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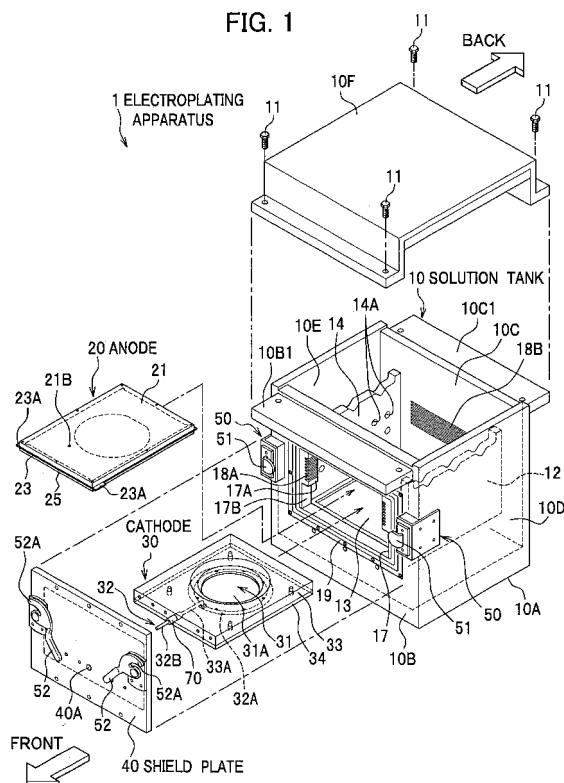
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(54) Electroplating apparatus

(57) An electroplating apparatus is provided which includes a solution tank which has at least a bottom plate and a side plate and inside which electroplating solution is poured and a cathode plate and an anode plate which are horizontally placed so as to face each other in the electroplating solution in the solution tank, in which one plate of the cathode plate and the anode plate is an object to be electroplated and placed in a lower position than the other plate, in which an opening through which the cathode plate and the anode plate are inserted into the solution tank is provided in the side plate of the solution tank, and in which a shield plate which is detachable shields the opening of the solution tank.



Description

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0001] The present invention relates to an electroplating apparatus for performing electroplating and anodic oxidation on surfaces of, for example, wafers, glass substrates, and ceramic substrates.

2. DESCRIPTION OF THE RELATED ART

[0002] In recent years, electroplating technologies are applied to various kinds of technical fields, including wiring technologies in semi-conductors. In the field of semi-conductors, wiring pitches are required to be reduced to accomplish high integration and performance. For example, in a wiring technology employed in latest years, an interlayer insulated film is formed, and then dry etching process is performed on the interlayer insulated film to form wiring grooves into which wiring material is electroplated and filled.

[0003] To achieve such an electroplating technology, it is required to electroplate wiring material evenly in grooves which are formed on an object to be electroplated. For this purpose, the applicant has proposed an electroplating apparatus which forms an even electroplating film on a surface to be electroplated of an object to be electroplated. (Refer to JP 2003-301299A, for example.)

[0004] In the above-mentioned electroplating apparatus, a cathode plate, which is the object to be electroplated, and an anode plate are placed to face each other in a solution tank inside which electroplating solution is poured. A power source is connected to the cathode plate and the anode plate in order to generate electric field between the cathode plate and the anode plate to electroplate a surface of the cathode plate.

[0005] By the way, in the electroplating apparatus described in JP 2003-301299A, bubbles mainly composed of hydrogen are generated from the surface to be electroplated of the cathode plate while the cathode plate is being electroplated. Then, the bubbles rise along the surface to be electroplated of the cathode plate one after another since the cathode plate, as well as the anode plate, is placed vertically in the solution tank. Accordingly, a thickness of an electroplating film formed on the surface to be electroplated of the cathode plate becomes uneven since the bubbles go along the surface to be electroplated of the cathode plate. As a result, there is a problem that high quality of the electroplating film cannot be always assured.

[0006] To solve such a problem, in a well-known method, an electroplating apparatus is rotated by 90 degrees after a cathode plate and an anode plate are installed vertically. Then, the cathode plate in a lower position and the anode plate in a higher position are held horizontally to prevent bubbles from going directly along the surface

of the cathode plate. However, such a method requires another device to rotate the electroplating apparatus. Accordingly, there is a problem that the whole electroplating apparatus becomes large and complicated.

SUMMARY OF THE INVENTION

[0007] In view of such a background, it is an object of the present invention to provide an electroplating apparatus which is able to form an electroplating film with an even thickness all over a surface to be electroplated so as to improve quality of the electroplating film, as well as to downsize and simplify the whole electroplating apparatus.

[0008] To solve the above-mentioned problem, in one aspect of the present invention, there is provided an electroplating apparatus including a solution tank which has at least a bottom plate and a side plate, and inside which electroplating solution is poured, and a cathode plate and an anode plate which are horizontally placed so as to face each other in the electroplating solution in the solution tank. In the electroplating apparatus, one plate of the cathode plate and the anode plate is an object to be electroplated and placed in a lower position than the other plate. In addition, an opening through which the cathode plate and the anode plate are inserted into the solution tank is provided in the side plate of the solution tank. Furthermore, a shield plate which is detachable shields the opening of the solution tank.

[0009] In such a configuration, when the cathode plate and the anode plate are installed, the cathode plate and the anode plate are inserted into the solution tank through the opening provided in the side plate of the solution tank. Accordingly, it is easy to install the cathode plate and the anode plate horizontally and parallel each other in the solution tank. In addition, the one plate of the cathode plate and the anode plate, which is an object to be electroplated, is placed in the lower position than the other plate. Therefore, it is possible to let bubbles which are mainly composed of hydrogen and generated from a surface to be electroplated of the one plate, go up directly to outside without going along the surface to be electroplated of the one plate. Moreover, it is also easy to install the cathode plate and the anode plate horizontally in the solution tank as described above. Consequently, a large scale device which rotates the whole solution tank by 90 degrees described in the well-known method is not required. In the present invention, the object to be electroplated may be connected to a negative electrode of a power source in order that the surface of the object to be electroplated is electroplated. Moreover, the object to be electroplated may be also connected to a positive electrode of the power source in order that an anodic film, which is an oxide film, is formed on the surface of the object to be electroplated.

[0010] In the electroplating apparatus, a slot which holds the cathode plate and/or the anode plate horizontally may be provided in the side plate of the solution tank.

[0011] In such a configuration, it is required only to engage the cathode plate and/or the anode plate in the slot provided in the side plate of the solution tank in order to hold the cathode plate and/or the anode plate horizontally in the solution tank. Accordingly, it is easy to install the cathode plate and/or the anode plate.

[0012] In the electroplating apparatus, a plurality of the slots which hold the cathode plate and/or the anode plate horizontally may be vertically arranged in the side plate of the solution tank in order to adjust a height of the cathode plate and/or the anode plate.

[0013] In such a configuration, it is possible to change a vertical installation position of the cathode plate and/or the anode plate so as to change a distance between the cathode plate and the anode plate. Therefore, it is possible to properly control, for example, a thickness of an electroplating film formed on the surface to be electroplated of the cathode plate (or the anode plate) which is the object to be electroplated.

[0014] In the electroplating apparatus, the slots may be used to adjust a height of the other plate. In addition, a conductive member which conducts electricity to the other plate may be inserted downward from above toward inside of the solution tank into the other plate so as to be electrically connected to the other plate. Moreover, the conductive member may be supported in the solution tank in such a manner that a height of the conductive member is adjustable corresponding to the height of the other plate.

[0015] In such a configuration, the conductive member is inserted downward from above toward inside of the solution tank. Thus, an end of the conductive member can be electrically connected to the other plate, which is placed in the higher of two positions of the cathode plate and the anode plate. Moreover, when the height of the other plate in the higher position is changed, the height of the conductive member is adjusted corresponding to the height of the other plate in the higher position. Consequently, it is easy to engage and electrically connect the conductive member to the other plate in the higher position.

[0016] In the electroplating apparatus, the one plate may be cantilevered and attached to the shield plate.

[0017] In such a configuration, to install the one plate, which is placed in the lower of two positions of the cathode plate and the anode plate, the one plate is attached to the shield plate in advance and then installed in the solution tank. Accordingly, the one plate can be easily cantilevered and attached to the shield plate. Thus, a worker does not need to bother to extend his/her hand into the opening of the solution tank to install the one plate in the lower position. Moreover, to install the shield plate to the solution tank, only one edge of the one plate in the lower position needs to be cantilevered. After the shield plate has been installed in the solution tank, the other edge of the one plate in the lower position can be, for example, hung on a portion of the solution tank which faces the shield plate or engaged in a slot formed in the solution

tank so that both sides of the one plate can be supported. Therefore, the one plate in the lower position is stably held in the solution tank. In addition, a bolt having a head may be attached to the lower side of the other end of the one plate in the lower position in order to support the other end of the one plate with the head of the bolt being touched on the bottom of the solution tank.

[0018] In the electroplating apparatus, a conductive member which conducts electricity to the one plate may pass through the shield plate horizontally toward inside of the solution tank so as to be electrically connected to the one plate.

[0019] In such a configuration, the conductive member passes through the shield plate horizontally toward inside of the solution tank. Therefore, it is easy to electrically connect the conductive member to the one plate, which is placed in the lower of two positions of the cathode plate and the anode plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is an exploded perspective view showing an electroplating apparatus according to an embodiment of the present invention.

FIG. 2 is an exploded perspective view showing the electroplating apparatus with a cathode of FIG. 1 being attached to a shield plate.

FIG. 3 is a front view of a solution tank used in the embodiment of the present invention.

FIG. 4 is a left side view of the solution tank used in the embodiment of the present invention.

FIG. 5 is a left side view of the electroplating apparatus according to the embodiment of the present invention.

FIG. 6 is a front view of the electroplating apparatus according to the embodiment of the present invention.

FIG. 7 is a front view of the electroplating apparatus from which the shield plate is detached.

FIG. 8 is an exploded perspective view showing an anode used in the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Next, an embodiment of the present invention will be described in detail, referring to the accompanied drawings as needed.

[0022] As shown in FIGs. 1-4, an electroplating apparatus 1 generally includes a solution tank 10, an anode 20, a cathode 30, and a shield plate 40. Electroplating solution is poured and filled inside the solution tank 10.

[0023] As shown in FIGs 1-4, the solution tank 10 has a bottom plate 10A, a first side plate 10B as a front plate (hereafter referred as a side plate 10B), a second side plate 10C as a back plate (hereafter referred as a side

plate 10C), a third side plate 10D as a left side plate (hereafter referred as a side plate 10D), a fourth side plate 10E as a right side plate (hereafter referred as a side plate 10E), and a top plate 10F which is fastened to brackets 10B1 and 10C1 respectively provided on upper ends of the side plates 10B and 10C, with bolts 11, 11, 11, and 11 (see FIG. 2). Additionally, as shown in FIG. 3, a right vertical plate 14 (hereafter referred as a vertical plate 14) erected on the bottom plate 10A, a horizontal plate 13 extending horizontally from a lower portion of the vertical plate 14, and a left vertical plate 12 (hereafter referred as a vertical plate 12) erected on a left end of the horizontal plate 13 are formed inside the solution tank 10.

[0024] Moreover, a plurality of circulation holes 14A, 14A, ..., and 14A (see FIG. 1) are cut through the vertical plate 14. In addition, a plurality of circulation holes 13A, 13A, ..., and 13A are also cut through the horizontal plate 13. Furthermore, a drain hole 10A1 is cut through the bottom plate 10A. In addition, as shown in FIGs. 3 and 5, a pump attachment opening 15 to which a pump (not shown) is to be attached is cut through the side plate 10C of the solution tank 10 between the side plate 10E and the vertical plate 14. Moreover, a cover plate 16 shown in FIG. 5 is placed between upper ends of the vertical plate 12 and the vertical plate 14.

[0025] Therefore, when the pump is operated, electroplating solution is poured from the pump in direction indicated by an arrow A as shown in FIG. 3. Then, the poured electroplating solution circulates in direction indicated by an arrow B through circulation holes 14A and in direction indicated by an arrow B' over the top of the vertical plate 14, so as to be poured into a space surrounded by the vertical plates 12 and 14 and the horizontal plate 13. Moreover, the electroplating solution poured into the space circulates in direction indicated by an arrow C through circulation holes 13A and in direction indicated by an arrow D over the top of the vertical plate 12, so as to be poured under the horizontal plate 13. Then, the electroplating solution is drained outside in direction indicated by an arrow F through the drain hole 10A1. Thus, the pump circulates the electroplating solution in predetermined direction in order to prevent the electroplating solution from staying. As a result, the pump prevents "residues" which are generated while a wafer (a cathode plate) 31, which will be described later, is being electroplated, from sticking on the wafer 31.

[0026] Here, as shown in FIGs. 1-3, an opening 17 is formed in a substantially two-tiered shape in the side plate 10B of the solution tank 10. Additionally, the opening 17 includes a narrow portion 17A which is horizontally narrower and a wide portion 17B which is horizontally wider and connected to a lower side of the narrow portion 17A. Moreover, a plurality of slots 18A, 18A, ..., and 18A are vertically arranged along right and left peripheries of the narrow portion 17A of the opening 17. Here, the slots are formed in substantially U-shapes, and a pair of the slots face each other on the right and left peripheries. In

addition, a plurality of slots 18B, 18B, ..., and 18B which extend and elongate in horizontal direction are formed in the side plate 10C of the solution tank 10 at positions respectively corresponding to the pairs of the slots 18A, 18A, ..., and 18A in the side plate 10B. Furthermore, a sealing member 19 formed as a substantially quadrangular frame is attached to the side plate 10B of the solution tank 10 so as to surround the periphery of the opening 17. In addition, holding members 51 and 51 which form parts of lock mechanisms 50 and 50 respectively are fixed and attached to a corner between the side plate 10B and the side plate 10D and a corner between the side plate 10B and the side plate 10E.

[0027] As shown in FIG. 8, the anode 20 includes an anode cartridge pan 21 which is made of insulation material such as acrylic and formed in a quadrangular shape having a quadrangular recess 21A, an anode plate 22 which is made of metallic material such as steel and nickel and formed in a quadrangular shape so as to fit in the recess 21 A of the anode cartridge pan 21, an anode cartridge holder 23 which is made of insulating material such as acrylic in order to hold the anode plate 22 between the anode cartridge holder 23 and the anode cartridge pans 21, an anode bag 24 which is made of fibrous material such as cloths and lined on a surface (a lower side in FIG. 8) of the anode cartridge holder 23, and an anode bag holder 25 which is made of insulating material such as acrylic to hold the anode bag 24 between the anode bag holder 25 and the anode cartridge holder 23. By the way, it is possible to change shape, size, and so on of an hole 25A formed in the anode bag holder 25 as needed depending on shape of a surface 31A to be electroplated of the wafer 31.

[0028] Here, first engaging protrusions 23A and 23A formed in substantially quadrangular shapes are protruded on both sides of the front end of the anode cartridge holder 23. Moreover, a back end of the anode cartridge holder 23 is a second engaging protrusion 23B which is protruded backward through between the anode cartridge pan 21 and the anode bag holder 25. Accordingly, as shown in FIGs. 5-7, the first engaging protrusions 23A and 23A are engaged in the pair of the slots 18A and 18A (See FIG. 5) while the second engaging protrusion 23B (see FIG. 8) is engaged in the slot 18B. Thus, the anode 20 is installed. As a result, the anode 20 is horizontally and stably held by three points support in the electroplating solution in the solution tank 10. By the way, the anode bag 24 prevents "residue", which is generated while the wafer 31 is being electroplated, from adhering to the anode plate 22.

[0029] Moreover, a conductive rod (a conductive member) 26 on an anode side is inserted from above into a circular hole 21B which is cut through the anode cartridge pan 21. Accordingly, an end (a lower end) of the conductive rod 26 on the anode side electrically contacts with the anode plate 22. Then, the conductive rod 26 on the anode side is screwed into a screw hole (not shown) which is cut through the cover plate 16. Thus, a worker

can rotate the conductive rod 26 on the anode side in order to adjust the height of the end of the conductive rod 26 on the anode side corresponding to the height of the anode 20.

[0030] Structure of a cathode 30 is substantially similar to the cathode cartridge described in JP 2003-301299A. The cathode 30 is placed horizontally and parallel to the anode 20 in a lower position than the anode 20. Moreover, the cathode 30 includes the wafer 31, which is an object to be electroplated, a cathode conductor 32 which is a conductive member to conduct electricity to the surface 31A of the wafer 31, a first insulator 33 which is made of insulating material such as acryl to cover the frontside (the side of the surface 31A) of the wafer 31 and hold the cathode conductor 32, and a second insulator 34 which is made of insulating material such as acryl to cover the backside (the opposite side of the surface 31A) of the wafer 31 and hold the wafer 31. Moreover, the cathode conductor 32 includes a conductive ring plate 32A and a conductive rod 32B on the cathode side which is electrically connected to the conductive ring plate 32A.

[0031] Additionally, as shown in FIG. 2, a front edge of the first insulator 33 of the cathode 30 is fastened and attached to a shield plate 40, which will be described later, in the manner of a cantilever. Moreover, the conductive rod 32B of the cathode conductor 32 passes through the shield plate 40 horizontally toward inside of the solution tank 10 to be electrically connected to the wafer 31 through the conductive ring plate 32A. As shown in FIGs. 1 and 2, insert holes 33A and 40A through which the conductive rod 32B is inserted are respectively provided in the first insulator 33 and the shield plate 40. Thus, the conductive rod 32B protrudes outside from the shield plate 40 through the insert holes 33A and 40A. In addition, a cylindrical sealing member 70 (see FIG. 5) fluid-tightly seals between the conductive rod 32B and the insert hole 33A and between the conductive rod 32B and the insert hole 40A. Therefore, the electroplating solution is prevented from leaking from the insert holes 33A and 40A. Moreover, ring sealing members (not shown) fluid-tightly seal between the wafer 31 and the first insulator 33 and between the first insulator 33 and the second insulator 34 respectively.

[0032] The shield plate 40, which is formed as a substantially quadrangular board member, is affixed to an outer periphery of the sealing member 19 to shield the opening 17. Moreover, a lever member 52 which forms a part of the lock mechanism 50 is provided on each of the right and left sides of the shield plate 40 so as to be rotatable. Then, an end of the lever member 52 is latched to the holding member 51 so as to strongly press the shield plate 40 toward the sealing member 19. Accordingly, it is possible to fluid-tightly seal the opening 17 with the shield plate 40 and prevent the electroplating solution from leaking from the opening 17.

[0033] The number "60" in FIG. 5 shows a mixing tool which is able to move back and forth on the upper end of the solution tank 10. As shown in FIGs. 5-7, the mixing

tool 60 generally includes a support plate 62 which has rotatable rollers 61 and 61 on front and rear sides, vertical panels 63 and 63 which vertically hang down from the support plate 62, and a connecting rod 64 which connects the lower ends of the vertical panels 63 and 63. In addition, an operation plate 65 which is operated from outside to move the mixing tool 60 back and forth is provided to the support plate 62. Moreover, in the mixing tool 60, an actuator (not shown) actuates the operation plate 65 to move back and forth so as to cause the vertical panels 63 and 63 and the connecting rod 64 to stir the electroplating solution in order to prevent the electroplating solution from staying in the solution tank 10.

[0034] In such a configuration of the present embodiment, after the pump is powered on, the conductive rod 26 on the anode side is connected to a positive electrode of a power source. In addition, the conductive rod 32B on the cathode side is connected to a negative electrode of the power source. Accordingly, an electroplating film is formed on the surface 31A of the wafer 31 of the cathode 30.

[0035] Here, the cathode 30 in a lower position is placed horizontally and parallel to the anode 20 in a higher position. Therefore, it is possible to let bubbles which are mainly composed of hydrogen and generated from the surface 31A of the wafer 31 of the cathode 30, go up from the surface 31A of the wafer 31 to escape outside. Thus, the bubbles do not go along the surface 31A of the wafer 31. As a result, it is possible to equalize the thickness of the electroplating film formed on all over the surface to be electroplated to improve quality of the electroplating film.

[0036] Moreover, the opening 17 through which the anode 20 and the cathode 30 are inserted into the solution tank 10 is formed in the side plate 10B of the solution tank 10. Accordingly, it is easy to insert the anode 20 and the cathode 30 horizontally into the solution tank 10 through the opening 17. Thus, it is possible to easily install the anode 20 and the cathode 30 in the solution tank 10 so as to improve work efficiency of installing the anode 20 and the cathode 30. Therefore, a large scale device which rotates the entire solution tank by 90 degrees as described in the well-known method is not necessary. As a result, it is possible to downsize and simplify the whole electroplating apparatus.

[0037] Moreover, the slots 18A are provided in the side plate 10B of the solution tank 10. In addition, the slot 18B is provided in the side plate 10C of the solution tank 10 at a height corresponding to the slots 18A. Accordingly, the anode 20 is engaged in the slots 18A and 18B so as to be held horizontally in the solution tank 10. Thus, it is easy to install the anode 20.

[0038] Furthermore, the plurality of slots 18A, 18A, ..., and 18A and the plurality of slots 18B, 18B, ..., and 18B are respectively arranged in the side plate 10B and the side plate 10C of the solution tank 10 in vertical direction. Therefore, it is possible to change the installation position of the anode 20 corresponding to the height of the slot

18A and 18B in order to change a distance between the anode 20 and the cathode 30. As a result, it is possible to appropriately control the thickness of the electroplating film formed on the surface 31A of the wafer 31 of the cathode 30.

[0039] The conductive rod 26 is inserted downward from above toward inside of the solution tank 10 into the anode 20 which is placed in the higher of two positions of the anode 20 and the cathode 30, so as to be electrically connected to the anode 20. In addition, the conductive rod 26 is supported in the solution tank 10 in such a way that the height of the conductive rod 26 can be adjusted corresponding to the height of the anode 20. Therefore, it is easy to adjust the height of the conductive rod 26 depending on the height of the anode 20 in order to engage the conductive rod 26 in the anode plate 22.

[0040] Moreover, the cathode 30 is cantilevered and attached to the shield plate 40. Therefore, to install the cathode 30, the shield plate 40 to which the cathode 30 has been attached in advance, is installed into the solution tank 10. Thus, the worker does not need to bother to extend his/her hand into the opening 17 of the solution tank 10 to install the cathode 30. As a result, it is possible to easily install the cathode 30.

[0041] Moreover, the conductive rod 32B of the cathode conductor 32 passes through the shield plate 40 horizontally so as to be electrically connected to the cathode 30 which is placed in the lower of two positions of the anode 20 and the cathode 30. Therefore, it is easy to electrically connect the conductive rod 32B to the wafer 31 of the cathode 30 through the conductive ring plate 32A.

[0042] In the present embodiment, description has been given to an example where the anode 20 is installed in the solution tank 10 in such a way that the height of the anode 20 can be changed and the cathode 30 is attached to the shield plate 40. However, the present invention is not limited to this. For example, the anode 20 may be attached to the shield plate 40, and the cathode 30 may be installed in the solution tank 10 in such a way that the height of the cathode 30 can be changed. Moreover, an anode plate may be an object to be electroplated and placed in a lower position than a cathode plate. In this case, an anodic film, which is an oxide film, may be formed on a surface of the anode plate.

[0043] Moreover, in the present embodiment, description has been given to an example where only the ring sealing members (not shown) are used to fluid-tightly seal between the wafer 31 and the first insulator 33 and between the first insulator 33 and the second insulator 34 respectively. However, the present invention is not limited to this. For example, air pressure of the back side of the wafer 31 can be made and kept negative using a pump (not shown) or the like in order to affix the whole wafer 31 on a surface of the ring sealing member with even pressure so as to improve the sealing performance of the ring sealing member. In this case, the sealing member 70 also has a function to prevent a problem that the

electroplating solution infiltrates into a portion other than the surface 31A of the wafer 31 in combination with the ring sealing members.

[0044] Furthermore, as shown in FIG. 5, in the present embodiment, description has been given to an example where the connecting rod 64 of the mixing tool 60 is formed as a round rod. However, the present invention is not limited to this. For example, the cross section of the connecting rod 64 of the mixing tool 60 may be formed in a quadrangle, a triangle, or other shape.

[0045] According to the present invention, a thickness of an electroplating film formed on a surface to be electroplated of an object to be electroplated can be equalized all over the surface so as to improve quality of the electroplating film. In addition, it is easy to install a cathode plate and an anode plate horizontally inside a solution tank through an opening provided in a side plate of the solution tank so as to improve work efficiency of installing the plates. Moreover, a large scale device which rotates the solution tank by 90 degrees is not required. As a result, a whole electroplating apparatus is possible to be downsized and simplified.

[0046] While the described embodiments represent the preferred forms of the present invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied within the spirit and scope of the following claims.

Claims

1. An electroplating apparatus, comprising:

a solution tank which has at least a bottom plate and a side plate and inside which electroplating solution is poured; and
a cathode plate and an anode plate which are horizontally placed so as to face each other in the electroplating solution in the solution tank, wherein
one plate of the cathode plate and the anode plate is an object to be electroplated and placed in a lower position than the other plate, wherein an opening through which the cathode plate and the anode plate are inserted into the solution tank is provided in the side plate of the solution tank, and wherein
a shield plate which is detachable shields the opening of the solution tank.

2. An electroplating apparatus according to claim 1, wherein a slot which holds the cathode plate and/or the anode plate horizontally is provided in the side plate of the solution tank.

3. An electroplating apparatus according to claim 1, wherein a plurality of slots which hold the cathode plate and/or the anode plate horizontally are verti-

cally arranged in the side plate of the solution tank in order to adjust a height of the cathode plate and/or the anode plate.

4. An electroplating apparatus according to claim 3, wherein the slots are used to adjust a height of the other plate, wherein
a conductive member which conducts electricity to the other plate is inserted downward from above toward inside of the solution tank into the other plate so as to be electrically connected to the other plate, and wherein
the conductive member is supported in the solution tank in such a manner that a height of the conductive member is adjustable corresponding to the height of the other plate.
5. An electroplating apparatus according to any one of claims 1-4, wherein the one plate is cantilevered and attached to the shield plate.
6. An electroplating apparatus according to any one of claims 1-4, wherein a conductive member which conducts electricity to the one plate passes through the shield plate horizontally toward inside of the solution tank so as to be electrically connected to the one plate.
7. An electroplating apparatus according to claim 5, wherein a conductive member which conducts electricity to the one plate passes through the shield plate horizontally toward inside of the solution tank so as to be electrically connected to the one plate.

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FIG. 1

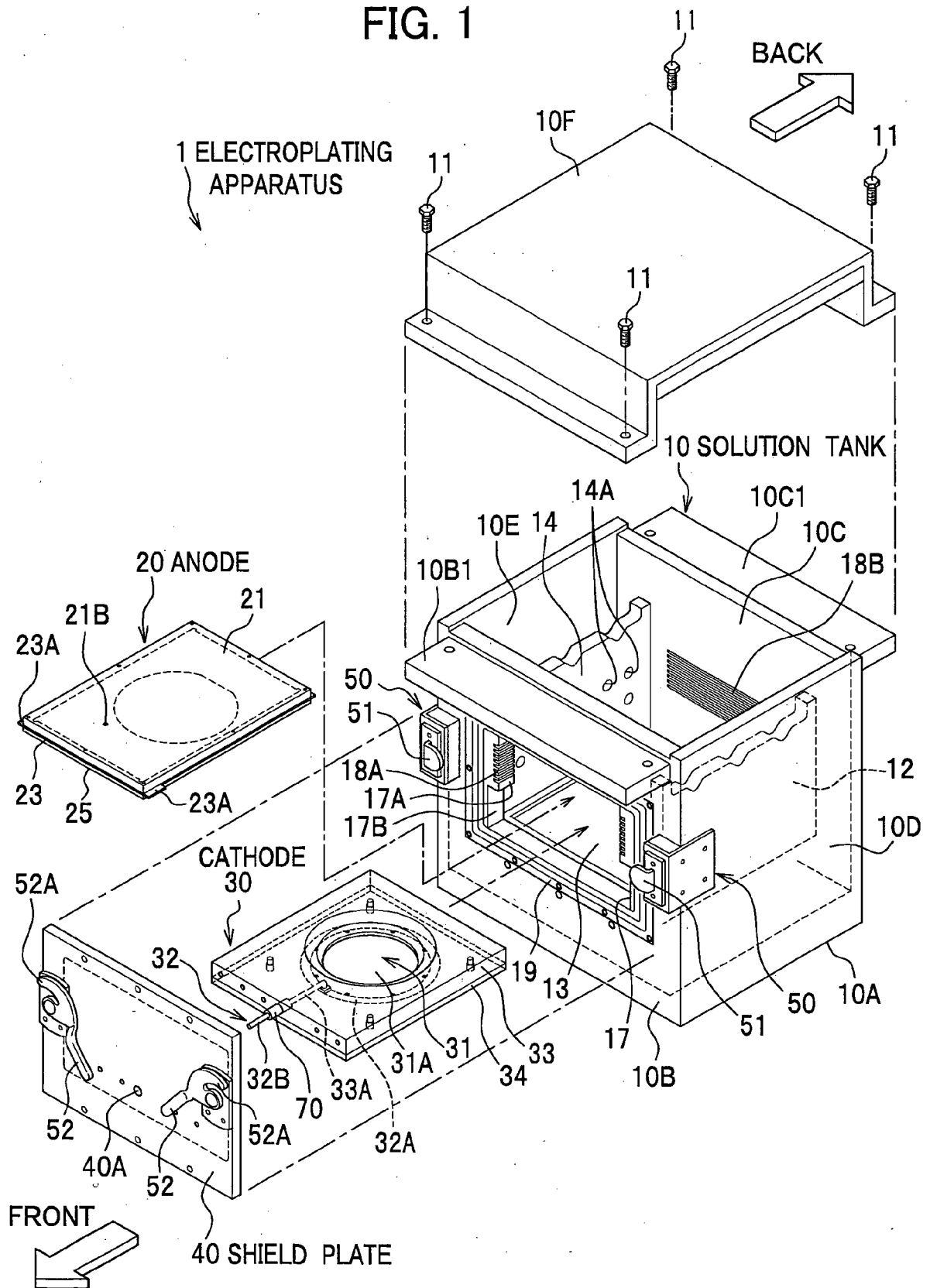


FIG. 2

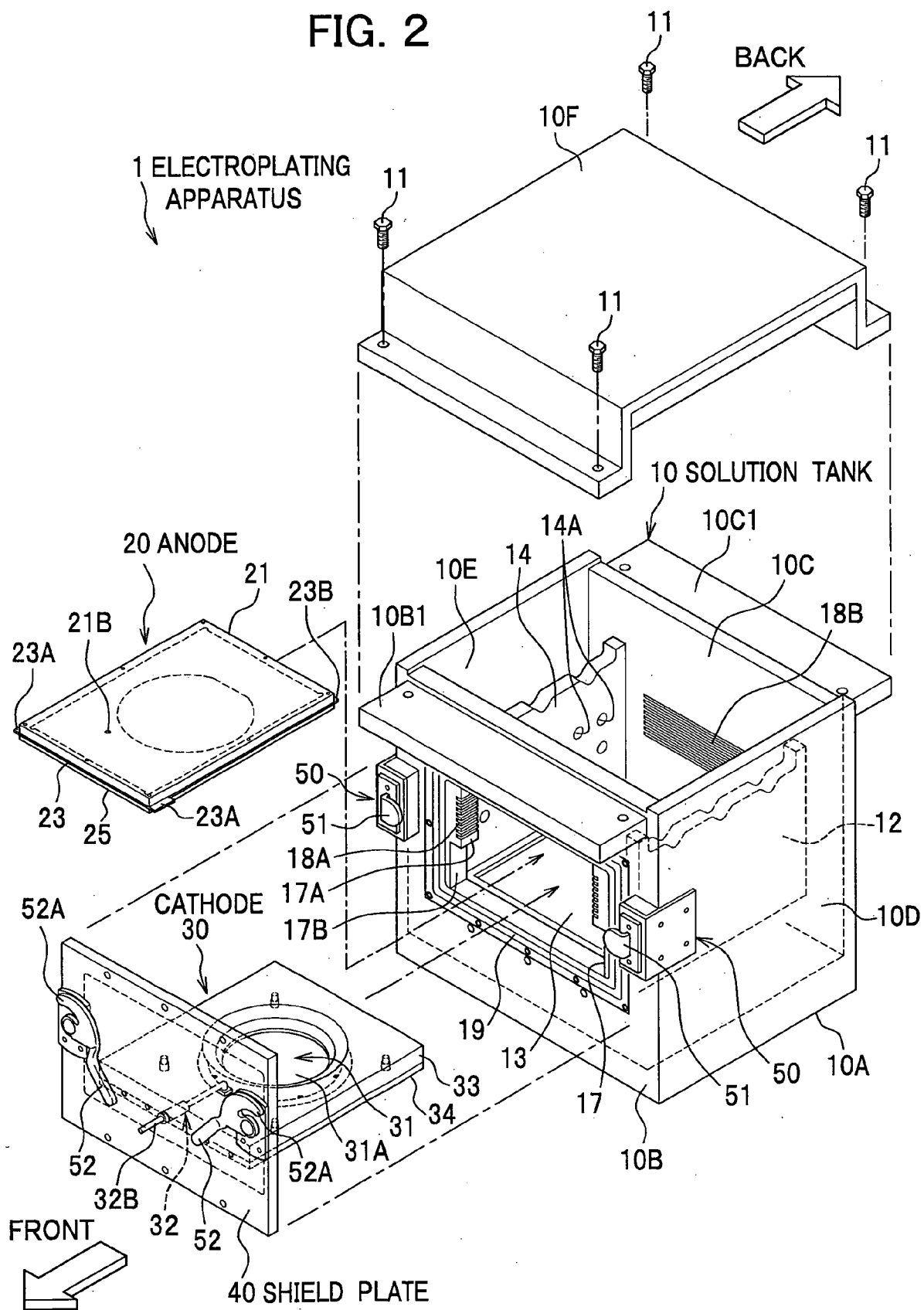


FIG. 3

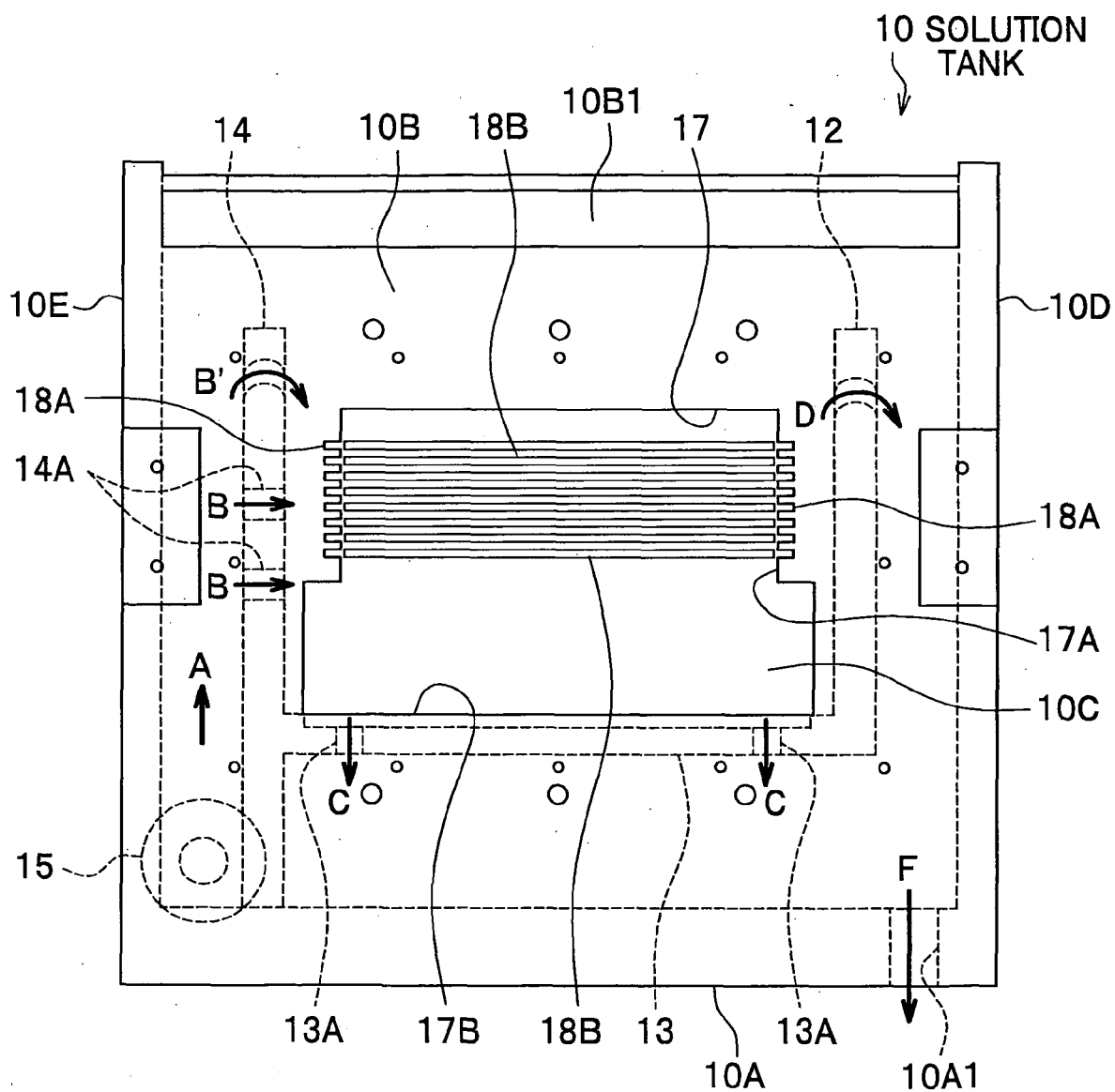


FIG. 4

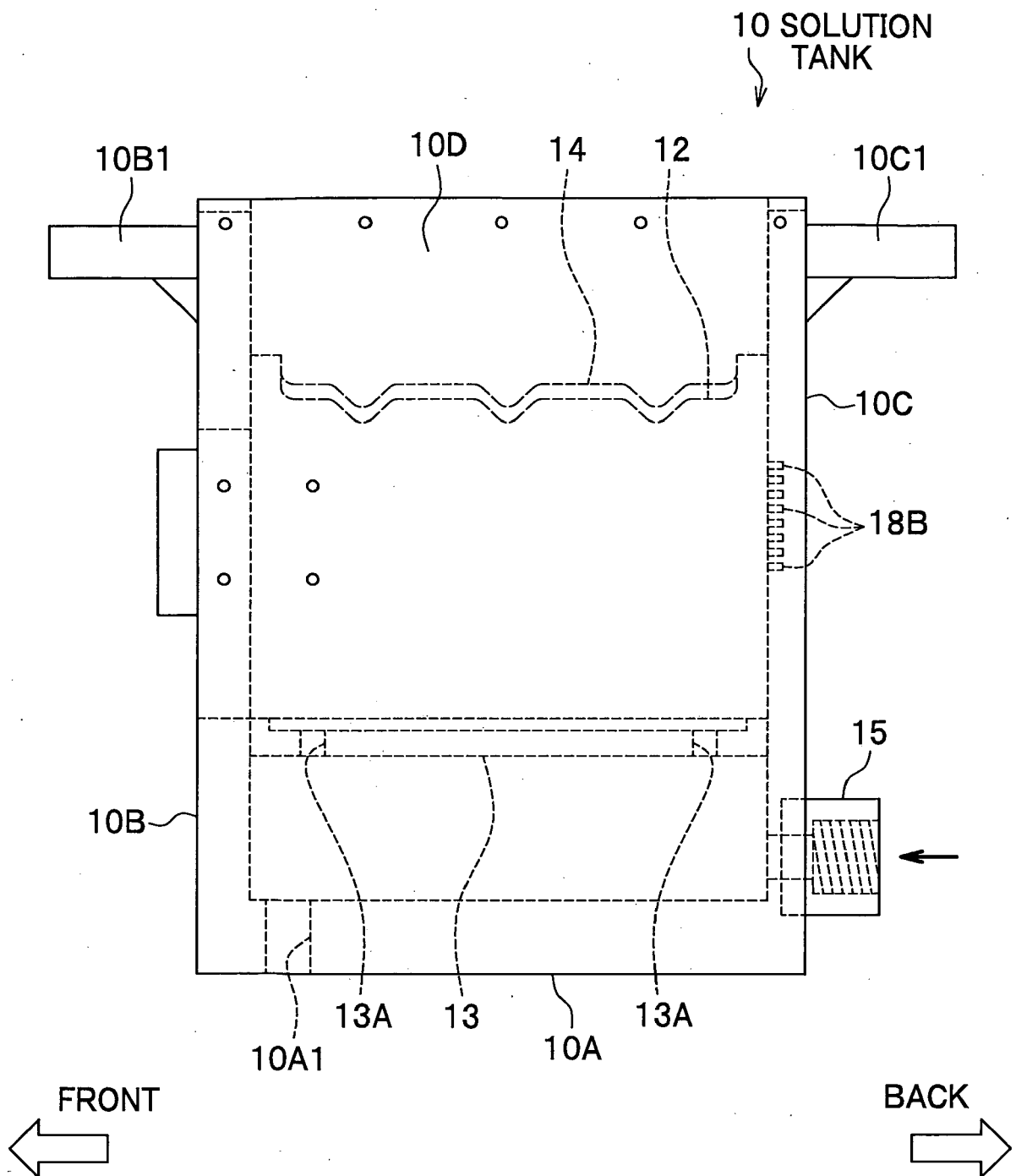


FIG. 5

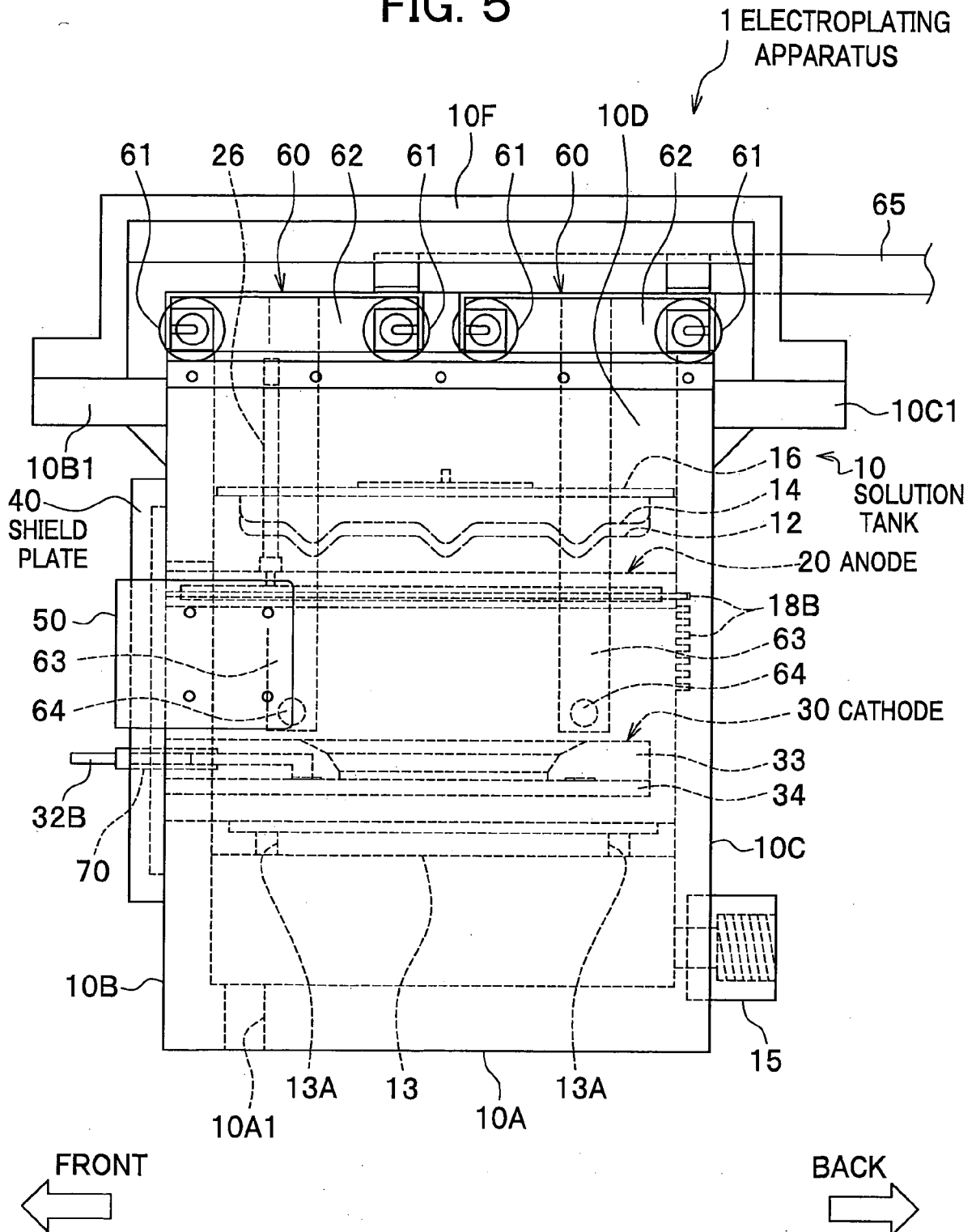


FIG. 6

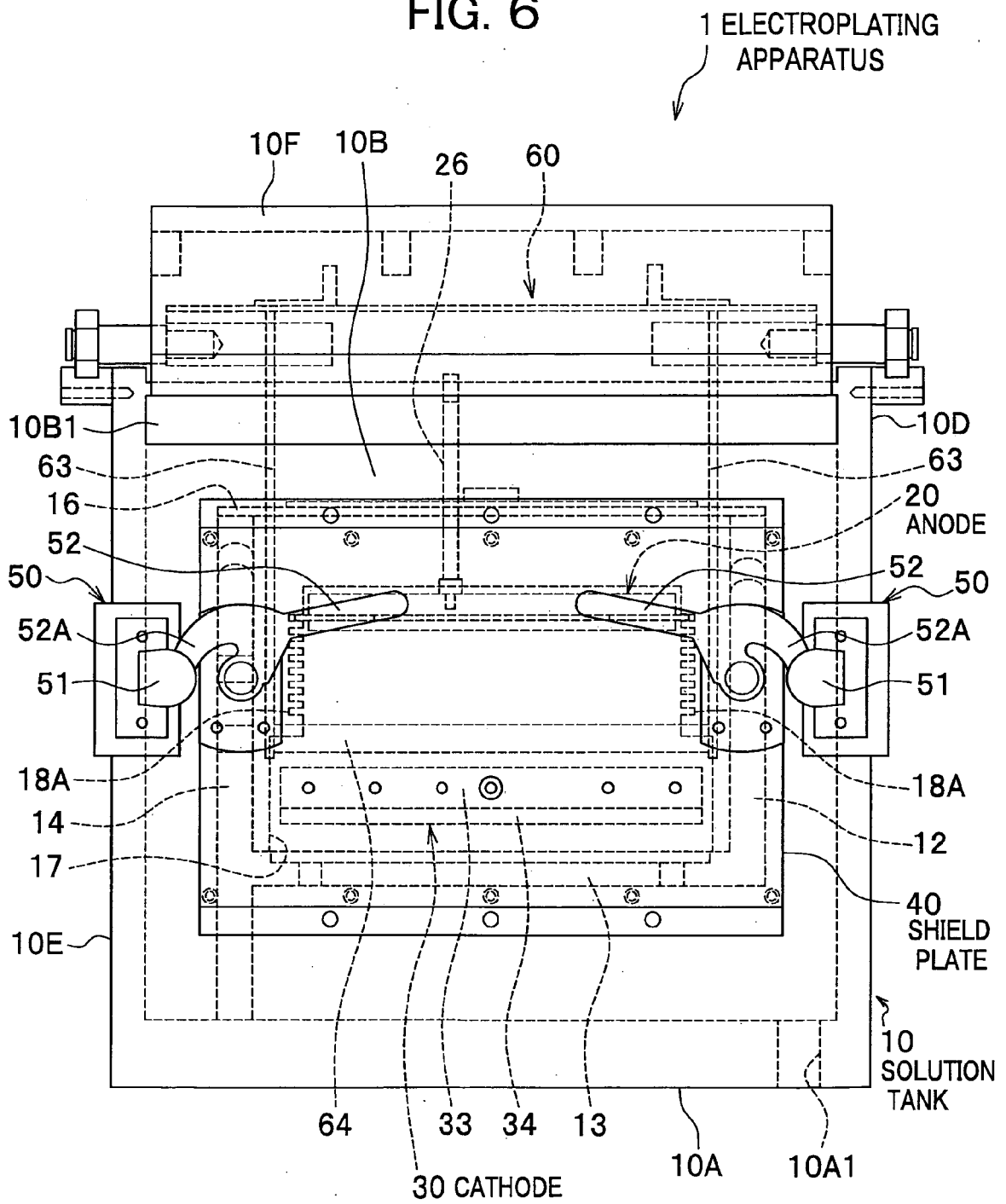


FIG. 7

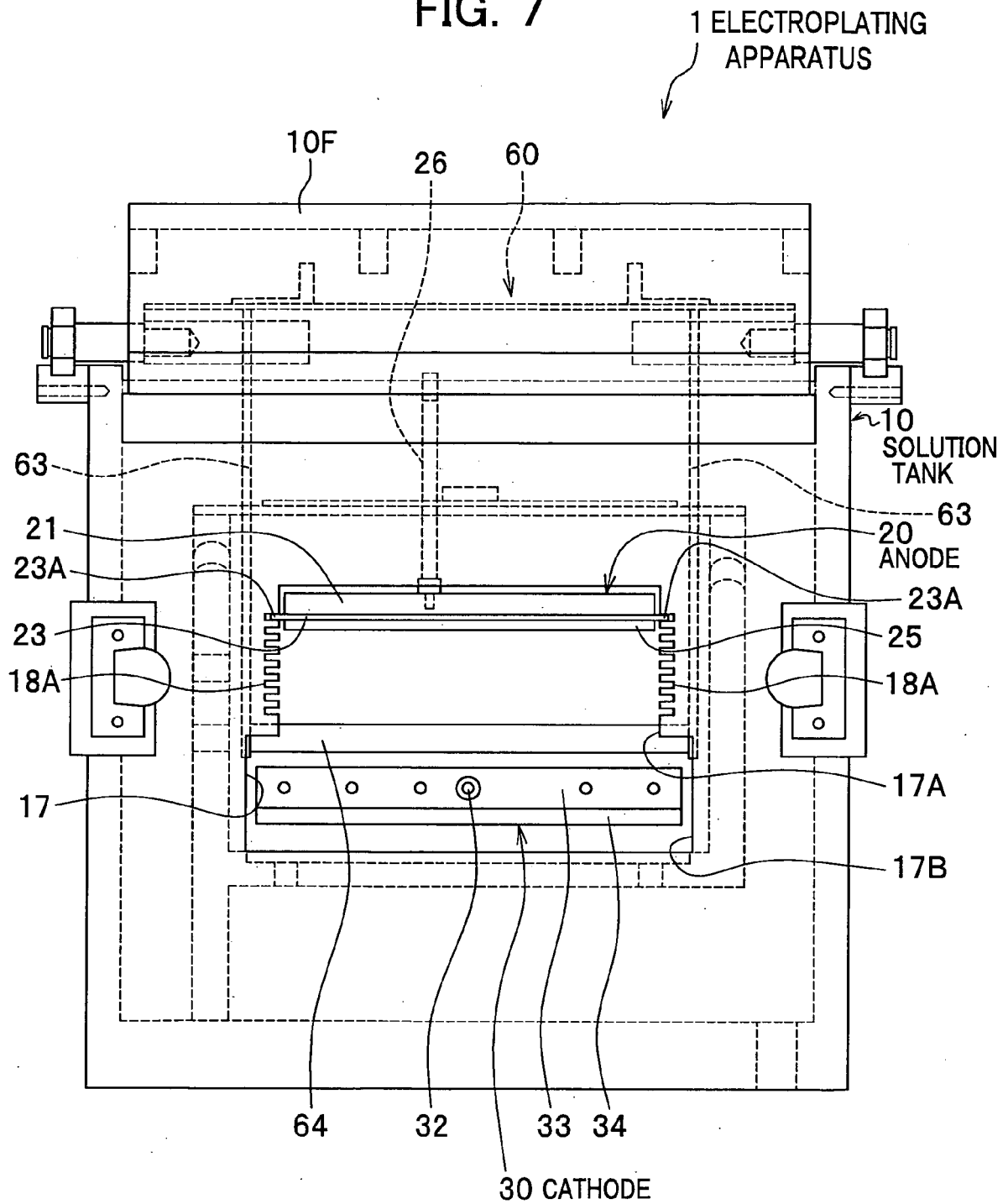
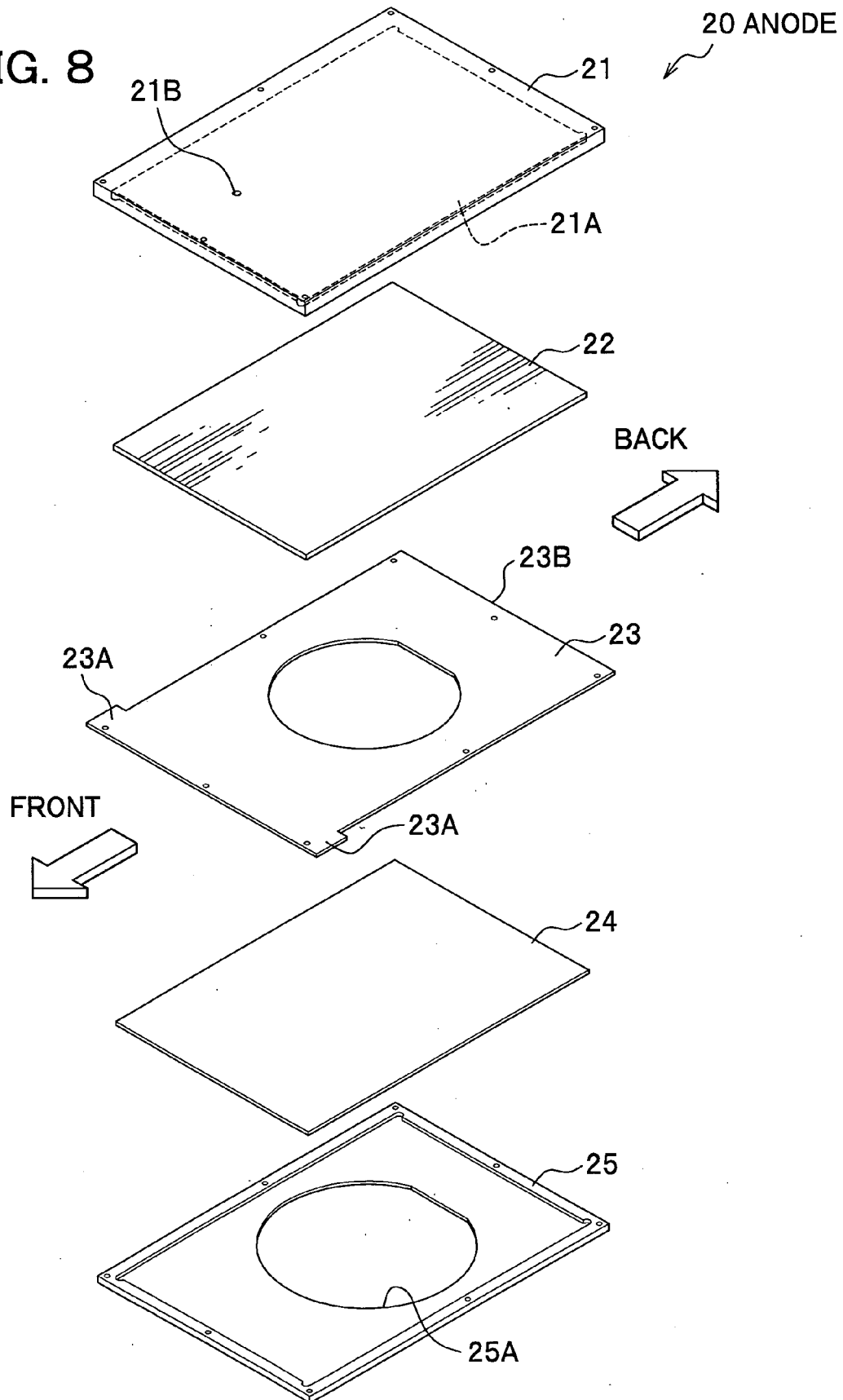


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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