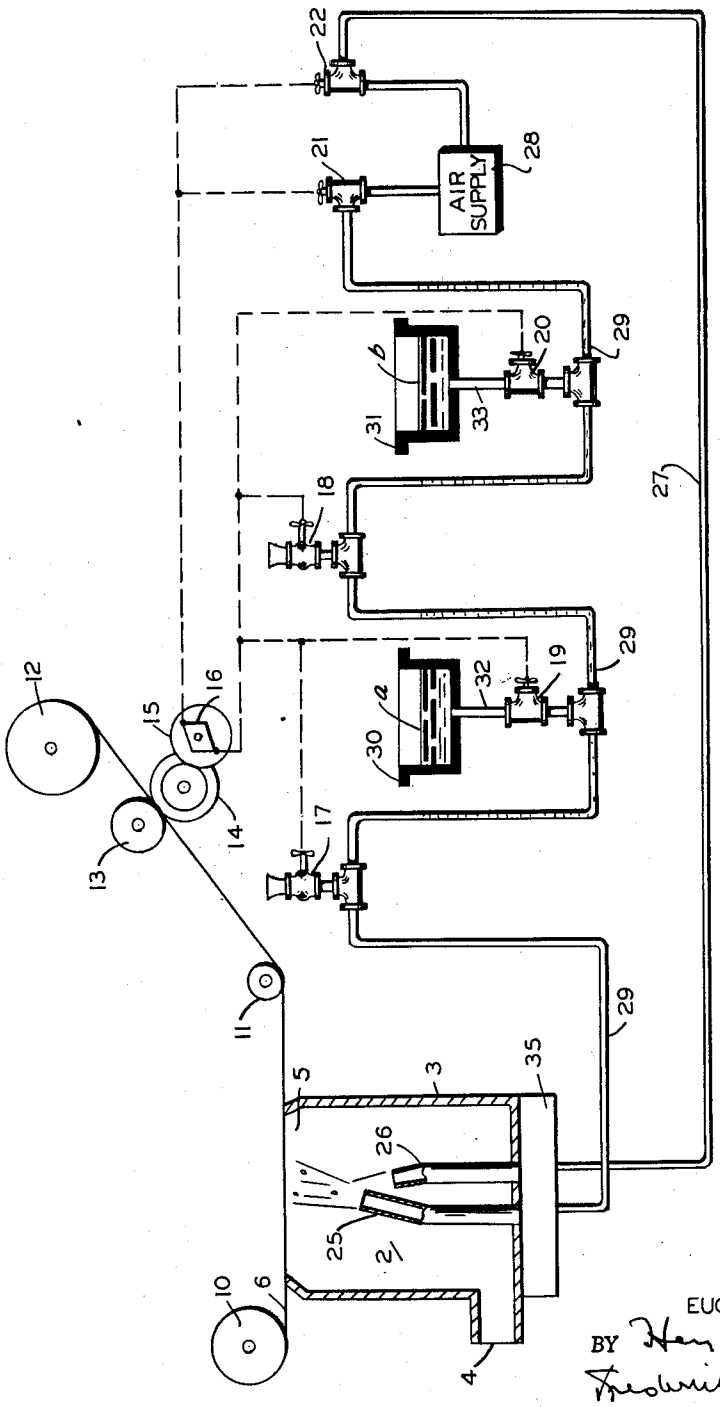
Jan. 26, 1960 E. F. BERLEY 2,922,353

SYSTEM FOR RAPID PROCESSING OF PHOTOGRAPHIC FILM

Filed Oct. 24, 1957



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United States Patent Office 2,922,353
Patented Jan. 26, 1960

2,922,353

SYSTEM FOR RAPID PROCESSING OF PHOTOGRAPHIC FILM

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Application October 24, 1957, Serial No. 692,182

6 Claims. (Cl. 95—89)

This invention relates to the rapid processing of photographic film by spraying the film with a plurality of processing solutions and, more particularly, to a system which includes a single conduit means for transporting a plurality of film processing solutions to the film in a sequential manner.

Normal photographic processing methods are entirely too slow for rapid recording of data in conjunction with modern computing machines and the like. To meet this requirement, attempts have been made to reduce photographic processing time from minutes to a matter of a few seconds in miniaturized equipment capable of being attached directly to a data producer.

Rapid processing, as applied to a unit area of film, requires successive uniform application of well agitated minute quantities of processing solutions. Two general methods of application are in present use, namely, parallel flow and impingement types. The present invention is directed to the latter method, and includes both solution jets of various types and aspirator spray types.

Since all photographic processing systems use some form of solution agitation, the purpose being to fortify or renew the chemical solution in immediate contact with the photographic emulsion, the impingement method generally, and the aspirator spray type in particular, offer the most promise of optimum agitation for rapid processing since solution impact normal to the emulsion surface is used to drive the solution into the emulsion layer. Considering a relatively small area of film, the method is capable of uniform application.

In addition, in normal processing procedures, the time element between the application of various solutions is not of particular consideration since it is normally short when compared to the individual processing time cycle. Considering rapid processing, the time element is important for two reasons. First, it may become proportionately large when compared to the solution time cycles and thus contributes materially to the overall time cycle. For example, several rapid processing systems now in use apply the procedure of sequentially timed valve action for applying the solutions with a lost time interval existing between the closing of one valve and the opening of the next valve in the succession. Further, in order to minimize this lost time element, the processing sequence is often reduced to its basic solutions, thereby eliminating the secondary elements in the cycle which are essential to good processing. In addition, as the processing cycle is shortened, the application time for any solution becomes extremely short so that any small between-the-solution variable, as may be introduced by valve action and the like, will materially effect the desired result.

It is, therefore, an object of this invention to provide an improved rapid film processing system assuring the precise, successive application of minute quantities of processing solutions without loss of sequence, overlap or contamination.

It is a further object of this invention to provide an improved rapid film processing system in which each

step of the required processing sequence immediately follows the preceding step so as to realize the shortest potential processing cycle.

A further object of this invention is to provide an improved rapid film processing system which eliminates critical timing adjustments for the sequential application of the separate processing solutions.

Another object of this invention is to provide an improved rapid film processing system which is inherently self-cleaning after each cycle of operation.

In accordance with this invention, an applicator nozzle is provided through which a plurality of separated solutions are sequentially sprayed onto the film to be processed. The nozzle is connected to a supply tube, which in some instances may be a capillary type, and means are provided for charging the tube with separate quantities of distinct processing solutions and interposing gas bubbles between each of these solutions. Pressure means are included for expelling the contents of the tube in sequential order through the solution nozzle, thereby to be sprayed on the film.

Other objects, features and advantages will be apparent from the following description of the invention, pointed out in particularity in the appended claims and taken in connection with the accompanying drawing, in which:

The figure is a diagrammatic view, partly in section, of a film processing apparatus embodying the invention.

Referring now to the drawing, there is shown a high speed processing chamber **2** having spaced walls **3** which define, at one end, a drain **4** and, at the other end, an aperture **5**. Located over the aperture **5** of the chamber **2** is the film **6** to be processed. The latter may be arranged to move over the chamber **2** intermittently in such a manner that picture areas are either sequentially placed for processing or are processed at a uniform rate, so that each processing cycle covers distinct areas of the film.

The movement of the film is preferably interlinked with the actuation of the valves which control the ejection and replenishing of the processing solutions. The film movement and interlinkage is schematically shown, consisting of the film supply roll **10**, guide roller **11** and windup roll **12**. Metering rollers **13** and **14** contact the edge of the film **6**, or perforations thereof, so that these rollers turn in accordance with the movement of the film. Coupled to the roller **14** is the valve actuating roller **15** having a suitable cam **16** which, in any desired manner, such as by pneumatic or electric means, initiates operation of the valves every time that the film **6** travels a predetermined distance. The interconnection of the cam **16** with the valves **17**, **18**, **19**, **20**, **21** and **22** is shown schematically by dotted lines.

Within the film processing chamber **2** is positioned the processing solution nozzle **25**. In addition, an air nozzle **26** is positioned within the same chamber and adjacent to the solution nozzle **25** for introducing a gas, normally air, for drying the film and to supply additional kinetic energy to the jet of the solution emerging from the solution nozzle **25**. It should be noted that the arrangement of the nozzles may take several forms; an aspirating type may be used, but I prefer a non-aspirating type, as illustrated. A divergent air nozzle is used to avoid the known "critical pressure" problem which limits the discharge of gases or vapors from the drill hole of this type of nozzle. The solution nozzle **25** is adjacent to but not interconnected with the gas nozzle in order to make the discharge mutually independent. This arrangement provides a controlled solution droplet size, larger than normally obtained with aspirator sprays which tend to atomize liquids. An air supply tube **27** is connected directly to the air nozzle **26** and drying air valve **22** is provided to control the flow of air to the film processing chamber

from air supply tank 28. Likewise, the supply tube 29 is connected to the solution nozzle 25.

An important part of this invention is the manner in which the supply tube is charged with properly sequenced measured quantities of the processing solution. The various processing solutions *a*, *b*, etc., are held within reservoirs 30 and 31. For the sake of simplicity, only two reservoirs are shown, but it is readily apparent that any number can be employed, connected to the system in the manner shown. The reservoirs 30 and 31 are connected to the tube 29 through connecting conduits 32 and 33 and charging valves 19 and 20, respectively. The charging system operates under a gravity flow arrangement wherein the liquids or solutions supplied by the reservoirs tend to seek their own level within the tube 29 upon opening of the charging valves 19 and 20, as clearly shown in the drawing. Thus, the volume of processing solution which is allowed to enter the tube 29 under the gravity flow principle is determined by the liquid level within the reservoirs as well as the inner diameter and the length of the tube 29. It is easily seen that the quantity of each processing solution delivered to the processing chamber is predetermined and remains constant regardless of the number of operating cycles of the processing apparatus. Each time the charging valves 19 and 20 are opened, a measured quantity of processing solution is allowed to enter the tube 29.

In addition, the air vent valves 17 and 18 play an important part in this invention and upon opening allow air to enter the tube 29 and be interposed between the separated distinct quantities of processing solutions. In addition, the air column in the tube 29 provides a required "time" interval between the delivery and discharge of the successive processing solutions within the film processing chamber so that there is an avoidance of solution-to-solution contamination and insures that each successive solution application be distinct from the preceding solution.

Discharge valve 21 is provided to allow the introduction of sufficient air pressure from the tank 28 to expel the separated distinct solutions and the dividing air columns from within the tube 29, thereby to effect the sequential discharge of the contents into the film processing chamber 2 through the solution nozzle 25. Both the solution supply tube 29 and the air supply tube 27 pass preferably through a temperature controlled heated compartment 35 just prior to their discharge in the processing chamber 2 in order to avoid solution "breakdown" under prolonged high temperature storage.

In the preferred embodiment, the solution charging valve members 17 and 18 and the discharge valves 19 and 20 are operated simultaneously, so as to establish the solution level and the separating air columns. Thereafter, the valves are closed and valves 21 and 22 are opened to expel the solution and add an air jet from nozzle 26.

The operation of the valves may be accomplished in various ways. Instead of individual valves, as shown, a master valve may be employed of such construction as to allow operation of the system in the sequence indicated from one central point.

The individual valves shown may be interlinked in such a manner that as the film is moved the required distance, the rotation of the rollers 13 and 14 positions the cam 16 to open first valves 17, 18, 19 and 20 while the film 6 is moving.

When the film 6 has traveled the distance required for a new frame or area to be sprayed over the aperture 5 of the chamber 2, the cam 16 will be in a position to close valves 17, 18, 19 and 20 and effectuate the opening of the discharge valves 21 and 22. The air pressure thus released expels the spaced liquids in the tube 29 and also releases an air stream for the air jet 26.

It is seen from the above that, in essence, the reservoirs 30 and 31 and the tubular conduit 29 with its vertical portions extending above the reservoir, form communicating vessels at atmospheric pressure when the valves 17 and 18 are opened so that the volume of liquid in each particular section will be the same. This is governed, of course, by the height of the solution in the reservoirs. Since the volumetric content of the reservoirs is extremely large in comparison with the volumetric content of the vertical and lower horizontal portions of the tube 29, uniform metering of the solutions is assured for repeated operations when the tube 29 is charged.

While this invention is described in connection with the rapid processing of photographic film employing sequential delivery of film processing solutions in separate and distinct measured quantities from a single capillary tube, I do not desire the invention to be limited to the particular construction shown and described and the appended claims are intended to cover all modifications within the spirit and scope of my invention.

I claim:

1. An apparatus for rapid processing of photographic film by successively spraying minute quantities of processing solutions on the film comprising at least one processing solution nozzle, means for supporting the film in proximity to said nozzle, a tube connected to said nozzle, gravity operated means for charging said tube with separate quantities of distinct processing solutions, gravity operated means for interposing a quantity of immiscible gas between each of said separate quantities of distinct processing solutions, whereby said gas maintains solution separation, and means for moving said separate quantities of distinct processing solutions and each interposed quantity of gas through said tube to said nozzle, whereby said processing solutions are sequentially sprayed onto said film.

2. An apparatus as claimed in claim 1 wherein said interposed quantity of immiscible gas is an air column.

3. Apparatus as claimed in claim 1 further including means for heating the contents of said tube prior to delivery to said processing solution nozzle, said heating means being positioned between said processing solution nozzle and said charging means for charging said tube.

4. Apparatus for rapid processing of photographic film comprising a plurality of reservoirs containing distinct processing solutions, a tubular conduit interconnecting said reservoirs, said conduit having portions extending vertically above said reservoirs and horizontal portions interconnecting said vertical portions whereby said reservoirs and said tubular conduit form communicating vessels, a nozzle at one end of said conduit directed toward the film to be processed, an air storage tank above atmospheric pressure connected to the other end of said conduit, including an air pressure valve, valve means between each said reservoirs and said conduit, an air inlet in each said horizontal portion including inlet valves therefor, means for simultaneously opening and closing said valve means and said inlet valves thereby charging said conduit with said solutions and retaining an air column between them and means for opening said air pressure valve for expelling said charge and said retained air through said nozzle.

5. Apparatus for rapid processing of photographic film comprising a plurality of reservoirs containing distinct processing solutions, a tubular conduit interconnecting said reservoirs, said conduit having portions extending vertically above said reservoirs and horizontal portions interconnecting said vertical portions whereby said reservoirs and said tubular conduits form communicating vessels, a nozzle at one end of said conduit directed toward the film to be processed, means for transporting discrete portions of said film past said nozzle, air pressure means connected to the other end of said conduit, including an air pressure valve, valve means between each said reservoirs and said conduit, an inlet in each said horizontal portion including inlet valves therefor, means interconnected with said transporting means for simul-

taneously opening and closing said valve means and said inlet valves while said film is in motion thereby charging said conduit with said solutions and means interconnected with said transport means for opening said air pressure valve for expelling said charge through said nozzle while said discrete portion is in position to receive said charge.

6. Apparatus as claimed in claim 4 including a second nozzle connected by means of a conduit to said air storage tank including a release valve, said second nozzle

providing an air stream intermixed with the stream of said first nozzle, and means for opening said release valve simultaneously with said air pressure valve.

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