Jan. 27, 1970 N. GOLD 3,491,675

PHOTOGRAPHIC TREATING APPARATUS

Filed May 8, 1967 3 Sheets-Sheet 1

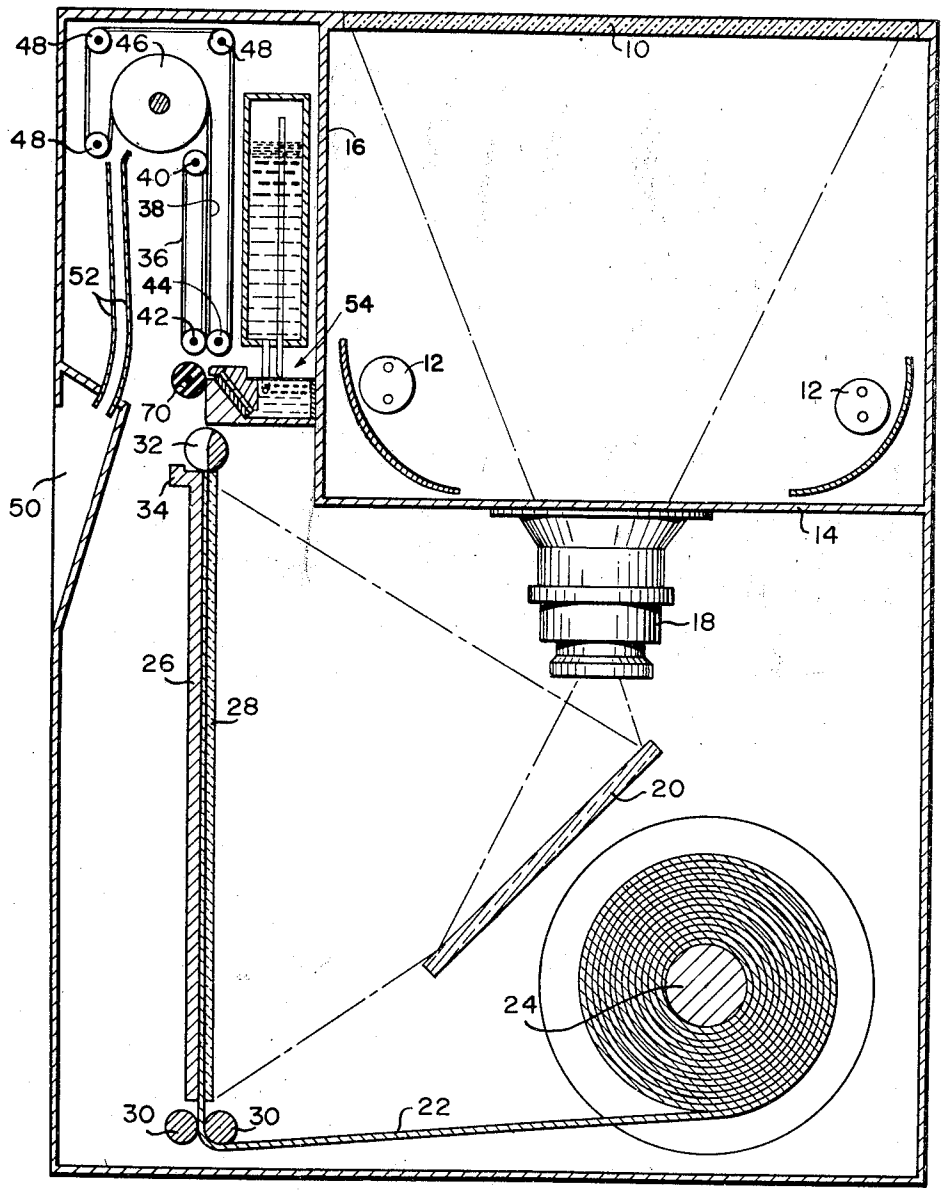


FIG. 1

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PHOTOGRAPHIC TREATING APPARATUS

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FIG. 2

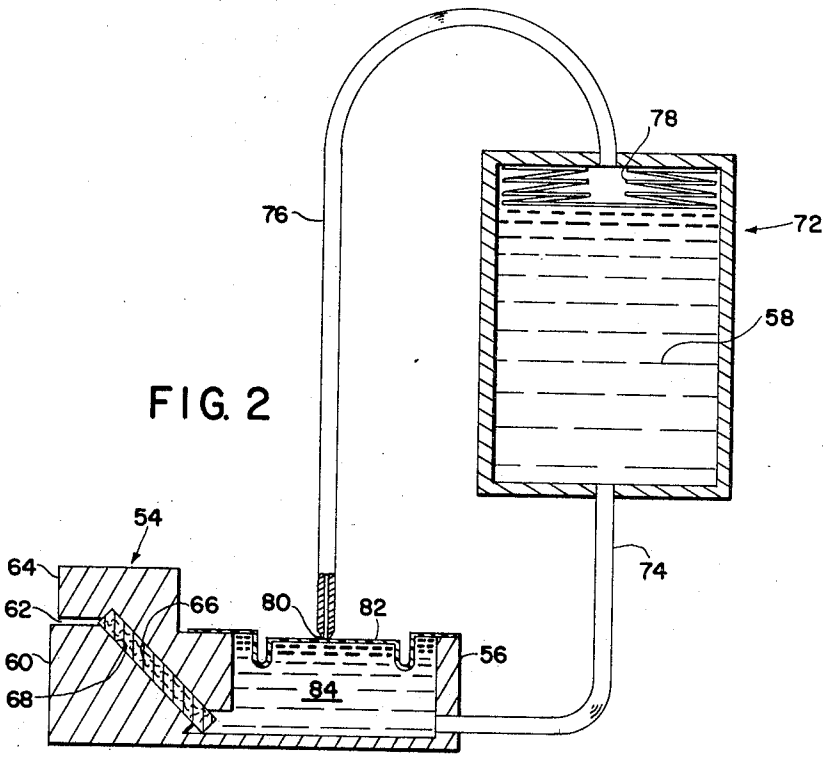
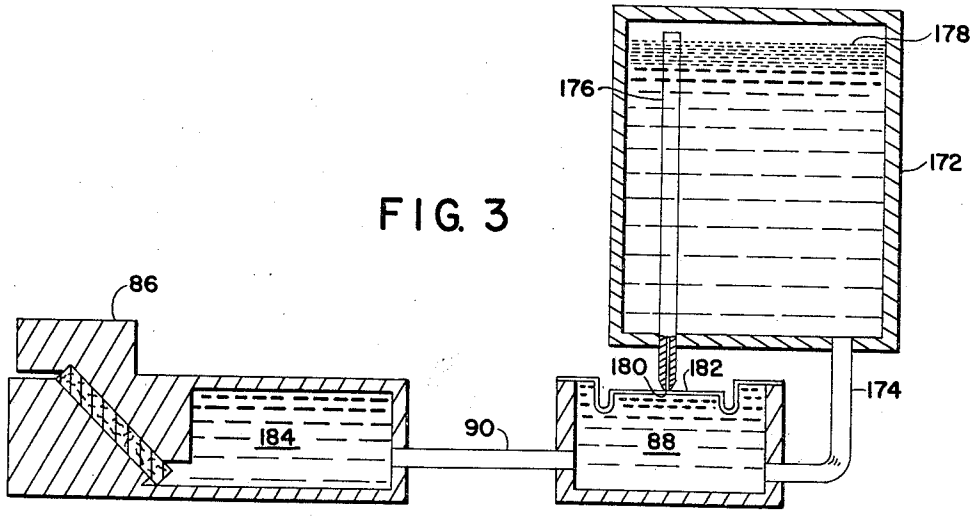


FIG. 3



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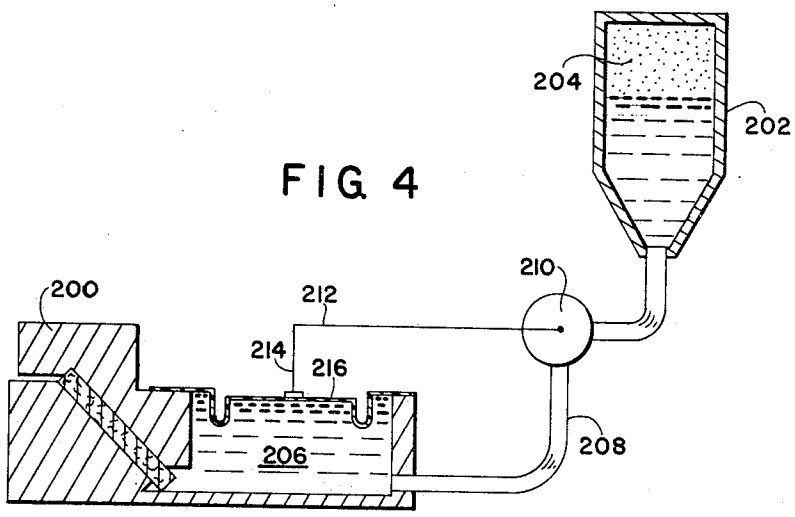
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PHOTOGRAPHIC TREATING APPARATUS

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FIG. 4



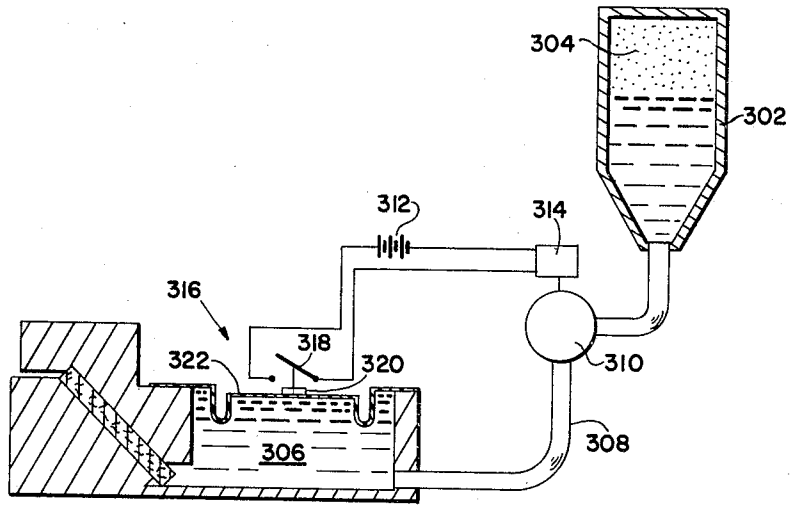


FIG. 5

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PHOTOGRAPHIC TREATING APPARATUS

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Int. Cl. G03d 3/00
U.S. Cl. 95—89 20 Claims

ABSTRACT OF THE DISCLOSURE

A liquid applicator including a reservoir for holding a quantity of liquid and a container for replenishing the supply of liquid in the reservoir. The container has a conduit for feeding liquid to the reservoir, an air vent for providing a barometric feed of liquid to the reservoir, and a layer of oil or a protective bellows-type member on the top surface of the liquid in the container for protecting the processing liquid from the air admitted by the vent. The reservoir has a capillary slot for applying liquid to the web being treated, and a diaphragm attached to the reservoir for controlling the flow of liquid from the container to the reservoir in predetermined levels. When the liquid in the reservoir has reached the predetermined level, the diaphragm cooperates with the air vent of the container to prevent any further barometric feed of liquid to the reservoir.

This invention relates to a novel apparatus for supplying liquid to a reservoir and controlling the level of liquid in the reservoir while simultaneously essentially isolating the liquid from the atmosphere. Photographic apparatus is disclosed in which the reservoir is a component of a liquid applicator including capillary means for withdrawing the liquid from the reservoir and applying it to an exposed photosensitive sheet. The liquid is supplied in a closed container mounted above the reservoir and connected thereto by a conduit. The container is provided with a vent for admitting air to the container to allow liquid to flow therefrom through the conduit to the reservoir, and control means are provided for closing the vent when the level of liquid in the reservoir is above a predetermined level and opening said vent when the level of liquid is below a predetermined level.

The invention further relates to novel apparatus for controlling the level of liquid in an applicator and, more particularly, to apparatus used in controlling the amount of processing fluid available in an applicator of the type used in photographic apparatus, e.g., document copiers.

A number of photographic processes involve the application of a nonviscous liquid reagent to a photographic sheet. In a typical process, the reagent may include a light-sensitive material, a sensitizer, a reagent for processing an exposed light-sensitive layer to produce a visible image or a composition for protectively coating and/or treating a visible image. The present invention is particularly concerned with the application of liquid reagents employed to produce a visible image in a layer of an exposed light-sensitive image-recording sheet material, in apparatus such as a camera, document duplicator or the like, in which the light-sensitive material is exposed. Liquid processing reagents employed for the latter purposes are generally highly alkaline and subject to deterioration due to evaporation and contact with the atmosphere, thus requiring that the liquid be confined in such a way as to protect and preserve its quality and stability.

Delivery of the liquid from a reservoir to a sheet and accurate metering as well as uniform distribution of the liquid on a surface of the sheet may be achieved by a capillary through which the liquid flows by capillary action. In such a case the quantity of liquid applied is directly related to the height of liquid in the reservoir as well as the width of the capillary channel and the linear rate of movement of the sheet past the capillary channel.

Accordingly, an object of the present invention is to provide novel and improved means for automatically controlling the level of liquid in an applicator.

Another object of the invention is to provide novel means as described, in which the liquid is protected from the deleterious effects of the atmosphere.

Another object of the invention is to provide novel means as described, in which the liquid is moved from a reservoir to a sheet by capillary action.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a sectional, elevational view of photographic apparatus embodying the invention;

FIG. 2 is an enlarged sectional view of a liquid applicator and level control constructed in accordance with the invention;

FIG. 3 is an enlarged sectional view of another embodiment of the liquid applicator and level control;

FIG. 4 is a schematic showing of another embodiment of the liquid applicator and level control; and

FIG. 5 is a further schematic showing of another embodiment of the liquid applicator and level control.

Reference is now made to FIGURE 1 of the drawings wherein there is illustrated document-copying apparatus embodying the invention. The document copier comprises means for exposing successive areas of a combined image-recording and image-receiving sheet, severing successive sections of the sheet, each containing an exposed area, from the remainder of the sheet and means for processing the successive sections of the sheet including means for applying a nonviscous (e.g., viscosity of water) liquid reagent to one side of each of the sections.

The apparatus comprises exposure means including a window **10** in the upper wall of the housing of the apparatus for supporting an original, e.g., document, in position for exposure to light from lamps **12** mounted within an enclosed chamber separated from the remainder of the interior of the housing by a lower wall **14** and a side wall **16**. Light reflected from an original positioned on window **10** is transmitted by a conventional objective lens, part of a lens and shutter assembly **18** toward a focal plane in the apparatus at which the lens forms an image of the original. The optical system includes, in addition to the lens of assembly **18**, a mirror **20** positioned beneath the lens for reflecting light toward one side of the housing and means for supporting a light-sensitive image-recording sheet at the focal plane of the lens.

A supply of light-sensitive, image-recording sheet material, designated **22**, is provided coiled on a spool **24** in the lower portion of the apparatus behind mirror **20**. The means for positioning successive sections of the sheet in position for exposure include a support plate **26** and a juxtaposed transparent plate **28** located in a vertical plane with the surface of the transparent plate located substantially at the focal plane of the lens. Sheet **22** is withdrawn from spool **24** and moved upwardly between plates **26** and **28** by a pair of juxtaposed feed rolls **30** located beneath and adjacent to the lower edges of the plates.

A rotary knife **32** and anvil **34** are mounted above and adjacent the upper edges of plates **26** and **28** for sever-

ing successive exposed sections of the image-recording sheet as each section is advanced upwardly from between the plates between the knife and anvil. In the operation of the apparatus, a section of the image-recording sheet positioned between plates **26** and **28** is advanced, following exposure, upwardly past the knife into engagement with liquid applicator means and then through a sheet conveyor system designed to deliver the sheets from the applicator to an exit opening in the housing of the apparatus and to provide a delivery period of sufficient duration to permit completion of the processing of the image-recording sheet within a dark environment. The sheet delivery system includes two sets of endless conveyor belts **36** and **38**. The belts **36** are mounted on support rolls **40** and **42**, and belts **38** extend from support rolls **44**, juxtaposed with support roll **42**, upwardly in juxtaposition with belts **36** and around an enlarged drum or discs **46** and thence back to support roll **44** by way of support rolls **48** spaced around the periphery of drum or discs **46**. The conveyor belts **38** which contact the side of the sheets to which the liquid is applied are preferably quite narrow in order to limit the area of contact between the belts and the sheet, and in the preferred form, may comprise conventional O-rings.

The housing of the apparatus includes an opening **50** through which the processed sheets are delivered and a pair of guides **52** extending from the opening upwardly toward the points of tangency between belts **38** and discs **46** for guiding the sheets from between the belts and discs downwardly through opening **50**.

The liquid applicator and level control of the invention is designated **54** in FIGURE 1 and is shown in detail in FIG. 2 as comprising an elongated container **56** including a chamber **84** for holding a quantity of the processing liquid **58**. Container **56** and the chamber **84** containing a processing liquid are approximately equal in length to the width of the area of the photosensitive sheet material to be treated. Applicator **54** includes a section providing a generally planar support surface **60** at least equal in length to the width of the sheet material to be treated for guiding and supporting the sheet material during application of the processing liquid. Support surface **60** terminates at one side of a capillary channel or slot **62** at least equal in length to the width of the area of the sheet material to be treated and having a width of capillary dimensions such that an aqueous alkaline liquid having a viscosity substantially that of water will flow through channel **62** by capillary action. Applicator **54** includes a section on the opposite side of channel **62** from surface **60** providing a surface **64** set back from surface **60** by approximately the width of capillary channel **62**. The applicator including the portions thereof providing the container for the processing liquid, surfaces **60** and **64** and capillary channel **62**, may be formed of any material that is compatible with the processing liquid and preferably a material that is wet by the processing liquid in order to encourage flow thereof by capillary action. Suitable materials include organic polymers such as the acrylics, glass, ceramics and metals.

Liquid **58** is conducted from the chamber or reservoir **84** in which it is contained, to capillary channel **62** by a multiplicity of capillaries. In the embodiment shown, this multiplicity of capillaries is provided by a fibrous wick **66** formed, for example, of a nonwoven fabric composed of fibers of a material such as polypropylene, which is compatible with the processing liquid. Applicator **54** includes a section providing a channel **68** at least approximately equal in length to capillary channel **62** and communicating between capillary channel **62** and the lower portion of the reservoir of liquid. Wick **66** substantially fills channel **68** which, in the form shown in FIG. 2, extends from the bottom of the reservoir **84** upwardly and at an angle to a position above the level of capillary channel **62**. By virtue of this construction, liquid **58** is raised within channel **68** to a level above channel **62** and provides a supply head in the capillary channel.

It has been discovered that a single capillary channel or slot provides the best means for accurately metering and uniformly distributing the processing liquid in contact with the sheet material. A multiplicity of capillaries for conducting the liquid from a reservoir **84** to the metering and distributing capillary provides assurance of adequate supply of the liquid to the capillary channel despite the clogging or plugging of a number of the supply capillaries. The invention comprehends a construction incorporating a sufficient number of supply capillaries for conducting at least twice the amount of liquid that can be carried by the metering and distributing capillary channel.

The apparatus for automatically supplying liquid to reservoir **84** and controlling the level of liquid in the reservoir **84** is most clearly shown in FIG. 2, as comprising a closed storage tank or container **72** having a supply of processing liquid therein. Container **72**, which is mounted at a higher level than reservoir **84** so as to provide a gravity flow, is fluidly connected with reservoir **84** by conduit **74**. Provision is made for maintaining the liquid within container **72** substantially at ambient pressure while at the same time protecting the liquid from the air. This is accomplished by providing container **72** with a vent **76** having an end **80** which is open to the ambient pressure at a point adjacent the top of the reservoir **84** and a flexible bellows **78** secured in the container to the walls thereof so as to protect the liquid from air admitted through vent **76**. Other suitable means, e.g., as shown in FIG. 1, a layer of oil on top of the processing liquid, could be substituted for the bellows-type member **78**. In the latter case a vent **98**, similar to vent **76** would extend directly through the processing liquid and oil and emerge in the area above the oil. Referring again to FIG. 2, vent **76** has an opening **80** adjacent a diaphragm **82** attached to the walls of the reservoir **84**. Diaphragm **82** may be made of any material that is compatible with the processing liquid. When the processing liquid in reservoir **84** is above a predetermined level the liquid will cause diaphragm **82** to flex into a position closing the opening **80** of vent **76**. As the developing liquid is applied to sheet material **22** container **72** replenishes the liquid taken from the reservoir **84**. After a period of time the liquid in storage tank **72** is prevented from flowing into the reservoir **84** due to the lower pressure created in the area above the liquid. This lower pressure is due to the expanding volume of the gas in that part of storage tank **72** above the level of the liquid. Continued use of the developing liquid will lower the level of liquid in the reservoir **84** to a point below a predetermined level where diaphragm **82** is allowed to flex to a position uncovering opening **80** of vent **76**. With vent **76** now open, the pressure on the fluid in storage tank **72** is increased to that of the ambient pressure thereby allowing liquid to flow from container **72** to the reservoir **84**. It should be noted that the cross-sectional area of opening **80** is substantially smaller than the area of the diaphragm **82**. At times the pressure in vent **76** will be lower than the pressure acting on diaphragm **82** thereby tending to keep diaphragm **82** in contact with opening **80** by its vacuum action. However, due to the relatively small size of opening **80** the reduced pressure in vent **76** acts on a correspondingly small area of diaphragm **82**. Accordingly, due to this large differential in areas the suction or lower pressure in vent **76** does not adversely affect the responsiveness of diaphragm **82**.

An alternative embodiment of the applicator and liquid level control of the invention is shown in FIG. 3. Applicator **86** is essentially the same as applicator **54** except in this embodiment the means controlling the liquid level is remote from the reservoir. Closed container **172** is fluidly connected to a secondary reservoir **88** by con-

duit means **174**. Container **172** is vented to the ambient pressure by vent **176** and the liquid in container **172** is protected from the adverse effects of the atmosphere by means such as a layer of oil **178** as in FIG. 1. Vent **176** has an opening **180** therein which is closed by diaphragm **182** when the liquid in reservoir **88** is above a predetermined level and is uncovered when the liquid in reservoir **88** is below a predetermined level thereby allowing liquid to flow from container **172** to secondary reservoir **88**. Secondary reservoir **88** is fluidly connected with reservoir **184** by conduit **90**. With the above arrangement of elements greater flexibility in the positioning of the elements is available. For example, reservoir **88** could be located outside of the photographic apparatus so as to be easily accessible for inspection of diaphragm **182** and opening **180**.

Another embodiment of the applicator and liquid level control of the invention is shown in FIG. 4. Applicator **200** is similar to the applicator shown in the previous embodiments. Container **202** containing a developing liquid is pressurized by a gas **204** such as nitrogen. Obviously, any gas which is compatible with the developing liquid may be used as the pressurizing means. Container **202** is fluidly connected with reservoir **206** by means of conduit **208** having valve **210** therein. Valve **210** is actuated by a lever member **212** having a vertical extension **214** adjacent diaphragm **216** which is attached to the walls of reservoir **206**. When the level of liquid in reservoir **206** is above a predetermined value, diaphragm **216** is in contact with the end **214** to maintain the valve **210** in a closed position. When the level of liquid in reservoir **206** is below a predetermined value, diaphragm **216** flexes downwardly allowing member **214** to follow it, thereby opening valve **210** to allow fluid to flow from container **202** into reservoir **206**.

A further embodiment of the applicator and liquid level control of the invention is shown in FIG. 5. In this embodiment, container **302**, containing a developing liquid charged by means such as nitrogen **304**, is fluidly connected with reservoir **306** by means of a conduit **308** having a valve **310** therein. An electrical circuit is shown for actuating the valve **310**. As shown, the circuit comprises energy means such as a battery **312**, a relay **314** and switching means **316**. Switching means **316** consists of a switch **318** having a portion **320** in contact with diaphragm **322**. Valve means **310** is normally in the closed position. When the level of liquid in reservoir **306** is above a predetermined value, switch **318** is open as shown. When the level of liquid in reservoir **306** falls below a predetermined value, switch **318** is closed thereby energizing relay **314** to move valve **310** to an open position thereby allowing fluid to flow from container **302** to reservoir **306** by means of conduit **308**.

It will be understood that the conduits and vents may be made from rigid or flexible materials as long as the material is compatible with the processing liquid. If the vents are made from a flexible material, suitable means will be provided for holding the openings **80**, **180** in a position adjacent their respective diaphragms. Also reservoir **88** and/or storage tank **72**, **172**, **202**, **302** may be mounted exteriorly of the photographic apparatus.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A photographic processing apparatus for applying, to an exposed photosensitive element, a predetermined, uniformly distributed quantity of processing liquid subject to deterioration when exposed to the atmosphere, said apparatus comprising, in combination:

applicator means including a reservoir;

capillary means for conducting liquid from said reservoir to said photosensitive element, the rate of application of said liquid to said element being a function of the level of liquid in said reservoir;

a closed container for said liquid;

a conduit for conducting said liquid from said container to said reservoir;

means for causing the liquid to flow from said container to said reservoir; and

control means for controlling the flow of liquid through said conduit including means attached to said reservoir for protecting the liquid in said reservoir from the atmosphere, the last-mentioned means being responsive to the level of liquid in said reservoir for arresting the flow of liquid to said reservoir when said liquid in said reservoir reaches a predetermined level and initiating flow of said liquid to said reservoir when said liquid falls below a predetermined level in said reservoir.

2. The apparatus of claim **1**, wherein the last-mentioned means comprise a diaphragm supported on the surface of said liquid within said reservoir.

3. Apparatus as defined in claim **2**, including means for essentially isolating the liquid in said container from the atmosphere.

4. Apparatus as defined in claim **3**, wherein said control means comprise a vent operatively coupled with said diaphragm and the cross-sectional area of the opening in said vent is a fraction of the area of said diaphragm.

5. Apparatus as defined in claim **3**, wherein said means for isolating the liquid from the atmosphere comprise a bellows-type member.

6. Photographic processing apparatus for applying, to an exposed photosensitive element, a predetermined, uniformly distributed quantity of processing liquid subject to deterioration when exposed to the atmosphere, said apparatus comprising, in combination:

applicator means including a first reservoir;

capillary means for conducting liquid from said first reservoir to said photosensitive element;

a second reservoir connected to said first reservoir;

a closed container for said liquid;

a conduit for conducting said liquid from said container to said second reservoir;

means for causing the liquid to flow from said container to said second reservoir; and

control means for controlling the flow of liquid through said conduit including means attached to said second reservoir for protecting the liquid in said second reservoir from the atmosphere, the last-mentioned means being responsive to the level of liquid in said second reservoir for arresting the flow of liquid to said second reservoir when said liquid in said second reservoir reaches a predetermined level and initiating flow of said liquid to said second reservoir when said liquid falls below a predetermined level in said second reservoir.

7. Apparatus for supplying liquid to a reservoir from which liquid is withdrawn and controlling the level of liquid in said reservoir comprising, in combination:

a closed container for said liquid;

a conduit for conducting said liquid from said container to said reservoir;

means for causing the liquid to flow from said container to said reservoir; and

control means for controlling the flow of liquid through said conduit including means attached to said reservoir for protecting the liquid in said reservoir from the atmosphere, the last-mentioned means being responsive to the level of liquid in said reservoir for arresting the flow of liquid to said reservoir when said liquid in said reservoir reaches a predetermined level and initiating flow of said liquid to said reservoir when said liquid falls below a predetermined level in said reservoir.

8. The apparatus of claim 7, wherein the last-mentioned means comprise a diaphragm supported on the surface of said liquid within said reservoir.

9. Apparatus as defined in claim 8, including means for essentially isolating the liquid in said container from the atmosphere and means defining a capillary for withdrawing liquid by capillary action from said reservoir.

10. Apparatus as defined in claim 9, wherein said control means comprise a vent operatively coupled with said diaphragm and the cross-sectional area of the opening in said vent is a fraction of the area of said diaphragm.

11. Apparatus as defined in claim 9, wherein said means for isolating the liquid from the atmosphere comprise a bellows-type member.

12. Apparatus as defined in claim 7, including a second reservoir connected to said first-mentioned reservoir.

13. Apparatus as defined in claim 7, wherein said container is mounted above said reservoir and said control means include vent means for allowing air to enter said container to allow for gravity flow of liquid from said container to said reservoir.

14. Apparatus as defined in claim 13, wherein said last-mentioned means is operatively coupled with one end of said vent means for opening or closing said one end in response to changes in the level of liquid in said reservoir thereby starting or stopping the flow of liquid from said container to said reservoir.

15. Apparatus as defined in claim 14 wherein said vent means extends upwardly through the liquid in said container and means comprising a layer of oil on top of said liquid in said container for isolating said liquid from the atmosphere.

16. Apparatus as defined in claim 7 wherein said means for causing liquid to flow comprises a pressurized gas.

17. Photographic processing apparatus as defined in claim 7, wherein said last-mentioned means is movable in response to changes in the level of liquid in said reservoir.

18. Photographic processing apparatus as defined in claim 17, wherein said control means include valve means, and motion-transmitting means having one end coupled to said valve means and another end coupled to said last-mentioned means for opening and closing said valve means in response to movement of said last-mentioned means.

19. Photographic processing apparatus as defined in claim 17 wherein said control means include valve means, and electrical means including switch means operatively connected with said last-mentioned means for controlling said valve means, whereby movement of said last-mentioned means in response to changes in the level of liquid in said reservoir will open or close said switch means to allow said valve means to control the flow of liquid from said container to said reservoir.

20. Apparatus for supplying liquid to a reservoir and controlling the level of liquid in said reservoir comprising, in combination:

a closed container for said liquid mounted above said reservoir;

a conduit for conducting said liquid from said container to said reservoir;

vent means for admitting air to said container to allow liquid to flow therefrom through said conduit to said reservoir; and

control means including means attached to said reservoir and movable in response to the level of liquid in said reservoir for closing said vent means when said liquid is above a predetermined level in said reservoir and opening said vent means when said liquid is below a predetermined level in said reservoir.

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