United States Patent

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[72] Inventors **Leendert Johannes van der Windt, Burgerveen, and Johannes Jansen, Zwijndrecht, Netherlands**

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[73] Assignee **Brooks Instrument N. V. Veenendaal, Netherlands**
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[54] **MIXING DEVICE**
8 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **259/4**
[51] **Int. Cl.** **B01f 15/04**
[50] **Field of Search** 259/4, 36, 18, 60, 2, 95

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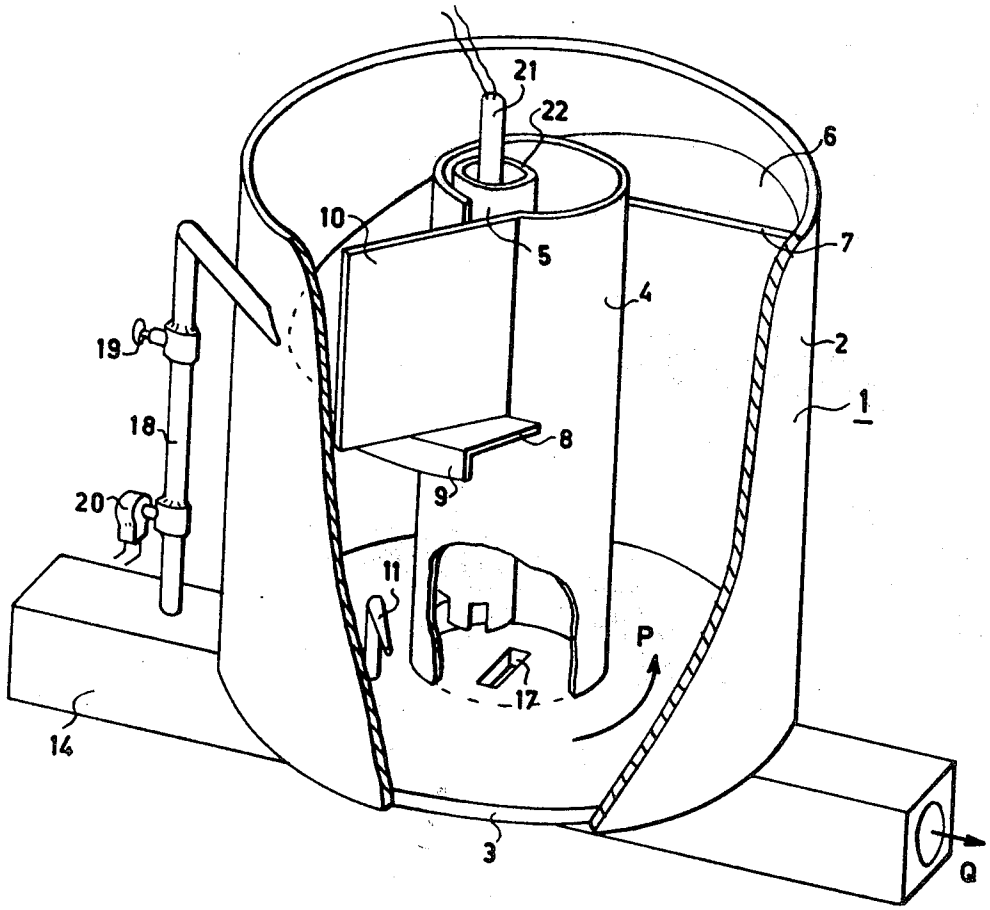
Attorney—Paul & Paul

ABSTRACT: Device for mixing solid or fluid materials or the like in a main liquid, said device comprising a vertically arranged substantially cylindrical reservoir for receiving the materials to be mixed, the bottom of the reservoir being provided with a nozzle, which is connected to a supply for said main liquid and positioned to spray said main liquid in substantially horizontal, and, in view of the vertical wall of the reservoir, tangential direction, an overflow tube, the upper end of which being provided with one or more inlet openings, being arranged in the reservoir together with a helical shaped baffle plate the fore edge of which, as seen in the direction of rotation of the liquid flow, is lying higher than the maximum liquid level and the back edge below the lowest inlet point of the overflow tube, the supply for said main liquid being formed by a branch of a delivery pipe of a liquid pump, the liquid from below the overflow tube being sucked off by a jet pump being mounted, after the branch, in the delivery pipe, the liquid level in the reservoir being controlled by means of a bypass tube with a valve in it operated by a liquid level control device.



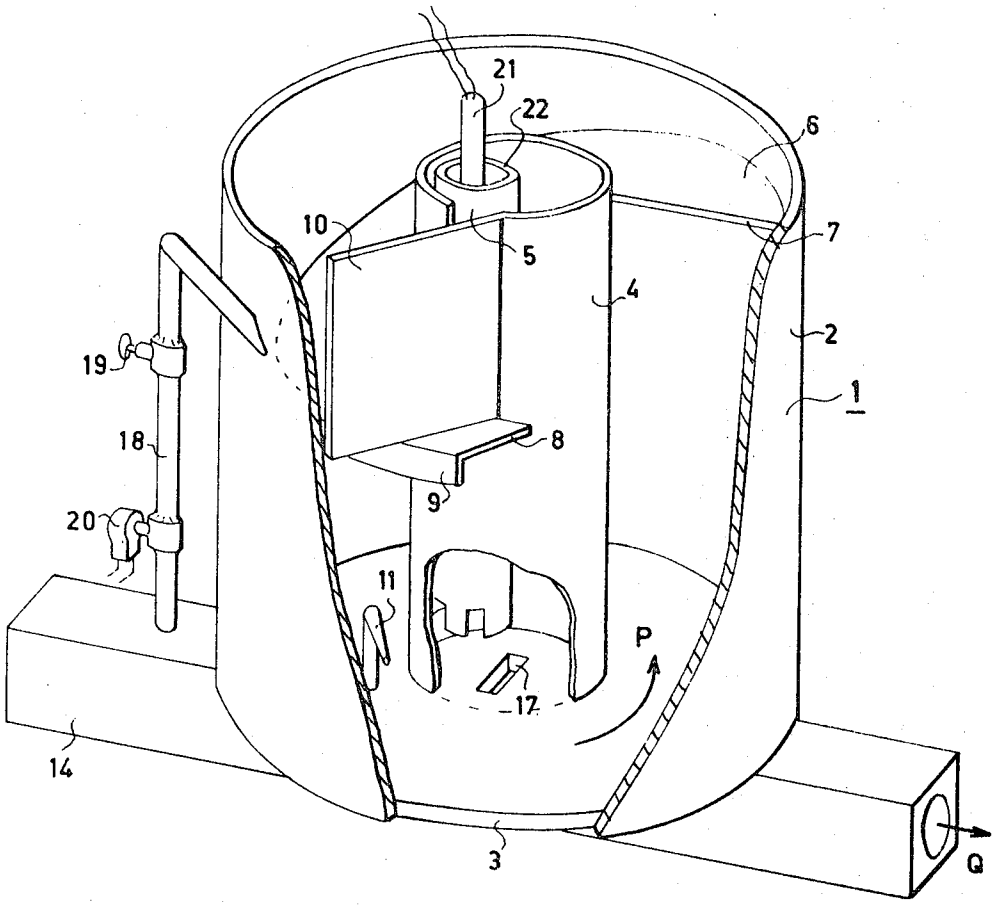


FIG. 1

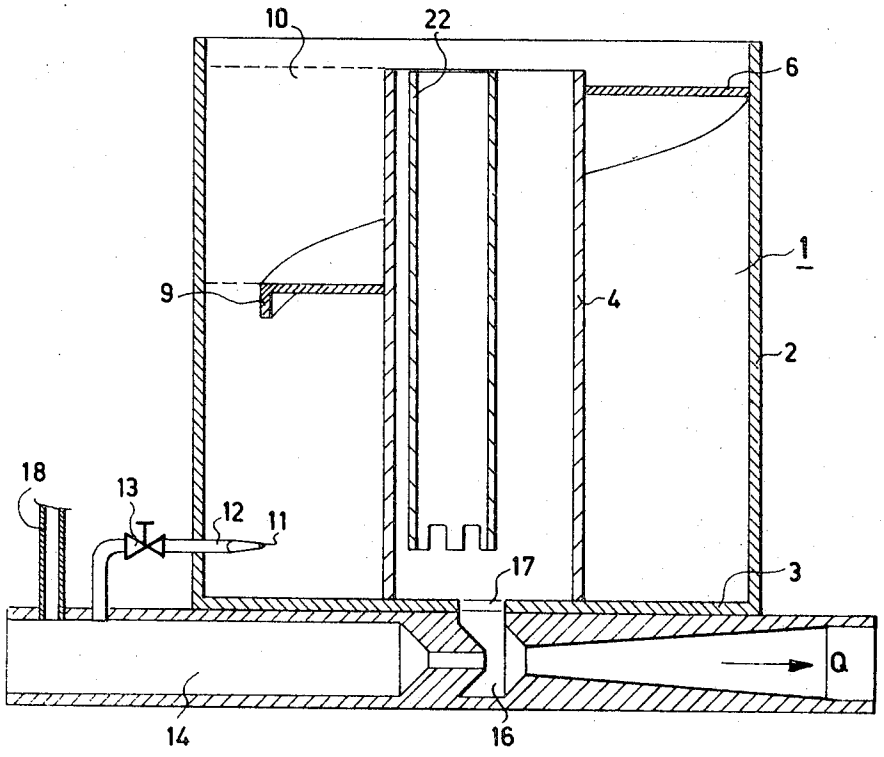


FIG. 2

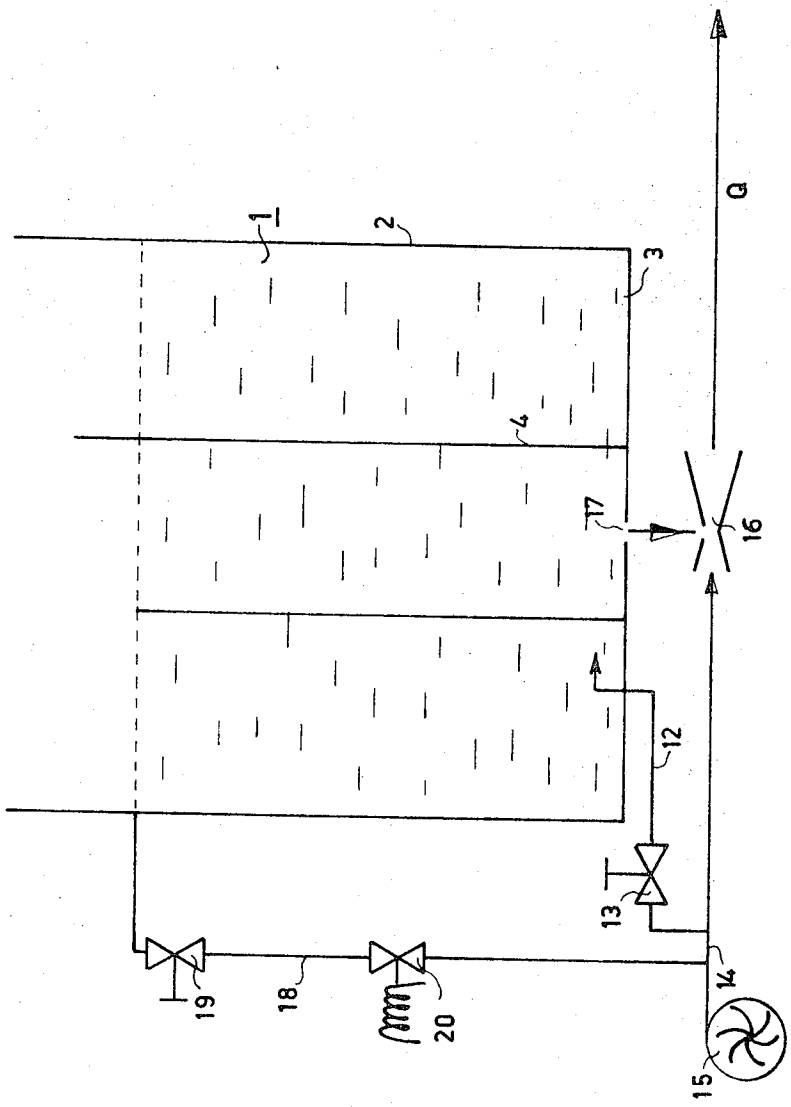


FIG. 3

MIXING DEVICE

The invention relates to a device for mixing solid or fluid materials or the like in a main liquid for obtaining a mixture, or a solution, or a suspension, or the like, said device comprising a vertically arranged substantially cylindrical reservoir for receiving the materials to be mixed.

With the known devices of this type generally a stirring device is arranged in the reservoir for mixing the main liquid with the solid or fluid materials. Then the mixture is, by means of a pump, sucked from the reservoir for being fed to the location where it is used.

The stirring device and its drive form a considerable part of the costs of the total mixing device. In many cases certain parts of the stirring device must, in order to obtain a reliable device, be executed in corrosion resistant materials, while especially with the working up of fire-risky materials, the drive of the stirring device, which, in most instances, comprises an electromotor, has be to explosion-proof.

In practice it further appears that with such devices a sufficient and correct mixing is not always obtained, among other things because, even with well-dimensioned reservoirs and stirring devices, "dead corners" originate where the velocity of the liquid is too low and the material to be mixed sags. Indeed it has been tried to prevent this by arranging baffle plates. This increases the costs, and the stirring device, is less accessible and consequently more difficult to clean.

A further objection of the use of a stirring device is that air bubbles, or generally gas bubbles, can land in the liquid and are carried away with the mixture. This can give difficulties when using the mixture, while the capacity of the suction pump will also be affected.

The invention now aims at removing the above-mentioned objections and for this purpose provides a device, which is characterized in that in the reservoir, near its bottom, and eventually at the locations suitable for this, at least one nozzle has been arranged connected to a supply for said main liquid and positioned to spray said main liquid in substantially horizontal and, in view of the vertical wall of the reservoir, tangential direction. In the reservoir an overflow tube has been placed the upper end of which is provided with one or more inlet openings, in such a way, that the liquid in the reservoir follows a helical path with an upwardly directed pitch. At the top of the reservoir, all round a part of the periphery of the overflow tube, a helical shaped baffle plate running substantially radially to the wall of the reservoir has been mounted. The pitch of this baffle seen in the direction of rotation of the flow of the liquid, is oppositely directed to the pitch of the flow of the liquid while, seen in the direction of rotation, the fore edge of the baffle plate lies higher than the maximum liquid level and the baffle plate extends below the minimum liquid level and somewhat beyond the lowest inlet point of the overflow tube.

By using the nozzle the whole bottom surface of the reservoir is covered, so that a flow of liquid rotating about the overflow tube originates with an upwardly directed velocity component. Because of this rotational movement a considerable vortex originates, which vortex contributes to a close mixing of the materials. When the liquid arrives at the highest level the helical baffle plate causes a velocity component in the downward direction, owing to which mixing takes place with the liquid coming from below. This mixing is further improved by the appearing whirls.

According to a preferred embodiment of the invention the inlet opening in the overflow tube is formed by a vertical slot in said tube whereby even with a varying liquid level a correct discharge of the liquid out of the reservoir and into the overflow tube is guaranteed.

In order to insure that the liquid flowing into the overflow tube, has as smooth a flow characteristics as possible, i.e. shows as little whirl as possible, the baffle plate, as seen in the direction of rotation of the flow of the liquid, for a portion of its length is spaced from the wall of the reservoir. Above the baffle plate, just after the inlet opening in the overflow tube, a partition plate which is substantially vertically has been arranged which extends between the wall of the reservoir and the overflow tube and extends above the maximum liquid level.

Advantageously the free rim of the baffle plate is provided with a downwardly reversed part. The baffle plate thus not only causes a downwardly directed velocity component, but at the same time causes the flow to be more concentrated around the overflow tube. Hereby an area with a more quiet flow originates above the baffle plate and between the wall of the reservoir and the overflow tube. Moreover a final close mixing will take place because the liquid, which at last lands above the baffle plate, at first must move downwardly and must flow around the reversed part.

Floating lumps, if any, of an added solid material are forced under the liquid level by the baffle plate, the reversed rim of the plate seeing to it that such lumps cannot land in the overflow tube. By making the reversed rim large enough not only floating, but also suspended parts will be kept in the mixing barrel, till they are completely dissolved. For this it is necessary that the reversed rim starts at the location where the baffle plate comes clear from the wall of the reservoir.

It is clear that the liquid must flow out of the nozzle with a certain force in order to obtain the effects described above. Because of the very close mixing in almost all cases only part of the total quantity of the liquid has to be worked up. The nozzle is connected with a branch of a delivery pipe of a liquid pump and the liquid from below the overflow tube is sucked off by a liquid jet pump mounted, after the branch, in the delivery pipe.

Because a pump does not have to be mounted in the piping through which the mixture is delivered from the mixing device if aggressive materials have to be added, this has no influence on the pump. The application of a liquid jet pump brings the advantage with it, that the liquid being sucked from the mixing reservoir is at the same time well mixed with the liquid coming immediately from the pump. For the rest it will be clear that a "water jet pump" can also work with other liquids.

For a good working of the mixing device it is necessary that the liquid level does not exceed the highest edge of the baffle plate and does not sink under the inlet opening in the overflow tube.

In order to be able to intercept the differences in pressure, which inevitably will appear, it will be necessary to give the mixing reservoir a large content. For preventing this the invention now provides in the overflow tube a level control device, which device operates a valve present in a bypass tube, running from a point of the delivery pipe, positioned before the water jet pump, to the mixing reservoir.

When the valve in the bypass tube is in its open position, the liquid level, in the mixing reservoir, must with a maximum capacity of the water jet pump, slowly rise. When the liquid level reaches its highest admissible point the valve in the bypass tube will close completely or partly. The liquid supply from the nozzle is less than the minimum suction capacity of the water jet pump.

With normal pressure differences occurring in practice a simple, and yet reliable working, device can be obtained by mounting in the bypass tube as well as in the piping running towards the nozzle, a hand-operated regulation valve, the valve in the bypass tube being completely opened or closed by the level control device.

The level control device and the valve operated by it then can be of a simple type, by which the chance of disturbances is minimal.

In order to see to it that the liquid supplied to the reservoir via the bypass tube only influences the flow in the reservoir slightly, the bypass tube can be connected with the wall of the reservoir at a point above the baffle plate and in such horizontal and tangential direction that the liquid coming out of the bypass tube mainly has the same flow direction as the main flow in the reservoir. In principle it is of course also possible to connect the bypass tube with a nozzle, working parallel with the main nozzle in the reservoir.

The invention is shown in the drawing, in which:

FIG. 1 shows a perspective view of a mixing device according to the invention, with which the wall of the reservoir and of the overflow tube has partly been left out;

FIG. 2 shows a vertical section over a device according to the invention; and

FIG. 3 shows a scheme of the connection of a mixing device with the delivery pipe of a pump.

With the device shown in FIGS. 1 and 2 the reservoir 1 has been built up from a shell 2 and a bottom 3, which in this case is formed by a flat disc. An overflow tube 4 which is nearly concentric with respect to the shell 2 is attached to the flat disc 3, and is provided with the longitudinal slot 5. All round the overflow tube 4 the baffle plate 6 is present, which, as appears more especially from FIG. 1, has a helical shape. The fore edge 7 of the baffle plate 6 lies above the maximum liquid level and the back edge 8 below the minimum liquid level. At the location of the fore edge 7 the baffle plate 6 extends itself over the whole distance between the overflow tube 4 and the shell 2, but after some distance the edge of the baffle plate comes clear from the shell 2 and is, from that location on, provided with a reversed rim 9, which runs on the to the back edge 8.

The back edge 8 ends at some distance beyond the longitudinal slot 5 in the tube 4. At the top of the plate 6 immediately after the slot 5 a plate 10 is mounted which runs between the overflow tube 4 and the wall 2 of the reservoir 1 and ends above the maximum liquid level.

At the bottom of the reservoir a nozzle 11 has, in about tangential direction, been mounted, from which nozzle liquid is sprayed into the reservoir, such that said liquid mainly follows a flow direction as indicated with the arrow P.

Owing to the continuous liquid supply the flow will run along a helical line with an upwardly directed pitch. The material to be added, which is added between the edges 7 and 8 of the plate 6, i.e. as seen in the direction of flow before the edge 7, will be taken along with the liquid flow and, as far as it has not yet been mixed with the liquid then, will be pressed against the plate 6 and obtain with the liquid a downward velocity so that a close mixing takes place with the liquid coming upward.

The nozzle 11 is by means of a piping 12 with a valve 13 in it, connected with the delivery pipe 14 of a pump 15, as has schematically been shown in FIG. 3.

In the delivery pipe 14 a jet pump 16 is present after the branch of the piping 12, which pump is connected with an outlet opening 17, which is present in the bottom 3 of the reservoir but within the periphery of the overflow tube 4. The jet pump 16 consequently sucks the liquid treated in reservoir 1, in the direction of the arrow Q. By the jet pump 16 the liquid treated in the reservoir 1, is mixed with the liquid that has not yet been treated, but has been supplied immediately from the pump 15.

With the embodiment shown in FIGS. 1 and 2 the delivery pipe 14 and the jet pump 16 has been executed as a whole and has been arranged against the bottom 3 of the reservoir 1. Hereby a very compact construction is obtained. In most instances use can be made of synthetic materials owing to which the construction can also be very cheap.

In order to maintain the liquid level at the desired height, between the edges 7 and 8 of the baffle plate 6, a bypass tube 18 is mounted between the delivery pipe 14 and the reservoir 1. In said bypass tube 18 a hand-operated regulation stop valve 19 is present and a solenoid valve 20, that is operated by means of a level-control device 21, which is present in the overflow tube 4. The level-control device 21 is protected by a tube 22, mounted in the overflow tube 4 and at its upper and lower side stands in open connection with said tube. Owing to this the level-control device 21 is not immediately hit by the liquid flowing via the longitudinal slot 5 into the overflow tube 4.

It is clear that the level-control device 21 works such, that, when the liquid level decreases under a certain value, the solenoid valve 20 is opened, by which extra liquid is supplied to the reservoir 1. Piping 18 discharges closely behind the plate 10 into the reservoir 1, so that the liquid coming from the tube 18 will hardly take part in the mixing process in the reservoir, but almost immediately will flow into the overflow tube 4. Hereby a quick regulation is ensured so that the level in the overflow tube 4 at all times is high enough to prevent air being sucked in. The tube 18 and the valves 19 and 20 must be dimensioned such, that the liquid level then rises slowly, so that after some time the level-control device 21 again will close the valve 20. The liquid level then decreases again and the cycle described above repeats. Instead of an "open-closed" regulation of course also a proportionally working device can be applied, owing to which the liquid level will fluctuate very little, but in most instances such an arrangement, which entails considerable more costs, is superfluous.

As has already been explained above there must be a certain connection between the suction capacity of the pump 16, the quantities of liquid which land in the reservoir 1 via the tube 12 with the nozzle 11 and the bypass tube 18 and the quantity of material supplied. With the help of the valves 13 and 19 in tubes 12 and 18 respectively the right quantities flowing through can be adjusted. Also with changing working conditions, thus e.g. a varying backpressure, it appears that in most instances it is not necessary to change this adjustment.

It will be clear that in the above only an embodiment has been described of the invention, and that many changes can be made without falling outside the inventive idea.

We claim:

1. Device for mixing solid materials, liquids or the like in a main liquid for obtaining a mixture, or a solution, or a suspension or the like, said device comprising a vertically arranged substantially cylindrical reservoir for receiving the materials to be mixed, characterized in that in the reservoir, near its bottom, at least one nozzle has been arranged connected to a supply for said main liquid and positioned to spray said main liquid in substantially horizontal and, in view of the vertical wall of the reservoir, tangential direction, that in the reservoir an overflow tube has been placed the upper end of which being provided with at least one inlet opening, in such a way, that the liquid in the reservoir follows an upward helical path, that at the top of the reservoir all round a part of the periphery of the overflow tube a helical-shaped baffle plate running substantially radially to the wall of the reservoir has been mounted the pitch of which, seen in the direction of rotation of the flow of the liquid, is oppositely directed to the flow of the liquid while, seen in this direction of rotation, the fore edge of the baffle plate lies higher than the maximum liquid level and the baffle plate at least extends till below the minimum liquid level and till somewhat beyond the lowest inlet point of the overflow tube.

2. Device according to claim 1, characterized in that the discharge opening is formed by a vertical slot in the overflow tube.

3. Device according to claim 1, characterized in that the baffle plate, seen in the direction of rotation of the liquid flow, after some distance, is lying clear from the wall of the reservoir and that above the plate, just after the discharge opening in the overflow tube, a partition plate running substantially vertically has been arranged which extends itself between the wall of the reservoir and the overflow tube and which runs on to above the maximum liquid level.

4. Device according to claim 3, characterized in that the free rim of the baffle plate, lying opposite to the wall of the reservoir, is provided with a downwardly reversed part.

5. Device according to claim 1, characterized in that the nozzle is connected with a branch of a delivery pipe of a liquid pump and that the liquid from below the overflow tube is sucked off by a water jet pump being mounted, after the branch, in the delivery pipe.

6. Device according to claim 5, characterized in that in the overflow tube a level-control device has been arranged, which device operates a valve present in a bypass tube running from a point of the delivery pipe, positioned before the water jet pump, to the mixing reservoir.

7. Device according to claim 6, characterized in that both in the bypass tube and in the tube running towards the nozzle a hand-operated regulation valve has been arranged and that the valve in the bypass tube is completely opened or closed by the level-control device.

8. Device according to claim 6, characterized in that the bypass tube is connected with the wall of the reservoir in a point positioned above the baffle plate and in such a horizontal, tangential direction, that the liquid coming from the bypass tube mainly has the same flow direction as has the main flow in the reservoir.