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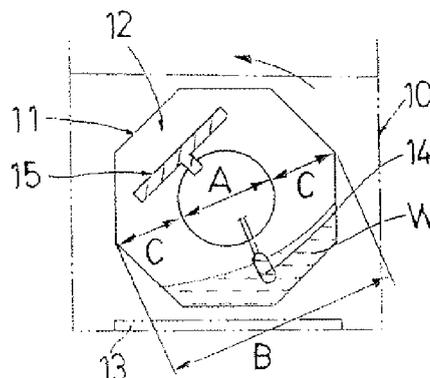
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(54) **Barrel apparatus for barrel plating**

(57) A barrel apparatus (11) for barrel plating in which a barrel having openings at both ends is used, a workpiece (W) is accommodated inside the barrel and immersed in a plating liquid, power is supplied to a negative electrode (14) that is arranged inside the barrel from the opening and a positive electrode that is arranged in the plating liquid, and the barrel is rotated about a center shaft while electroplating is performed, wherein, the internal positive electrode (15) is arranged at a position of

the upper portion and to the left that is away from the workpiece inside the barrel against the workpiece (W) that is deposited at the lower portion to the right inside the barrel when the barrel (11) is seen from the rear portion in a direction that rotates to the left or is arranged at a position of the upper portion and to the right that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to the left inside the barrel when the barrel is seen from the rear portion in a direction that rotates to the right.

FIG. 2



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## Description

[Technical Field]

**[0001]** The present invention relates to a barrel apparatus for barrel plating in which a barrel having openings at both ends is used, a workpiece is accommodated inside the barrel and immersed in plating liquid, power is supplied to a negative electrode that is arranged inside the barrel from the opening and a positive electrode that is arranged in the plating liquid and the barrel is rotated about a center shaft while electroplating is performed, and specifically relates to measures for the environmental protection.

[Background Art]

**[0002]** Recently, a problem regarding measures for the environmental protection is discussed even in the plating industry. Various methods are considered to answer the problem in the industry, measures are considered in which for example, an amount of electricity that is required for a plating process is decreased, precision in the management of the plating liquid is further increased and the like. In barrel plating, a barrel drum (hereinafter, simply referred to as a barrel) is used, wherein a plurality of penetrating holes is provided at the resin drum made of non-conductivity resin material such as vinyl chloride (PVC), polypropylene (PP) or polyethylene (PE). In a state where a rod-shaped electrode (a negative electrode, a cathode) is arranged inside the barrel, a workpiece is input and the barrel is immersed in the plating liquid, power is supplied between the cathode and an electrode (positive electrode, anode) that is arranged under the plating liquid outside the barrel, and then the plating is performed.

**[0003]** More specifically, in most instances, a plurality of plating tanks is used for commercial use. Usually, as shown in Fig. 8, power is supplied to each of the electrodes from one rectifier. If the workpiece that is input to each barrel is different, the input amount is calculated beforehand and input so that the surface area of the workpiece that is input is the same as that in each barrel. In other words, constant electric current control is performed, the lengths of the wirings from the rectifier to each barrel are different from each other as shown in Fig. 8 and electric current is easily flowed in order from the nearest rectifier, so that the condition is not strictly the same as that for all the barrels.

**[0004]** In returning to the fundamental question and considering that plating is based on Faraday's law, the amount of material deposited is proportional to the amount of electricity that is throughout when the electrolytic solution is electrolyzed. The amount of electricity that is required to deposit material equivalent to 1 gram is constant whatever the kind of materials. Specifically, in zinc plating that consumes a large amount of electricity, if 1.0A of the electric current flows to a unit of an area of

1dm<sup>2</sup> (10cmX10cm=100cm<sup>2</sup>) for 1 hour, the plating film 17.1μm thick is deposited. The depositing speed is 0.285μm/min, however in barrel plating, the plating film is deposited by an electricity conductor body (lead wiring) referred to as a conductor that is arranged inside a rotating barrel such that the film thickness is not only achieved according to a calculation, but also skillful workers are required.

**[0005]** For example, the following elements are considered to be involved in the calculation.

- An amount of electricity that is required to deposit the plating film (the film thickness) affects the setting of the electric current density.
- At the time of applying power, the shape of a contact point that is concerned in the conductivity affects the electric resistance.
- A surface area of an anode affects the electric resistance.
- Concentration of zinc metal inside the barrel is lowered in accordance with the lapse of time.
- The number of rotations of the barrel affects the deposited amount (the film thickness) of the plating film that is formed on the workpiece surface.
- Liquid temperature inside the plating tank affects the deposited amount (the film thickness) of the plating film.
- The volume of the workpiece that is input affects the deposited amount (the film thickness) of the plating film.

Accordingly, in order to maintain a constant thickness of the plating film, it is important to solve not only elements such as the difference in the distance between the rectifier and barrel, but also the above-described calculation elements. Accordingly, the running costs are capable of being decreased and the discharge of CO<sub>2</sub> is capable of being decreased.

**[0006]** Meanwhile, the barrel plating of a prior art is based on JP—B—62—21879 that discloses a barrel for the barrel plating process and barrel plating method using the same. The invention of the above-described prior art uses a so-called barrel without a lid, the barrel has openings at both ends so as to remove and attach the negative electrode, to input a plating target (workpiece) that is to be plated, to cause the plating liquid to flow and to pass an electric current of the electric field. Also the barrel is configured as a hollow body having penetrating holes for draining at the sidewall. However, in the above-described invention, there is a problem that the positive electrode (anode) is arranged outside the barrel so that electric resistance is large. In order to support the environment, it is required that electric resistance is decreased, plating efficiency is promoted and the amount of electricity is decreased. However, in the above-described invention, the amount of electricity cannot be decreased. The amount of electricity that is required to deposit the plating film (required film thickness) is decreased so that energy

is decreased. As a result, the amount of CO<sub>2</sub> that is generated when power is supplied is capable of being decreased. Also, the heating of the electrolyte that is generated at the time of the plating is decreased so that energy is capable of being decreased. The amount of chemicals or water that is used in the plating process is decreased so that the environmental burden is capable of being decreased.

**[0007]** [Patent Document] JP-B-62-21879

[Disclosure of the Invention]

[Problem that the Invention is to Solve]

**[0008]** The invention is made in view of the above-mentioned points, and an object is to decrease the electric resistance in barrel plating, improve plating efficiency and decrease the amount of electricity. Also, another object of the invention is to provide a barrel apparatus for barrel plating that is capable of supporting the improvement of the environment in accordance with the decrease in the amount of electricity, especially when zinc plating is performed using a barrel without a lid.

[Means for Solving the Problem]

**[0009]** To achieve above objects, the invention provides a barrel apparatus for barrel electroplating comprising a barrel having openings at both ends adapted to accommodate a workpiece inside and to be immersed in a plating liquid, wherein the barrel is further adapted to be rotated around a center axis; a negative electrode arranged inside the barrel adapted to be supplied with power; and an internal positive electrode arranged inside the barrel at an upper left portion of the barrel and at a position apart from and opposite to the workpiece that is deposited inside the barrel at the lower right portion, when the barrel is seen from the rear portion and when the barrel rotates in a counter-clockwise direction or arranged inside the barrel at an upper right portion of the barrel and at a position apart from and opposite to the workpiece that is deposited inside the barrel at the lower left portion, when the barrel is seen from the rear portion and when the barrel rotates in a clockwise direction from this view. In other words, the positive electrode is mounted at the upper left portion inside the barrel in case the barrel is adapted to be rotated in a counter-clockwise direction or is mounted at the upper right portion inside the barrel in case the barrel is adapted to be rotated in a clockwise direction, both with respect to a view of the barrel from the rear portion.

According to a similar definition the invention provides a barrel apparatus for barrel plating in which a barrel having openings at both ends is used, a workpiece is accommodated inside the barrel and immersed in a plating liquid, power is supplied to a negative electrode that is arranged inside the barrel from the opening and a positive electrode that is arranged in the plating liquid, and the barrel

is rotated about a center shaft while electroplating is performed, wherein, an internal positive electrode is arranged at a position of the upper portion and to the left that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to the right inside the barrel when the barrel is seen from the rear portion in a direction that rotates to the left or is arranged at a position of the upper portion and to the right that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to the left inside the barrel when the barrel is seen from the rear portion in a direction that rotates to the right.

**[0010]** As described above in part, the main subject of the invention is zinc plating where the amount of electricity that is used is great. Most of all, it is zinc plating in an alkali bath that is referred to as a zincate bath (a cyanide-free bath) that removes cyan from a cyan bath. The zincate bath is excellent for the uniformity of thickness of the plating film, however there is no way of telling whether the plating efficiency thereof is better compared to that of an acidic bath. Thus, the invention uses the characteristics of the zincate bath while increasing plating efficiency and obtains a uniformity of thickness of the film.

**[0011]** The apparatus of the invention is an improved technique for barrel plating in which the barrel having openings at both ends is used, the workpiece is accommodated inside the barrel and immersed in a plating tank, power is supplied to a negative electrode that is arranged inside the barrel from the opening and a positive electrode that is arranged under the plating liquid, and the barrel is rotated about a center shaft while electroplating is performed. The barrel is the above-described barrel without the lid, the diameters of both the front and rear ends of the barrel body are narrowed and the openings are formed at both the ends that are narrowed. The barrel is a rotational body that is rotatable about the center shaft. It is optional as to which opening is the front end or rear end, however when the description is given with reference to Fig. 1, in the invention, the side where the negative electrode and the internal positive electrode are inserted is the rear end and the side where a workpiece W enters is the front end.

**[0012]** Thus, the barrel internal positive electrode is arranged at a position of the upper portion and to the left that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to the right inside the barrel when the barrel is seen from the rear portion in a direction that rotates to the left or is arranged at a position of the upper portion and to the right that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to the left inside the barrel when the barrel is seen from the rear portion in a direction that rotates to the right. In Fig. 1, the right side is the rear section and left side is the front section of the drawing. Figs. 2 and 3 are in states where the barrel is seen from the rear section. In Figs. 2 and 3, when a barrel 11 rotates to the left, the workpiece

W inside the barrel is biased and deposited to the right inside the barrel so that a space 12 is formed at a portion opposite to the deposited portion inside the barrel, in other words, at a portion that is away from the workpiece. Thus, an internal positive electrode 15 is arranged at the space 12 that is the position of the upper portion and to the left inside the barrel, that is away from the workpiece W. Thus, a negative electrode 14 is arranged at a position with respect to the workpiece W. Conversely, the internal positive electrode 15 is arranged at a position of the upper portion and to the right that is away from the workpiece inside the barrel against the workpiece that is deposited at the lower portion to left inside the barrel, when the barrel is seen from the rear portion in a direction that rotates to the right. In any case, the barrel is required to be in a state of being immersed in the plating liquid.

**[0013]** The internal positive electrode 15 that is arranged inside the barrel may be, in a first embodiment, the only positive electrode provided in the barrel apparatus or, in a second embodiment, the electrode provided together with one or more other positive electrodes arranged outside the barrel. In other words, in case the barrel has no lid, which is the practice in the prior art as referred to in the Background Art, a configuration is given such that an external positive electrode 13 is arranged inside a plating tank 10 and an external positive electrode is arranged on the exterior of the barrel, so that when the external positive electrode 13 is the main positive electrode, the internal positive electrode 15 that is arranged inside the barrel is an auxiliary electrode. However, in the invention, it is not essential that the external positive electrode 13 is arranged in the plating liquid outside the barrel. Accordingly, the plating is capable of being performed by only the internal positive electrode 15 inside the barrel as the main positive electrode without using the external positive electrode 13 in the plating liquid outside the barrel.

**[0014]** Fig. 2 shows that the diameter of an opening 16 of the rear end is A, the diameter of the barrel 11 is B, a difference between the diameter of the barrel and the diameter of the opening is C and the portion C is a workpiece input portion. Of course, the diameter of an opening of the front end is A or less. When the input amount of the workpiece W is over the portion C, the workpiece W overflows and dropped so that the barrel without the lid cannot perform the process. Accordingly, the large space 12 is formed at a portion opposite to the workpiece-input portion across a center shaft of the barrel, so that the space 12 is used as an arrangement portion of the internal positive electrode 15.

**[0015]** The shape, the size or the like of the internal positive electrode 15 arranged inside the barrel may be selected freely provided they are not outside the spirit of the invention. For example, a structure may be given such that the internal positive electrode is formed of a plate-shaped electrode plate, each of the electrode plates is bent through a bending process and a plurality of the positive electrodes are laminated with intervals between

them. In the above-described configuration, the effective area of the internal positive electrode is capable of being made larger, so that the configuration has the advantage in solving the problem of the invention.

[Advantage of the Invention]

**[0016]** Since the invention is to have the above-described configuration and function, wherein the internal positive electrode is arranged at the position away from the workpiece inside the barrel, an advantage of the invention is that when barrel plating is performed, the electric resistance is capable of being decreased, the improvement in plating efficiency is capable of being enhanced and the amount of electricity is capable of being decreased. Also, according to the invention, the amount of electricity that is required to deposit the plating film (the required film thickness) is decreased so that energy is decreased, as a result, the amount of CO<sub>2</sub> generated at the time of power generation is capable of being decreased and especially, in a case where zinc plating is performed using the barrel without the lid, the barrel apparatus for the barrel plating is capable of being supplied to support the improvement of the environment.

[Best Mode for Carrying Out the Invention]

**[0017]** Hereinafter, the invention will be described in more detail with reference to the embodiments shown in the drawings. Fig. 4 is a drawing illustrating a barrel apparatus 21 for barrel plating of an embodiment according to the invention. Similar to the barrel apparatus for barrel plating as shown in Figs. 1 to 3, the barrel apparatus 21 is also used for zinc plating using the cyanide-free bath, the workpiece is immersed in a plating liquid that is filled inside the barrel and the plating process is performed using the plating tank 20.

**[0018]** In respective drawings, 17 is a base support of a barrel plating apparatus A, 18 is a traveling mechanism that is provided and moved along the base support in a direction orthogonal to the drawing plane, 19 is an elevator that is provided in the traveling mechanism 18 and the barrel apparatus 21 is attached to the elevator 19. 22 is a rail that is provided at an ascending position of the base support, 23 is a rail that is provided at a descending position and the traveling mechanism 18 is capable of being moved on the rails by traveling wheels 24 and 25 that are provided in the elevator 19. 26 is a hanger and is provided in a state where the hanger 26 is suspended from a suspension-supporting section 28 at the front end of an arm 27 extended from the elevator 19. The hanger 26 engages the barrel apparatus 21 of the invention at a portion of the side plates 29 and 29' of both the front and rear ends, and attached in a state where the barrel apparatus 21 is suspended.

**[0019]** A barrel 30 is a barrel without a lid having openings 31 and 31' at both front and rear ends. The barrel 30 is configured such that the barrel 30 has a driven gear

32 at the outside the front opening 31 and is rotated by a driving gear 33 that is provided at the front end of the arm 27 through a middle gear 34 that is provided at the hanger 26. Also, the barrel 30 is attached at the lower end of the suspension-supporting section 28 through a pivot shaft 28a. Accordingly, as shown in a trace R, the barrel 30 may rotate in a vertically oscillating manner such that the barrel 30 is disposed so as to conveniently discharge the workpiece W. Also, the barrel 30 is non-conductive of which the material is a resin such as vinyl chloride (PVC), polypropylene (PP) or polyethylene (PE), and has a plurality of penetrating holes at the circumference surface.

**[0020]** Terminals 35 and 36 are provided at the lower surface of the arm 27 that is extended from the elevator 19 and receives a power supply in accordance with its connection to feeding terminals 37 and 38 that are provided at the descending position. The terminal 35 of the plus side is connected to the internal positive electrode 40 that is arranged inside the barrel by wiring via a middle connecting terminal 39. The terminal 36 of the minus side is connected to the negative electrode 42 that is arranged inside the barrel by wiring via a middle connecting terminal 41. The negative electrode 42 is the so-called rod-shaped electrode. Two negative electrodes 42 are arranged and firmly attached by a member 44 that is provided at the rear end plate 29' so that they resist the external force of the workpiece W that flows inside into the barrel. In a case of the embodiment as shown in the drawings, the apparatus is configured such that an external positive electrode 43 is arranged at the lower portion of the plating tank 10 that is on the exterior of the barrel 30. Thus, the external positive electrode 43 is directly connected to original terminals 45 and 46 of the base support 17 by wiring. Each of electrodes 40, 42 and 43 receives the power supply as described above and the internal positive electrode 40 is designed as an auxiliary positive electrode in the embodiment shown in the drawings.

**[0021]** In the barrel plating apparatus A having the structure as described above, when the barrel 30 is seen from the rear portion in a direction such that the barrel 30 rotates to the left, the barrel apparatus 21 according to the invention includes a configuration in which the internal positive electrode 40 is arranged at the upper portion and to the left that is away from the workpiece W inside the barrel against the workpiece W that is deposited at the lower portion to the right inside the barrel. A main body of the barrel 30 of the barrel apparatus 21 has a body section of which the cross section is octagonal. The main body is formed of a drum having a long conical pyramid portion of which the rear portion is short and the front portion is long. The internal positive electrode 40 having a length that is substantially the same as that of the body section of the barrel 30 is attached to the side plate 29' of the rear portion using an attaching member 47. The attaching member 47 entered inside into the barrel from the opening 31' of the rear portion and the internal

positive electrode 40 is supported in a cantilever manner.

**[0022]** In the embodiment shown in the drawings, the internal positive electrode 40 is formed of plate-shaped electrode plates 48. The internal positive electrode 40 is formed of a plurality of electrode plates that have been bent through a bending process. Each of electrode plates is assembled in a laminated structure with intervals between them. The internal positive electrode 40 having the above-described configuration is capable of increasing the surface area thereof so that the plating process is capable of being processed with a sufficient electric current density and the internal positive electrode 40 contributes to decreasing the voltage. A mark D shown in Fig. 7 is the position of the liquid surface of the plating liquid and the internal positive electrode 40 is arranged in the plating liquid.

**[0023]** Even though barrel plating is performed using the barrel apparatus 21 having the above-described configuration, it is natural that pre-treatment such as alkali degreasing, alkaline electrolysis, acid cleaning and electrolytic degreasing is performed beforehand. In the plating process, a predetermined amount of the workpiece W is input inside into the barrel apparatus 21 from the opening 31 of the front portion, the barrel plating apparatus A starts and the electric current is applied to each of electrodes 40, 42 and 43. In accordance with the starting of the barrel plating apparatus A, the workpiece W inside the barrel tends to move and deposit in the rotation direction. In this state, the electric current flows through the negative electrode 42 of which the front end is positioned inside the workpiece W and the exterior of the barrel; the external positive electrode 43 that is arranged in the plating liquid; and the internal positive electrode 40 that is positioned substantially opposite to the negative electrode 42 across the center shaft of, and then the plating is performed.

**[0024]** In the barrel plating apparatus A of the invention, the configuration of the power distribution that is schematically illustrated in Fig. 9 is desirable. In other words, as the barrel plating apparatus that is shown at numerals 1 to 5 in Fig. 9, an exclusive rectifier is arranged at each barrel, all the electrodes including the internal positive electrode of each of the barrels and the rectifier are connected with wires, and a necessary and sufficient amount of electricity is supplied to each barrel. Accordingly, management of the plating film thickness and management of the amount of electricity can be precisely performed.

**[0025]** According to the above-described apparatus of the invention, the amount of electricity that is required to deposit the plating film (required film thickness) is capable of being decreased so that energy is decreased. As a result, the amount of CO<sub>2</sub> generated at the time of power generation is capable of being decreased. Also, the electrolytic heat that is generated at the time of plating is decreased, so that energy is capable of being decreased. The amount of chemicals and water that is used in the plating process can be decreased, so that the en-

environmental burden is capable of being decreased.	26	hanger
[Brief Description of the Drawings]	27	arm
<b>[0026]</b>	5 28	suspension-supporting section
[Fig. 1] Fig. 1 is an explanatory drawing illustrating a principle of barrel in a barrel plating according to the invention.	29, 29'	side plate
[Fig. 2] Fig. 2 is an explanatory drawing of the same apparatus seen from the rear portion.	32	driven gear
[Fig. 3] Fig. 3 is a front view illustrating operation of the same apparatus.	33	driving gear
[Fig. 4] Fig. 4 is a side view illustrating an embodiment of the same apparatus.	34	middle gear
[Fig. 5] Fig. 5 is an enlarged side view of a portion of Fig. 4.	15 35, 36	terminal
[Fig. 6] Fig. 6 is a plan view illustrating a main portion of the same apparatus.	37, 38	feeding terminal
[Fig. 7] Fig. 7 is a drawing illustrating a state where the barrel is seen from the rear portion.	39, 41	connecting terminal
[Fig. 8] Fig. 8 is a conceptual explanatory drawing of a plating apparatus according to a constant voltage control.	20 45, 46	original terminal
[Fig. 9] Fig. 9 is a conceptual explanatory drawing of an example of a desired voltage control according to the invention.	47	attaching member
	25 48	electrode plate

### Claims

#### [Description of Reference Numerals and Signs]

#### **[0027]**

10, 20	plating tank
11, 30	barrel
12	space
13, 43	external positive electrode
14, 42	negative electrode
15, 40	internal positive electrode
16, 31, 31'	opening
17	base support
18	traveling mechanism
19	elevator
21	barrel apparatus
22, 23	rail
24, 25	traveling wheel

- 30 1. A barrel apparatus for barrel electroplating comprising a barrel (11, 30) having openings (16, 31, 31') at both ends adapted to accommodate a workpiece (W) inside and to be immersed in a plating liquid, a negative electrode (14, 42) arranged inside the barrel (11, 30) adapted to be supplied with power, wherein the barrel is adapted to be rotated around a center axis,
- 35 wherein, an internal positive electrode (15, 40) is arranged inside the barrel (11, 30) at an upper left portion of the barrel (11, 30) and at a position apart from the workpiece (W) and opposite to the workpiece (W) that is deposited inside the barrel (11, 30) at the lower right portion, when the barrel (11, 30) is seen from the rear portion and when the barrel (11, 30) rotates in a counter-clockwise direction or
- 40 is arranged inside the barrel (11, 30) at an upper right portion of the barrel (11, 30) and at a position apart from the workpiece (W) and opposite the workpiece (W) that is deposited inside the barrel (11, 30) at the lower left portion, when the barrel (11, 30) is seen from the rear portion and when the barrel (11, 30) rotates in a clockwise direction.
- 45
- 50 2. The barrel apparatus for barrel plating according to claim 1, wherein the internal positive electrode (15, 40) is formed of a plurality of plate-shaped electrode plates (48), and has a structure in which each of the electrode plates (48) is bent and the plurality of the
- 55

electrode plates (48) are arranged in a laminated structure with intervals between them.

3. The barrel apparatus for barrel plating according to claim 1 or 2, further comprising a positive electrode (13, 43) arranged in the plating liquid outside the barrel (11, 30) as a main positive electrode and the internal positive electrode (15, 40) arranged inside the barrel (11, 30) is an auxiliary positive electrode.

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FIG. 1

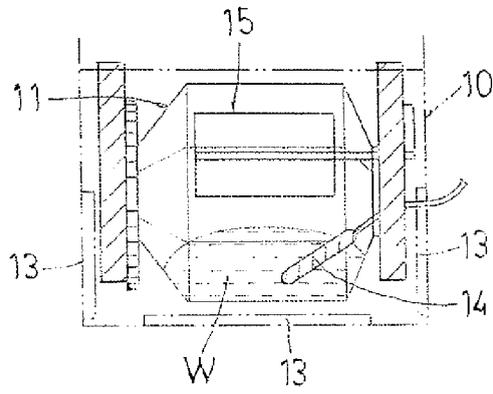


FIG. 2

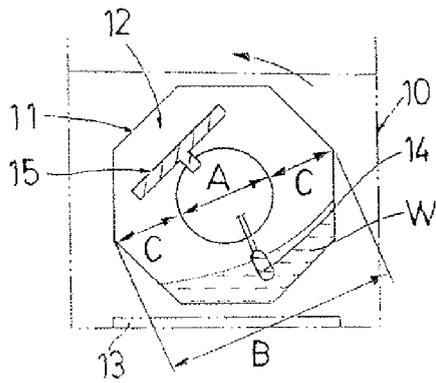


FIG. 3

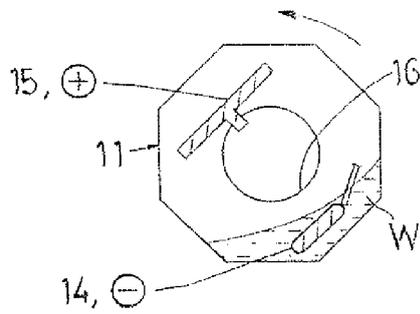


FIG. 4

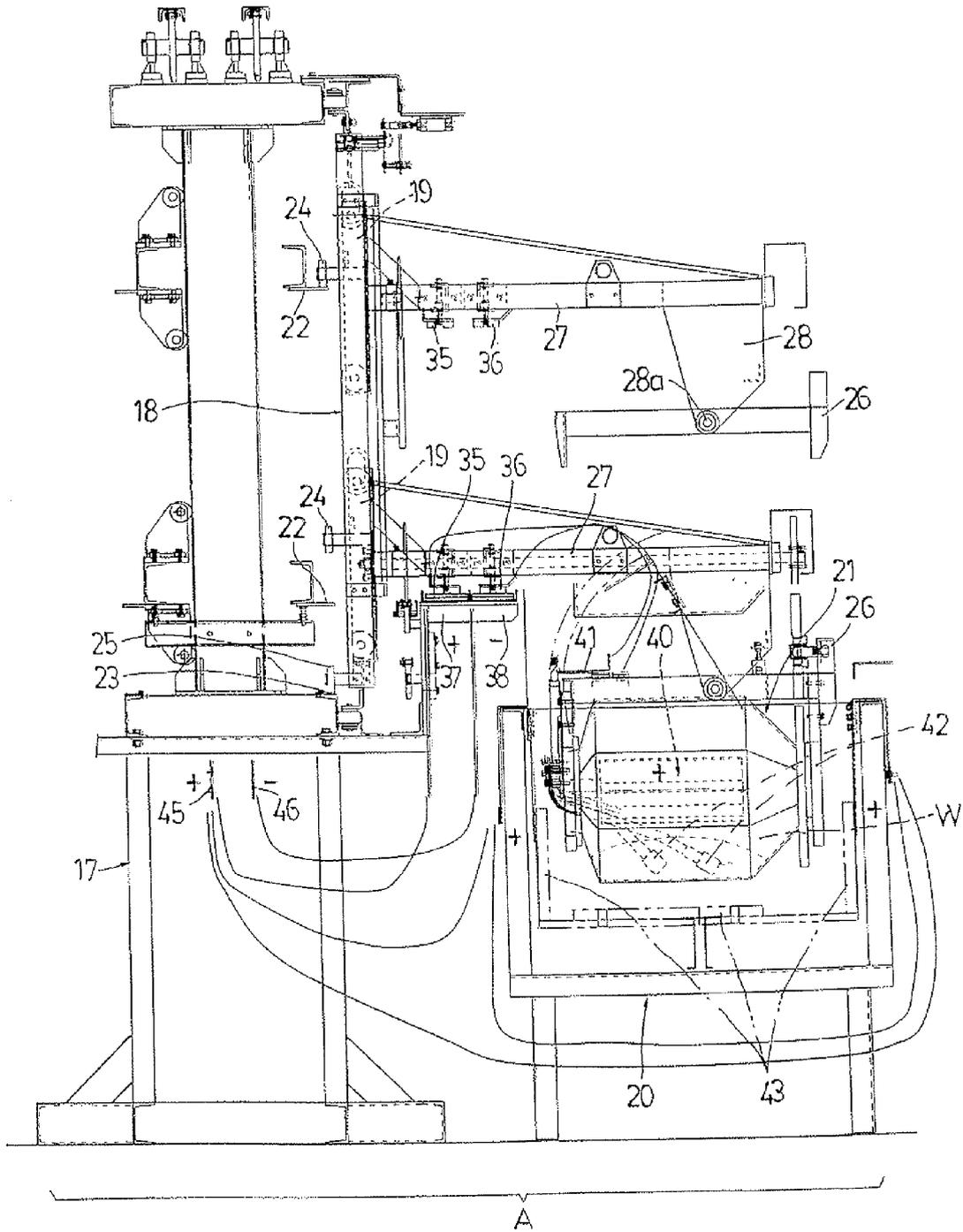


FIG. 5

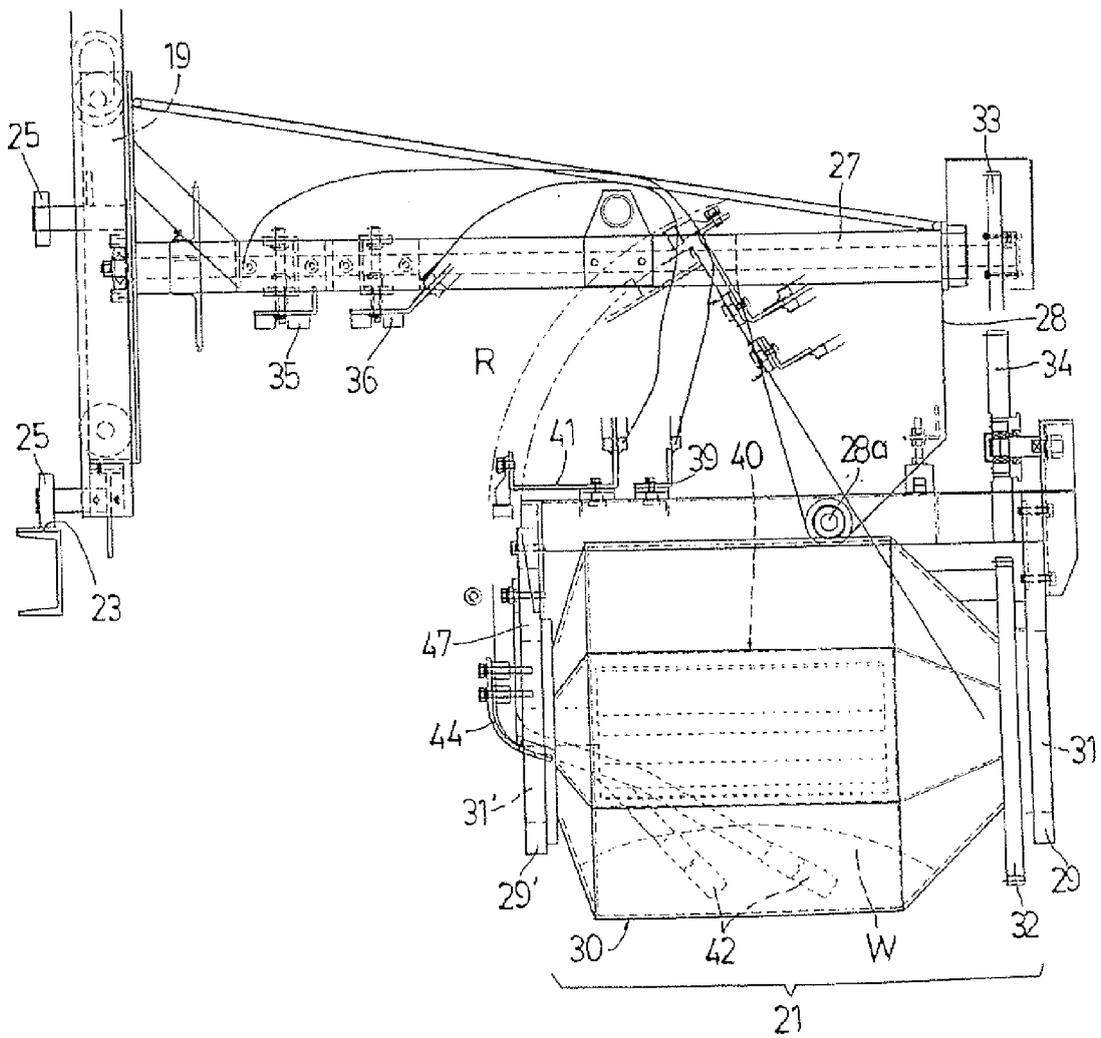


FIG. 6

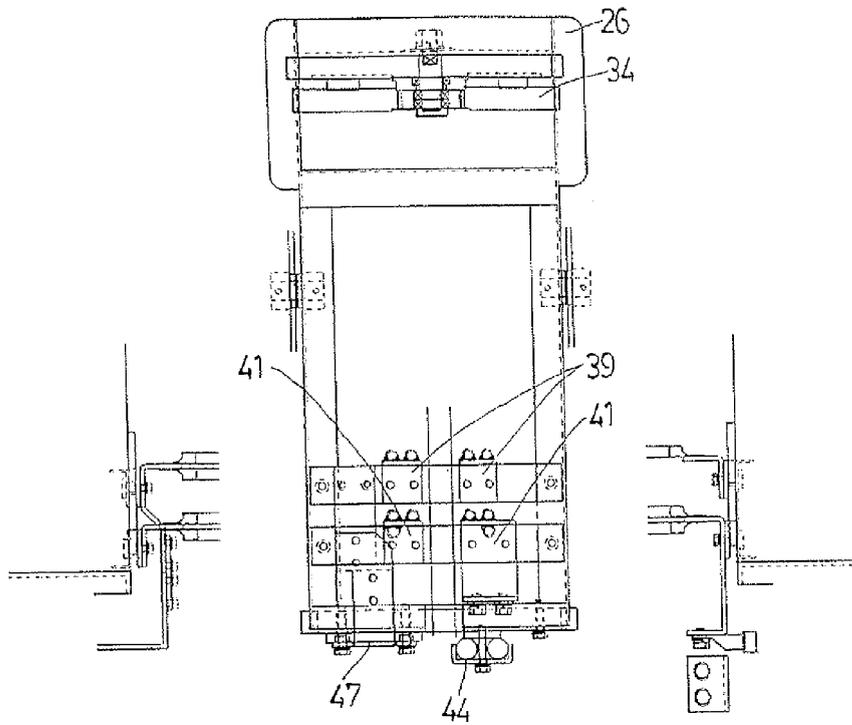


FIG. 7

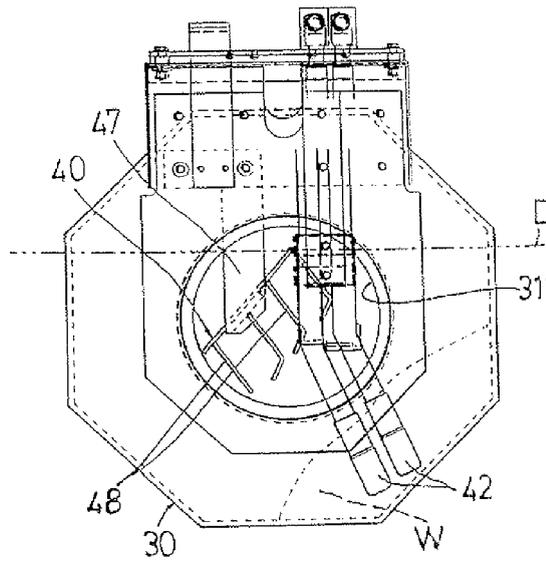


FIG. 8

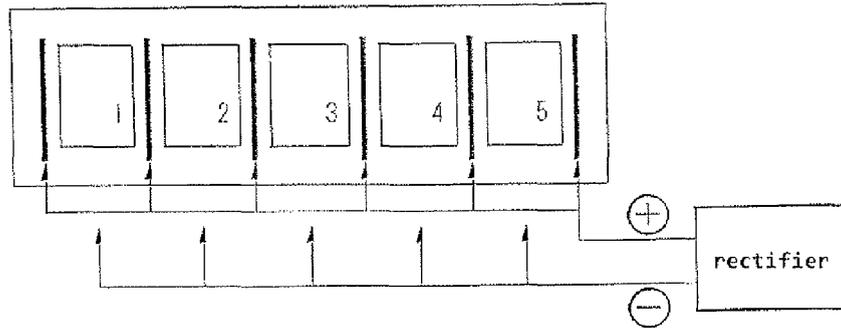
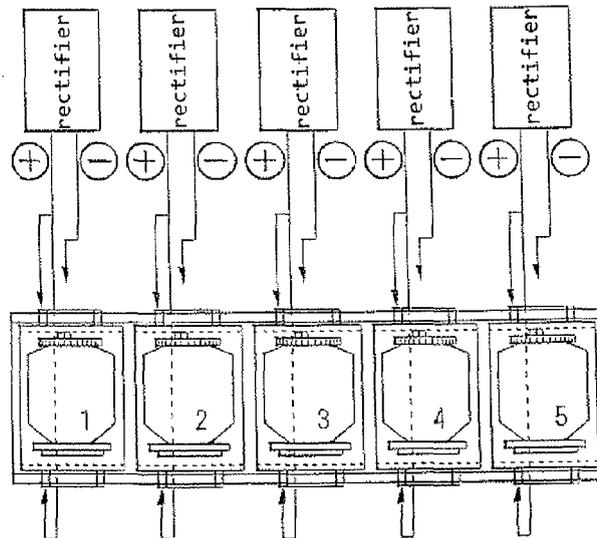


FIG. 9





EUROPEAN SEARCH REPORT

Application Number  
EP 11 17 5733

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 791 231 A (M L ALKAN LTD; CYRIL WILLIAM JAMES MORLEY) 26 February 1958 (1958-02-26) * page 1, line 23 - page 4, line 69; figures 1-13 *	1,3	INV. C25D17/22
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A	FR 1 287 576 A (BERTHOLLET & FILS ETS) 16 March 1962 (1962-03-16) * the whole document *	1-3	
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 31 October 2011	Examiner Suárez Ramón, C
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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                      &amp; : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 17 5733

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31-10-2011

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