

Aug. 8, 1967

M. FRIEDEL

3,334,566

PHOTOGRAPHIC DEVELOPING APPARATUS

Filed Feb. 2, 1965

FIG. 1

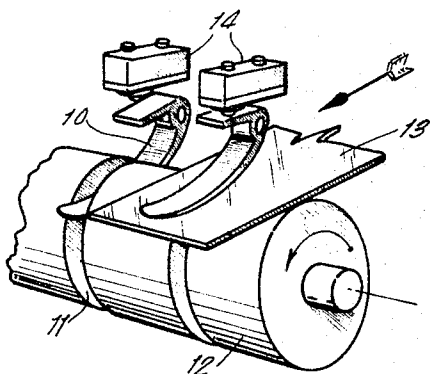
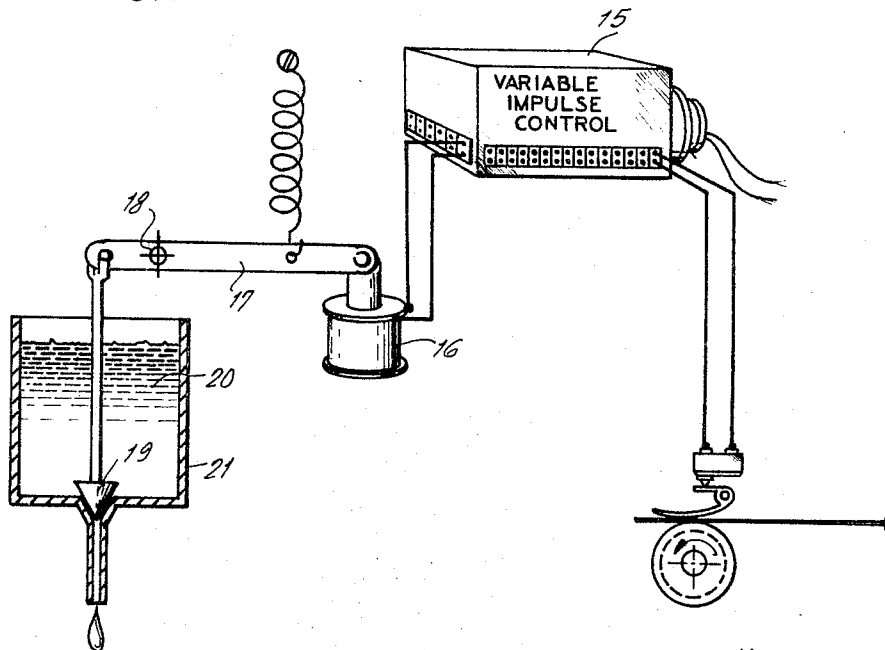


FIG. 2

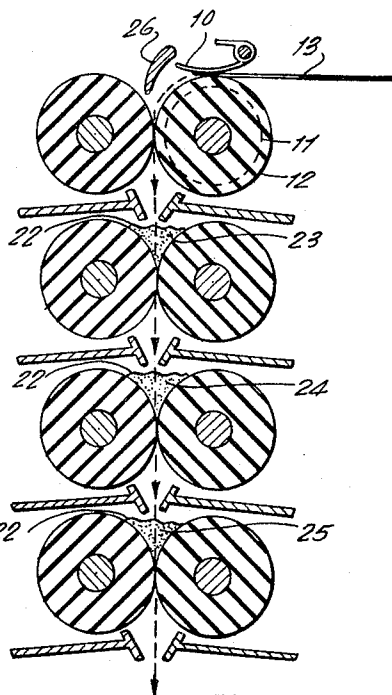


FIG. 3

INVENTOR.
MURRAY FRIEDEL

BY *Albert F. Korman*

ATTORNEY

1

3,334,566

PHOTOGRAPHIC DEVELOPING APPARATUS

Murray Friedel, North Miami Beach, Fla., assignor to Visual Graphics Corp., New York, N.Y., a corporation of New York

Filed Feb. 2, 1965, Ser. No. 429,750

1 Claim. (Cl. 95—89)

ABSTRACT OF THE DISCLOSURE

Apparatus, responsive to the passage of a sheet of photographic material therethrough, for adding processing chemicals to a processing bath in order to maintain the bath at a constant strength throughout continued operation of the processor.

This invention relates to photographic developing apparatus. In particular, this invention relates to photographic developing apparatus equipped with means for automatically maintaining processing solutions at proper strength.

In many photographic processing operations, it becomes a problem to maintain the concentration of the various processing solutions at proper strength. This is particularly a problem with respect to the developer solution, the function of which is to reduce to metallic silver those grains of silver halide in the emulsion that have been previously activated by the absorption of light energy.

This chemical reduction or development process must be carefully controlled with respect to a number of variables. In the usual practice, the initial exposure is controlled so as to give a latent image which, when processed under standard conditions, will develop to the proper density. Obviously, if the conditions are other than standard, the image will be either over or underdeveloped, and the image quality correspondingly poor. The most important variables in the processing operation are time, temperature and the concentration of the solution.

The time of development is easily controlled by a variety of well known mechanical means, or may be controlled manually by the operator with the aid of a timer.

Similarly, control of the processing temperature ordinarily presents no particular difficulty. Control of the concentration of the developer, however, is more of a problem. Being a reducing agent, the developer is subject to oxidation by the atmosphere, and such oxidation consumes the reducing agents, lowering the effective concentration of the solution. Also, each piece of photographic material (film, paper, etc.) that is processed consumes a portion of the reducing agents in the developer so that the developer gradually becomes exhausted.

The traditional approach to the problem of keeping the developer strength constant within reasonable limits has been to use large volumes of solution, protecting them so far as possible against atmospheric oxidation, and to limit the number of pieces processed by a given batch so that the effective concentration of the developer does not vary appreciably between the first and the last piece processed. This approach is wasteful in that, if the concentration of the solution when discarded was substantially the same as its concentration when fresh, large amounts of unused reductant are necessarily discarded.

The problem of maintaining developer concentration is particularly acute in connection with certain more recent types of photographic processing equipment, in which the reservoir of processing liquid is a chamber formed by a plurality of contiguous rollers. In order to make a liquid tight seal, such rollers must be made and mounted to close tolerances. This fact adds to their cost,

2

the the difficulty and expense of constructing such apparatus mount sharply as the size increases. More over, processing apparatus of this type is frequently designed for applications requiring compactness, such as use aboard spacecraft and the like. In keeping such apparatus small, whether for cost or end-use requirements, it is necessary to make the reservoir of processing fluid correspondingly small. This, in turn, aggravates the difficulties mentioned above, and makes it more difficult to maintain the effective concentration of the processing solution. An object of the invention is to provide improved apparatus for developing photographic materials.

Another object is to provide apparatus for automatically maintaining the concentration of photographic processing solutions.

Another object is to provide a photographic processing apparatus which makes more efficient usage of processing chemicals, and wastes less of such chemicals than apparatus and methods heretofore proposed.

A further object is to provide means for effectively maintaining the concentration of processing solutions in apparatus using small volumes of such solutions.

A feature of the present invention is the use of sensing means to signal the passage of a sheet of photographic material to or through a processing machine.

Another feature is the use of dispensing means for delivering repeated small, controlled increments of processing chemicals to a reservoir of processing solution.

Still another feature is the use of sensing means for signaling the approximate size of a piece of photographic material being processed, and dispensing means responsive to said sensing means; for adding an increment of processing chemical to a reservoir of processing solution, said increment being approximately proportioned to the amount of processing chemical consumed by the processing of said piece of photographic material.

The invention consists of the construction, combination and arrangement of parts, as herein illustrated, described and claim.

In the accompanying drawing, forming a part hereof is illustrated several embodiments of the invention, and in which:

FIGURE 1 is a somewhat diagrammatic view, partly in perspective and partly in central cross-section of an apparatus according to one embodiment of the invention.

FIGURE 2 is a fragmentary perspective view of the sensing means according to a slight different embodiment of the invention.

FIGURE 3 is a central cross-section of a photographic processing apparatus according to another embodiment of the present invention.

Referring now more particularly to FIGURES 1 and 2, the apparatus comprises sensing means in the form of fingers 10, which normally ride in channels 11 cut in roller 12. Roller 12 may be simply a part of the sensing system, but for economy of construction, it is generally made a part of the feed system whereby the sheet material is fed into the apparatus. As a sheet of photographic material 13 is fed into the apparatus, it lifts one or more fingers 10 out of their respective channels 11, closing an associated switch 14. Switch 14, in turn, signals a variable impulse control 15, which transmits an impulse to control means represented by solenoid 16. Solenoid 16, through a suitable linkage represented by lever 17, pivoted at 18, momentarily opens an appropriate dispensing valve such as needle valve 19, which allows the flow of a controlled increment of processing chemical solution 20 out of a supply tank 21 into the working reservoir of processing solution (not shown in these figures).

In the preferred embodiment of the invention, there are provided a plurality of sensing fingers 10 in side-by-side

parallel relationship, each riding in its own respective channel 11. Each of the sensing fingers 10 actuates a switch 14, and each of switches 14 feeds a separate channel in the variable impulse control 15.

The variable impulse control is an assembly of conventional circuitry responsive to two characteristics of the input signals: (1) the number of channels activated (i.e. the number of sensing fingers 10, lifted by the incoming sheet material) and (2) the length of time for which each channel is activated. These responses can be achieved in a variety of ways. In one convenient arrangement the variable impulse control includes a "clock circuit" which periodically samples each of the sensing channels. Such a clock circuit may, for example, make contact with each of five sensing channels for one-fifth of a second each second. The clock circuit may feed the received impulse signals into a delay line or directly to the solenoid 16 (through an amplifier if desired) so that each pulse sensed from the sampling of the sensing fingers causes the solenoid to open valve 19 for a discrete interval, thereby dispensing a controlled increment of processing chemical solution 20.

The solenoid may of course, if desired, be preceded by a counter, and open the valve only once for a predetermined number of impulses, rather than opening it in response to each impulse.

The concentration of the processing chemical solution and the duration of the period during which the valve is opened in response to each impulse should be chosen so as to keep the effective concentration of the processing bath substantially constant. In this respect, it may be observed that (neglecting the effect of atmospheric oxidation) the depletion of the effective strength of the processing solution arises from two sources: (1) the depletion of reductant values by chemical reaction with the material being processed, and (2) mechanical removal from the bath of solution which has soaked into the material being processed. Both of these sources of depletion are proportional to the area of the sheet material being processed.

Atmospheric oxidation may be disregarded for all practical purposes, because of the fact that the solution is continually being replenished, so that the effect of atmospheric oxidation is easily compensated for by slightly correcting upwardly the size of the increment of processing chemical dispensed in response to each impulse.

In order to keep the volume of the bath constant, the apparatus should be adjusted so that the volume of makeup solution added is substantially equal to the volume of solution mechanically removed by the sheet material as it is discharged. This is easily accomplished, bearing in mind that: (1) the volume of solution dispensed as makeup, and the amount of solution mechanically removed from the processing bath, are both proportional to the area of the sheet material being processed; and, (2) the sensing means is responsive to the area of the sheet material, because the number of impulses is proportional to the product of the length and the width (and hence the area) of the sheet material.

Fine adjustments to the mechanism are generally most easily and effectively made by periodically checking the concentration and level of the processing solution in the actual processing bath, rather than by calculating the proper settings a priori. Thus, the apparatus is initially set to deliver a volume of solution approximately equal to that mechanically removed in processing, and at an effective concentration approximating that of the initial charge to the processing bath. After the apparatus has run for a moderate period of time, the liquid level in the processing bath is checked, as is the effective concentration thereof. (By the term "effective concentration" is meant the concentration of active reductant, disregarding the presence of spent reductant in the solution.)

If the volume of the liquid in the processing bath tends to decrease, it indicates that the volume of liquid re-

moved mechanically, as liquid soaked into the sheet material, is greater than the volume of the increment of solution added in response to the sensing means. In such a case, the length of the pulse may be increased, or the value may be adjusted to deliver a greater volume of liquid at each pulse. Similarly, if the tendency is for the volume of the processing bath to increase, the pulse may be shortened or the valve may be adjusted to deliver a smaller volume of solution for each pulse.

If the volume remains constant (after any necessary adjustment, as just described) but the solution in the processing bath becomes progressively more or less concentrated, the situation is easily compensated by respectively decreasing or increasing the concentration of the makeup solution.

It may be noted that it is ordinarily not necessary to perform chemical tests in order to detect changes in the concentration of the solution (although chemical tests may be used, if desired). Normally, the operator is able very readily to detect a weak or an overly strong developer merely by observing the condition of the processed material as it emerges from the machine.

In this way, by merely observing the changes, if any, in the volume of the processing solution and in the degree of development of the processed sheet material, the operator can make small adjustments as needed and keep the processing solution at substantially constant, optimum strength.

If desired, even these observations and adjustments can be readily automated, by interposing concentration and volume sensing means and adjusting means in the form of a feedback loop which, however, is not a part of the present invention.

FIGURE 3 illustrates in central cross-section, one type of photographic processing apparatus to which the present invention is applicable. In the apparatus according to FIGURE 3, a plurality of processing baths 22 are provided, each bath consisting of a body of liquid processing chemical solution or the like, contained in a reservoir formed by the V-shaped trough between a pair of contacting rollers, together with suitable end-plates (not shown) to close the ends of the troughs.

In the apparatus according to this embodiment of the invention, the various solutions are arranged in a vertical array, and the sheet of photographic material 13 enters at the top and passes downwardly through the various processing baths in turn. The processing baths may be, in a typical case, a developer solution 23, a stop-bath 24, and a fixer 25 such as sodium thiosulfate solution, in order named, proceeding from top to bottom.

At it is fed into the apparatus, the sheet material 13 initially passes over roller 12, lifting fingers 10 out of channel(s) 11 as it goes. Sensing fingers 10 are connected to switches 14, which transmit signals to a variable impulse control 15, which in turn controls a dispensing valve 19, as illustrated in FIGURE 1, and dispensing valve 19 controls the addition of makeup solution to at least one of processing baths 22. Normally, the first processing bath 22 is the one which contains the developer solution, and this will be replenished by a makeup system responsive to sensing fingers 10. If desired, the other processing baths may also be replenished in the same way, but the concentration of the other baths, such as the stop bath and the fixer are not as critical. For this reason, it may be found more desirable from an economic standpoint to provide for automatic control of only the developer, and rely on the operator to maintain an adequate concentration of processing chemicals in the other baths. In some applications, however, such as the processing of color film, precise control is required to be maintained on the concentration of several processing solutions. Where this is the case, the variable impulse control may be connected to a number of dispensing valves, each serving to replenish a different processing bath.

5

As the sheet material is fed into the apparatus of FIGURE 3, after passing between roller 12 and sensing fingers 10, it is deflected downwardly by flange 26 into the nip between the rolls, and is carried through the successive processing baths 22, as indicated by the dashed line and arrows.

The present invention, as above described, provides improved apparatus for developing photographic materials. In particular, it provides improved apparatus for maintaining a constant concentration in photographic processing solutions. The apparatus of this invention makes possible more efficient usage of processing chemicals, and minimizes waste of these materials. It is capable of automatically maintaining a constant effective concentration of processing chemicals, even in baths of very limited volume.

While this invention has been described with reference to certain preferred embodiments and illustrated by way of certain drawings, these are illustrative only, and many alternatives and equivalents will readily occur to those skilled in the art, without departing from the spirit and proper scope of the present invention.

Having thus fully described the invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

Apparatus for controlling the addition of processing chemicals to a photographic processing bath, said apparatus comprising in combination means for sensing the pas-

6

sage of a sheet of photographic material to said bath comprising a roller having a circumferential channel, a pivotally mounted sensing finger normally resident in said channel and subject to be lifted out of said channel by the passage of a sheet of photographic material over said roller, and an electrical switch responsive to the position of said sensing finger, means responsive to said sensing means for generating a timed series of spaced electrical pulses throughout the time said sensing means is activated by such sheet, a reservoir of processing chemical and valve means controlling the flow of processing chemical from said reservoir to said processing bath, said valve means being responsive to said electrical pulses to permit the flow of a predetermined increment of processing chemical from said reservoir into said processing bath in response to a predetermined number of said pulses.

References Cited

UNITED STATES PATENTS

20	2,446,668	8/1948	Tuttle et al.	95—89
	2,778,734	1/1957	Fairbank.	
	2,837,988	6/1958	Pavelle	95—89
	3,142,242	7/1964	Erikson	95—89
25	3,202,072	8/1965	Limberger	95—89

NORTON ANSHER, *Primary Examiner.*

F. L. BRAUN, *Assistant Examiner.*