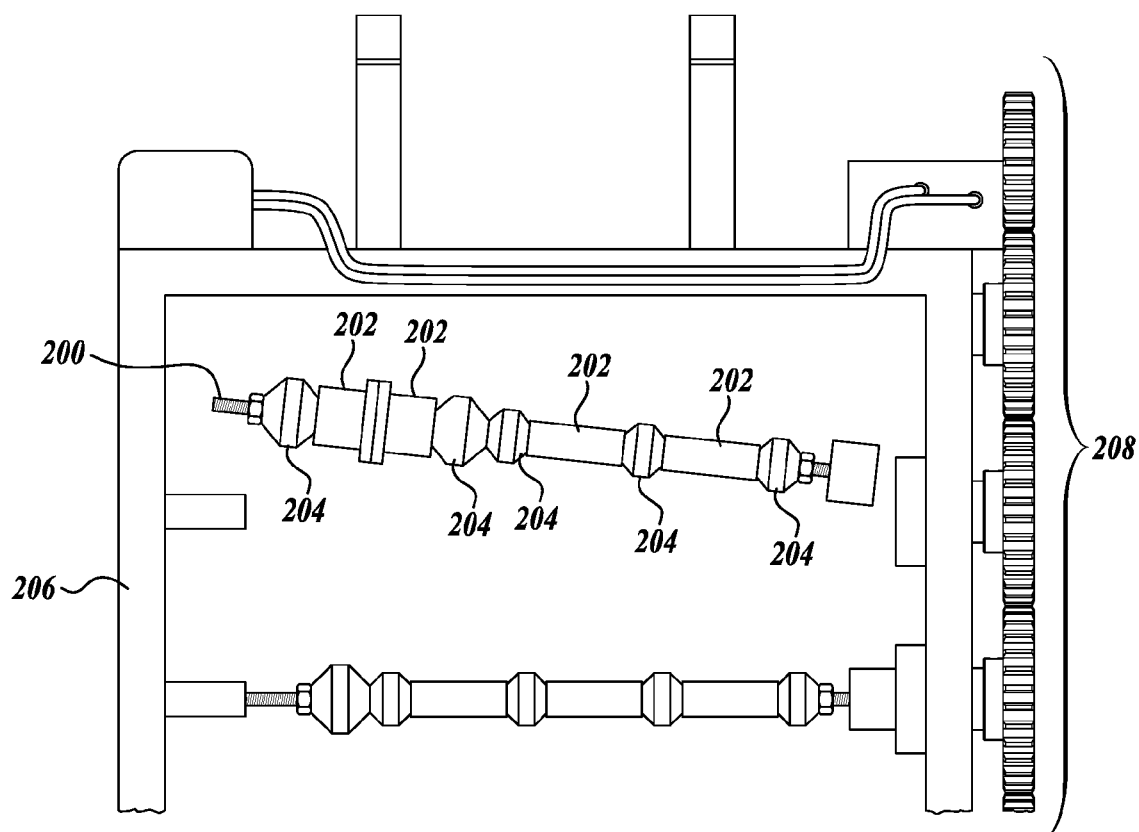


FIG. 7B

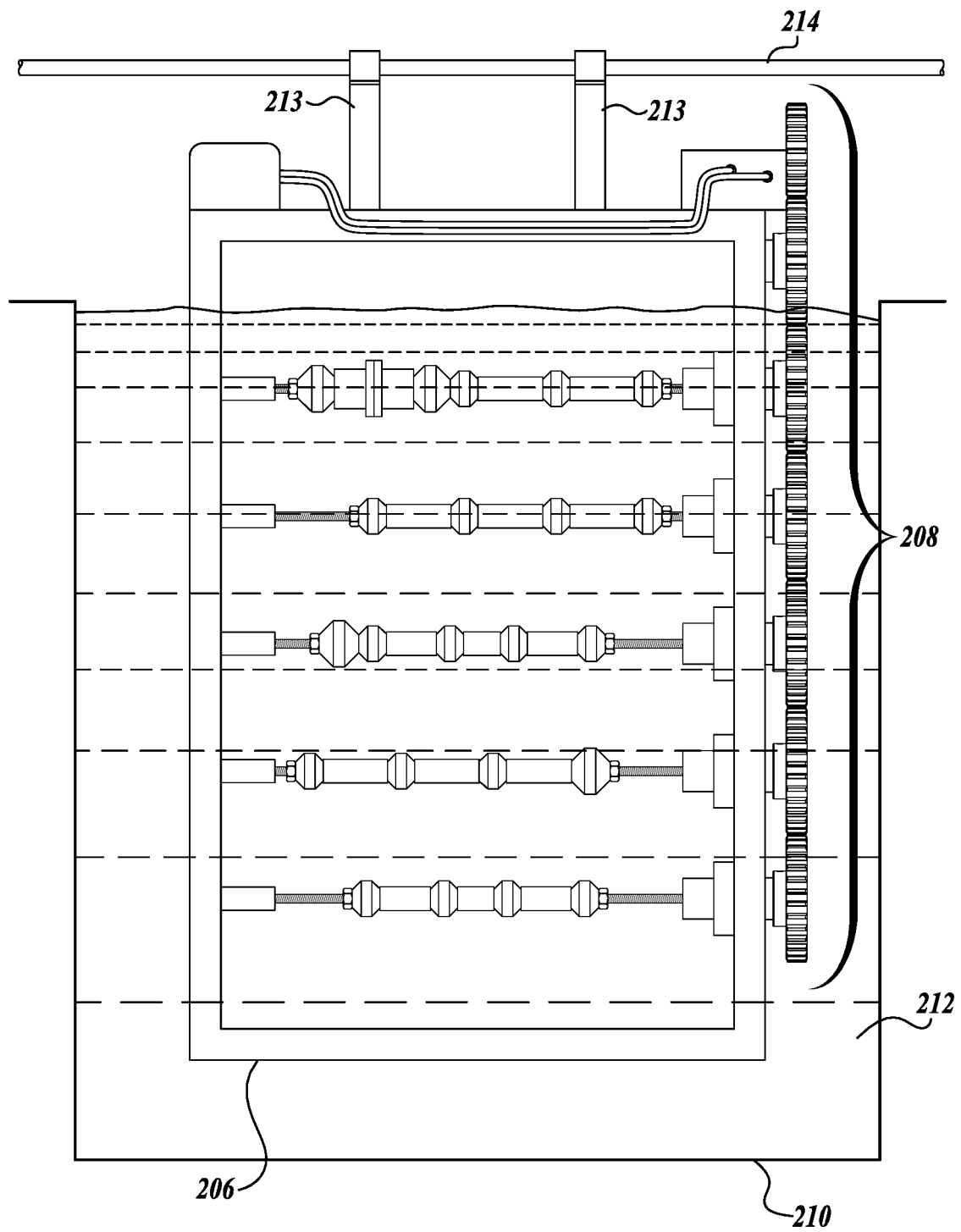


FIG. 7C

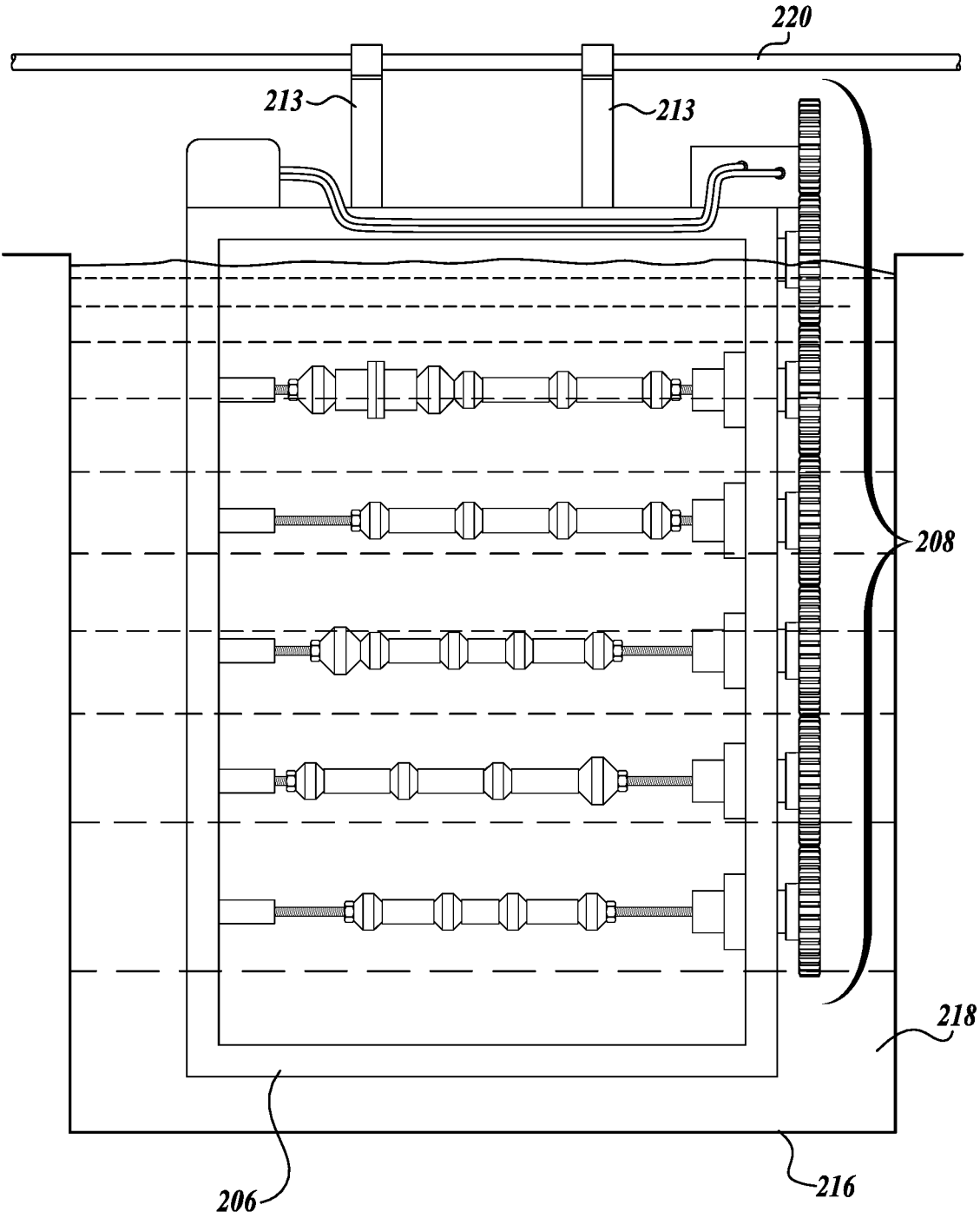


FIG. 7D

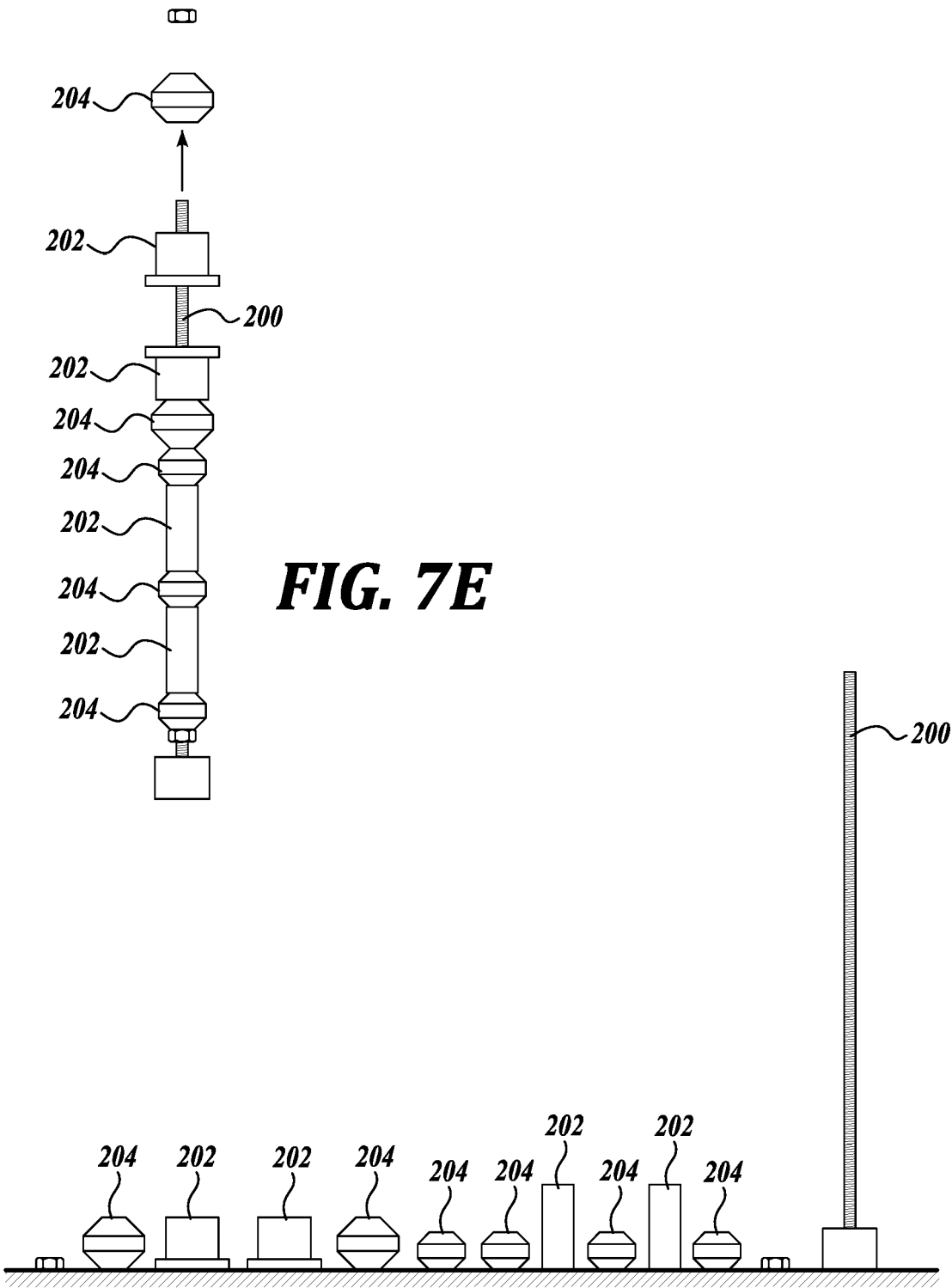


FIG. 7F

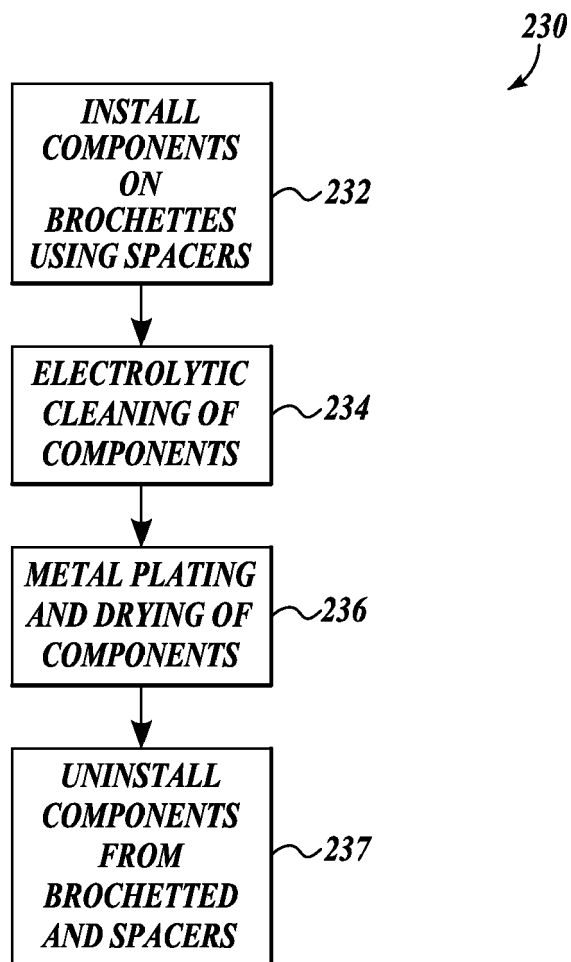


FIG. 8



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 16 2756

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Y	* abstract; figure 1 * * paragraph [0008] - paragraph [0014] * * paragraph [0019] *	5,14	
X	JP 2007 009265 A (MAZDA MOTOR) 18 January 2007 (2007-01-18) * abstract; figures 1, 2 * * paragraph [0005] * * paragraph [0008] * * paragraph [0017] - paragraph [0018] *	1,6,13	
X	US 2002/070119 A1 (WILSON STEPHEN A [GB] ET AL) 13 June 2002 (2002-06-13) * paragraph [0001]; figures 1, 3, 4 * * paragraph [0006] * * paragraph [0011] * * paragraph [0017] - paragraph [0018] * * paragraph [0034] - paragraph [0038] *	1,6-9, 13,15	
Y	DE 39 02 057 A1 (GOETZE AG [DE]) 26 July 1990 (1990-07-26) * abstract; figures 1, 2 * * column 2, lines 26-37 *	5,14	
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Place of search The Hague		Date of completion of the search 27 June 2017	Examiner Telias, Gabriela
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

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EP 17 16 2756

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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27-06-2017

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