United States Patent [19]

Shida

[11] **3,841,351**

[45] **Oct. 15, 1974**

[54] **VERSATILE REPLENISHMENT SYSTEM FOR AUTOMATIC FILM PROCESSORS**

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[73] Assignee: **Log Electronics Inc.,** Springfield, Va.

[22] Filed: **Apr. 9, 1973**

[21] Appl. No.: **349,361**

[52] **U.S. Cl.** ..... **137/572,** 354/324, 134/57 R

[51] **Int. Cl.** **G03d 3/02**

[58] **Field of Search** ..... 137/572; 354/324; 134/57 R

[56] **References Cited**

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Primary Examiner—Henry T. Klinksiek

Attorney, Agent, or Firm—Elliott I. Pollock

[57] **ABSTRACT**

A replenishment system for a film processor comprises a tank containing a supply of processing chemical associated with a fluid distribution system for supplying a quantity of processing chemical from the supply tank to a treatment tank in the processor. The fluid distribution system includes a plurality of parallel flow lines associated with valves for causing each of said lines to exhibit a different flow rate; and a selected one or more of said lines is opened by energizing a solenoid valve in the associated line to cause processing chemical to flow from the supply tank to the treatment tank at a selected one of plural possible flow rates. A switching arrangement is provided to select the particular solenoid valve which is to be energized, and for controlling the conditions of its energization so as to cause it to be energized continuously, or to be energized for a duration related to the length of a sheet of film being processed and its speed of transport, or to be energized for a selected time interval.

10 Claims, 5 Drawing Figures

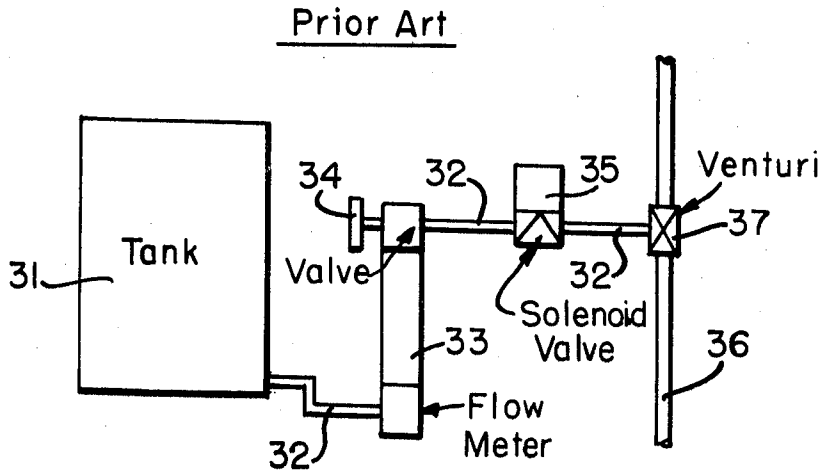


FIG. 1.

Prior Art

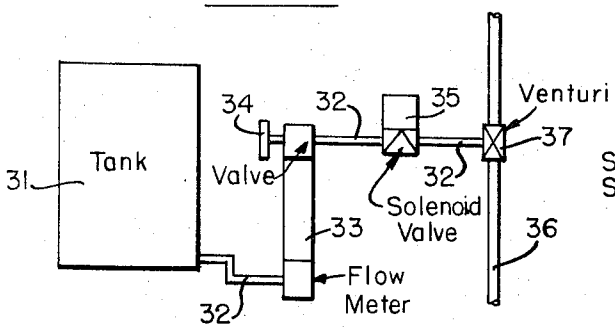


FIG. 3.

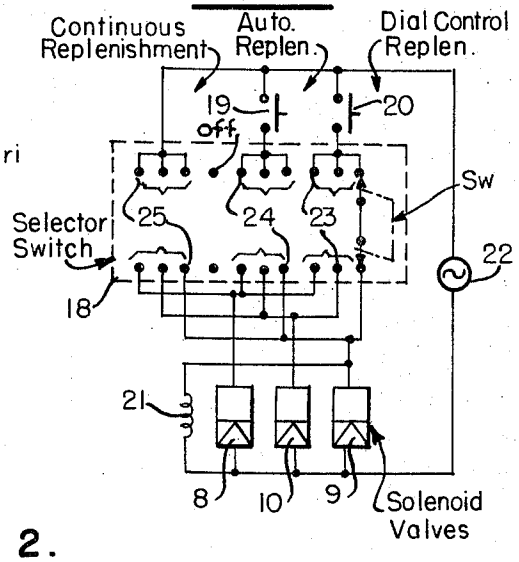


FIG. 2.

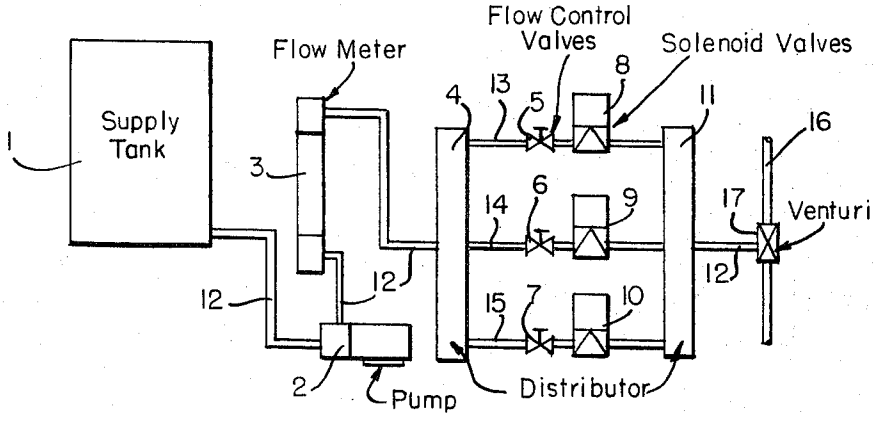


FIG. 5.

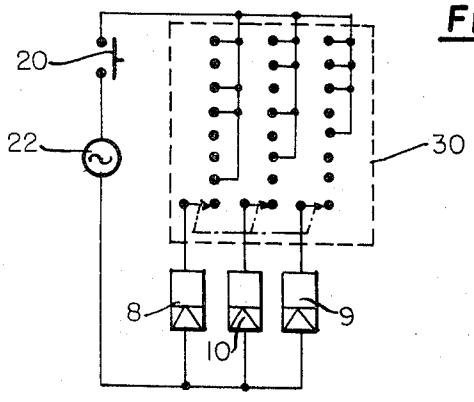
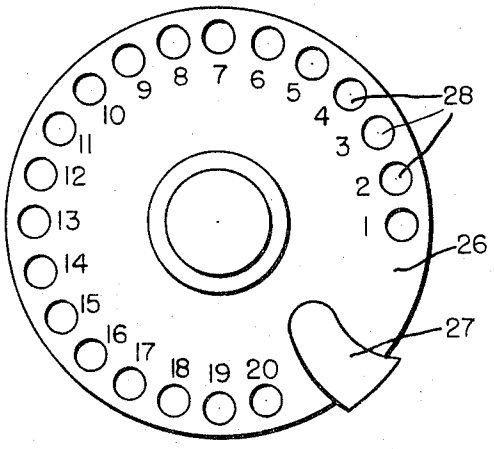


FIG. 4.

Rate	400 cc/Min.			800 cc/Min.						1600 cc/Min.		
Size / %	8/10	11/14	14/17	16/20	18/23	20/24	22/28	24/30	24/36	30/40	40/40	40/60
25%	1	2	3	2	3	3	4	5	6	4	6	7
50%	2	4	7	5	6	7	9	10	13	9	12	13
75%	3	7	10	7	9	10	13	16	19	13	18	19

Replenishing

29



VERSATILE REPLENISHMENT SYSTEM FOR AUTOMATIC FILM PROCESSORS

BACKGROUND OF THE INVENTION

The present invention is concerned with automatic processors for photographic film, and is more particularly concerned with an improved apparatus for supplying replenishment chemicals to the treatment tanks of such a processor.

In conventional automatic film processors, every time that a sheet of film is treated the developing and fixing properties, or chemical activity, of the processing chemicals employed are lowered. In the absence of other considerations, therefore, if several sheets of film were exposed to an image under identical conditions of exposure, and if they were thereafter developed in sequence at precisely the same temperatures and for the same periods of time, the resulting developed images would nevertheless exhibit variations in density from one sheet to the next due to the depletion of the chemistry in the processor. In order to avoid this highly undesirable result, therefore, it is necessary to replenish a portion of the processing chemicals every time that a sheet of film, or a prescribed number of sheets, are treated to restore the chemical activity of the solution being employed in the processor, and to maintain that chemical activity at a desired level.

In its simplest form, a replenishment system need only comprise a supply tank containing a quantity of replenishing chemical, and a valved conduit disposed between said supply tank and an associated treatment tank in the processor. Since the replenishment chemical cannot be supplied in arbitrary quantities, however, practical replenishment systems of the types suggested heretofore customarily include valving mechanisms for defining the flow rate from the supply tank, in association with an electromagnetic solenoid valve which is adapted to be opened for a prescribed period of time during which replenishment is to be effected. Moreover, it has been customary heretofore to include a variable timing mechanism for controlling the duration during which the solenoid valve is open, thereby to permit the amount of replenishment chemical which is supplied to be adjusted to compensate for the processing conditions which have been encountered. In the case of the developing solution employed, as the size of the film sheet and its percentage of exposure increase, the amount of replenishment of the developing solution should also be increased; and, in the case of the fixing solution, as the percentage of exposure in a sheet of film being treated decreases, the amount of replenishment of the fixing solution should be increased.

In replenishment systems of the types discussed above, when the flow rate of the chemical being replenished is maintained at a constant value, the time during which replenishment must be effected may vary from several seconds to several minutes depending upon the film area and its percentage of exposure. Some replenishment systems suggested heretofore have included provisions for permitting the flow rate to be selectively increased thereby to reduce the necessary replenishment time period, e.g. an operator, by watching a flow meter associated with the replenishment system, may adjust the flow rate upwardly thereby to reduce the time of replenishment. However, since operations are customarily carried out in a darkroom, the need to monitor a flow meter and make adjustments in flow rate gives rise to considerable inaccuracies and operational problems.

In view of the problems discussed above, it is customary for most replenishment systems to employ a constant flow rate, and to include provisions for conveniently varying the time of replenishment under darkroom conditions. A known mechanism of this general type employs a manually operable dial-controlled timer generally similar in construction to a telephone dial so that an operator, by increasing the angle through which the dial is manipulated, can correspondingly increase the time duration during which replenishment chemical is supplied at a constant flow rate. In these known arrangements, however, since the total time which is available from even a full operation of the dial is limited, it may become necessary, when the amount of replenishment chemical required is very large, for the operator to "double-dial" the timer.

It is therefore a primary object of the present invention to provide a replenishment system for a film processor which overcomes the foregoing defects of conventional systems suggested heretofore, and which makes it possible to increase the flow rate of the replenishment chemical instantaneously and with ease, even under darkroom conditions, so as to reduce the time of replenishment. Moreover, the present invention provides a replenishment system wherein the controlling conditions for replenishment may be readily varied, thereby to permit replenishment to occur at any desired one of plural flow rates for any selected interval of time, or to occur at any one of plural possible flow rates for an interval of time dependent upon the length of a sheet of film being processed and its speed of transport, or to permit replenishment to occur continuously at any one of plural possible flow rates.

SUMMARY OF THE INVENTION

A replenishment system of the type contemplated by the present invention comprises a supply tank containing a quantity of replenishment chemical, associated with a fluid distribution system disposed between an outlet from said supply tank and an inlet (e.g. a venturi in a circulation line) to said treatment tank. The fluid distribution system includes a plurality of parallel flow lines, preferably at least three such lines, each of which includes an adjustable flow control valve so that the various different lines exhibit different flow rates respectively. Each line further includes a solenoid valve; and a switching arrangement is provided for energizing a selected one of said valves, or a selected combination of valves, when it is desired to effect replenishment so as to achieve a flow of replenishment chemical from the supply tank to the treatment tank at a particular one of plural possible flow rates determined by the line or lines which have been opened by energization of their associated solenoid valves.

In order to increase the versatility of the system, the switching mechanism employed includes means not only for selecting the particular one or ones of the solenoid valves to be energized, but also includes a plurality of selectable switching paths through which the selected valve may be energized to effect different types of replenishment. When a first of these switching paths is selected, replenishment may be effected continuously, e.g. to restore the chemical activity of the processor to a desired level after the processor has been

out of use for a significant period of time. When a second of the switching paths is selected, so-called "autoreplenishment" may be effected, i.e., replenishment may be initiated in response to the entry, into the processor, of a sheet of film to be processed, and replenishment may be continued for a duration of time which is dependent upon the length of said sheet of film and its speed of transport. When a third of the switching paths is selected, replenishment is effected for a preselected time interval which is in turn controlled by a dial-type timing mechanism; and in this condition of operation, resort may be had to a table associated with the timer dial to permit variations in the time of replenishment in accordance with the film size and its percentage of exposure.

In one embodiment of the system, only a single one of the solenoid valves is energized at any given time, so that the flow rate of replenishment chemical is governed by the single line with which a selected solenoid valve is associated. In an alternative embodiment of the invention, however, selected ones, combinations, or all of the solenoid valves can be energized simultaneously to achieve a greater variation in the possible flow rates which are available. In addition, one or more of the lines can be associated with an electrically energizable pumping mechanism, and the switching means employed can also include means for selectively energizing the pumping mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of a conventional, prior art replenishment system;

FIG. 2 is a schematic diagram of a replenishment system constructed in accordance with the present invention;

FIG. 3 illustrates a switching mechanism which can be employed in the arrangement of FIG. 2;

FIG. 4 depicts the dial of a dial-controlled timer, and its associated table, used in conjunction with the switching mechanism of FIG. 3; and

FIG. 5 illustrates another embodiment of the present invention wherein more than one solenoid valve can be energized simultaneously.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a known form of replenishment system of the general type described earlier. A supply of replenishment chemical is maintained in a tank **31**, and is selectively fed to a treatment tank in an automatic film processor via a conduit **32** which includes a flow meter **33** associated with an adjustment valve **34**, and a solenoid valve **35**. When solenoid valve **35** is opened, a portion of the chemical in tank **31** flows through conduit **32** at a given rate determined by the setting of valve **34**, and is supplied to a venturi **37** located in a line **36** through which the processing chemical in the treatment tank of the processor is continually circulated by means of a pump (not shown). The fluid in line **32** is accordingly drawn into line **36** by the action of venturi **37**, and is added to the processing fluid already circulating through line **36**.

The amount of replenishment fluid supplied to the treatment tank is a joint function of the flow rate determined by the setting of valve **34**, and the time during which solenoid valve **35** is open; and each of these parameters can be varied to control the amount of replenishment. As discussed earlier, an operator of the equipment can reduce the time during which replenishment takes place by opening valve **34**, while watching flow meter **33**, so as to increase the rate of flow; but this type of operation is extremely difficult to perform under darkroom conditions. Accordingly, it is more customary for replenishment to be effected at a constant flow rate, and for the amount of replenishment to be controlled by means of a timing mechanism (such as a variable dial-controlled timer) which determines the time during which solenoid valve **35** is energized to its open condition. Since this latter type of operation may require a comparatively long replenishment time however, involving possible double-dialing of the timer, it too imposes disadvantages.

The present invention is intended to provide a far more versatile type of operation wherein the flow rate of the replenishment fluid can be increased very easily even under darkroom conditions, and wherein the time during which fluid is supplied at any one of a plurality of possible flow rates can be in turn controlled by a variable timing mechanism, or by other control parameters to be discussed hereinafter. A replenishment system of the general type contemplated by the present invention is depicted in FIG. **2**, and comprises a supply tank **1** an output of which is coupled via a conduit **12**, which includes a pump **2**, to a flow meter **3** and thence to a branched distributor **4–11**. The distributor comprises a plurality of parallel flow lines **13, 14, 15** respectively each of which includes an adjustable flow control valve **5, 6**, or **7**, respectively, and each of which also includes an individually energizable solenoid valve **8, 9** or **10** respectively. The fluid flowing through a selected one or more of the lines **13, 14** or **15** via its associated flow control and solenoid valves passes to a further branched distributor **11** and thence via conduit **12** to a venturi **17** in the circulation line **16** coupled to the processor treatment tank. Line **16** may be associated with a filter (not shown) and with a thermostatically controlled heater (not shown) for keeping the temperature of the treatment fluid at a desired value.

Valves **5, 6** and **7** are individually adjustable to control the flow rates through their associated flow lines **13, 14, 15**; and said valves are normally so adjusted that the flow rates through said associated lines differ from one another. In one typical embodiment of the present invention, useful in some types of commercially available automatic processors, the valves **5, 6** and **7** are so adjusted that, when the associated solenoid valves are opened, the flow rate through line **13** is approximately 400 cc/min., the flow rate through line **14** is approximately 1,600 cc/min. and the flow rate through line **15** is about 800 cc/min. It will be understood, however, that these flow rates can be varied by appropriate adjustment of valves **5, 6** and **7** to satisfy the needs of the particular processor with which the replenishment system of the present invention is associated.

Pump **2** is adapted to be electrically energized, but is so constructed that, even when it is not energized, processing fluid can flow from the inlet to the outlet of the pump simply due to the pressure across the pump. When a selected one of valves **8** or **10** is opened, therefore, fluid will flow via either line **13** or **15** at a flow rate determined by the setting of flow control valve **5** or **7**, even though pump **2** is not energized. In order to achieve the maximum flow rate provided by line **14**,

however, pump **2** is normally energized concurrently with the energization of solenoid **9.**

FIG. **3** illustrates a switching mechanism which is employed in conjunction with the arrangement of FIG. **2** to control the amount of replenishment and the conditions of its occurrence. The mechanism includes a selector switch **18** (which can be a rotary switch, but is shown in linear form for ease of understanding) comprising a switch arm Sw associated with three sets of paired triple contacts **23, 24** and **25** respectively. The first contact in the lower deck of each set **23, 24** and **25** is connected to the upper side of solenoid valve **9,** the lower side of which is connected to one side of energization source **22;** the second contact in the lower deck of each set **23, 24** and **25** is similarly connected to solenoid valve **10,** and the third contact in the lower deck of each set is connected in similar fashion to solenoid valve **8.** The three upper contacts of set **23** are connected together and, via a selectively closeable switch **20,** to the other side of source **22.** Similarly, the upper three contacts of set **24** are connected together and, via a further selectively closeable switch **19,** to the other side of source **22,** and the upper contacts of set **25** are connected together directly to the other side of source **22.** An open pair of "off" contacts is disposed between sets **24** and **25** as illustrated.

Selectively closeable switch **20** forms a portion of the dial-controlled timer to be discussed subsequently in reference to FIG. **4.** Operation of that timer causes switch **20** to be closed for a selected period of time; and if switch arm Sw is on one of the contacts **23** when switch **20** is closed, replenishment will be effected at a rate determined by the flow line associated with the selected one of solenoid valves **8, 9** or **10,** for a period of time during which switch **20** has been closed by the dial-controlled timer. A coil **21** is connected in parallel with solenoid valve **9,** and comprises the energization coil of a relay provided to energize pump **2** concurrently with energization of solenoid valve **9** for the reasons discussed earlier.

Switch **19** comprises a microswitch disposed adjacent the film transport path in the film processor, and is adapted to be closed when it is engaged by a sheet of film being transported through the processor. Switch **19** will accordingly be closed for a duration determined by the length of the sheet of film being processed and its speed of transport; and, accordingly, if the switch arm *Sw* is in engagement with one of the contacts **24,** replenishment will be accomplished at a flow rate determined by the line associated with the energized one of solenoid valves **8, 9,** or **10,** for the period of time during which switch **19** is closed by the sheet of film being transported. This type of operation is conventionally called "auto-replenishment."

If switch arm *Sw* is moved into engagement with one of contacts **25,** a selected one of solenoid valves **8, 9,** or **10** will be energized continuously to effect continual replenishment at a rate determined by its associated flow line. This type of replenishment is sometimes desirable when the automatic processor has not been used for a significant period of time, e.g. if the developer solution in such a processor is allowed to stand for a period of time, its developing activity will gradually lower even though no film has been processed in the interim. Accordingly, when the processor is first activated in the morning, or when the processor has been otherwise out of use for a comparatively long period of time, continuous replenishment can be effected to return the developer activity to a desired level for commencing the processing of films. Since such continuous replenishment occurs relatively infrequently, however, the switch contacts **25** are preferably disposed on the side of the "off" contacts opposite to the side on which switch sets **23** and **24** are located to prevent inadvertant continuous replenishment.

By reason of the three different switching paths provided by switch sets **23, 24,** and **25,** replenishment can be effected under three different conditions of operation, i.e., continuously, or as a function of film length, or as a function of a variably selectable time, simply by moving switch arm Sw to a position adjacent the selected one of said sets. Moreover, for each selected condition of operation, replenishment can be effected at any one of three different flow rates simply by moving switch arm *Sw* to a selected one of the three differing contacts in each set.

FIG. **4** illustrates a portion of the dial-controlled timer mechanism which may be employed to selectively close switch **20** of FIG. **3.** The mechanism comprises a dial **26,** similar in construction to a telephone dial, disposed adjacent a finger stop **27** and provided with a plurality of numbered finger holes **28.** The dial mechanism may be disposed on the control panel of the film processor, and a table **29** is also located on said control panel adjacent the dial **26** to provide information for the manipulation of dial **26** and selector switch **18** (FIG. **3**). An operator may manipulate dial **26** by inserting his finger into a selected one of holes **28** and then turning the dial until his finger engages stop **27.** The operator then releases the dial to permit it to return, under the control of an associated timer, to its starting position. A mechanism (not shown) is associated with dial **26** to close switch **20** as soon as the dial **26** is moved away from its starting position, and to keep the switch **20** in its closed condition until the dial has returned to its starting position. The time interval during which switch **20** is closed, therefore, is a function of the angle through which the dial has been turned away from its starting position, i.e., it is determined by the finger hole **28** used by the operator to turn dial **26.**

Table **29** is provided with an uppermost horizontal scale which subdivides the table into three fields related to the flow rate provided by lines **13, 15,** and **14** respectively; a lower horizontal scale which identifies the size of a sheet of film being processed, i.e., 8/10 (or 8 inches by 10 inches) etc.; and a vertical scale at the left edge of the table corresponding to the percentage of exposure in a sheet of film being processed. The two horizontally extending uppermost scales in table **29** are used by the operator to set selector switch **18,** i.e., if the size of the sheet of film being processed is between 8/10 inches and 14/17 inches, switch arm Sw should be set to energize slenoid **8** so as to eventually achieve a flow rate of 400 cc/min.; if the size of the film sheet is between 16/20 inches and 24/36 inches, switch arm *Sw* is set to eventually energize solenoid **10** to achieve a flow rate of 800 cc/min., etc. Once selector switch **18** has been set, the operator, knowing the size of the sheet of film being processed, then estimates the percentage of exposure of said sheet, and thereafter manipulates dial **26** by finger-engaging a particular one of holes **28** is designated in the remainder of the table.

For example, let us assume that the sheet of film being processed is 11 inches by 14 inches, and that the operator estimates that the sheet has a 50 percent area of exposure. Referring to table **29**, the operator sets switch **18** to achieve a flow rate of 400cc/min. and thereafter turns dial **26** by finger-engaging the hole **28** which is designated "**4.**" As another example, if the size of the sheet of film being processed is 24 inches by 30 inches, and the percentage of exposure is estimated to be 75 percent, switch **18** is first adjusted to achieve a flow rate of 800cc/min., and dial **26** is thereafter turned by use of the finger hole designated "**16.**" In short, reference to table **29** permits the operator to select a particular one of plural possible flow rates, and a particular one of plural possible replenishment times, which will achieve proper replenishment with greatest efficiency.

In the circuit described with reference to FIG. **3**, only one of the three valves **8, 9** or **10** is energized at any given time. However, it is possible to construct the circuit so that two or more such valves are open simultaneously, thereby to achieve a composite flow rate which is determined by the flow rates of a plurality of the flow lines. Such a modification is illustrated in FIG. **5**, wherein the three valves **8, 9** and **10** are selectively energized by source **22**, under the control of timer switch **20**, in a combination determined by switch **30**. When the switch arms are in their lowermost position, none of the valves are energized. As the switch arms are moved upwardly, valve **8** alone is energized, then valve **10** alone, then valve **9** alone, then valves **8** and **10** together, then valves **8** and **9** together, then valves **10** and **9** together, and finally all of the valves **8–10** together.

While FIG. **5** contemplates that the circuit is used in conjunction with the timer-control switch **20**, it will be appreciated that a similar arrangement can be used in conjunction with the auto-replenishment switch **19**, and/or in conjunction with the continuous replenishment portion of the circuit shown in FIG. **3**.

The foregoing description has assumed that the replenishment system of the present invention is used for replenishing the developer solution of an automatic film processor. It will be appreciated, however, that a related arrangement can be used to replenish the fixing solution. It must therefore be understood that the foregoing description is intended to be illustrative only and not limitative of the present invention, and all such variations and modifications as are in accordance with the principles described are meant to fall within the scope of the appended claims.

Having thus described my invention I claim:

1. A replenishment system for a film processor of the type comprising a treatment tank containing a processing chemical for treating an exposed photographic film, said replenishment system being operative to supply additional processing chemical to said treatment tank to maintain the chemical activity in said tank at a desired level, said replenishment system including a supply tank containing a quantity of said processing chemical, fluid distribution means between an outlet from said supply tank and an inlet to said treatment tank, said fluid distribution means comprising a plurality of parallel flow lines, flow control means coupled to said lines for causing said lines to exhibit different flow rates respectively, electrically operable solenoid valve means in each of said lines for normally preventing the flow of fluid therethrough, an energization source, and switch means for selectively coupling said energization source to at least one of said solenoid valves for causing processing chemical to flow from said supply tank to said treatment tank at a selected one of plural possible flow rates.

2. The system of claim **1** wherein said plurality of parallel flow lines constitutes at least three lines having three different flow rates respectively.

3. The system of claim **2** wherein said flow control means comprises an adjustable valve in each of said lines.

4. The system of claim **1** wherein said switch means includes timing means for selectively varying the time during which said processing chemical is supplied at said selected flow rate.

5. The system of claim **4** wherein said timing means comprises a manually operable dial-controlled timer.

6. The system of claim **1** wherein said switch means comprises a sensor disposed adjacent the film transport path in said film processor means and responsive to the length of a sheet of film being processed for coupling said energization source to said selected solenoid valve for a duration jointly related to the length of said film sheet and to its speed of transport.

7. The system of claim **2** wherein said switch means includes means operative to couple said energization source simultaneously to a selected plurality of said solenoid valves for causing said processing chemical to flow to said treatment tank at a composite rate determined by the flow rates of a plurality of said lines.

8. The system of claim **1** wherein said fluid distribution system includes an electrically energizable pump, said switch means including means operative to energize said pump simultaneous with the energization of a selected one of said solenoid valves.

9. The system of claim **1** wherein said switch means includes means for connecting said energization source to any selected one of said solenoid valves through any one of a plurality of different switching paths, a first one of said switching paths including timer means for selectively closing said first switching path for a selected time interval, and a second one of said switching paths including means for monitoring the length of a sheet of film being processed in said processor for selectively closing said second switching path for a duration related to said film sheet length.

10. The system of claim **9** wherein said plurality of switching paths include a third switching path for directly connecting said energization source to a selected one of said solenoid valves to selectively provide a continuous supply of said processing chemical to said treatment tank.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,841,351 Dated October 15, 1974

Inventor(s) Junji Shida

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Page 1 item [73] correct the name of the assignee to read

-- LogEtronics Inc. --

Column 6 last line preceding "is" insert -- which --

Signed and sealed this 17th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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