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PHOTOGRAPHIC FILM PROCESSING METHOD

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Fig. 1.

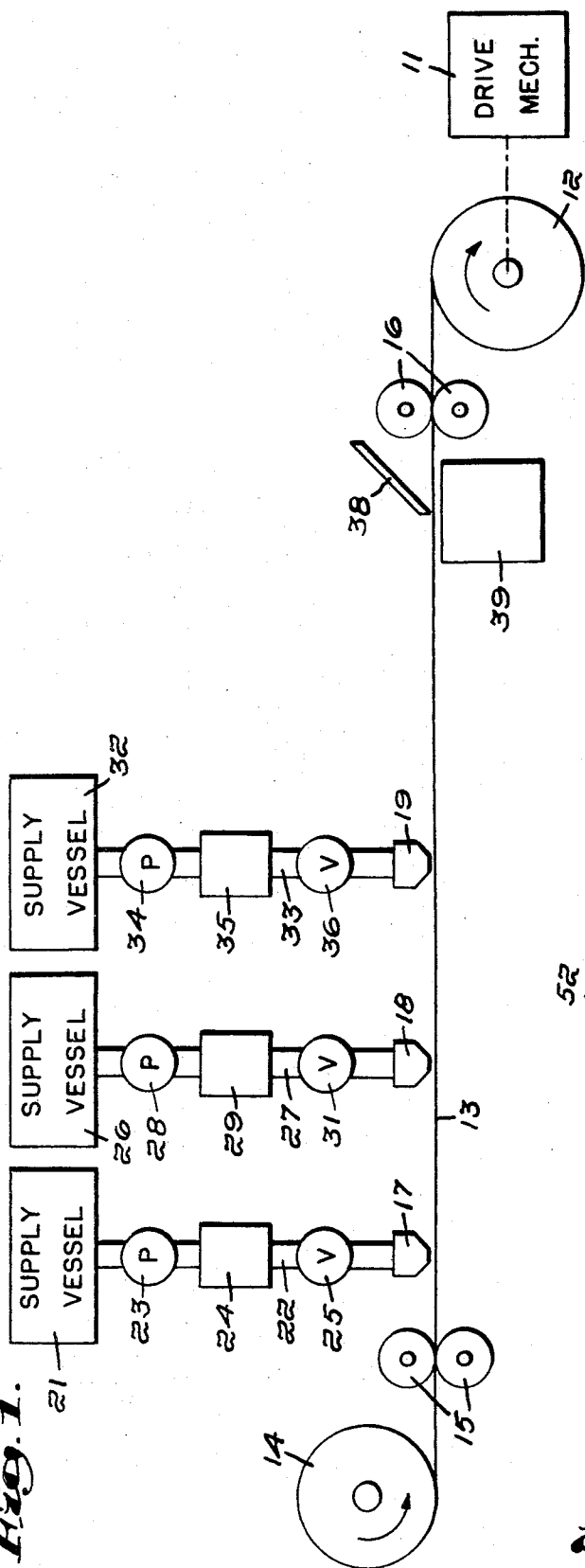


Fig. 3.

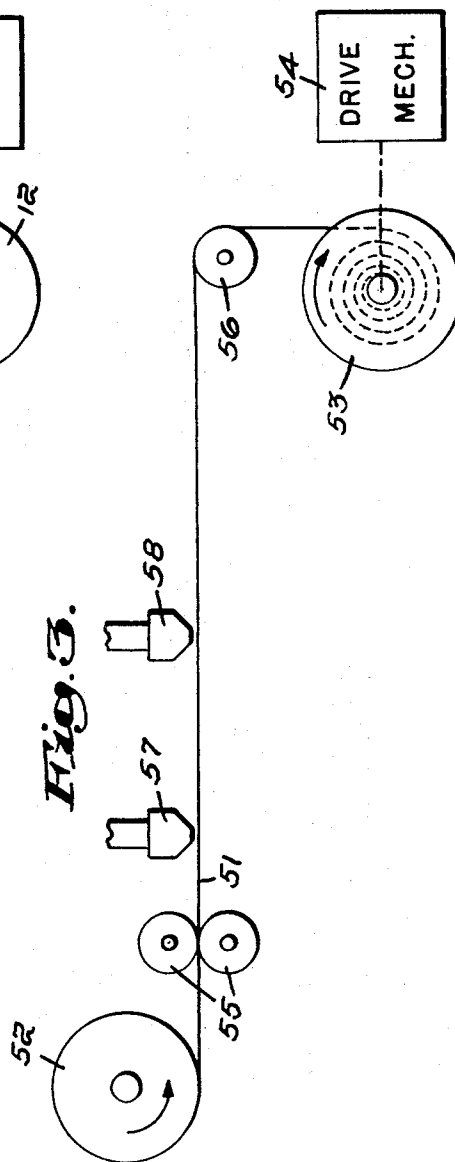
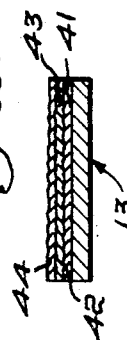


Fig. 2.



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PHOTOGRAPHIC FILM PROCESSING METHOD
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8 Claims

ABSTRACT OF THE DISCLOSURE

A method for processing photographic film with multiple layers of different viscous processing reagents is disclosed. The method involves applying a first viscous processing layer to the film followed by the application of a second viscous processing layer upon the first layer. Because the two layers have viscosities of at least 5,000 centipoises, the first layer supports and initially isolates the second processing layer. Both layers are left on the film until reagent from the second viscous layer diffuses through the first layer and completes processing of the film.

BACKGROUND OF THE INVENTION

This invention relates generally to a method and apparatus for processing photographic film. The invention is especially suited for the viscous processing of continuous film strips.

According to well known processing techniques, an exposed film strip is transported through a plurality of tanks each containing a different liquid processing reagent. In a typical application, the individual tanks might contain a developing liquid, a shortstop liquid, a fixing liquid and a washing liquid. Normally, liquid immersed guide rollers are mounted at opposite ends of each tank and additional guide rollers are provided between the separate tanks. These roller members guide the processing film strip in a generally sinuous path through the individual liquid reagents. Processing apparatus of this type is disclosed and shown, for example, in U.S. Pat. No. 2,248,056 issued July 8, 1941 and U.S. Pat. No. 2,651,245 issued Sept. 8, 1953.

Such conventional processing methods exhibit numerous disadvantages, the primary of which is the requirement for costly and cumbersome equipment. Another undesirable requirement is that the path length of the processing film be of substantial length. Both of these factors are particularly objectionable when available space is somewhat limited as in airborne film processing applications. Still other problems associated with known processing apparatus are the tendencies of their numerous rollers to scratch film surfaces and to introduce distortion thereof because of excessive tensioning or existence of differential speeds between separate longitudinal sections of the processing strip.

One method that requires fewer sequential processing operations entails the use of the well known monobath solution. By combining a plurality of processing liquids into a single reagent mixture, equipment needs are substantially reduced. Thus, many of the above mentioned problems are alleviated. However, monobath processing itself suffers from a number of undesirable characteristics, the dominant of which is a lack of flexibility. Since a monobath solution stops film development after a given predetermined time, variations in development can be achieved only by utilizing separately prepared solutions. Also, monobath processing both limits attainable density because of the desolving and loss of silver halide and tends to degrade image quality and resolution.

The object of this invention, therefore, is to provide

an improved film strip processing method and apparatus that offers the advantages of multi-reagent processing while reducing the attendant equipment requirements.

CHARACTERIZATION OF THE INVENTION

The invention is characterized by the provision of a method for processing photosensitive materials including the steps of applying a first layer of a given viscous processing reagent to an exposed surface of photographic film, applying a second layer of different viscous processing reagent over the first layer which initially isolates the different viscous reagent from the exposed material surface, and maintaining the first and second layers on the film's exposed surface for a time period of sufficient length to permit the different viscous reagent to contact the exposed surface by diffusing through the first layer of given processing viscous reagent. This method provides the processing flexibility attainable with distinct separate purpose reagents while eliminating the cumbersome procedural requirement of removing a previously applied reagent before the application of a new one.

A feature of this invention is the provision of a method of the above type wherein the given viscous processing reagent comprises an image developing substance and the different viscous processing reagent comprises a development stopping substance. According to this method the density of the developed image is determined by the time required for the stop reagent to diffuse through the layer of developing substance and thereby stop the development process.

Another feature of this invention is the provision of a method of the above featured types wherein the viscous processing reagents have viscosities of greater than 5000 centipoises. The physical stability of high viscosity reagents enhances their ability to be applied in layer form one above the other.

Another feature of this invention is the provision of a method of the above featured types wherein the second layer of viscous processing reagent has a greater depth than does the first viscous layer. The greater depth of the second layer increases the rate at which it diffuses through the first viscous layer.

Another feature of this invention is the provision of a method of the above featured types wherein the second layer of viscous reagent has a lower viscosity than does the first layer. This difference in relative viscosities also increases the rate at which diffusion through the bottom layer occurs.

Another feature of this invention is a provision of a method of the above featured types wherein the second layer of viscous reagent is applied at a higher temperature than is the first layer. Again, the difference in relative temperatures enhances the required diffusion process.

Another feature of this invention is the provision of a method of the above featured type including the steps of applying a fixer substance layer over the stop substance layer and removing the three substance layers from the exposed film surface after the fixer substance has penetrated both the developer and stop layers. The hardening produced by the fixer substance after diffusion through the lower substance layers prevents emulsion damage during their removal.

The invention is characterized further by the provision of a photographic film processing apparatus including transport means for continuously feeding an elongated strip of photographic film from a feed position to a takeup position, a first applicator for applying a layer of a given viscous processing reagent to an exposed surface of the film strip, and a second applicator for applying a second layer of a different processing reagent over the first layer. This apparatus is uniquely suited for practicing the

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above described methods for continuous processing of roll film.

Another feature of this invention is the provision of a photographic processing apparatus of the above type including depth and temperature regulators for controlling the depths and application temperatures of the first and second viscous processing reagent layers. The temperature and depth regulators permit the attainment of predetermined relative layer depths and temperatures as described above.

Another feature of this invention is the provision of a photographic film processing apparatus of the above featured types including a removal mechanism for automatically removing both the first and second applied layers after a time period required for diffusion of the second layer through the first.

Another feature of this invention is the provision of a photographic film processing apparatus of the next above featured type including a film strip takeup mechanism adapted to prevent surface contact between different sections of the accumulated film. In this embodiment, the reagent layers are not removed and processing action continues after film strip takeup.

These and other objects and features of the present invention will become more apparent upon a perusal of the following specification taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic illustration of a preferred processing apparatus embodiment of the invention;

FIG. 2 is a cross-sectional view of the film strip shown in FIG. 1; and

FIG. 3 is a schematic illustration of another preferred processing apparatus embodiment of the invention.

Referring now to FIG. 1 there is shown a drive mechanism 11 operatively coupled to the takeup reel 12 and adapted to produce movement of the photographic film strip 13 from the supply reel 14. During movement between the supply reel 14 and takeup reel 12, the film strip 13 passes between the adjacent alignment rollers 15 and the longitudinally spaced, adjacent alignment rollers 16. Mounted in longitudinally spaced positions above the film strip 13 are the applicator nozzles 17, 18 and 19.

The first nozzle applicator 17 is connected for fluid communication with the processing reagent supply vessel 21 by the supply tube 22. Disposed in the supply tube 22 are the fluid pump 23, the thermostatically controlled immersion heater 24 and the pressure regulating valve 25. Similarly, the second applicator nozzle is connected to the supply vessel 26 by the supply tube 27 that includes the fluid pump 28, the thermostatically controlled immersion heater 29 and the pressure regulating valve 31. Finally, the third applicator nozzle 19 is connected to the processing reagent supply vessel 32 by the supply tube 33 also including a fluid pump 34, thermostatically controlled immersion heater 35 and pressure regulating valve 36.

The doctor blade 38 is mounted above the film strip 13 between the third applicator nozzle 19 and the alignment rollers 16. Positioned below the film 13 and in vertical alignment with the doctor blade 38 is the processing reagent collection vessel 39. The doctor blade 38 is adapted for vertical adjustment to permit selective engagement with viscous reagent carried on the top surface of the film strip 13.

During typical operation of the apparatus shown in FIG. 1, the supply vessel 21 contains viscous substance comprising a conventional developer solution to which a chemically inert thickening agent has been added. The supply vessel 26 is filled with a viscous substance comprising a conventional shortstop solution to which thickening agents also have been added. Similarly, the supply vessel 32 contains a viscous substance comprising a conventional fixer solution and chemically inert thickeners. Thickening agents suitable for use in preparing viscous film processing reagents include, for example, natural

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and synthetic polysaccharides, enzymes, starches, thermoplastic and thermosetting acrylic resins, etc.

As either a black and white or color film strip 13 passes beneath the first applicator nozzle 17 its upper exposed surface is coated with a layer of viscous developer reagent supplied from the supply vessel 21 by the fluid pump 23. The temperature and depth of the applied layer is accurately controlled by adjustment of the thermostatically controlled immersion heater 24 and fluid pressure regulating valve 25. The film strip 13 then moves past the second applicator nozzle 18 and the previously applied developer layer is covered with a layer of viscous shortstop that is supplied from the supply vessel 26 by the fluid pump 28. Again, the temperature and layer depth of the viscous shortstop is precisely controlled by selective adjustment of the thermostatically controlled immersion heater 29 and the pressure regulating valve 31. Finally, as the film 13 moves under the third applicator nozzle 19, the previously applied shortstop layer is covered with a layer of viscous fixer supplied from the supply vessel 32 by the fluid pump 34. The temperature and layer depth of the viscous fixer also is regulated by selective adjustment of the thermostatically controlled heater 35 and fluid pressure regulating valve 36. Thus, as shown in FIG. 2, after moving beneath the third applicator nozzle 19, the exposed surface 41 of the film strip 13 supports in three separate and distinct layers the viscous developer substance 42, the viscous shortstop substance 43 and the viscous fixer substance 44.

The transport rate of the film strip 13 and the distances between the applicator nozzles 18 and 19 and the doctor blade 38 are such that the viscous layers 42, 43 and 44 remain on the exposed film surface 41 for predetermined time periods. These periods are of sufficient length for both the shortstop substance 43 and fixer substance 44 to diffuse through the developer layer 42 into contact with the exposed film surface 41. Thus, at a predetermined time after having been applied the shortstop reagent 43 diffuses through the developer layer 42 to terminate development in the conventional manner. Subsequently, at some later predetermined time, the fixer substance 44 penetrates both the shortstop layer 43 and the developer layer 42 to fix and harden the film 13 without formation of sludge or scum. Consequently, the emulsion is not damaged during removal of the viscous layers by the doctor blade 38 and a fully processed and cleaned film strip 13 is accumulated by the takeup reel 12.

The above described method and apparatus permits the execution of distinct film processing steps with separate viscous reagents and without the requirement for sequential removal of the separately applied reagents. This latter factor substantially reduces the complexity and cost of necessary equipment in addition to shortening the required processing time. Furthermore, the unique method offers great flexibility since the various process stages can be controlled individually. Such control is obtained by selectively establishing the time periods required for the upper viscous layers to diffuse through the lower layers into contact with the film surface. These diffusion time periods can be regulated by a number of controllable viscous reagent characteristics including, for example, individual depths of the applied layers, absolute and relative viscosities, processing chemical concentrations, absolute and relative temperatures, types of thickeners used, humidities, etc.

Preferably, the reagents have viscosities of greater than 5000 centipoises at 70° F. so as to exhibit a physical stability suitable for their application in layers. Also, the desirable diffusion rates are obtained by applying layers of viscous reagent over reagent layers of lower viscosity. Further enhancement of the diffusion process is obtained by sequentially applying reagent layers of increasing temperature and depth. However, it will be appreciated that the various factors influencing diffusion rate can be modified in particular processing applications.

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FIG. 3 shows another embodiment wherein the film strip 51 is driven between the supply reel 52 and the take-up reel 53 by the drive mechanism 54. Guiding the movement of the film strip 51 are the pair of adjacent roller members 55 and the longitudinally spaced single roller member 56. The applicator nozzles 57 and 58 are disposed at spaced positions above the travel path of the film strip 51.

The operation of this embodiment is similar to that described above with the nozzle applicators 57 and 58 applying layers of different viscous processing reagents to the transported film strip 51. However, in this case the applied reagents are not removed before accumulation of the film strip 51 on the takeup reel 53. Therefore, processing action can continue on film surface portions already wound on the takeup reel 53. For this reason, the length of the processing path can be reduced with a corresponding reduction in the overall dimensions of the processing equipment. Preferably, the takeup reel 53 is of the spiral-wind type that precludes surface contact between radially adjacent sections of the accumulated film strip thereby preventing the application of external pressure on the applied reagent layers.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. For example, the number and kinds of viscous reagent layers applied can vary depending upon the results desired and the particular films, such as black and white or color, being processed. Therefore, the specific embodiments described above should be considered merely exemplary with the understanding that the invention can be practiced otherwise within the scope of the appended claims.

What is claimed is:

1. A method for processing photosensitive material comprising the steps of applying a first layer of a given viscous processing reagent to an exposed surface of the photosensitive material, applying a second layer of a different viscous processing reagent upon said first viscous layer so that said first viscous layer supports and initially isolates said different viscous processing reagent from said exposed surface, said first and said second viscous layers having viscosities of at least 5,000 centipoises measured at 70° F., and maintaining both of said first

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and said second layers on said exposed surface for a time period of sufficient length to permit said different viscous processing reagent to contact and process said exposed surface by diffusing through said first layer of said given viscous processing reagent.

2. A method according to claim 1 wherein said given reagent has a lower viscosity than said different reagent.

3. A method according to claim 1 wherein said photosensitive material is an elongated film strip and including the step of accumulating the reagent covered strip in a collection mechanism prior to termination of the time period.

4. A method according to claim 1 wherein said given viscous processing reagent comprises an image developing substance and said different viscous processing reagent comprises a development stopper substance.

5. A method according to claim 4 including the step of removing said given and said different viscous processing reagents from said exposed surface.

6. A method according to claim 1 including the step of removing said given and said different viscous processing reagents from said exposed surface.

7. A method according to claim 6 including the step of controlling the application temperatures of said given and different viscous processing reagents such that said different reagent is applied at a higher temperature than said given reagent.

8. A method according to claim 1 including the step of controlling the depths of said first and second layers such that said second layer has a greater depth than said first layer.

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