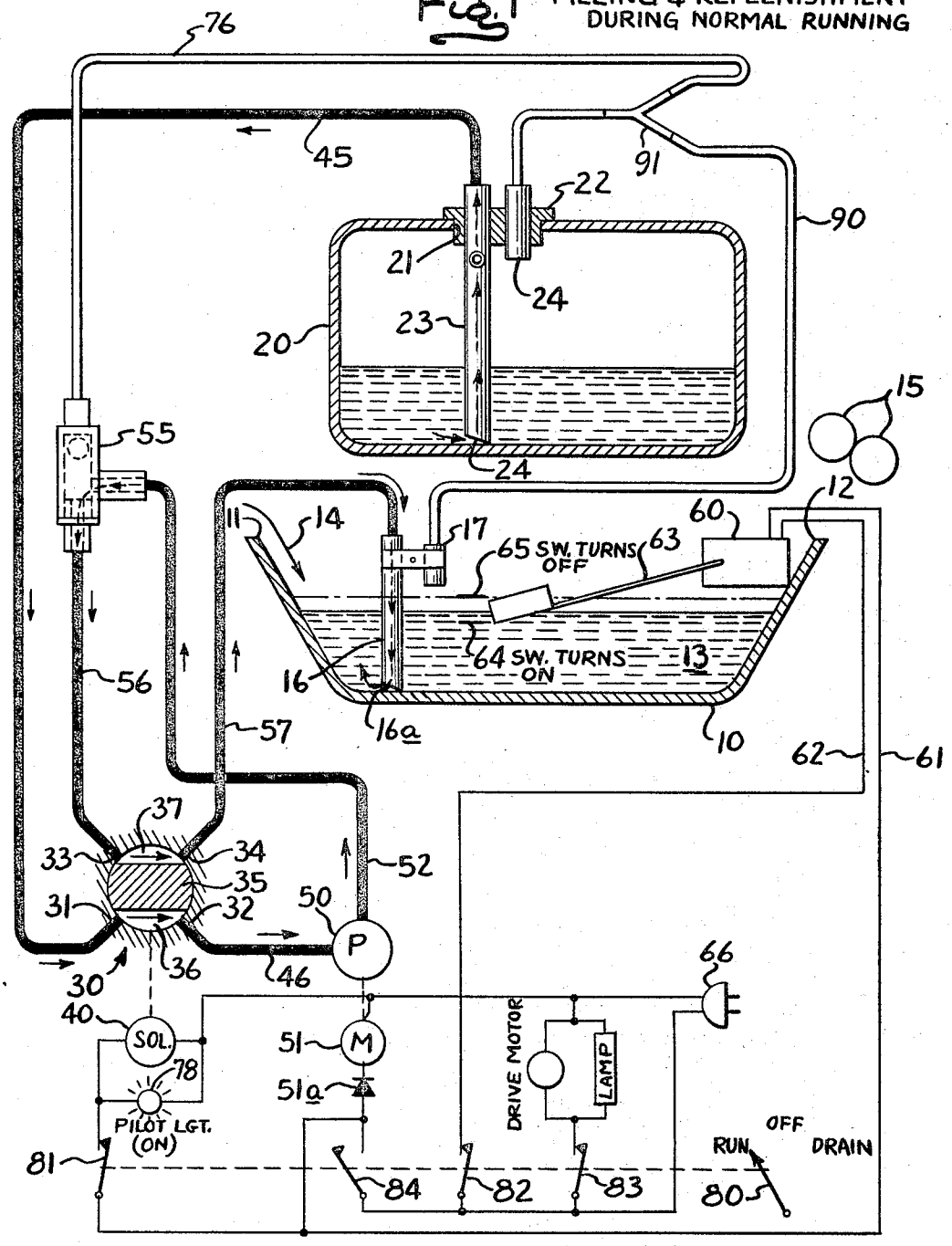
July 25, 1967 C. E. ANDERSON ETAL 3,332,435

PUMPING ARRANGEMENT FOR PHOTOCOPY MACHINE

Filed Jan. 14, 1964 3 Sheets-Sheet 1

Fig. 1 FILLING & REPLENISHMENT DURING NORMAL RUNNING



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PUMPING ARRANGEMENT FOR PHOTOCOPY MACHINE

Filed Jan. 14, 1964 3 Sheets-Sheet 2

Fig. 2 BUBBLE BYPASS

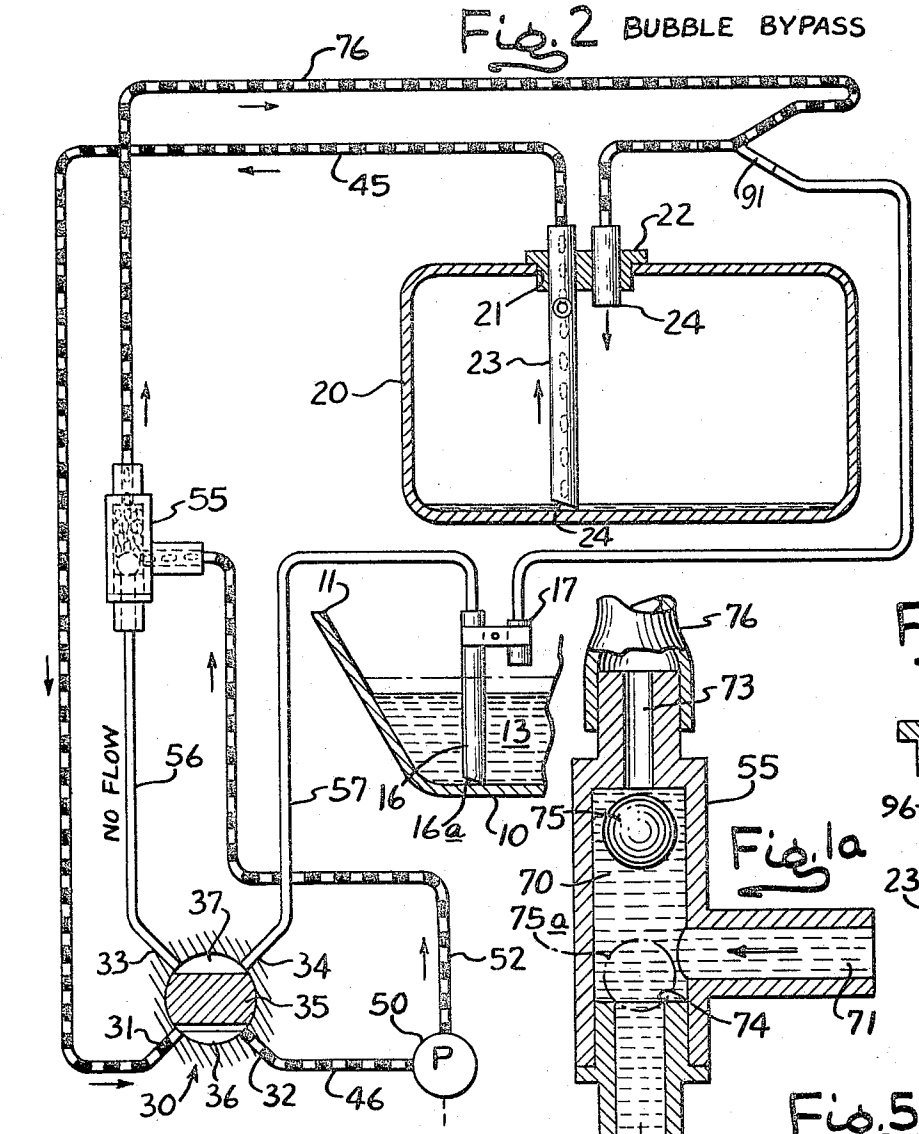


Fig. 4

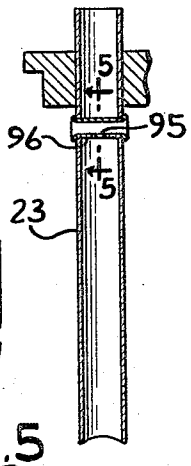
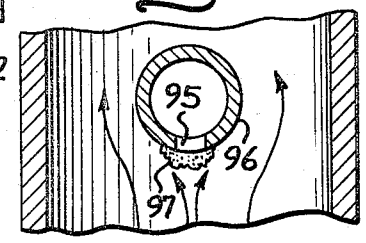


Fig. 1a

Fig. 5



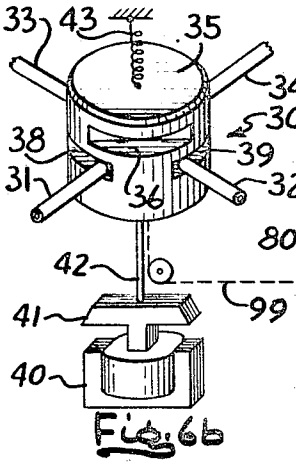


Fig. 6b

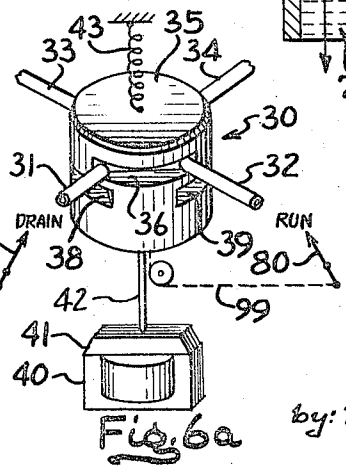


Fig. 6a

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PUMPING ARRANGEMENT FOR PHOTOCOPY MACHINE

Filed Jan. 14, 1964 3 Sheets-Sheet 3

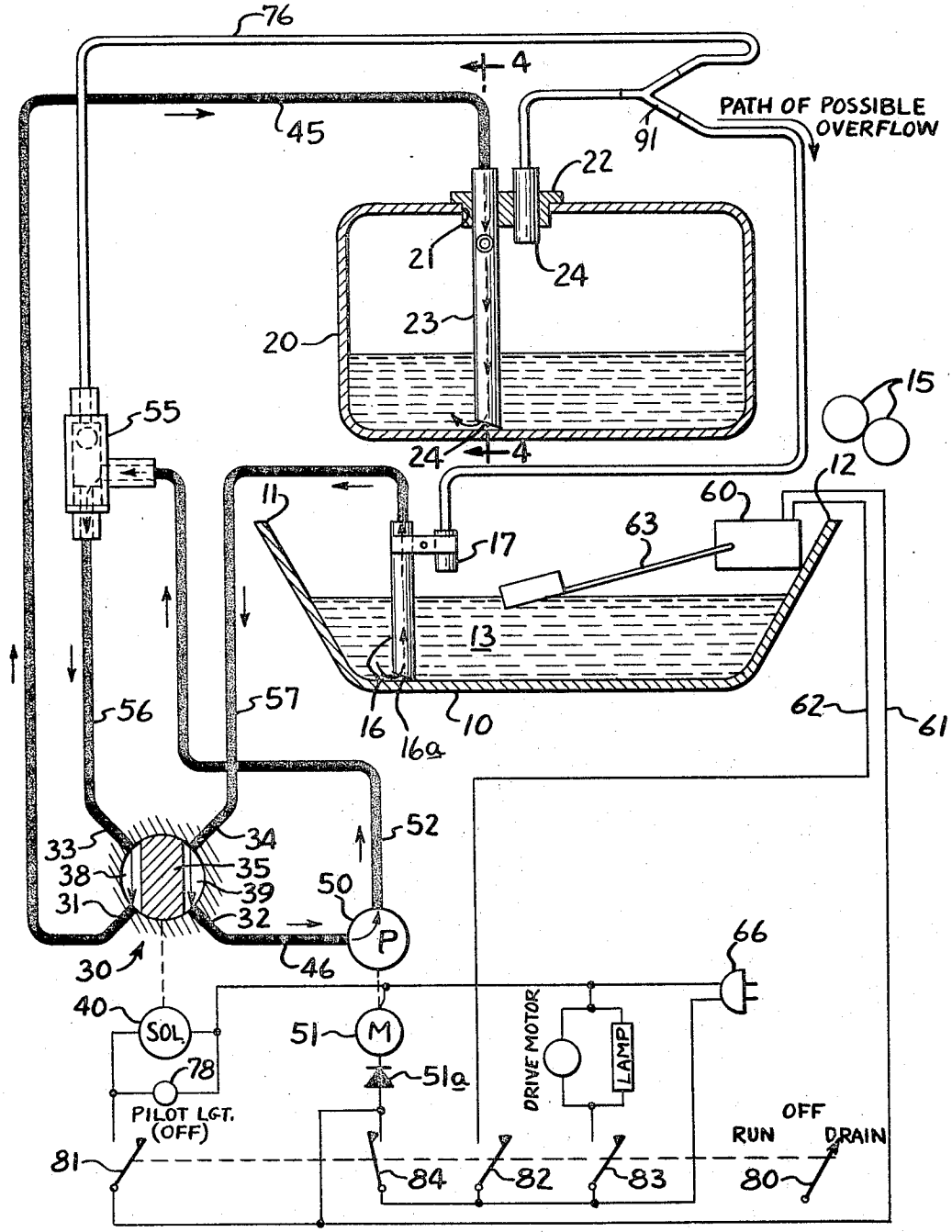


Fig. 3 DRAIN

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3,332,435

PUMPING ARRANGEMENT FOR PHOTOCOPY MACHINE

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13 Claims. (Cl. 137—394)

The present invention relates to photocopy machines and more particularly to means for draining and replenishing the liquid in a machine employing liquid developer.

Photocopy machines of the transfer diffusion type, for example, as described in L. J. Stuckens U. S. Patent 3,034,413, are inherently low in cost and produce good results making them well suited for use in the large majority of offices where a reasonable number of copies are required. However, the use of "dry" photocopy machines, for example, of the electrostatic type, has tended to reduce the popularity of "liquid" machines because of the fact that the latter generally require the pouring and handling of liquid developer. Thus, in conventional machines employing a liquid reservoir, the developer liquid, when it becomes spent or exhausted, must be poured from the tray either down the drain or back into the bottle or reservoir so that the latter may be replaced by a reservoir containing a fresh supply. While the developer liquid is not dangerous to handle, it is possible that clothing may become spotted if one is not careful. This difficulty has been recognized and attempts have been made to correct it by employing reservoirs which are mounted for vertical movement between an upraised or "fill" position and a lowered or "drain" position. This involves complications in the structure of the machine and still requires physical manipulation of the reservoir by the operator. Attempts have, moreover, been made to effect liquid transfer by pumping, but pumping systems for the most part, have been quite expensive and susceptible to generating bubbles or foam under certain conditions causing the developer tray to overflow and requiring a time-consuming cleanup.

It is an object of the present invention to provide an improved pumping arrangement for liquid transfer between a reservoir and developer tray in a photocopy machine which is easy to operate and which avoids manipulation of the reservoir usually required in either filling or draining the tray. Thus it is an object to provide a liquid handling arrangement for a photocopy machine in which filling and replenishment are effected automatically and in which draining of the spent liquid from the tray may be accomplished simply by throwing a switch, following which the reservoir containing the spent liquid may be discarded and replaced by a reservoir containing a fresh supply.

It is another object of the present invention to provide an improved pumping arrangement for a photocopy machine of the liquid type which is completely safe and foolproof and which avoids the pumping of air into the developer tray when the reservoir supply finally becomes exhausted. In this connection it is a more specific object in the present invention to provide a novel air detector in the liquid supply line leading to the developer tray which is effective to transfer developer fluid as a solid stream but which responds to the presence of air in the stream causing the stream to be diverted back into the reservoir where the air can do no harm.

It is another object of the present invention to provide a pumping arrangement which is sensitive to the level of liquid developer in the developer tray so that upon any

tendency for the level to drop after a period of usage, and as a result of the loss of liquid in the treated copy sheets, the pump is automatically energized to bring the liquid up to rated level by pumping of an additional supply from the reservoir, following which the pump is automatically turned off. It is therefore an object of the present invention to provide a liquid handling system for a photocopy machine which permits use of a relatively larger capacity renewable reservoir permitting automatic replenishment of the developer tray for long periods of time so that many copies may be produced before draining of the tray and replacement of the reservoir becomes necessary. In this connection it is one of the more detailed objects of the present invention to provide a liquid handling arrangement for a photocopy machine in which visual indication is given to the operator when the resevoir is empty and should be replaced.

It is still another object of the present invention to provide a liquid pumping and handling arrangement for a photocopy machine which enables easy draining of the tray back into the reservoir where the machine may not be used for a period of time, for example over a vacation period, and which thereby minimizes the effect upon the developer by reason of the action of oxygen on the exposed surface of the liquid in the tray. It is an object of the invention in one of its detailed aspects to provide means for preventing overflow of the reservoir either when the reservoir is to be used for temporary storage purposes or where the developer liquid is returned to the reservoir prior to renewal.

It is another object of the invention in one of its aspects to provide means for insuring against unwanted siphoning of liquid from the reservoir to the developer tray due to the difference in level between the two, particularly where a valve is employed having liberal clearance between the valve members.

It is, moreover, one of the objects of the present invention to provide a pumping arrangement for a photocopy machine or the like which is capable of using a unidirectional pump, for example, of the simple and inexpensive vibratory type but which nevertheless permits pumping of the liquid in two directions in the associated system.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIGURE 1 is a simplified diagrammatic showing of the present invention illustrating the condition of the device for filling and replenishment during normal operation.

FIG. 1*a* is an enlarged section taken through the air detecting diverter.

FIG. 2 shows a portion of the system of FIG. 1 under conditions where air is being sucked into the liquid supply line and showing the diversion of the air back into the reservoir whereby the formation of foam in the developer tray is effectively avoided.

FIG. 3 is a diagram similar to FIG. 1 but showing the condition of the system during intentional draining of the developer tray.

FIG. 4 shows a vertical section taken through the reservoir dip tube along the line 4—4 in FIG. 1.

FIG. 5 is an enlarged section taken through the transverse port member of the dip tube along line 5—5 in FIG. 4 showing the dissolving or flushing away of any crystallized or collected solid material which may tend to collect at the anti-siphon port.

FIG. 6*a* is a diagrammatic perspective of the valve plunger and solenoid and with the solenoid energized.

FIG. 6*b* is a figure similar to FIG. 6*a* but with the solenoid deenergized.

As used herein, the term "buoyancy" refers to the power of a fluid to exert an upward force on a body placed in it.

Turning now to FIG. 1 of the drawings there is shown, in simplified form, and somewhat diagrammatically, a developer tray **10** forming a part of a photocopy machine having an entryway **11** and exit **12**, the photocopy paper being understood to pass from left to right under the level of the developer liquid **13**. For a more detailed showing of the developer tray sheet guiding means, reference may be made to the above-mentioned Patent 3,034,413. In the transfer-diffusion procedure a negative sheet is optically exposed to the original, a positive copy sheet is placed face to face with the negative, and the two sheets are passed as one, indicated at **14**, through the solution and subsequently between a pair of resilient expeller rollers **15** which squeeze any excess liquid from the sheets back into the tray. The sheets may then be peeled apart, the positive sheet being retained as the photocopy and the negative sheet being discarded. While the invention is particularly applicable to photocopy machines of the transfer diffusion type, it will be apparent as the discussion proceeds that the invention is not limited thereto but may be employed wherever it is desired to transfer liquid between a tray and a liquid reservoir.

Mounted in the tray in the present instance is a dip tube **16** and a short overflow tube **17**, to be discussed at a later point.

For the purpose of supplying developer liquid to the tray **10**, and for removing the liquid when it becomes spent, after a large number of copies have been made, there is provided a reservoir **20** which is usually, but not necessarily, arranged at a higher level than the tray, for example, directly above it as shown. The reservoir has an opening **21** which is sealed during shipment but which in normal use receives a plug **22** mounting a dip tube **23** and a vent or overflow tube **24**. The dip tube **23** is sufficiently long as to extend to near the bottom of the reservoir and the lower end **24** is preferably angled as shown in order to prevent inadvertent seal-off. The reservoir may be made of any suitable material, for example, polyethylene plastic.

For transferring liquid between the reservoir and the tray a transfer line is provided including a liquid pump and driving motor together with control means switchable between a "fill" condition and a "drain" condition so that the direction of flow may be selected by the operator. It is a further feature of the invention, in one of its aspects, to utilize a unidirectional pump, with the control means being in the form of a four-way valve, or equivalent, interposed in the liquid line so that the pump, although unidirectional, is capable of pumping liquid in either direction between the tray and reservoir. Thus, referring to FIG. 1 of the drawings, as well as to FIGS. 6*a*, 6*b*, there is provided a four-way valve **30** having external port connections **31**, **32**, **33**, **34** and a movable spool or plunger **35** having a first pair of segmental cross-slots **36**, **37** and a second pair of cross-slots **38**, **39**, arranged at right angles thereto. The valve is controlled by a solenoid **40** having a plunger **41** and mechanical connection **42**, with a suitable spring **43** being provided to draw the plunger to its upraised position. It will be seen in FIGS. 1 and 6*a* that with the solenoid energized, as it is during filling or replenishment, the ports **31**, **32** are interconnected by slot **36** and ports **33**, **34** are interconnected by slot **37**.

For conducting the liquid from the dip tube **23** of the reservoir to the valve port **31**, a line **45** is provided; a line **46**, in turn, connects the port **32** to a pump, indicated at **50**, having a drive motor **51**. From the pump the liquid passes through a line **52**, through an air-sensitive diverter **55**, to which more detailed reference will be made, and a line **56** which is connected to the valve port **33**. From the valve port **34** the liquid path is completed to the tray via a line **57** which is connected, as shown, to the tray dip tube **16**. The dip tube **16** is sufficiently long to extend to near the bottom of the tray **10** and the lower end **16***a* is preferably angled as shown in order to prevent inadvertent seal-off.

In carrying out the present invention a level detector is provided in the tray, preferably in the form of a float switch, which is operated whenever the liquid level falls below a predetermined point for energizing the pump-motor and the associated control means so that liquid is passed from the reservoir to the tray and automatically maintained at the desired level under the control of the float switch. In this way the liquid which is lost on the sheets is replenished as necessary to keep the machine operating efficiently and without any care or attention on the part of the operator. Thus, turning to FIG. 1 of the drawings a float switch **60** is provided, preferably in an out-of-the-way position at one end of the tray **10**, having electrical connections **61**, **62** and a float **63**. The construction of the float switch **60** forms no part of the present invention and it will suffice to say that contact is made when the float **63** drops to a level **64** and contact is broken when the float rises to the level **65**, the latter determining the operaing range for the liquid level. The lead **61** from the float switch is connected, as shown, to the solenoid **40** and motor **51**. The opposite terminals of the solenoid and motor are connected to the supply line via a plug **66** and the circuit is completed to the opposite side of the supply line by the switch lead **62**. It will be apparent then, that when the tray is empty, or when the liquid level in the tray is below the minimum, turning on of the float switch causes both the solenoid and motor to be energized, switching the valve to the position in FIG. 1 and turning on the pump so that liquid is drawn from the dip tube **23** of the reservoir, through line **45**, through ports **31**, **32** of the valve and thence through line **46** to the inlet of the pump. From the outlet of the pump the liquid flows through line **52**, line **56**, ports **33**, **34** of the valve and thence through line **57** which is connected to the dip tube **16** of the tray causing the liquid level in the latter to rise. Flow continues until the float swings upwardly to the level **65**, turning off the motor **51** and deenergizing the solenoid **40**. Thereafter as the liquid is consumed, whenever the float drops to the level **64**, the motor and solenoid are both energized so that additional pumping occurs, usually of only a few seconds' duration, without care or attention on the part of the operator, to raise the liquid in the tray to the maximum operating level. Since the reservoir preferably has a capacity which substantially exceeds the amount of liquid in the tray, replenishing liquid is available, from the reservoir, over a long period of time, which may correspond to a thousand or more copies.

In accordance with one of the important features of the present invention an air-sensitive diverter is provided in the liquid line so that when the liquid in the reservoir is drawn down to the point where air can enter, i.e., below the lower end of the dip tube, flow to the tray is effectively cut off and the air or mixed liquid-air stream is diverted, instead, back to the reservoir. This avoids the passage of the air to the tray with danger that foam may be produced in the tray and cause the liquid therein to overflow. It will be understood that the air which activates the diverter to cut off flow to the tray may be in the form of a bubbly stream, or the air may fill entire sections of the line.

In the present instance the diverter, indicated at **55**, is in the form of a chamber having a valve seat at its lower end normally closed by a free valve member having a specific gravity which is just slightly greater than that of the liquid, causing the valve seat to remain closed during entry of an air-containing stream but with the valve member capable of being dislodged upon entry of a solid stream by reason of buoyancy and the lifting force of the incoming liquid. Thus, referring to FIG. 1*a*, the air-sensitive diverter **55** defines a liquid chamber **70** having a normal inlet port **71** at the side of the chamber, a normal outlet port **72** at the bottom of the chamber, and an

auxiliary outlet or escape port 73 at the top of the chamber. The outlet port 72 has a valve seat 74 which cooperates with a free valve member 75 having a specific gravity which is just slightly higher than that of the liquid. The valve member 75 may be in the form of a ball of nylon having a specific gravity of 1.13 to 1.15 or, if desired, some other suitable plastic, metal, or other material having a specific gravity greater than that of the liquid being pumped. The diameter of the chamber 70 is preferably only a limited amount greater than the diameter of the ball to prevent the ball from being excessively displaced from the center of the valve seat 74 and so that the ball, left to its own devices, will normally tend to return to its seated position. However, the chamber 70 must also be sufficiently large to prevent the ball from sticking to the side walls in the presence of surface tension with the liquid. Chamber diameters about 20 to 25% larger than the ball diameter have been found to be satisfactory.

Under normal conditions of refill or replenishment, a solid stream of liquid, arriving through the port 71, enters into the chamber 70 where it collects and exerts a buoyant effect upon the ball 75, thus reducing the seating pressure of the ball against the valve seat 74 to the point where the ball is readily dislodged by the force of the incoming stream, permitting passage of the liquid through the normal outlet port 72 from whence it flows, via the valve 30, to the tray. The ball may be forced up into the top portion of the chamber 70, as illustrated in the drawings, or it may merely be displaced over against the side wall of the chamber, as long as it permits passage of the liquid from the inlet port 71 into the outlet port 72. However, where the incoming stream 71 contains air, the air tends to fill the chamber 70. Since the air does not have any substantial buoyant effect upon the ball 75, and since the air or liquid-air mixture entering through the port 71 is of reduced mass and has less lifting or dislodging effect, the ball 75 tends to remain seated in the position 75*a* so that the air cannot pass to the normal outlet port 72 but is, instead, diverted upwardly through the auxiliary outlet port 73 where a line 76 carries the stream back to the vent 24 and/or 17 where it is expelled into an open area above the liquid level. Since the reservoir is enclosed, the air is safely contained and simply recirculates harmlessly about the path shown in FIG. 2, rather than being discharged into the liqiud so as to generate a foam. In accordance with one of the more detailed features of the invention a pilot light 78 connected across the solenoid 40, by reason of its staying lit continuously, clearly indicates to the operator that the tray is calling for liquid but that this demand cannot be met by the liquid from the reservoir and that, consequently, it is time for the reservoir to be replaced with one having a fresh charge of developer liquid.

In carrying out the present invention, means are provided for switching the fluid transfer means to a second or "drain" mode of operation and for energizing the pump motor so that the liquid is withdrawn from the tray and discharged back into the reservoir. This second mode of operation is conveniently achieved by means of a control switch 80 movable from an "operate" position to a "drain" position and controlling a set of contacts. Thus a contact 81 is provided which is open in the "drain" setting thereby to disable the solenoid so that the valve plunger is free to move, under the action of its spring 43, to an upraised position in which the slots 36, 37 are moved out of the circuit and the slots 38, 39, at right angles thereto, are moved into the circuit to establish an opposite direction of flow. Moreover, a contact 82 is provided, connected in series with the line 62 from the float switch, so that the float switch is disabled by opening of the switch contact 82 under "drain" conditions. A third contact, indicated at 83, is connected in series with the machine drive motor and lamp so that the machine cannot be operated due to opening of the switch contact 83 while the liquid is being drained. Finally, a contact 84, closed under draining conditions, provides an alternate path for current flow directly from the supply line to the motor 51, thus powering the motor as long as the switch 80 is in its "drain" position.

The operation of the fluid transfer circuit in the "drain" condition will be apparent from FIG. 3. Thus, line 57 from the dip tube of the tray causes fluid to be passed through port 34 and out of valve port 32 via line 46 to the inlet of the pump. The pump forces the liquid through the line 52, through the air-sensitive diverter 55 and into line 56 which is connected via the ports 33, 31 of the valve to the line 45 which discharges into the dip tube 23 of the reservoir. The switch 80 is maintained in its "drain" position for a predetermined length of time, adequate to empty the tray, or until the sound of the pump indicates that air rather than a solid stream of liquid is being pumped. In the event that an air or mixed liquid-air stream is passed to the diverter 55 toward the end of the drain period, the diverter will operate as previously described, causing the stream to be harmlessly discharged through the line 76 to the upper end of the reservoir, with the result that air is prevented from bubbling up through the body of liquid in the reservoir. Normally the amount of liquid which is in the reservoir after the tray is drained will be substantially less than the amount contained in a fresh reservoir.

After the tray has been drained, the control switch 80 is moved to a central "off" position in which all of the contacts 81–84 are open so that the entire machine, including the pump motor, is deenergized. The plug 22 may then be removed from the reservoir and the reservoir may be removed from the machine and discarded. A fresh reservoir is substituted, the plug 22 is reinserted, and the switch 80 is moved to the "operate" position, thereby reestablishing the conditions described in connection with FIG. 1. Thus the float switch 60 is closed energizing both the solenoid and the pump motor so that liquid is pumped from the reservoir into the tray with automatic shutoff when the level reaches the desired height and with subsequent replenishment whenever the level drops below the operating range.

While the "drain" operation is of primary use in draining the tray of spent liquid, it is one of the features of the present device that the "drain" control may be employed for restoring the liquid to the reservoir when the machine is to be idled for a period of several days or weeks. Since the liquid in the reservoir is enclosed, the degree of oxidation by atmospheric air is reduced so that the liquid tends to be preserved in its fresh state.

Where the liquid is drained temporarily back into a relatively fresh reservoir, utilizing substantially the full capacity of the reservoir, it is possible that a condition of overflow may exist. This would occur in the event that the reservoir has been replaced inadvertently without draining, or fully draining, the tray, in which case the total amount of liquid in the system might exceed the reservoir capacity. In order to prevent the reservoir from overflowing, an auxiliary overflow line 90 is connected from the vent of the reservoir to the overflow tube 17 in the tray. Since this makes a total of two lines, 76, 90, both connected to the reservoir vent, a Y connection 91 is used. It will be apparent, then, that any liquid forced up into the vent is simply drained through the line 90 for redeposit in the tray. While it is true that the tray under such conditions will have the residual amount of liquid, such residual will be augmented by fresh liquid when the machine is put back into operation, and any excess liquid in the system will be consumed on the copies which are subsequently produced.

It is one of the detailed but nevertheless important features of the present system that an anti-siphon opening is provided at the upper end of the reservoir dip tube 23, thus avoiding any possibility that liquid may continue to flow from the reservoir into the tray by gravity siphoning action after the pump motor 51 has been turned off by the float switch. Thus, referring to FIGS. 4 and 5, an

anti-siphon opening 95 is formed in a transverse tube 96 which is diametrically arranged within openings formed in the wall of the dip tube. Conveniently, the ends of the tube 96 may be simply spun over in place to secure a good mechanical joint as well as a liquid seal. The anti-siphon opening 95 is necessarily small in order to avoid defeating the sucking action of the pump and also to avoid the entraining of bubbles into the stream during normal operation. As a result it may be expected that during continued use the opening 95 will tend to become clogged with a crystalline or other deposit 97 (FIG. 5). It is one of the features of the present construction that the opening 95 is located directly in the stream of liquid pumped from the reservoir which insures that any deposit will be either dissolved or physically washed away so that the anti-siphon opening is kept clear. Since the anti-siphon action is desired immediately following the pumping of liquid from the reservoir, it will be apparent that there is no possibility that the accumulated deposit will be reformed in time to interfere with the anti-siphon function. The anti-siphon action is so effective that a valve 30 may be employed which is of simple and inexpensive construction having clearance between the valve plunger and the bore; in short, a slightly leaky valve free of packing and its accompanying friction, may be used.

In the above discussion it has been assumed that the pump 50 is unidirectional, i.e., capable of pumping liquid in one direction only. For reasons of economy and simplicity, we prefer to empty a pump 50 having a vibratory-type motor and intended for powering directly from an A-C supply line via a rectifying diode, indicated at 51*a*, which provides separate half waves of motor input current. A number of different motors are commercially available but we prefer to use the motor manufactured by the Gorman-Rupp Company of Bellville, Ohio.

It has also been assumed that the valve 30 is of the simple four-way type switchable to its alternate position by a solenoid 40. However, it will be apparent to one skilled in the art that the valve need not be solenoid operated. The valve plunger 35 may be connected, if desired, for manual operation via a direct mechanical connection, as for example, a cable indicated at 99 in FIGS. 6*a* and 6*b*.

Since the motor and pump, tubing, bubble-sensitive diverter and float switch are all inherently inexpensive, it will be apparent that the features of the present invention may be achieved at low cost. Moreover, since the parts may be compactly made, the features of the invention may be incorporated in existing designs of photocopy machines with minimum modification of structure or housing.

In the following claims the term "dip tube" will be understood to be any tube having an opening which is at the bottom of the body of contained liquid. The term "developer tray" shall be understood to mean a liquid tray or container requiring draining either periodically or for renewal purposes. The term "float switch" will be understood to refer to any switch means capable of making an electric circuit in response to variations in liquid level.

We claim as our invention:

1. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a closed reservoir having a dip tube, liquid transfer means including a pump for interconnecting the respective dip tubes, a motor for driving the pump, control means associated with the pump and motor for determining the direction of flow of the liquid stream, a float switch associated with the developer tray, means for manually switching the control means to a first or "run" condition in which the float switch is connected to the pump so that liquid is passed from the reservoir to the tray and automatically maintained at a desired level under the control of the float switch, means for detecting the presence of air in the liquid stream incident to the liquid in the reservoir being consumed to the point where the level thereof drops below the level of the reservoir dip tube for diverting such stream back to the reservoir, said switching means having provision for positioning said control means to a second or "drain" condition in which liquid is passed from the developer tray back to the reservoir for replacement of the reservoir by a flash unit.

2. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a liquid reservoir having a dip tube, liquid transfer means including a pump and conduit means for interconnecting the dip tubes, control means associated with the pump for causing the pump to pump liquid in opposite directions through the conduit means, means for switching the control means between a first condition in which liquid is pumped from the reservoir to the tray and a second condition in which liquid is pumped from the tray back to the reservoir regardless of the difference in level between the tray and reservoir.

3. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a liquid reservoir having a dip tube, liquid transfer means including a pump and conduit means for interconnecting the respective dip tubes, a motor for driving the pump, control means associated with the pump and motor for determining the direction of liquid flow through the conduit means when the pump is turned on, a level switch associated with the tray and arranged to operate when the liquid in the tray is below a desired level, means for switching the control means to a first or "run" condition in which the float switch is controllingly connected to the motor so that liquid is positively pumped from the reservoir to the tray and automatically maintained at the desired level and a second or "drain" position in which the liquid is positively pumped from the tray back to the reservoir.

4. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a liquid reservoir having a dip tube, liquid transfer means including a pump for interconnecting the respective dip tubes, control means associated with the pump for determining the direction of liquid flow, means for switching the control means between a first or "run" condition in which the liquid is passed from the reservoir to the tray and a second or "drain" condition in which the liquid is passed from the tray back to the reservoir, said reservoir being of enclosed construction, and means including an air-sensitive diverter in the transfer means and connected to the reservoir so that when the level of the liquid in the reservoir drops below the level of the dip tube producing an air-containing stream the presence of air in such stream operates said diverter to divert the stream back into the reservoir thereby to prevent discharge of the air-containing stream into the tray.

5. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, an enclosed reservoir having a dip tube, liquid transfer line means including a pump and drive motor, control means associated with the pump and drive motor for positive pumping of the liquid in opposite directions, means for switching the control means from a first condition in which liquid is pumped from the reservoir to the tray and a second condition in which liquid is pumped from the tray to the reservoir, an air-sensitive diverter having a normal input and a normal output connection interposed in the transfer line means and having an auxiliary output connection to the reservoir, said diverter having a valve seat and movable valve member associated with the movable valve member being so arranged and of such specific gravity so that the buoying effect of an incoming liquid stream substantially free of air is effective to displace the valve member from the seat

thereby to permit normal flow of the liquid through the output connection so that an air-containing stream has insufficient buoying effect and thus is ineffective to displace the valve member from the seat with the result that the air-containing stream is diverted through the auxiliary output connection back into the reservoir for safe containment therein.

6. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a reservoir having a dip tube, liquid transfer line means including a pump and driving motor for interconnecting the respective dip tubes, control means associated with the pump and motor for positive pumping of the liquid in opposite directions, an air-sensitive diverter having a normal input and a normal output connection interposed in the transfer line means and having an auxiliary output connection connected to the reservoir, said air-sensitive diverter being in the form of an enclosed chamber with the normal output connection at the bottom thereof having an associated valve seat and cooperating dislodgeable valve member, said dislodgeable valve member having a specific gravity greater than the liquid and said normal input connection being arranged at the side of the chamber so that an incoming liquid stream which is substantially free of air is capable of dislodging the valve member by reason of the lifting effect of the stream combined with the buoyant effect of the liquid so that liquid is free to flow through the normal output connection whereas an air-containing stream providing less lifting effect and less buoyancy for the valve member is incapable of dislodging the valve member from the seat for resultant diversion of the air-containing stream through the auxiliary output connection to the reservoir, said reservoir being closed for safe containment of the air.

7. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a reservoir having a dip tube, liquid transfer line means including a pump and driving motor for interconnecting the respective dip tubes, control means associated with the pump and motor for enabling positive pumping in opposite directions, a bubble-sensitive diverter in the form of a chamber having a normal input connection at the side thereof and having a normal output connection at the bottom interposed in the transfer line means and having an auxiliary output connection at the top connected to the reservoir, a valve seat at the bottom of the chamber, a valve member in the form of a ball normally occupying said seat, said ball having a specific gravity which is just slightly greater than the liquid and said input connection being arranged opposite the seated ball so that an incoming liquid stream which is substantially free of bubbles is capable of dislodging the ball from the seat in the face of the buoyant upward force exerted upon the ball by the liquid in the chamber so that the liquid is free to flow through the normal output connection whereas a bubbly stream providing less buoyancy and dislodging effect is incapable of dislodging the ball from the seat for resultant diversion of the bubbly stream through the auxiliary output connection to the reservoir, said reservoir being enclosed for the safe containment of bubbles.

8. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a reservoir having a dip tube the developer tray and reservoir being mounted one above the other, liquid transfer means including a pump having an associated drive motor interconnecting the respective dip tubes, control means associated with the pump and motor for determining the direction of liquid flow, the dip tube in the upper one of the tray and reservoir having a small anti-siphon opening for breaking the liquid column thereby to prevent undesired gravitational siphoning of liquid through said transfer means.

9. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a reservoir having a dip tube and arranged above the developer tray, liquid transfer means including a pump and associated drive motor for connecting the respective dip tubes, control means associated with the pump and motor for determining the direction of liquid flow, the dip tube in the reservoir having an anti-siphon member incorporated therein, said anti-siphon member being in the form of a short length of tubing transversely arranged in the dip tube above the level of the liquid and having a small opening formed in the underside thereof directly in the path of movement of the liquid being withdrawn from the reservoir so that any material which may be accumulated about the anti-siphon opening is either dissolved or dislodged by the liquid flow insuring that the opening will be open and thus effective to prevent siphoning when the intentional transfer of liquid from the reservoir is completed.

10. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a reservoir having a vertical dip tube, liquid transfer means for drawing the liquid upwardly through the dip tube for discharge at a lower level, the dip tube having an anti-siphon member incorporated therein, said anti-siphon member arranged in the dip tube above the level of the liquid and having a small anti-siphon opening formed in the underside thereof directly in the path of movement of the liquid being withdrawn from the reservoir so that any material which may be accumulated about the anti-siphon opening is either dissolved or disloged by the liquid flow insuring that the opening will be open and thus effective to prevent siphoning when the intentional transfer of liquid from the reservoir is completed.

11. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a liquid reservoir having a dip tube, a unidirectional pump having an associated motor, liquid transfer means including valving for effectively reversing the pump connections so that the pump may be utilized for pumping liquid from the reservoir to the tray and from the tray to the reservoir depending upon the valve setting, a float switch in the tray, control means associated with the valving and pump motor for setting said valving and for connecting the float switch to the motor so that in a first setting of the control means liquid is pumped from the reservoir to the tray and maintained at a predetermined level in the latter under the control of the float switch and so that in a second setting of the control means the liquid is pumped from the tray back into the reservoir for disposal with the latter.

12. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray having a dip tube, a reservoir having a dip tube, a unidirectional liquid pump and an associated drive motor, liquid transfer means interposed between the dip tubes including a four-way valve settable between a first position in which liquid is caused to be pumped from the reservoir to the tray and a second position in which the liquid is caused to be pumped from the tray to the reservoir, a float switch in the tray, and control means capable of switching the valve to its first position and connecting the float switch to the motor so that liquid is pumped from the reservoir to the tray and maintained at a predetermined level in the latter under the control of the float switch, said control means having provision for setting said valve so that liquid is pumped from the tray to the reservoir.

13. In a liquid handling arrangement for a photocopy machine or the like, the combination comprising a developer tray, a dip tube, a reservoir having a dip tube, a unidirectional liquid pump and an associated drive motor, liquid transfer means interposed between the dip tubes including a four-way valve settable between a first position

in which liquid is caused to be pumped from the reservoir to the tray and a second position in which the liquid is caused to be pumped from the tray to the reservoir, a float switch in the tray, a solenoid for operating the valve, and control means for (a) connecting the float switch to the motor and solenoid so that liquid is pumped from the reservoir to the tray and maintained at a predetermined level in the latter and (b) energizing the motor independently so that liquid is pumped from the tray back to the reservoir.

References Cited

UNITED STATES PATENTS

2,059,417	11/1936	Thomas	137—563 X
2,210,751	8/1940	Cronkhite	137—174
3,027,908	4/1962	Cochran	137—571 X
3,203,336	8/1965	Limberger	95—89

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