Oct. 9, 1951 F. G. ALBIN 2,570,627

FILM PROCESSING DEVICE

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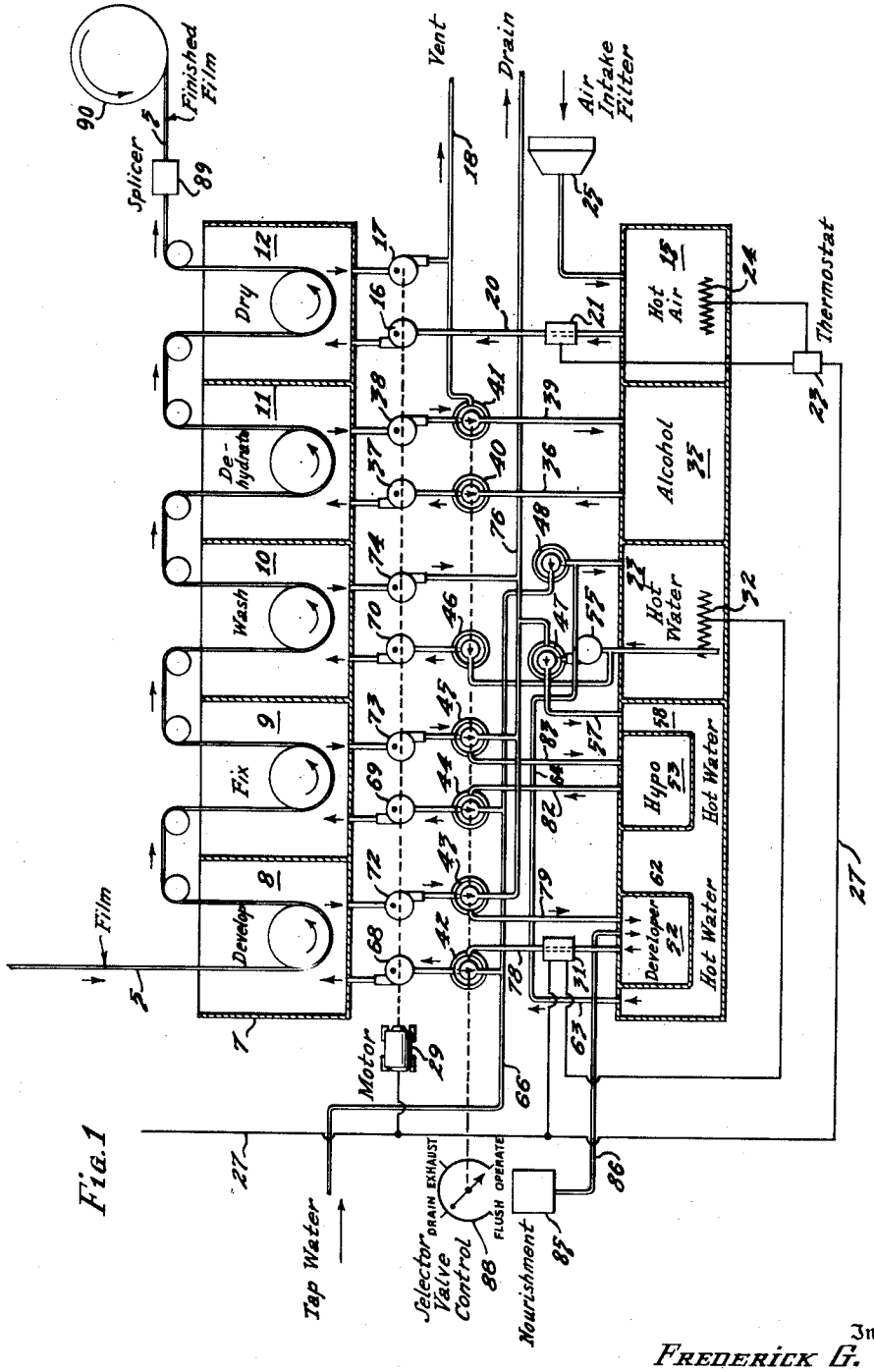


FIG. 1

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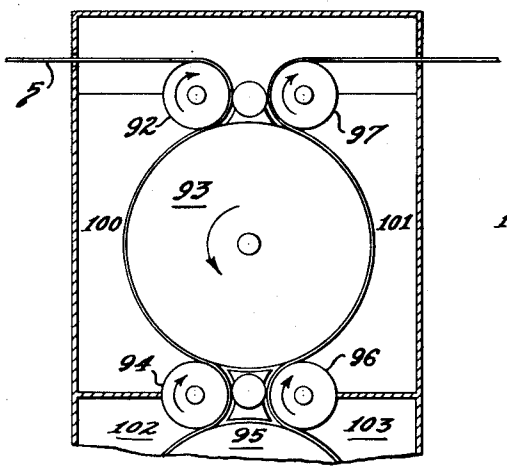


Fig. 2

Fig. 6

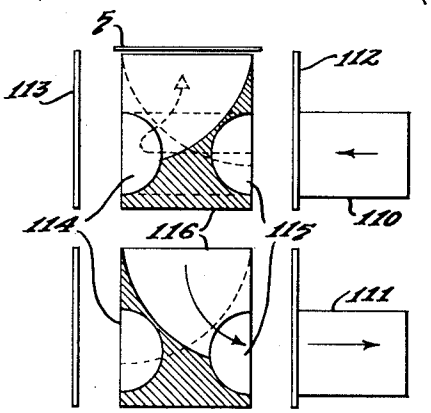


Fig. 3

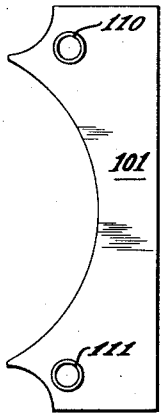


Fig. 5

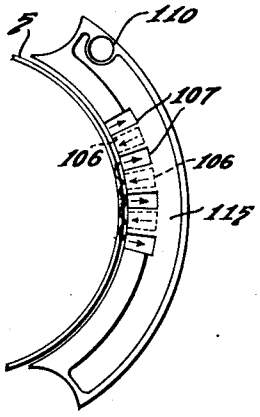
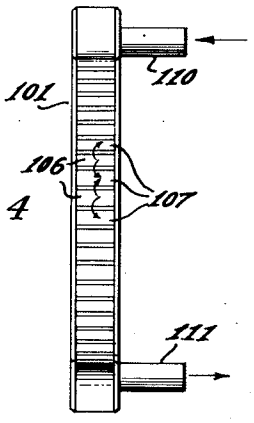


Fig. 4



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FILM PROCESSING DEVICE

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12 Claims. (Cl. 95—94)

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This invention relates to photographic film processing systems, and particularly to a high speed motion picture film processing system.

The transmission of pictures by television, wherein the received images are photographed or impressed on a film which is continuously developed and then projected to a screen for observation, has been formerly suggested, reference being made to U. S. Patent No. 1,775,241 of September 9, 1930. In such a system, it is particularly desirable that the film be developed rapidly to permit optimum functioning of the system, a speed above that of the normal developing process being used to shorten the period between the reception and projection of the pictures.

The present invention is directed to a system for the development of motion picture film at a high rate of speed. In any type of emulsion processing system, it is well-known that to increase the speed of development, it is necessary to bring the processing reagents into contact with the silver halides in the film and to remove the products of the reaction at a rapid rate. In the early type of film processing systems, the film was immersed in a tank, or tray, after winding on racks, reels, drums, or spiral supports, agitation of the fluid relative to the film being accomplished by a continuous or reciprocating motion imparted to either the body of the fluid or to the film support. To increase the speed of development and the speed at which the reagents are brought into contact with the film emulsion, necessitates the rapid removal of the products of the reaction. Failure to remove the reaction products not only has a deleterious effect on reducing the speed of development, but also produces other deleterious effects.

In the developing of film emulsions, the silver halide, which has been exposed to light, is reduced to metallic silver, and the negative halogen ions are released and they diffuse to the surface by osmosis. A concentration of these halogen ions retards silver reduction in the area of the concentration. Thus, in developing a film upon which are superimposed areas of large and small exposures, typical of most photographs, the areas of large exposure release a concentration of halogen ions which spreads over and retards the development of the adjacent areas of smaller exposure. The areas of smaller exposure consequently suffer subnormal development in the vicinity of the areas of larger exposure, and thus, suffer non-uniformity of development. Also, the areas of large exposure suffer abnormal development in the vicinity of the areas of small exposure, and thus, also suffer non-uniformity of development.

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The present types of modern film processing machines consist of large tanks containing a multiplicity of both driving and driven pulleys so disposed that the motion picture film travels continuously through the machine by passing over the pulleys. The tanks contain many gallons of fluid, and the film is caused to pass longitudinally through a large volume of fluid. One of the disadvantages of this type of fluid motion relative to the film is that the regular longitudinal motion produces a regular pattern of rivulets from sprocket holes and other causes, and, thus, produces a streaked rather than uniform result. This has been corrected, to some extent, by introducing random turbulence to the large bath of fluid by motor driven agitators. It has also been the practice to install nozzles on the inlet pipes, and accelerate the rate of flow of the recirculating system. These methods, however, are inefficient since a large amount of work is expended in moving a large volume of fluid, while only a small fraction of the motion is effective at the surface of the film.

It has been found in recent investigations on this subject that the highest ion concentration lies in a lamina of liquid very thin and close to the surface of the film emulsion, and that this lamina can be disturbed only by considerable physical force. It might also be pointed out that the proportional dilution of the reservoir of liquid by reaction products during the period of time for a point on the film to travel through the machine, or during one cycle of the liquid recirculation through the machine, is extremely small. Thus, the indications are that the volume of liquid circulated is much larger than necessary. Also, in existing machines, the film is suspended in space from one pulley to the next, surrounded only by liquid, and it is, therefore, necessary to thread the film by hand, manually guiding it from one pulley to the next in the proper sequence.

The principal object of the present invention, therefore, is to facilitate the processing of the emulsion on a film.

Another object of the invention is to provide an improved film processing system in which the volume of developer is a minimum.

A further object of the invention is to provide a film processing system which is self-threading.

A still further object of the invention is to provide an improved film processing system in which the uniformity of development is maximum.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawings, forming a part hereof, in which:

Fig. 1 is a diagrammatic view of a film processing system embodying the invention.

Fig. 2 is an elevational view of one stage of the processing system.

Fig. 3 is a side view of the developer jet block.

Fig. 4 is an end view of the jet block shown in Fig. 3.

Fig. 5 is a cross-sectional view of the jet block shown in Fig. 3, and

Fig. 6 is a developed view of a jet block showing the manner of flow of the developer therethrough.

Referring now to the drawings, in which the same numerals identify like elements, a film 5 may come from a television receiver or any other source of exposed film, such as a reel taken from the magazine of a camera. For purposes of illustration, the film is shown passing into a tank 7 having five compartments 8, 9, 10, 11, and 12, which develop, fix, wash, dehydrate, and dry the film, respectively. Each compartment is connected with inlet and outlet pipes for liquids or air to provide for the rapid processing of the film 5.

For instance, in the drying tank 12, air is taken from a storage tank 15 and pumped by a pump 16 into the tank 12, while a pump 17 draws the air out through a vent pipe 18. The air from the tank 15 passes through a pipe 20, which, in turn, is surrounded by a temperature control unit 21. The unit 21 controls the amount of electrical energy passing through a thermostat 23 to a heating unit 24 shown diagrammatically. An air intake filter 25 which removes dirt, together with an air conditioner, may be provided in case the ambient surrounding humidity is high. The power supply line is shown diagrammatically as a single conductor 27, power being supplied to the heating unit 24, as well as to a motor 29 for driving pumps 16 and 17, as well as to other pumps to be described. A second heat control unit is shown at 31 to control electrical energy to a heater 32 for a hot water tank 33.

The dehydrating tank 11 is supplied with alcohol from a storage tank 35 through a pipe 36, the alcohol being pumped to the tank 11 by a pump 37 and pumped out by a pump 38 through a pipe 39. Valves 40 and 41 in the pipes 36 and 39 control the flow of alcohol between tanks 11 and 35.

In tanks 8, 9, and 10, which develop, fix, and wash the film 5, the respective fluids are controlled by a series of valves 42, 43, 44, 45, 46, 47, and 48 in conjunction with a series of pumps 68, 72, 69, 73, 70, and 74. The developer is circulated from a storage tank 52, the hypo from a tank 53, and the wash water from the tap supply. The proper temperature of the developer and hypo is maintained by pumping hot water from tank 33 by a pump 55 around the developer and hypo storage tanks. That is, when the valve 47 is opened between pump 55 and pipe 57, pump 55 will circulate water through pipe 57 into tank 58, out of tank 58 through pipe 63 back to the hot water reservoir 33. Replenishing tap water may be supplied to the reservoir 33 through pipe 66 when valve 48 is opened.

For flushing the developing, fixing, and washing tanks 8, 9, and 10, valves 42, 43, 44, 45, and 46 may be turned so that tap water from pipe 63 will be circulated through these tanks by pumps 68, 72, 69, 73, 70, and 74. The wash water may be released to the drain pipe 76.

For the developing process, the pump 68 will pump developer through pipe 78 into developing tank 8 and pump 72 will pump it back through pipe 79. The heat control unit 31 surrounds the pipe 78, thus controlling the temperature of the developer by the temperature of the hot water from tank 33. Similarly, hypo is pumped into fixing tank 9 through pipe 82 and back again through pipe 83. The developer in tank 52 may be replenished and/or nourished as required from a tank 85 through pipe 86.

The so far described system is one wherein the proper amount of developer and hypo at the proper temperature may be supplied, while the film may be washed, dehydrated, and dried in continuous steps. The tanks may be rapidly washed and cleaned by rotating a master valve control 88, to which all the valves are connected, to permit the performance of the various functions indicated on the dial as described above. The machine will be completely light-tight so that it may be operated in a fully illuminated room, the the film passing through the machine at a continuous rate. A splicer is shown at 89 in case certain sections of the film are to be deleted before being wound on a reel 90.

Referring now to the other figures, the details of the developing tank are shown to permit the feeding of developer at a very rapid rate to the film, as well as carry off the products of the developing reaction. The film 5 passes around a sprocket or roller 92, then to a large, flanged drum 93. The film then may either continue around the single drum 93 and back to a roller, or sprocket 97, or proceed around a roller 94 to a second drum shown partially at 95. The film may then pass back around a roller 96, drum 93, and sprocket or roller 97, into the next tank. Surrounding drum 93 and drum 95 are jet blocks 100 and 101, 102 and 103, shown in detail in Figs. 3, 4, and 5. These blocks are provided with a multiplicity of alternately disposed inlet orifices 106 and outlet orifices 107.

Each orifice is in the shape of a narrow rectangle with the narrow dimension in the direction of the film motion. The orifices all lay in the concave inner surface of the jet blocks which are placed adjacent to the emulsion side of the film. Thus, the fluid which is ejected by the inlet orifices must pass through the narrow space between the film and the jet block to the outlet orifices, effecting a scrubbing action over a large area of the surface of the film, while using a minimum amount of fluid. The developer is conducted into the jet block through an inlet pipe 110 and out through an outlet pipe 111.

This arrangement permits a large amount of active developer to be supplied directly to the emulsion without excess volume, while the spent developer is removed as rapidly as the fresh developer is supplied. By equipping the machine with the nourishing injector, regulated by the amount of film footage passing through the machine, a constant processing characteristic throughout the life of the developer solution is obtained. This feature, together with the temperature control, provides uniformity of the

product during the useful life of the developer. If the operation of the machine were to be nearly continuous, a silver remover on the hypo tank could be installed, while a distiller of the alcohol reservoir would reclaim the alcohol. A period of one-half minute is all that is required for the complete development of the film, which is a sufficiently short period to permit the machine to be used in a theatre television system.

In order to illustrate the passage of the developer through the jet block, reference is made to Fig. 6, the upper portion of the drawing being a section through an inlet orifice **106**, and the lower portion of the drawing being a section through an outlet orifice **107**. In this figure, the fluid is shown entering through inlet pipe **110** and passing through duct **114**, the inlet orifice to the film surface, and out through the outlet orifice duct **115** and outlet **111**, as indicated by the arrows. The jet blocks are each assembled of three members, a central member **116**, and two side or cover members **112** and **113**. Member **116** has slots **106** milled to intersect duct **114**, and alternately disposed slots **107** milled to intersect duct **115**. Covers **112** and **113** are securely attached to member **116**. Cover **112** embraces inlet pipe **110**, which engages duct **114**, and outlet pipe **111**, which engages duct **115**.

By confining the film into narrow channels, as indicated in Fig. 2, the machine is able to thread itself.

To compensate for the shrinkage of the cellulose nitrate or cellulose acetate base of the film, the film is propelled through the machine by means of the sprockets **92** and **97**, these sprockets being coupled to the drive shafts through springs which take up the slack in the film between the sprockets and maintain constant tension on the film.

I claim:

1. A film processing machine comprising a plurality of functioning compartments through which film is adapted to be advanced, one of said functioning compartments being a film developing compartment, a second plurality of storage compartments to supply different fluids to said first plurality of functioning compartments, means for conducting fluids between the respective storage and functioning compartments, said means including electrical heat control means and a plurality of pumps to circulate the respective fluids between the respective storage compartments and functioning compartments, a plurality of interlinked valves in said conducting means adapted to be simultaneously moved to different positions, said valves interconnecting different respective storage compartments with respective functioning compartments whereby when said valves are in one position said storage compartments are connected with said functioning compartments, and when in another position certain of said functioning compartments are connected in parallel, an electrical source, and heating elements connected to said source and to said heat control means for heating the fluids in said respective storage compartments.

2. A film processing machine comprising a plurality of functioning compartments through which film is adapted to be advanced, one of said functioning compartments being a film developing compartment, a second plurality of storage compartments to supply fluids to said first plurality of functioning compartments, means for conducting fluids between the respective storage and functioning compartments, said means including a plurality of pumps to circulate the respective fluids between the respective storage compartments and functioning compartments, and a plurality of interlinked valves in said conducting means, said valves interconnecting different respective storage compartments with respective functioning compartments, said developing compartment including a jet block having a plurality of alternately arranged inlet orifices and outlet orifices, said fluids being forced against the film adjacent said orifices.

3. A film processing machine including means for applying developer to a moving film, said means comprising a flanged drum around which said film passes emulsion side out, a pair of jet blocks substantially surrounding said drum, said blocks having alternately disposed inlet and outlet orifices closely adjacent said film, and means for circulating developer over said film between adjacent inlet and outlet orifices.

4. A film processing machine in accordance with claim 3, in which said block is divided into radial passages, alternate passages being connected to a developer inlet and said other alternate passages being connected to a developer outlet.

5. A film processing machine comprising means for advancing film in an arcuate path, a plurality of nozzles positioned in an arcuate path having substantially the same curvature as said film path and having their outlets closely adjacent and facing the emulsion on said film, said nozzles having their axes normal to said film, pumping means for directly applying an emulsion processing fluid through said nozzles to said emulsion at right angles to the surface of said film, a second plurality of nozzles interleaved with and closely adjacent said first plurality of nozzles and in the same arcuate path as said first plurality of nozzles and having their intakes closely adjacent the emulsion on said film, said second plurality of nozzles also having their axes normal to said film, and pumping means for directing said fluid away from said emulsion after contact therewith through said second plurality of nozzles.

6. A film processing machine in accordance with claim 5, in which both pluralities of said nozzles are an integral unit with separate inlet and outlet ports.

7. A film processing machine for rapidly passing a large volume of film processing fluid in contact with a moving film, comprising means for advancing said film, means for directing said fluid to the emulsion side of said film in a plurality of narrow streams moving at right angles to said film, the termination of said means being closely adjacent said film, and means for removing said fluid after contact with said film in a second plurality of narrow streams, the termination of said fluid removing means being closely adjacent said film, said means for directing said fluid to said film being interleaved with said means for removing said fluid from said film.

8. A film processing machine in accordance with claim 7, in which said film advancing means is the cylindrical roller and said last mentioned means are jet blocks having radial slots therein adjacent the surface of said roller.

9. A film processing machine comprising means for advancing a film strip in an arcuate path, means for directing a multiplicity of streams of developer toward the emulsion on said film at right angles to the surface of said film, and

means for directing said developer away from said emulsion at right angles to the surface of said film in a multiplicity of streams, said directing means including a concave jet block having a multiplicity of slots therein, alternate slots directing said developer to said film and alternate slots directing said developer away from said film.

10. A film processing machine comprising a plurality of functioning compartments through which film is adapted to be advanced, one of said compartments being a film developing compartment, a second plurality of storage compartments to supply different fluids to respective compartments of said first plurality of functioning compartments, means for conducting fluids between said storage and functioning compartments, said means including heat control means and a plurality of pumps to circulate the respective fluids between the respective storage compartments and functioning compartments, a plurality of interlinked valves in said conducting means adapted to be simultaneously moved to different positions, said valves interconnecting different storage compartments with respective functioning compartments whereby in one position of said valves certain storage compartments are connected with certain functioning compartments and in another position certain of said functioning compartments are connected together, and heating elements connected to said heat control means for heating certain of the fluids in said storage compartments.

11. A film processing machine comprising a plurality of functioning compartments through which film is adapted to be advanced, a second plurality of storage compartments to supply different fluids to said first plurality of functioning compartments, a water supply, fluid conducting means between said respective functioning and

storage compartments, a plurality of pumps in said conducting means for circulating said fluids between respective functioning and storage compartments, a plurality of valves in said conducting means, and means for interconnecting said valves for simultaneous operation, one position of said valves interconnecting certain of said storage compartments with certain of said functioning compartments, and another position of said valves connecting certain of said compartments to said water supply.

12. A film processing machine in accordance with claim 11, in which additional valves are provided for controlling the circulation of said water between certain compartments.

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