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[54]	APPARATUS FOR WET TREATMENT OF PHOTOSENSITIVE MATERIAL				
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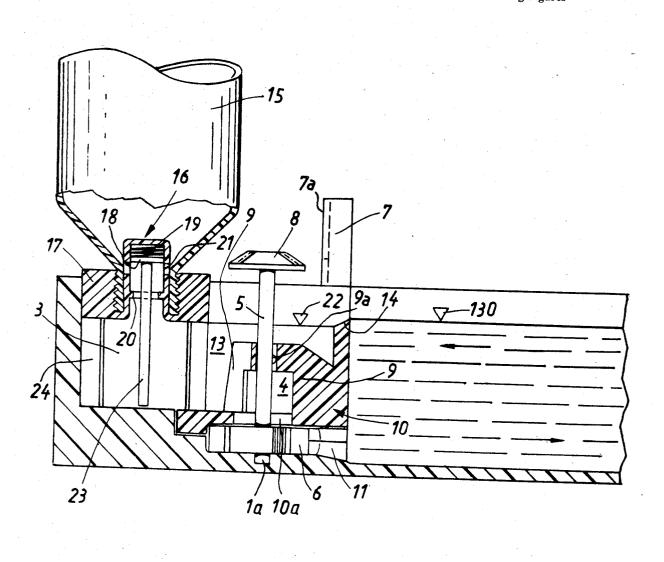
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[57] ABSTRACT

Apparatus for wet treatment of sheets or webs of photosensitive material has a housing with first and second vessels which are separated from each other by an overflow weir. The photosensitive material is transported through the first vessel whereby such material removes a certain quantity of liquid. A pump which is installed in a channel between the two vessels causes a stream of liquid to flow from the second vessel into the first vessel so that the liquid fills the first vessel and overflows the weir to return into the second vessel. An inverted bottle whose neck contains a valve is mounted in the second vessel to automatically deliver fresh fluid when the body of liquid in the second vessel descends below a predetermined level.

14 Claims, 3 Drawing Figures



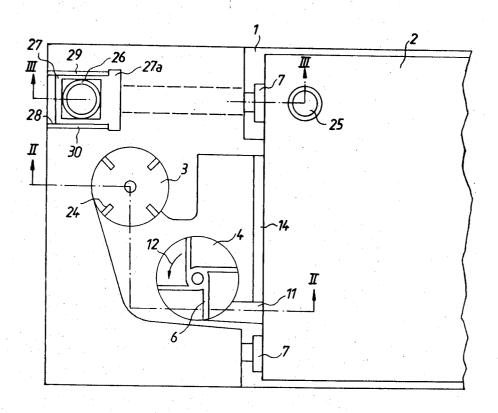
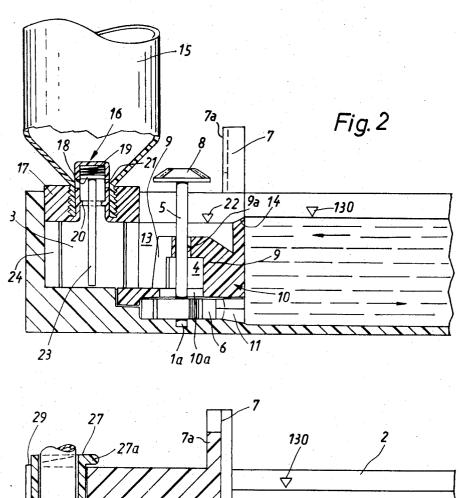
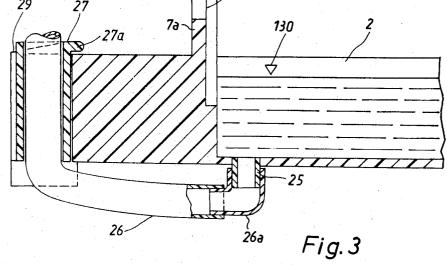


Fig.1





APPARATUS FOR WET TREATMENT OF PHOTOSENSITIVE MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for wet 5 treatment of photographic films, prints or the like. More particularly, the invention relates to improvements in apparatus for wet treatment of sheet-like commodities which are provided with layers of photosensitive material and are transported through a vessel 10 which is filled with liquid so that the liquid overflows to thus insure that the level of liquid in the vessel remains constant.

In presently known apparatus of the just outlined character, the liquid level in the vessel for wet treat- 15 ment of sheet-like material often fluctuates within a certain range. This is especially undesirable when the quantity of liquid which is being withdrawn from the vessel depends on the level of liquid therein. Moreover, the length of the path which extends through the body of liquid in the vessel depends on the level of liquid therein so that, by changing the level of liquid, one can influence the duration of treatment. This might adversely influence the quality of treated material, especially when the vessel contains a developing solution. For example, when the path for the material to be treated includes a downwardly sloping first section, horizontal second section and an upwardly sloping third section, the length of the first and third sections 30 is greatly influenced by changes in the liquid level.

It was already proposed to provide a vessel for wet treatment of photosensitive sheet material with a relatively simple refilling device which automatically admits fresh liquid when the liquid level in the vessel decreases. Conventional refilling devices normally employ floats or constitute fountains of the type known as automatic chick waterers. A drawback of such refilling devices is that they cannot prevent the fluctuation of liquid level in the vessel but merely maintain the fluctuation within a certain range. This is due to surface tension of liquid as well as to inertia of the refilling device. Therefore, such refilling devices cannot insure that the wet treatment is carried out with a very high degree of accuracy and reproducibility, such as is desirable for 45 development of photosensitive material.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel and improved apparatus which is capable of reliably main- 50 taining the upper surface of liquid in the vessel for wet treatment of photosensitive material at a selected level, whose operation is economical, which is of simple and compact design, and which can be used for any desired wet treatment of photosensitive material, such as fix- 55 ing, developing and/or others.

Another object of the invention is to provide the apparatus with novel and improved means for circulating the liquid in the vessel for wet treatment of photosensitive material and with novel and improved means for replenishing the supply of liquid as well as with novel and improved means for evacuating the liquid when necessary.

A further object of the invention is to provide the apparatus with novel and improved means for changing the liquid level in the vessel for wet treatment of photographic material when necessary.

Still another object of the invention is to provide the apparatus with novel and improved means for storing a supply of liquid for admission into the treating vessel at the rate which corresponds to the rate of liquid removal by treated material and/or as a result of evaporation.

The invention is embodied in an apparatus for wet treatment of photographic films or analogous sheet-like commodities which comprises first and second liquidcontaining vessels which are preferably formed as parts of a single housing with an overflow weir therebetween whereby the material to be treated enters into, passes through and leaves the first vessel to thus entrain a certain quantity of liquid therefrom, refilling means which is arranged to automatically discharge liquid into the second vessel when the supply of liquid therein descends below a predetermined level which is preferably below the highest point of the weir, and pump means which is operable to convey liquid from the second vessel into the first vessel whereby the liquid overflows the weir and reenters the second vessel in response to continuing operation of the pump when the first vessel is filled with liquid.

The refilling means may comprise a receptacle, such as an inverted bottle, which is mounted above the second vessel and whose neck is provided with a valve arranged to open automatically when the liquid in the second vessel descends below the predetermined level.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary schematic plan view of an apparatus which embodies the invention;

FIG. 2 is a vertical sectional view as seen in the direction of arrows from the line II—II of FIG. 1; and FIG. 3 is a vertical sectional view as seen in the direction of arrows from the line III—III of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a portion of an apparatus for wet treatment of sheets or webs of photosensitive material. The apparatus comprises a housing 1 provided with a relatively large first vessel 2 through which the material is transported for treatment of its photosensitive layer. The means for transporting material through the body of liquid in the vessel 2 is not shown in the drawing; such transporting means preferably comprises pairs or groups of conventional rolls which define for the material a predetermined elongated path wherein the material advances lengthwise. The last group or groups of rolls may constitute a means for squeezing excess liquid from the travelling material and for returning such excess into the vessel 2. Reference may be had, for example, to the commonly owned copending application Ser. No. 177,022 filed Sept. 1, 1971, now U.S. Pat. No. 3,733,992, which further shows the manner in which the rate of outflow of liquid from the vessel increases in dependency on the quantity of processed material when the leading or

trailing portion of a sheet or web expels a wave of liquid from the vessel. This is desirable in order to maintain the activity of the bath at a constant value because the expelled quantity of liquid is replaced by an equal quantity of regenerated liquid. The quantity of liquid 5 which is entrained from the bath in the vessel depends to a large degree on the level of liquid therein.

The left-hand portion of the housing 1 (which is shown in the form of a solid block with channels, recesses and passages for reception and flow of liquid) is 10 provided with an inlet opening 3 for a refilling device here shown as including a receptacle or bottle 15 which is mounted on the housing 1 in inverted position as shown in FIG. 2. The left-hand portion of the housing culate the liquid between the vessel 2 and a smaller auxiliary vessel or tank 13. The housing 1 is further provided with a discharge opening 25 through which the liquid may be evacuated from the vessel 2 and with recesses or grooves 7 formed in upwardly extending 20 posts 7a for reception of groups of transporting rolls.

FIG. 2 illustrates the rotor 6 of the pump 4. This rotor is mounted on a vertical shaft 5 the lower end of which is received in the blind bore 1a of the housing 1 and an intermediate portion of which is rotatable in a bearing 25 9a. The upper end portion of the shaft 5 carries a bevel gear 8 which meshes with a driven bevel gear (not shown) when the housing 1 is properly positioned in or on a supporting structure. The engagement of bevel gear 8 with the complementary bevel gear preferably 30 takes place simultaneously with introduction of the aforementioned film transporting rolls into the grooves 7. The rolls can receive torque from the motor which rotates the bevel gear for transmission of torque to the bevel gear 8.

The rotor 6 of the pump 4 is partially overlapped by a carrier 10 which includes the bearing 9a for the shaft 5 and is provided with ribs 9 forming passages for the flow of liquid from above to the vanes of the rotor 6.

FIG. 1 shows a channel 11 which extends tangentially 40 of the rotor 6 and serves to deliver liquid into the bottom region of the vessel 2. When the rotor is driven by the shaft 5 to rotate in the direction indicated by arrow 12, the pump 4 draws liquid from the tank 13 and conveys such liquid into the vessel 2 by way of an opening 45 10a in the carrier 10 and by way of the channel 11. The tank 13 is located at a level above the pump 4.

The vessel 2 can accommodate additional means for controlling the circulation of liquid therein in such a way that the liquid forms a current which flows along the bottom wall of the vessel 2, thereupon upwardly along the right-hand end wall (not shown in FIG. 1) of the vessel, and toward and over an elongated weir 14 which permits the liquid to overflow into the tank 13.

The neck of the bottle 15 (which is shown in inverted position) extends into the inlet opening 3, and the open end of the neck is closed by a valve 16 which is held in the neck by means of a retaining ring 17. The valve 16 comprises a valve disk 18 which is biased by a valve spring 19 against the projections 20 of the ring 17 so that the disk 18 prevents the outflow of liquid from the bottle 15 when the latter is lifted off the housing 1 with the ring 17. A post 23 constitutes a valve opening means and is mounted in the housing 1. This post extends from below into the neck of the bottle 15 and can displace the disk 18 upwardly so as to allow the liquid to flow from the bottle by way of openings 21. The bot-

tle 15 acts not unlike an automatic chick waterer and determines the upper level 22 of the supply of liquid in the tank 13. The illustrated level 22 is flush with the underside of the retaining ring 17. When the retaining ring 17 is placed onto the supporting members 24 in the inlet opening 3 of the housing 1, the valve 16 is opened by the post 23 and the liquid flows from the bottle 15 into the tank 13. The flow of liquid from the bottle 15 is interrupted when the level of liquid in the tank 13 rises to the underside of the retaining ring 17 because the liquid in the tank 13 then prevents the inflow of air into the bottle. When the level of liquid in the tank 13 descends below the retaining ring 17, the bottle 15 again discharges regenerated liquid until the liquid in 1 further contains a vane pumps 4 which serves to cir- 15 the tank 13 again interrupts the inflow of air into the bottle. The pressure in the bottle 15 is low enough to enable the body of liquid in the tank 13 to seal the central opening of the retaining ring 17 against entry of air into the bottle as soon as the upper surface of liquid in the tank 13 reaches the level 22.

FIG. 3 illustrates the means for evacuating liquid from the vessel 2. The discharge opening 25 in the bottom wall of the vessel 2 is connected to one end of a flexible conduit or hose 26 by way of an L-shaped nipple 26a. The other end of the hose 26 is received in a prismatic guide or mounting means 27 which is movable in a slot 28 of the housing 1. The guide 27 is provided with a handgrip portion 27a which is accessible from above the housing 1 and can be grasped to move the guide 27 along ways 29 and 30 which are provided in the housing 1 along the slot 28. When the guide 27 assumes the position shown in FIG. 1, its handgrip portion 27a engages the right-hand edge faces of the ways 29 and 30. Thus, in order to move the guide 27 to a horizontal position in which the liquid can flow from the vessel 2 by way of the hose 26, it is necessary to lift the handgrip portion 27a above the ways 29, 30 before the guide 27 can be moved to the horizontal position so that the corresponding end of the hose 26 is located below the discharge opening 25 to permit the liquid to flow the vessel 2 by gravity. When the evacuation of the liquid from the vessel 2 is completed, the guide 27 is returned to the position of FIG. 3 in which the upper end of the hose 26 is located above the uppermost level 130 of liquid in the vessel 2. The just described arrangement exhibits the additional advantage that the guide 27 allows for insertion of the housing 1 into the supporting structure of a processing machine only when its handgrip portion 27a assumes the position of FIG. 3. This is due to the fact that the handgrip portion 27a can enter the supporting structure of the processing machine only when it takes the position shown in FIG. 3. The operation:

When the pump 4 is idle, the level of liquid in the vessel 2 is the same as in the tank 13. Such level extends at least to the plane of the underside of the retaining ring 17. If the apparatus is started, the pump 4 is driven together with the transporting rolls and causes a stream of liquid to flow from the tank 13 into the vessel 2 by way of the channel 11. When the liquid in the vessel 2 rises to the maximum level 130 shown in FIGS. 2 and 3, it begins to overflow the weir 14. The output of the pump 4 is selected in such a way that all of the liquid which is being delivered after the vessel 2 is filled can overflow into the tank 13. The level of liquid in the tank 13 has sunk below the previous level (when the

pump 4 was idle) because the pump was withdrawn

from the tank 13 a certain amount of liquid which was needed to fill the vessel 2 to the level 130. Therefore, the bottle 15 automatically admits into the tank 13 additional liquid in order to raise the liquid level in the tank 13 to the underside of the retaining ring 17. This 5 terminates the outflow of liquid from the bottle 15.

The paper layer and/or the emulsion layer of the material which is being transported through the liquid bath in the vessel 2 absorbs a certain amount of liquid. Additional liquid leaves the vessel 2 with successive in- 10 crements of the material which is advanced by the aforementioned transporting rolls. Some liquid can also leave the vessel 2 for reasons which are explained in the aforementioned copending application Ser. No. 177,022. Consequently, the removal of liquid from the 15 vessel 2 by the travelling material results in a lowering of liquid level in the tank 13 because the pump 4 insures that the level of liquid in the vessel 2 remains at 130. This causes the bottle 15 to admit fresh liquid into the tank 13. The freshly admitted liquid is thoroughly 20 intermixed with liquid in the tank 13 due to the fact that some liquid continuously overflows the weir 14 under the action of the pump 4. The freshly admitted liquid which enters the tank 13 in response to repeated lowering of liquid level below the retaining ring 17 fur- 25 ther prevents chemical exhaustion of the circulating liquid so that the activity of the liquid remains practically unchanged.

When the transport of photosensitive material is completed, the motor for the pump 4 and the transport- 30 ing rolls is arrested. The level of liquid in the vessel 2 then sinks because some liquid flows into the tank 13 by way of the channel 11. When the pump 4 is idle, the level of liquid in the vessels 2 and 13 is established somewhere between the levels 22 and 130. A sinking 35 of the liquid level in the vessel 2 in response to stoppage of the pump 4 is desirable because this allows for more convenient transport of the housing due to the absence of splashing. Also, the crystallizing of liquid in the vessel 2 takes place below the level 130, i.e., below that level which the liquid in the vessel 2 reaches when the apparatus is in use so that the crystals which develop during the interval of idleness of the pump 4 are automatically dissolved when the pump is started to again circulate the liquid from the vessel 2, over the weir 14, through the tank 13, through the channel 11 and back into the vessel 2. Moreover, as the liquid level in the tank 13 rises in response to each stoppage of the pump 4, the liquid in the tank 13 prevents unnecessary escape of fresh liquid from the bottle 15.

The liquid level in the vessel 2 can be regulated in a simple way by inclining the housing 1 with the vessel 2 and weir 14. The weir slopes downwardly in the direction of liquid flow from the vessel 2 into the tank 13 and may extend in parallelism with the direction of travel of material through the body of liquid in the vessel 2. By the simple expedient of changing the inclination of the housing, the operator can change the level of liquid in the vessel 2. This is particularly advantageous when one wishes to compensate for the fact that the aforementioned transporting rolls may convey films which absorb and entrain varying quantities of liquid.

The liquid is the vessel 2 and the tank 3 may be a developing solution, a fixing agent, an activator, a stabilizer or a washing or rinsing agent.

The output of the pump 4 can be readily selected in such a way that, when the pump is in operation, the

upper surface of liquid in the vessel 2 invariably remains at the level 130. The exact level of liquid in the tank 13 is not critical, i.e., such level can rise and fall while the level (130) of liquid in the vessel 2 remains unchanged. The length of the weir 14 is selected with a view to insure that all of the surplus liquid which flows into the vessel 2 when the pump 4 is on can overflow into the tank 13. The pump 4 is mounted at a level which is low enough to insure that the fluctuations of liquid level in the tank 13 cannot adversely influence its output.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

- 1. In an apparatus for wet treatment of photographic prints, films or analogous sheet-like commodities, a combination comprising a first liquid-containing vessel having an upper edge and a second liquid-containing vessel smaller than said first vessel and located at one side of the latter, the commodities to be treated being transported through said first vessel with resulting removal of liquid therefrom; refilling means arranged to automatically discharge liquid into said second vessel when the liquid in said second vessel descends below a predetermined level; a weir forming an elongated partition between said vessels and including overflow means located below the level of said upper edge of said first liquid-containing vessel; and pump means operable to convey liquid from said second vessel directly into said first vessel whereby the liquid overflows through said overflow means of said weir and reenters said second vessel in response to continuing operation of said pump after said first vessel is filled with liquid.
- 2. In an apparatus according to claim 1, wherein said overflow means consists of an overflow edge located in a substantially horizontal plane.
- 3. A combination as defined in claim 1 wherein said refilling means is an automatic waterer including a receptacle for a supply of liquid and valve means arranged to permit the flow of liquid from said receptacle into said second vessel in automatic response to descent of the body of liquid in said second vessel below said predetermined level.
- 4. A combination as defined in claim 3, wherein said receptacle is an inverted bottle having a neck and said valve means controls the outflow of liquid through the neck of said bottle.
- 5. A combination as defined in claim 1, wherein said pump means comprises a vertical shaft, a rotor provided in one of said vessels and secured to said shaft, and drive means located above said one vessel and arranged to rotate said shaft.
- 6. A combination as defined in claim 5, wherein said pump means is a vane pump.
- 7. A combination as defined in claim 1, wherein said vessels form part of a single housing.
- 8. A combination as defined in claim 1, wherein said weir extends upwardly to a level above said predetermined level.

9. A combination as defined in claim 1, wherein said weir extends in substantial parallelism with the direction of transport of commodities through said first vessel.

10. A combination as defined in claim 9, wherein said 5 weir is tiltable with said first vessel.

11. A combination as defined in claim 1, further comprising means for evacuating liquid from said vessels and channel means connecting said vessels so that the evacuation of liquid from one of said vessels results 10 in evacuation of liquid from the other vessel.

12. A combination as defined in claim 11, wherein said pump means is installed in said channel means.

13. A combination as defined in claim 11, wherein said one vessel has a bottom portion provided with a 15 discharge opening and said evacuating means comprises a conduit having a first end portion connected to said discharge opening and a second end portion, and mounting means for normally maintaining said second end portion at a level above said weir so as to prevent 20 the outflow of liquid by way of said conduit, said second end portion being movable to a level below said discharge opening to thereby allow for evacuation of liquid from said one vessel by gravity flow.

graphic prints, films or analogous sheet-like commodities, a combination comprising a first liquid containing vessel having an upper edge and a second liquid containing vessel smaller than the first vessel and located at one side of the latter, the commodities to be treated through said first vessel with result-

ing removal of liquid therefrom, one of said vessels having a bottom portion provided with a discharge opening; refilling means arranged to automatically discharge liquid into said second vessel when the liquid in said second vessel descends below a predetermined level; a weir forming an elongated partition between said vessels and including overflow means located below the level of said upper edge of said first liquid containing vessel; pump means operable to convey liquid from said second into said first vessel whereby the liquid overflows said overflow means of said weir and reenters said second vessel in response to continuing operation of said pump means after said first vessel is substantially filled with liquid; means for evacuating liquid from said vessels and comprising a conduit having a first end portion connected to said discharge opening and a second end portion, and mounting means comprising a hand-grip portion for normally maintaining said second end portion at a level above said weir so as to prevent outflow of liquid by way of said conduit, said second end portion being movable to a level below said discharge opening to thereby allow for evacuation of liquid from said one vessel by gravity flow; channel means connecting said vessels so that evacuation of liquid from said one vessel results in evacuation of liquid from the other vessel; and means for separably supporting said hand-grip portion in such a position that said second end portion of said conduit is located at said

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