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[21] Appl. No. 686,561
[22] Filed Nov. 29, 1967
[45] Patented Sept. 22, 1970
[32] Priority Dec. 3, 1966
[33] Germany
[31] No. K60,857

[56]

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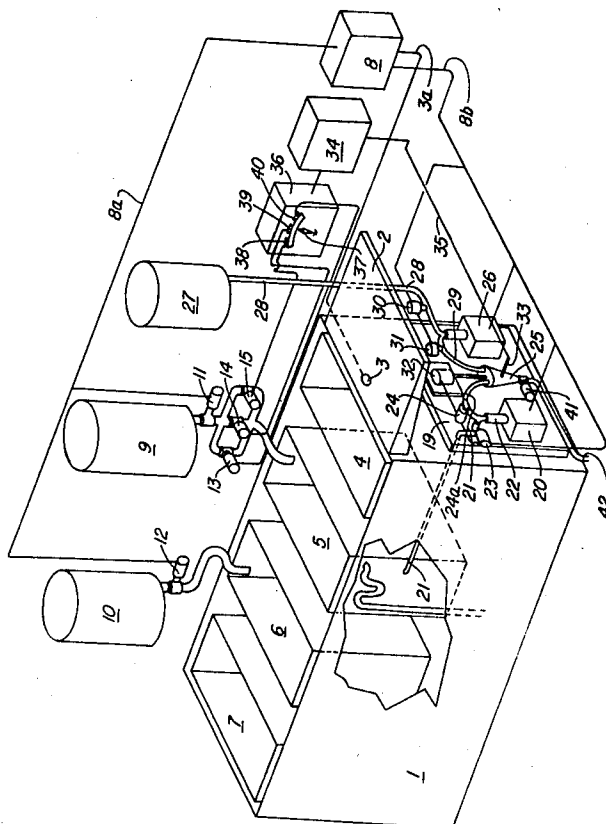
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[54] METHOD AND MEANS FOR CONTROLLING THE
ADDITION OF REPLENISHER TO AUTOMATIC
PHOTOGRAPHIC FILM PROCESSORS
4 Claims, 1 Drawing Fig.

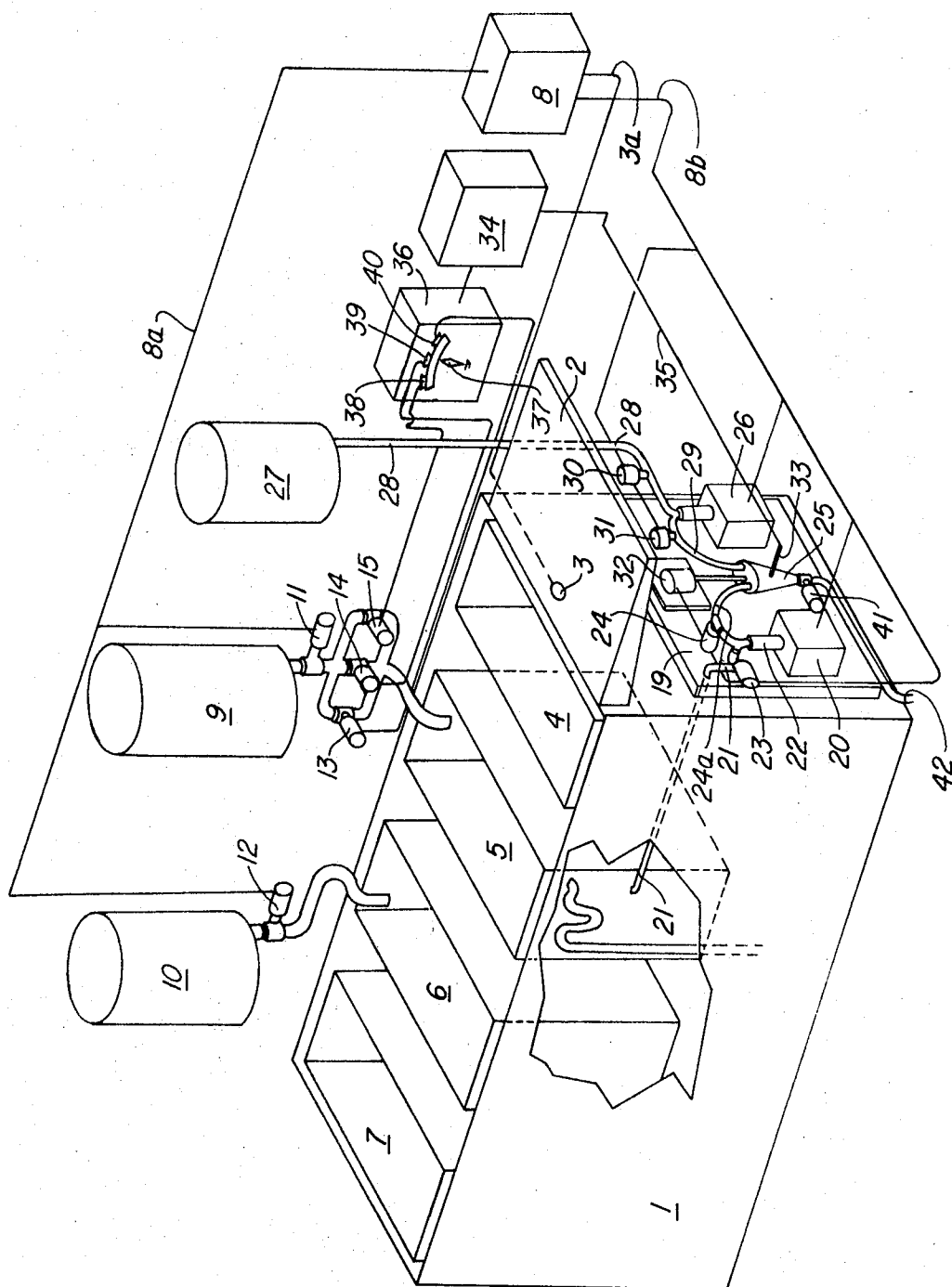
[52] U.S. Cl. 95/89,
23/230, 23/253
[51] Int. Cl. G03d 3/06,
G01n 31/00
[50] Field of Search 95/89;
96/(Inquired); 23/230, 230A, 253, 253A; 93/3, 93

ABSTRACT: A method for automatically and continuously replenishing a chemical composition constituent which is being consumed during a process in which the said constituent is being used and in which the said constituent is consumed to form a particular compound, which comprises periodically analyzing a sample of the said composition during its use to determine the quantity of the said compound in the sample and then adjusting the rate of supply of the replenishing material in direct relation with the variation of the quantity of the compound in the analyzed samples relative to a predetermined norm.



Patented Sept. 22, 1970

3,529,529



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METHOD AND MEANS FOR CONTROLLING THE ADDITION OF REPLENISHER TO AUTOMATIC PHOTOGRAPHIC FILM PROCESSORS

BACKGROUND OF THE INVENTION

In particular the invention concerns the automatic addition of replenisher for the developer being used in automatic photographic film processors.

Film processors serve to develop the latent image in exposed photosensitive emulsions. In the course of this process silver halide is reduced to metallic silver, whereby a reducing agent contained in the developer is used up and a concentration of free halide in the developer takes place. For the continuous development of a series of films of varying sizes and densities it is necessary to add to the developer a quantity of replenisher which corresponds to the actual consumption of developer and to drain away the spent solution. Such replenishers are distinguished from the basic developer bath by having a higher percentage of reducing agent and a smaller percentage of bromides or the complete absence thereof.

The consumption or developer depends mainly upon three factors, i.e., (1) the dimensions of the emulsion coated surface; (2) the average integrated density of the developed image; and (3) the oxydizing components, such as oxygen existing in the air present in the developing section of the processing apparatus.

It is evident, that the influence stated under factor 3 may be reduced to a negligible minimum by the use of a non-oxygen sensitive developer or by using a hermetically sealed developer tank such as that disclosed in my copending application, Ser. No. 671,083, filed Sept. 27, 1967 now U.S. Pat. No. 3,495,520. The difference between factors 1 and 2, however, consists in that the film surface can be assessed prior to starting the developing procedure whereas the density of the silver image and the corresponding consumption of developer can only be determined upon completion of development.

While the majority of processors is fitted with devices for measuring only the film feeding length it is also possible to determine automatically the width of the film and hence the area of film introduced to the developing section. Suitable elements for this purpose may be constituted by micro-switches or photocells using infra-red and by such means a basic feed rate for the developer replenisher can be established.

The object of the present invention, however, is to add automatically to the developer in film processors a quantity of replenisher solution which is directly proportioned to the actual consumption of developer so that consistent results are obtained over a practically unlimited period of time, whether the machine is in continuous use or not.

SUMMARY OF THE INVENTION

This problem is solved by a process whose main feature is the supplementing of the usual supply of replenisher, which is proportional to the film surface, by an automatic control means which adjusts the replenisher supply rate according to the actual consumption of developer, this control being based upon changes of the halide content of the developer bath which are periodically determined by automatic chemical analysis.

Consequently, the basic idea of the invention is to supplement the predosage of replenisher, which is based on the surface of the film fed into the machine, by a corrective value which depends on the actual consumption of developer and which is periodically determined by chemical analysis of the halide content of the developer bath by titration.

As mentioned before, the object of the chemical analysis is to determine the halide content of the developer bath, and an essential factor for choosing the appropriate method of assessing the halide content is the fact that the quantity of halide introduced into the developer in the course of development is strictly proportional to the quantity of silver formed by reduction in the photographic emulsion. Besides the advantages of strict proportionality another advantage resides in the fact

that means exist for a very sensitive quantitative analysis of halides through potentiometric titration (determination of the "end-point").

For an integration of these elements it is suggested that the time of run and/or the output of the replenisher pump be adjustable. For instance, it is possible to provide for a device permitting a fully automatic control of the time of run of the replenisher pump proportional to the film surface and an equally automatic increase or decrease of the rate of replenishment proportional to the lower or higher halide content of the developer bath as compared with a normal value.

It is relatively simple to realize by means of at least three regulators of the replenisher flux, preset at three different quantities. By means of several magnetic valves or a three-way valve, the flux of replenisher is directed via one of these regulators in such a way that for a normal halide content for a given film area the normal quantity of replenisher is added, and for an increase of halide content in the developer bath an increased quantity of replenisher is added and for a decreased halide content the supply of replenisher is reduced.

The same function can also be achieved by means of a remotely controlled regulator, the regulator of the pump speed or an additional control of the time the pump is in operation. It is furthermore possible to apply various systems for automatically determining the dimensions of the film surface.

DESCRIPTION OF THE DRAWING

The drawing shows, diagrammatically, a view illustrating a typical film processing the apparatus, the automatic titration means associated therewith, and the various operational steps of the process which is the subject of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawing a typical film processor 1 comprises an enclosure (shown without the top cover and film transport system) having a feed table 2 for the films to be processed, a control means 3, which may be working either on the photo-electrical or on the supersonic principle, for measuring the feeding rate of the film into the processor, i.e., the time it takes to feed the film into the machine. The film then passes through the various processing tanks which include a tank 4 containing a wetting bath, a tank 5 containing the developer, a tank 6 containing the fixer and a tank 7 in which the film is rinsed. It is understood that these tanks are correctly filled with the corresponding fluids before the processing operation starts.

The impulse registered by control means 3 is fed via electric lead 3a into a programming device 8 which starts the following series of operations. The stock solutions for replenishing, contained in special vessel 9 for the developer and in the vessel 10 for the fixer, are added, for instance, by means of magnetic valves 11 and 12, or appropriate pumps to the respective tanks 5 and 6. These valves 11 and 12 are connected with the programming device 8 by means of electrical lead 8a. The time it takes to add these fluids to the respective tanks is controlled by the programming device 8 to be proportional to the time it takes to feed the film into the processing machine or to the film surface area. The conduit of the developer replenisher which is situated beneath magnetic valve 11, is so designed that the replenisher passes through one of the three normally closed magnetic valves 13, 14 or 15. The three valves have different size orifice or passage cross-sections and, as will be explained, only one at a time of the three valves is used to add the replenisher to the developer tank 5. The orifice cross-section of valve 14, in the center, is sized to provide the normal or basic rate of flow of replenisher, the cross-section of valve 13 is smaller, thus reducing the rate of flow of replenisher and the cross-section of valve 15 is larger so that a greater quantity of replenisher may be added to the developer tank 5. When starting the operation the apparatus is set for the normal replenishing rate, the replenishing flow being by way of magnetic valve

Simultaneously with the feeding of the first film into the automatic processor the programming device 8 starts by way of electrical lead 8b, the operational cycle of the titration apparatus 19.

The operation of the titration apparatus 19 begins with the precision pump 20 which may, for instance, be constituted by a power-driven burette. This pump 20 draws a preselected quantity of the developer solution or composition from the developer tank 5 by way of the conduit 21. Thereby the suction cylinder 22 is filled with the solution to be analyzed, and to effect this the normally closed magnetic valve 23 in the conduit 21 is opened simultaneously with the operation of the pump 20 and the small normally closed magnetic valve 24 in the drain conduit 24a remains closed. The piston moving in the suction cylinder of the power-driven burette remains for a few seconds in its lowest position, then magnetic valve 23 is closed, the valve 24 is opened, and the piston returns to its uppermost position whereby the preselected quantity of developer composition is transferred into the test receptacle 25. Simultaneously a smaller power-driven burette 26 draws the titration solution (silver nitrate) in an accurately predetermined concentration from the stock vessel 27, via conduit 28 and transfers it via conduit 29 to the test receptacle 25. The flow of the titration solution from vessel 27 to the test receptacle 25, by way of pump 26, is controlled by magnetic valves 30 and 31 in the same manner as the flow of the developer composition by way of the pump 20.

A power-driven (motor 32) stirrer associated with the test receptacle 25 produces a homogeneous mixture of the two solutions. The measuring electrode 33 extending into the test receptacle 25 and linked to an amplifier 34 by means of line 35, furnishes the potentiometric value which is transferred by the amplifier 34 to the measuring instrument 36 which comprises a contacting element 37 and the contact ranges 38, 39 and 40. The contact range in which the measured value appears determines which one of the magnetic valves 13, 14 or 15 is opened while the two others are closed.

Upon completion of the measuring procedure the magnetic valve 41 below the test receptacle 25 is opened and the potentiometrically measured solution is drawn off to waste through conduit 42. As long as the analysis is in progress any further drawing of developer composition from the tank 5 through the conduit 21 is interrupted by closure of the valve 23. A new analyzing cycle starts again when the next film is fed to the processor, whereby the control element 3 and the programming device 8 operate in the above described way. The selected magnetic valve 13, 14 or 15 operated after each analysis by the contact piece 37, remains open until—following a

new complete analysis—the contact piece opens another one of these magnetic valves in order to adjust the replenishing rate to the result of the new analysis.

It will be obvious that for films which are developed before the analysis is made the replenisher will be supplied to the developer tank 5 at the basic rate through the magnetic valve 14. It is also possible to provide for a preselection of the basic replenisher rate, for example, to increase it for the development of negatives and to reduce it for the development of positives.

I claim:

1. The method for automatically replenishing a chemical composition constituent which is consumed at a variable rate during a process in which said composition is used, the said composition being a developer bath for photographic film and the said constituent being the reducing agent for the silver halide in the film emulsion, which comprises continuously supplying to the processing composition a replenishing quantity of the said constituent substantially equal to the average rate of consumption thereof as the composition is being used, periodically extracting a sample of the said composition during the said process and analyzing said sample to determine the free halide content thereof, and then adjusting the rate of supply of the said constituent in direct relation with the variation of the quantity of free halide in successive samples to maintain the desired concentration thereof in the processing composition.

2. The method as defined by claim 1 wherein the free halide content of the sample is determined by titration.

3. The method as defined by claim 1 wherein the free halide content of the sample is measured potentiometrically and the rate of supply of reducing agent to the developer bath is adjusted according to the potentiometric value of the said sample.

4. Means for maintaining a predetermined normal concentration of reducing agent in the developer bath of apparatus for processing photographic film comprising means for supplying a reducing agent replenisher to said bath at an average rate commensurate with the surface area of film being processed, means for periodically extracting measured amounts of the developer bath, titration means for testing each of said measured amounts potentiometrically to measure the free halide content thereof, and means actuated by the potentiometric impulse produced from said titration means for adjusting the rate of supply of the replenisher in direct relation with the rate that the said reducing agent is consumed in the processing apparatus.

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