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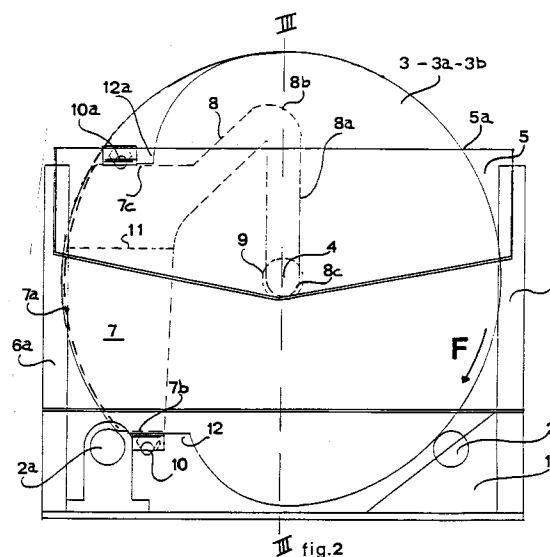
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I-20133 Milano (MI)(IT)(54) **Apparatus for automatic development of X-ray films, photographic films and the like.**

(57) Apparatus for automatically developing radiographic, photographic films and plates and the like, which apparatus comprises at least three cylindrical bodies or shells rotatably mounted facing each other, designed to rotate, intermittently and for preset time periods, around a common horizontal axis, driven by motor means acting on the periphery of said shells; inside the interior of each shell, a container is provided, which is suitable for containing a treatment liquid, which container is equipped with a reverse "L" bent duct with its outlet mouth in coaxial position with the common axis of the shells, with said outlet mouths being so connected with one another as to form one single duct rotatably connected, with water-tight connection, with the bottom of a fixed treatment tray containing the films or plates to be developed, which tray is hence filled with, and emptied of, in succession, and by gravity, the different treatment liquids.

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The present invention relates to an apparatus for automatically developing, within short development times, radiographic, photographic plates and films, and the like, normally used in dental offices and surgeries, also without using the obscure chamber.

Several types of apparatuses for the automatic development of sets of radiographic and photographic films and plates, also of large size, as used in medical field and, in particular, in dental sector, are already known, by means of which the complete development can be obtained within development times which are rather short and can be adjusted as a function of the stay times, required by the different types of plates or films in the developer bath, in the fixing bath and, possibly, also in the end washing bath.

So, for example, an apparatus known from the prior art uses separate and closely adjacent trays, gathered inside a body acting as a container/support, wherein the first one of said trays contains the developer bath, the successive tray contains the fixing bath and, in some cases, a third tray contains the washing bath; in this case, the plates or films are hung from clamps integral with a horizontally translatable, vertically mobile arm which moves the plates from bath to bath and moves them upwards and downwards.

This apparatus known from the prior art provides for well-defined stay times of the plates inside the individual baths, so the selected treatment type cannot be varied; furthermore, in order to make it possible the protection provided on the sensible portion of the individual plates to be removed, said apparatus still requires the use of the obscure chamber.

Other automatic development apparatuses known from the prior art provide for different, closely adjacent trays to be used, each of which contains a treatment bath, and with which a plurality of horizontal rollers are associated, which associated rollers are subdivided into groups of two rollers each, which rollers are driven to revolve in mutually opposite directions and are positioned inside the trays and above said trays, in offset arrangement, so as to convey the films from one bath to the successive bath, dipping them and lifting them at the end of each treatment step.

The pairs of rollers are driven, at a pre-programmed constant revolution speed, by actuator gear wheels positioned outside the trays.

In practice, this apparatus results to be very complex and cumbersome and requires the constant attendance by the operator, as well as a frequent servicing, besides blade means, or the like, in order to remove from the rollers the residues of the preceding bath. Furthermore, the use of the obscure chamber is always required.

In order to obviate, at least partially, these drawbacks and limitations which affect the apparatuses known from the prior art for automatic development, an apparatus for the automatic development of radiographic plates and films, and the like, was proposed in the past, which is so contrived as not to contain moving mechanical parts into contact with the liquids which compose the treating baths, and such as not to require the transfer of the film or plate from tray to tray.

This apparatus known from the prior art is constituted by a box-like support bearing, in its upper portion, a tray with openable cover designed to contain the plates or films to be treated, and, under said tray, two separate containers for the developer bath and the fixing bath, which, through pneumatic, multi-way valves, are connected with said upper tray and with means capable of sending, alternatively and during preset time periods, pressurized air into said containers, in order to transfer the therein contained liquids to the treatment tray. The apparatus is furthermore provided with timers which are suitably programmed in order to adjust the stay time of the individual baths inside said tray, and the return of the liquids, after the treatment, into their respective containers, takes place by gravity. Furthermore, a device is provided in order to send washing water into the tray at the end of the treatment, and heating means are optionally provided, to deliver hot air into said tray, in order to dry the films contained in said tray. As compared to the prior art, this apparatus offers the great advantage that it does not require the programmed transfer of the films between the several treatment trays; that it allows the length of the treatment times of the film inside the single tray provided, to be adjusted at will; that it eliminates any risks of mixing the liquids inside the tray; and that it does not require the development process to be carried out inside the obscure chamber. However, also this apparatus results to be quite complex owing to the presence of multi-way valves, pressurized air sources and connection pipes.

A purpose of the present invention is of providing an apparatus for the automatic development of radiographic or photographic plates and films, and the like, which is so contrived as to be very simple from the structural viewpoint, of reduced overall dimensions, highly reliable and therefore, in the overall, very cheap and hence particularly suitable for dental offices, surgeries, and the like.

Another purpose of the finding is of providing an apparatus for automatic development useable also outside the obscure chamber and so conceived as not to practically require any maintenance, to be easily adjusted and programmed for carrying out treatment cycles of different length and with the use of both fast-acting liquids and

normal liquids, as well as of partially depleted liquids.

A further purpose of the finding is of providing an apparatus capable of automatically developing films of also large size, exposed film rolls and plates in general, without any risks of damage to the same films and without any moving mechanical parts being into contact with the corrosive liquids used in the treating baths.

These and still other purposes, which will be clearer from the following disclosure, are achieved by an apparatus for the automatic development of radiographic, photographic films, and the like, kept stationary inside one single treatment tray, which apparatus is constituted, according to the present invention, by at least three cylindrical bodies or shells rotatably mounted opposite to one another, designed to rotate, intermittently and for preset time periods, around a common horizontal axis, driven by motor means acting on the periphery of said shells, with, inside the interior of each Shell, a container of elongated shape being provided and/or positioned, which is suitable for respectively containing a developer bath, a fixing bath and a washing bath, with said containers being equipped with a substantially reverse "L" bent, or reverse "C" shaped, duct, which is so extended, as to have its outlet mouth in coaxial position with the common revolution axis of said shells, with the outlet mouths of said containers being so connected with one another as to form one single duct rotatably connected, with water-tight connection, with said fixed treatment tray, in the nearby of the bottom thereof, so as to enable, by means of sequential revolutions of said shells, alternating with intermediate stops lasting preset time intervals, each of said containers to reach a position at a higher level than the tray, to cause its liquid contents to drain into said tray and then to travel back, after the treatment step, to a still vertical, but reversed (i.e., upside-down) position, in order to receive the same liquid by gravity, thus pre-arranging, after reaching its starting position, said tray to receive the liquid from the successive container.

More particularly, each of said containers of elongated shape is provided, at its opposite ends, with a float valve, or the like, suitable for enabling air to vent off from the interior of said container during the liquid draining and recovering steps after the end of the treatment step.

Furthermore, each of said shells defining and/or containing said containers, is rotatably mounted by means of pairs of parallel rollers, with at least one of said rollers being motor-driven, acting by friction on the external cylindrical surface of said individual shell.

Further characteristics and advantages of the present finding will be clearer from the following

disclosure in detail of a preferred form of practical embodiment thereof, made by referring to the accompanying drawing tables, which are supplied for merely indicative purposes, in which:

5 Figure 1 schematically shows a perspective view of an apparatus for the automatic development of exposed films, contrived according to the present invention and provided with three cylindrical bodies or shells, facing each other and coaxial with one another;

10 Figure 2 shows, also in schematic way, the sectional view made along the central axis of a cylindrical body of figure 1, perpendicular to the revolution axis thereof, and

15 Figures 3 and 3a show a diametrical sectional view made along the line III-III of Figure 1, respectively referring to the intermediate cylindrical body, and to the end cylindrical body at the opposite end relatively to the treatment tray.

20 Referring to said figures, the apparatus according to the present invention is constituted by a quadrangular prismatic base 1 with hollow interior, inside which three pairs of rollers 2-2a are rotatably mounted with their axes being horizontal, and parallel to one another; at least one roller from each roller pair is driven by a geared motor (not depicted) enslaved, through a timer, to a central electronic control unit suitably programmed in order to intermittently actuate said rollers, with alternating resting times of preset length, as is better explained in the following.

On each of said three roller pairs 2-2a, a cylindrical body or shell 3-3a and 3b is installed (Figure 1); therefore, said bodies result to be capable of revolving around a common axis 4; said bodies are placed closely adjacent to each other, as evidenced in Figure 3.

40 Facing the visible face of the cylindrical body 3 there is provided, closely adjacent to said cylindrical body, a prismatic tray 5, which is supported by two opposite uprights 6-6a extending upwards from the base 1. Said tray preferably has its bottom wall made in the form of two mutually opposite portions, each inclined towards the centre line of said tray, owing to reasons which are better explained in the following.

45 Inside the interior of each cylindrical body 3-3a-3b, there is formed (or inserted, if the bodies are constituted by hollow cylinders) a flattened container 7 (Figure 2), extending in the vertical direction and whose external wall 7a matches the bending of the cylindrical body, whilst the bottom wall 7b and the upper closure wall 7c are tapered. Each container 7 is provided, at its top, with a reverse "L" bent, or reverse "C" shaped tubular duct, the initial portion 8 of which is inclined towards the interior of the cylindrical body, and the end portion 8a of which is oriented perpendicularly

to the axis of revolution 4 of the same body. The bend 8b formed by the duct portions 8 and 8a is at a higher level than the upper peripheral edge 5a of the stationary tray 5. Furthermore, the outlet mouths 8c of the vertical duct portions 8a of the three containers are laterally connected with each other, with possibility of mutual revolution and with a water-tight connection, so as to form one single horizontal duct 9 coaxial with the revolution axis 4, which is then connected, still with possibility of revolution and with a water-tight connection, with a bore provided through the wall of the tray 5, in the nearby of the lowermost region of the bottom of said tray (Figure 2).

In greater detail, the individual mouths 8c of the vertical duct portions 8a open inside a transversal cylindrical chamber 8d (Figures 3-3a), at whose ends an annular connecting means or flange 8e is provided, which is suitable for entering, with water-tight engagement, the corresponding opening 8f of the adjacent duct 8a.

The vertical duct 8a of the container of shell 3b, i.e., the last shell of the set of shells, is closed by the external wall of said shell.

Therefore, the duct 9 results to be constituted by the coupling, by partial engagement of the various flanges 8e, with the interposition of ring-shaped sealing gaskets, inside the cylindrical hollows 8d of the portions 8a of the mutual facing containers, and constitutes a stationary revolution axis relatively to the tray, around which the stretches 8a of the containers revolve.

Furthermore, on the opposite closure walls of each container 7 a valve 10 and 10a, respectively, is positioned of float valve type or the like, suitable for enabling air contained inside said container to be vented off and air to enter the latter, during said container emptying/filling steps, in order to favour the liquid bath drain. Furthermore, the volume of the containers, and their degree of filling with the treatment baths are so calculated, that all the liquid means contained in each container can be charged to the tray, without the danger that the same liquid bath contained inside a tray may get mixed, by rising along the shared duct 9, into the other containers. In Figure 1, with the reference numeral 10b the caps for the fillers used to fill the liquids in the containers, are indicated.

The apparatus disclosed hereinabove is used as disclosed in the following.

All the containers 7 are positioned in the vertical direction and are filled by charging, e.g., the developer liquid, into the container of the shell 3, the fixing bath into the successive container and the washing bath into the last container.

In practice, each liquid can be inside a whatever one of the containers, because the sequence of their draining and recovery can be programmed

in order to perform always the correct treatment cycle; furthermore, the filling level indicated, e.g., with 11 in Figure 2, is kept approximately equal in all three containers. After filling, the bottom valves 10 are obviously closed, and the upper ones 10a are opened. Then, by causing the shell 3 to slowly revolve according to the arrow F of Figure 2, the respective container 7, containing the developer liquid, is transferred to a higher position relatively to the tray, and during the transfer to the horizontal position, the liquid is sent, by gravity, to fill the tray. When the same container reaches its horizontal position at said higher level than the tray (with the portion of duct 8a being horizontal), the revolution of the shell is stopped for a long enough time, to enable the development of the film charged to said tray, to occur; during this step, the liquid contained inside the tray partially rises, due to the principle of communicating vessels, inside the stretches 8a of the ducts of the other vertical, stationary containers, but the level of liquid inside said portions 8a (and, obviously, also of the liquid inside the tray) is always much lower than the level of the upper reverse "L" bent stretch 8b of said ducts; therefore, no dangers exist that the liquid may get mixed with the liquids contained inside the other containers.

The shell 3 is subsequently driven to rotate again, until the container is caused to reach, from its horizontal position above the tray, to its initial starting position, and then is stopped. During this movement, the liquid contained inside the tray, and also the liquid contained inside the stretches 8a of the other containers, is charged again, by gravity, to the container 7, so that, after each revolution of 360°, the container and the developer liquid contained therein are in a ready position to repeat the development step. After stopping the container with the developer liquid in its vertical starting position, the revolution of the adjacent shell 3a containing the fixing liquid is started and the operations of shell stopping, film treatment and fixing liquid recovery are repeated exactly in the same way as in the preceding step. At the end of the fixing step, the washing step is carried out in an analogous way, by using the container of the shell 3b.

According to a different form of practical embodiment of the present invention, instead of providing three driving rollers, i.e., one roller per each shell, in order to simplify and make the apparatus still simpler, one single drive roller can be provided, which has a length equating the width of the three side-by-side shells, under friction engagement with all three shells, and capable of driving each of them to revolve. In this case, in each shell the recessed portions 12 and 12a are provided, which, when the relevant shell should remain stationary in its resting position, reach a position adja-

cent to the drive roller and keep said shell out from the action performed by the roller during the preset time period, with each shell being also provided with suitable protruding parts, or projections, and suitable engagement means, not shown in the figures, for engaging and dragging to move the adjacent shell, at the preset time and position, and according to a preset program.

In order to carry out the end drying step, a whatever hot air generator, or an electrical resistor can be provided, either separate from, or installed in, said apparatus, which are suitable, in the first case, to send hot air into the tray containing the washed film, and, in the latter case, to heat the air contained inside it, over time periods of preset length.

Furthermore, the whole apparatus, or even only the front portion thereof, which contains the tray, can be enclosed inside a box-like container casing, provided, at least at one of its sides, of portholes, or similar openings, which allow operator's hands to enter the casing, thus allowing the plates to be developed, and contained inside the tray, to be suitably handled without the aid of an obscure chamber.

Finally, in order to automate the sequence of the operating steps, with the apparatus as disclosed hereinabove, a central control unit, e.g., a card microprocessor, or the like, is connected and so programmed as to accomplish, by means of timers, either rapid or normal treatment cycles.

From the above, it clearly appears that the finding, as disclosed hereinabove according to a preferred form of practical embodiment thereof, may be supplied with structurally and functionally equivalent modifications and variants, without departing from the scope of protection of the same finding.

Claims

1. Apparatus for the automatic development of radiographic, photographic films, and the like, kept stationary inside one single, fixed, treatment tray, characterized in that said apparatus is constituted by at least three cylindrical bodies or shells rotatably mounted opposite to one another, designed to rotate, intermittently and for preset time periods, around a common horizontal axis, by being so driven by motor means acting on the periphery of said shells, with, inside the interior of each shell, a container being provided and/or positioned, which is suitable for respectively containing a developer bath, a fixing bath and a washing bath, with said containers being equipped with a substantially reverse "L" bent, or reverse "C" shaped, duct, which is so extended, as to have

its outlet mouth in coaxial position with the common revolution axis of said shells, with the outlet mouths of said containers being so connected with one another as to form one single duct rotatably connected, with water-tight connection, with said fixed treatment tray, in the nearby of the bottom thereof, so as to enable, by means of sequential revolutions of said shells, alternating with intermediate stops lasting preset time intervals, each of said containers to reach a position at a higher level than the tray, to cause its liquid contents to drain into said tray and then to travel back, after the treatment step, to a still vertical, but reversed (i.e., upside-down) position, in order to receive the same liquid by gravity, thus pre-arranging, after reaching its starting position, said tray to receive the liquid from the successive container.

2. Apparatus according to claim 1, characterized in that each container is provided, at its opposite ends, with at least one float valve, or the like, suitable for making it possible steps of air venting from the container to be carried out alternating with air inlet steps into said container, during the steps of draining of the liquid bath in order to charge said liquid bath to the tray, and recovery of said liquid bath from said tray, after the end of the treatment step.
3. Apparatus according to claim 1, characterized in that each cylindrical body or shell is rotatably mounted on pairs of parallel, revolving rollers, with at least one of said rollers being motor-driven, acting by friction on the external cylindrical surface of the individual shells.
4. Apparatus according to claim 1, characterized in that each cylindrical body or shell is rotatably friction-driven by one single driving roller, the length of which equates the width of the three cylindrical shells placed side-by-side to each other, and that each shell is provided with a recess suitable for causing said shell to be stopped in its resting position, and with protruding elements, or projections, or other engagement means, suitable for enabling the adjacent shell to be dragged to revolve, according to a preset program.
5. Apparatus according to claim 1, characterized in that the reverse "L" shaped or reverse "C" shaped stretch of the duct integral with said containers is positioned, when the containers are stationary in their vertical position, at a higher level than of the upper edge of the treatment tray.

6. Apparatus according to claim 1, characterized in that said stationary treatment tray is made with its bottom wall being inclined towards the centre thereof, so as to favour the drain of all of the liquid bath containers inside it, through said single duct coaxial with the revolution axis of said containers. 5
7. Apparatus according to claim 1, characterized in that said tray is heated by means of hot air, or by means of an electrical resistor installed inside said tray, in order to perform the step of drying of the already washed films. 10
8. Apparatus according to claim 1, characterized in that said tray is thermostatted by means of the installation of an electrical resistor inside it. 15
9. Apparatus according to claim 1, characterized in that for performing the treatment cycles, said apparatus is equipped with a central electronic control unit with programmable timers, suitable for being set according to the required length of said treatment cycles. 20

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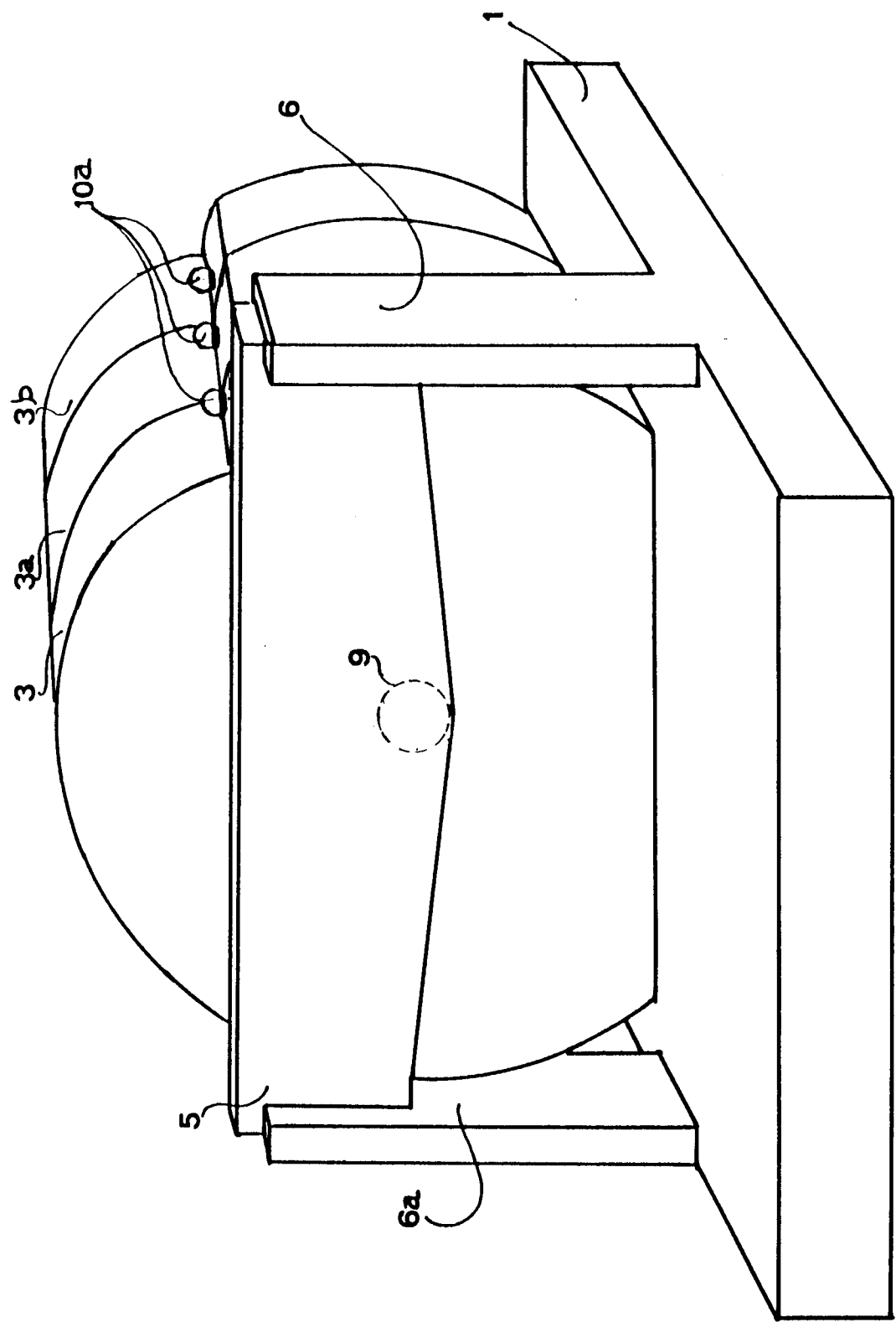


fig.1

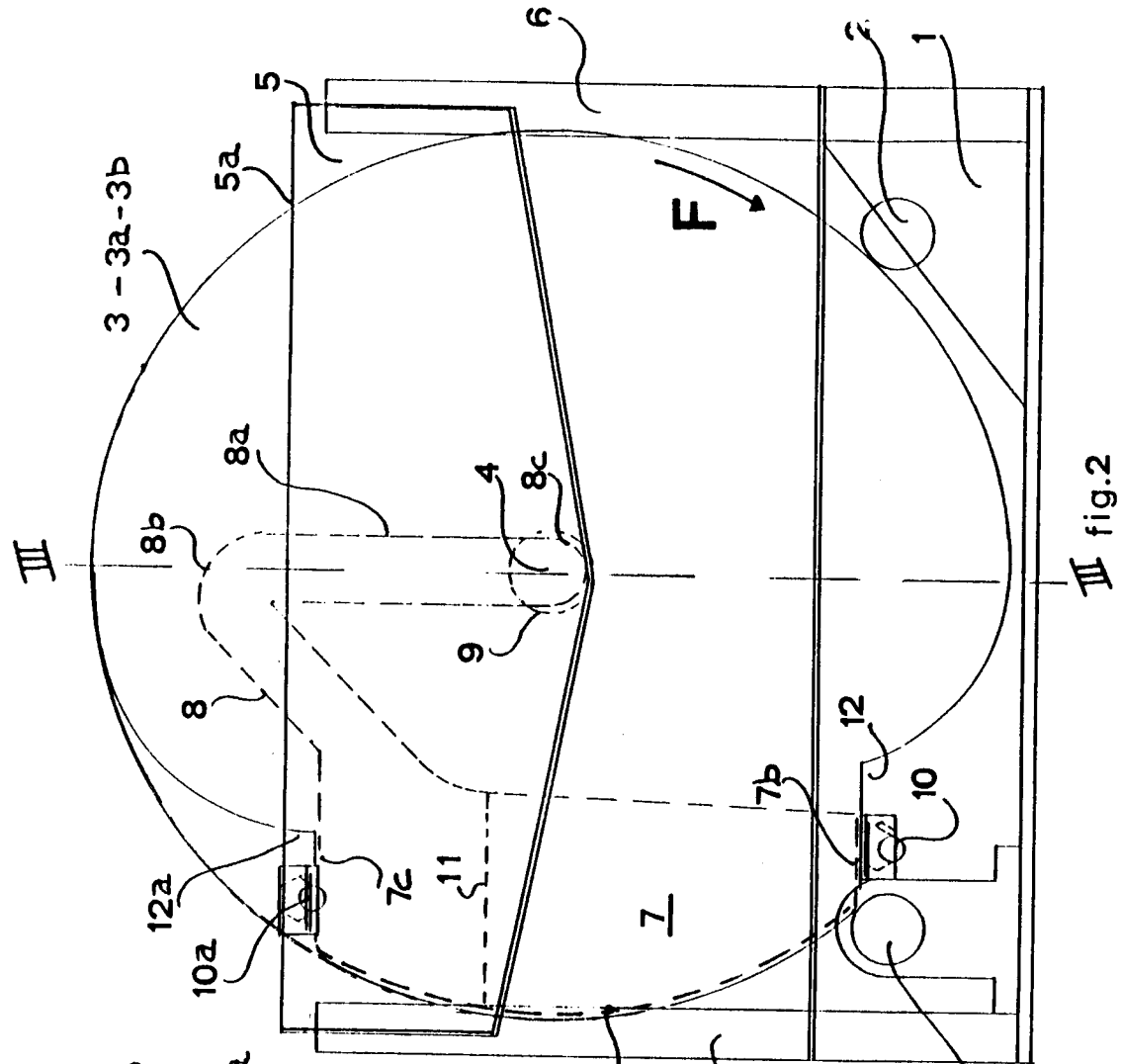


fig.2

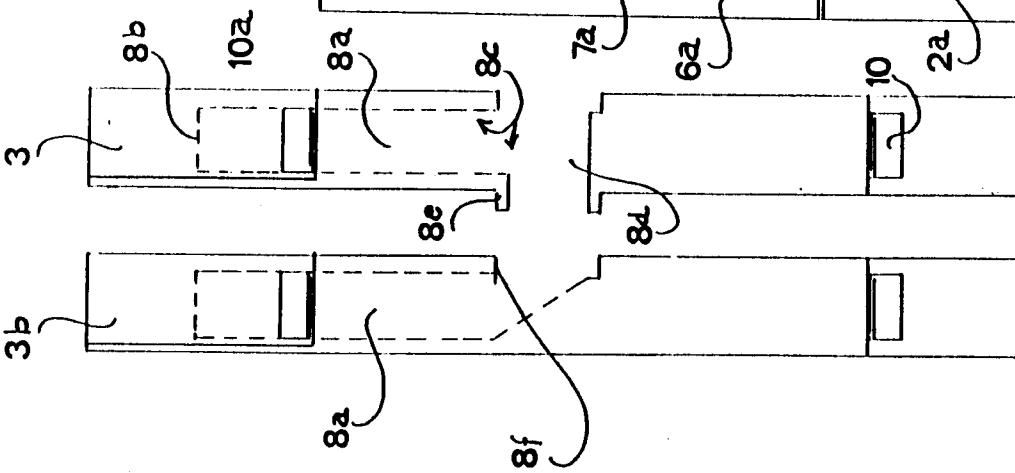


fig.3

fig.3a