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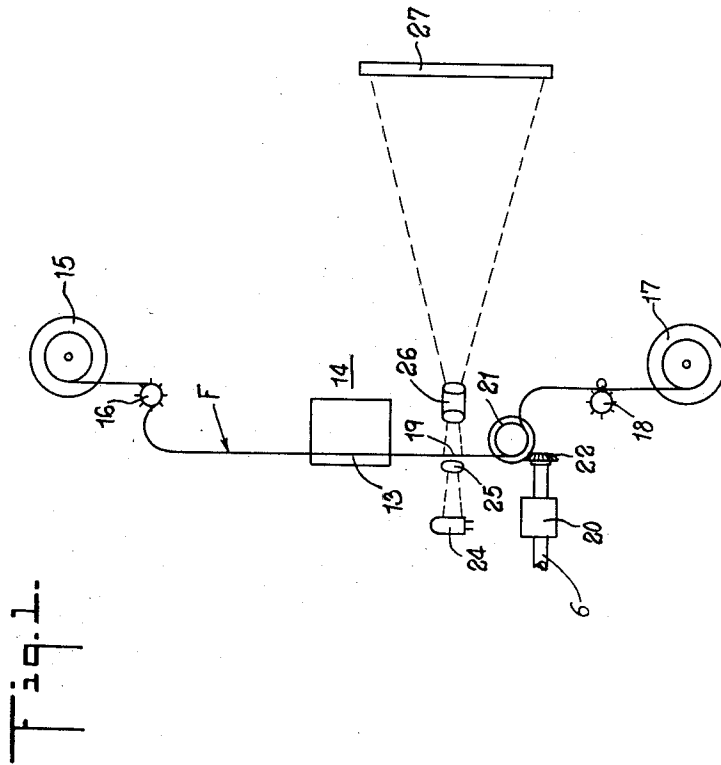
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RAPID PROCESSING OF PHOTOGRAPHIC FILM

Filed March 12, 1952

2 Sheets-Sheet 1



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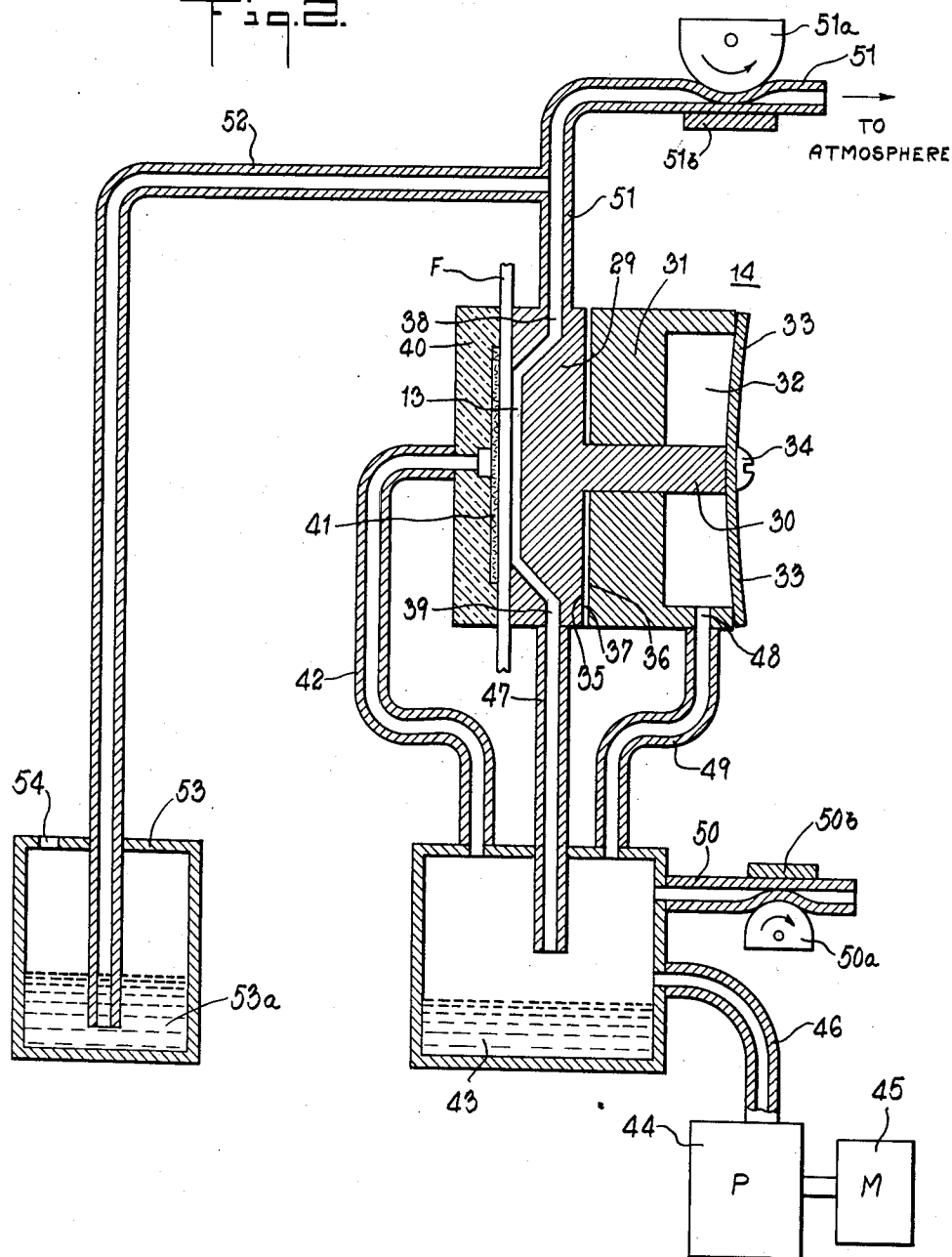
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Fig. 2.



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RAPID PROCESSING OF PHOTOGRAPHIC FILM

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Application March 12, 1952, Serial No. 276,112

4 Claims. (Cl. 95—89)

This invention relates to the rapid processing of photo-
 graphic images.

In copending applications of Clifton M. Tuttle and
 Paris Stafford Ser. No. 35,494, filed on June 26, 1948,
 now Pat. No. 2,582,182; Clifton M. Tuttle, Ser. No.
 35,493, filed June 26, 1948, now Pat. No. 2,631,511; and
 Clifton M. Tuttle and Fordyce M. Brown, Ser. No.
 114,701, filed September 9, 1949, now Pat. No. 2,665,-
 619, there are disclosed certain methods and means for
 rapid processing of photographic images. These prior
 methods and means rely upon the use of a multiplicity of
 chemical solutions for the preparation of the photographic
 latent image prior to its projection as a visual screen
 picture. More specifically, the developer solution is fol-
 lowed sequentially by a solution for arresting develop-
 ment, a solution for fixing the image, and a final washing
 solution.

While the systems disclosed in the aforesaid copend-
 ing applications possess significant advantages over the
 prior systems and are admirably suited for many pur-
 poses, they nevertheless have certain limitations. A mul-
 tiplicity of valving operations is necessary in order to
 control the sequential flow of processing solutions, and
 this increases the complexity and cost of the apparatus.
 The minimum total length of time necessary to complete
 the processing cycle is limited due to the fact that the
 fixing and washing steps consume more than half the
 total cycle. Also, the fixing operation (which is in es-
 sence the dissolving of the silver halide crystals that re-
 main unchanged after development) results in the forma-
 tion of free silver which has a tendency to "plate out" and
 clog the various solution orifices. This necessitates rather
 frequent cleaning and silver-removal operations, requir-
 ing a complete shutdown of the processing apparatus.
 Moreover, the use of multiple solutions necessitates the
 valving of liquid flow lines with very complete closures
 of the orifices. Because of the corrosive nature of the
 chemicals used in processing the film, valves made of
 commercially available materials will deteriorate and re-
 quire frequent replacement.

In accordance with the present invention, the film is
 processed in a head having a recess forming a process-
 ing station for the film. Inlet and outlet ports in the head
 communicate with the recess, and opposite the recess
 there is preferably a porous or channelled backing platen
 for the film, the path of film travel being between the
 backing platen and the processing head. The head is
 movable back and forth to engage and disengage the film
 in the area of the recess. A supply line is connected to
 the inlet port for delivering a developing solution to the
 recess, and a source of subatmospheric pressure is con-
 nected to the outlet port to draw the developing solution
 through the recess. Preferably, the back-and-forth move-
 ments of the processing head are effected by means com-
 prising a pneumatically operable member partly forming
 an actuator chamber communicating with the sub-atmos-
 pheric pressure source, the latter having a venting means
 for admitting air to break the suction in the processing

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recess and actuator chamber and retract the head through
 the action of the pneumatic member. The sub-atmos-
 pheric pressure source is preferably connected also to
 the backing platen to draw the film flat against it while
 the developer solution is drawn through the recess, the
 film being released from the platen when the vacuum
 source is vented to break the suction in the recess and the
 actuator chamber.

A further feature of the invention resides in a novel
 treatment of the exposed film whereby the usual alkalinity
 of the film due to the action of the developing solution
 thereon is eliminated, so that the film image remains
 stable after the developing step, even when subjected to
 moisture and even though it is not treated with the
 usual fixing solution. According to this feature of the
 invention, processing of the exposed film is effected under
 conditions which inhibit adsorption of the conventional
 developer salts in the film emulsion. This can be ac-
 complished by flowing over the emulsion side of the
 film, after the developing step, a gaseous fluid (the term
 "gaseous fluid" is used in its broadest sense to include
 a vapor) which is an acidifying agent and therefore con-
 verts the hydroxide constituent of the developer to a
 non-alkaline salt during the drying of the film; or by
 replacing the hydroxide constituent of the developing so-
 lution with an alkali in which the metallic radical is a
 gas, such as ammonium hydroxide. Since this radical is
 fugitive, it is completely removed upon completion of
 the flow of a drying medium over the emulsion after the
 developing.

In the description to follow, the invention is described
 as an accessory in the technique of single picture tele-
 vision and signalling as taught by U.S. Patent 2,404,839
 dated July 30, 1946. It will be understood, however,
 that the invention is not limited to this use and that many
 other useful applications of it are possible. In the ac-
 companying drawings:

Fig. 1 shows schematically a preferred form of the in-
 vention, and

Fig. 2 is a schematic view of the apparatus for pro-
 cessing photographic images in accordance with our in-
 vention.

Referring to Fig. 1 of the accompanying drawings, a
 television picture sent out by a broadcasting station is
 received and produced on the fluorescent screen of the
 usual cathode ray tube (not shown) from which the
 image is projected in any suitable manner upon a film
 band F. The latter is supported for successive transport
 from processing station 13 to projecting station 19 by
 film conveyor means including a supply reel 15 and a
 take-up reel 17 having cooperating sprockets 16 and 18,
 respectively. The processing of the image at station 13
 is effected very rapidly (in a fraction of a second). The
 newly processed image is then rapidly advanced to the
 projecting station 19, this movement being accomplished
 by a Geneva mechanism 20 driven by a shaft 6 and operat-
 ing a film sprocket 21 through the gear 22. At the
 projecting or viewing station 19, the processed image is
 illuminated by light received from lamp 24 through con-
 denser lens 25. An enlarged optical image is then pro-
 jected by lens 26 onto a suitable viewing screen 27.

The film processing apparatus 14, for processing the
 images at station 13, is shown in greater detail in Figure
 2. A block member 29 forms a film-processing head. At
 its front face, processing head 29 is provided with a
 shallow recess 13 which receives the fluid for processing
 the film F. The recess or shallow cup 13 forms the
 processing station for the film. At the top portion of head
 29 is an inlet port 38 communicating with the recess 13,
 and at the bottom portion of the head is an outlet port 39.

The processing head 29 is movable back and forth to
 engage and disengage the film in the area of the recess 13,

Any suitable displacement-imparting means may be utilized for this purpose. For example, the head 29 could be moved by electromagnetic means, such as a solenoid. In the embodiment shown in Fig. 2, the displacement-imparting means comprises a combination of mechanical and pneumatic means. At one face 35 of head 29 is a cylindrical shank portion 30 movably mounted in a metal journal member 31. At one end of the journal is a depression or well 32 which is closed and sealed by a resilient diaphragm 33, the diaphragm being secured to the shank 30 of head 29 by a screw 34. When the processing head 29 is in its retracted or inoperative position, face 35 thereof is in contiguous relation with face 36 of the journal 31, the processing head being maintained in this position under the biasing action of diaphragm 33. In the operating position shown in Fig. 2, processing head 29 has moved laterally away from the journal 31 (i.e. to the left) to form a clearance 37. This forward movement of the head 29 is effected by a vacuum drawn in the well 32 through a port 48 and suction line 49, as will be described in greater detail presently.

In order to hold the film F flat during processing and prevent its being drawn into the recess 13 by the partial vacuum therein, a backing platen member 40 is provided. The platen 40 is recessed to receive a porous block 41 engageable with the film F and connected to a source 43 of sub-atmospheric pressure through pipe 42; or the platen 40 may be formed with a channel in the shape of a ring surrounding the exposed area of the film and connected to the suction pipe 42.

The source of subatmospheric pressure 43 is a chamber which is evacuated through pipe 46 by pump 44 driven by motor 45. The outlet port 39 in head 29 is connected to chamber 43 by a suction pipe 47. The depression or well 32 in member 31 communicates with chamber 43 through a pipe 49 secured between an aperture 48 in the bottom of journal 31 and the interior of the chamber. A flexible conduit 50 fixed to the side wall of the chamber 43 connects the interior thereof to the atmosphere. An eccentric 50a is rotatably mounted adjacent the flexible conduit 50. At predetermined time intervals, the eccentric 50a rotates so as to "pinch" or close the flexible conduit 50 against a rigid backing 50b, thereby preventing the atmosphere from entering the interior of chamber 43. The valve or venting means 50a, 50b shown herein is by way of illustration only, and any suitable means for venting the chamber 43 to atmospheric pressure could be used.

The inlet port 38 in the processing head 29 is connected to a flexible conduit 51 having an atmospheric venting means 51a—51b similar to the venting means 50a—50b. A tank 53 contains the developer solution 53a and has an opening 54 for the purpose of insuring that the interior of the tank will be at atmospheric pressure. A developer supply pipe 52 extends from the solution 53a to the flexible conduit 51.

The operation of the processing head is as follows: In the position shown in Fig. 2, valve 50a has pinched the flexible conduit 50, thus excluding the atmosphere from the interior of chamber 43. Pump 44 thus evacuates the interior of chamber 43 so as to create a sub-atmospheric pressure therein. Since the depression or well 32 of journal member 31 is in communication with chamber 43 via pipe 49, it has substantially the same pressure as the chamber 43. The atmospheric air on diaphragm 33 therefore forces it inwardly toward the bottom of the depression, whereupon processing head 29 is displaced laterally in the same direction. The movement of head 29 to the left forces the recess 13 against the film so as to seal off the film in the area of the recess. The open end portion of conduit 51 is then closed by the valve or venting means 51a—51b, thereby creating a vacuum in the recess 13 and in conduit 51. Since the tank 53 is at atmospheric pressure and the recess 13 is now at sub-atmospheric pressure, the developer solution 53a travels

through supply pipe 52 into the recess 13, from which it is drawn through pipe 47 to the chamber 43. During this flow of the solution across the emulsion side of the exposed film, the film is held flat against the platen 40 by the suction in the porous block 41, due to its connection through suction tube 42 to the vacuum source 43. The flow of developer solution is continued for a brief time sufficient to completely develop the image in the film. The eccentric 51a then opens conduit 51 to the atmosphere and, as a result, the developer solution 53a ceases to flow. Air is now admitted to the recess 13 by way of conduit 51 and serves to dry the film. After drying, the vacuum in chamber 43 is broken by the eccentric 50a. The depression or well 32 in journal 31 thus returns to atmospheric pressure, and the diaphragm 33 snaps back to its normal position so as to retract the processing head 29 from the film F. At the same time, the vacuum in the porous member 41 of the platen is broken, thereby releasing the film for subsequent movement from the processing head.

The recess 13 is so dimensioned as to confine the flow of the developer solution to a very thin layer. Due to the high speed at which this thin layer flows, and the nature of the film F (which will be described presently), the exposed film may be completely developed in about one-tenth of a second, and also dried in about one-tenth of a second, bringing the overall elapsed time to about .2 second. The developing step requires about 0.1 cc. of a conventional developing solution for a 35 mm. film frame.

Upon completion of drying, the picture is ready for projection, the elapsed processing time as previously stated being in the order of .2 second. This time lapse is ten to twenty times shorter than that obtainable with other methods of quick-processing photography. However, this time can be cut even further if the drying operation is eliminated.

The developed image is projected at the station 14, and since it is dry, no further development takes place. If it is found desirable to do away with the drying cycle, thus saving still more time, it is possible to project the developed, wet picture by non-actinic light (that is, light which is visually effective on the viewing screen 27 but photographically ineffective in altering the developed film image). In this manner, the apparatus may be operated with an elapsed processing time in the order of .1 sec.

The film image when processed as previously described, though it remains stable to light in its dry state, becomes unstable when it is moistened, as would be the case if it is stored under conditions of high relative humidity. The reason for this instability lies in the fact that the conventional alkaline developer salts used in the process remain adsorbed to the emulsion after processing. Hence, only the addition of water is necessary to render these salts again active. Thus, the development can go to completion with the result that the image may gradually disappear.

In case it is desired to render the image permanent, we prefer to remove this alkalinity during the processing of the film.

The conventional photographic developer consists essentially of three parts: an organic reducing agent, an alkali, and water. The presence of all three constituents is necessary to enable the solution to convert the exposed silver halide of the latent image to metallic silver of the real image. A conventional developer formula is the following:

70	Elon*	grams	14
	Hydroquinone*	do	14
	Sodium sulphite, desiccated	do	52.5
	Potassium bromide	do	8.8
	Sodium hydroxide*	do	17.6
75	Water*	liters	1.1

The essential three constituents are marked with asterisks. The other constituents such as sodium sulfite and potassium bromide are present for other purposes not pertinent to this invention and not necessary to the basic chemical reaction of reduction of the latent image.

One way of removing the alkalinity is to introduce acid, either as a gas or as a vapor, by connecting the free end of conduit 51 to a source of an acid gaseous fluid at atmospheric pressure, instead of atmospheric air. For example, this fluid may be sulfur dioxide gas or carbon dioxide gas, or it may be a vapor such as acetic acid or any other acid having a high vapor pressure. Such vapor may be produced by allowing air to bubble through the acid on its way through tube 51 or merely to pass over a concentration of the liquid acid.

This acid gaseous fluid, which follows the developer solution through the processing recess 13, serves simultaneously to dry the film and to remove the alkalinity caused by the developing solution. Thus, without increasing the time cycle of our process, we, in effect, acidify the fluid used in the drying, and the hydroxide constituent of the developer is converted to a non-alkaline salt during the process of drying.

Another way to eliminate the alkalinity of the developer solution during the process is to replace the hydroxide constituent of the developer solution with an alkali in which the metallic radical is a gas. As an example of a suitable developer formula, we use the following:

Elon*	grams--	7
Hydroquinone*	do--	14
Sodium sulphite, desiccated--	do--	52.5
Potassium bromide	do--	8.8
Methanol	cc--	48
Ammonium hydroxide (28%)*	cc--	100
Water*	liters--	1

It will be noted that the three essential constituents of a developer are initially present in this formula; but because the NH_3 radical is fugitive, it is completely removed by the flow of the drying air from conduit 51, and the necessary constituents for development no longer remain adsorbed to the emulsion after completion of drying.

Since the invention utilizes only the developer solution (and possibly drying air) in the processing of the exposed film F prior to projection of the developed image upon a viewing screen, it is necessary that a special film be used in which the emulsion is spread more thinly than is normally the case and is also possessed of low turbidity so as to be characterized by the inability to scatter incident light. If the conventional film emulsion were used, the undeveloped silver halide would exhibit an optical density in specular (collimated) illumination almost as great as that of the developed silver image. Without fixation, an image on the conventional film would be entirely unsuitable, since its projected screen image would be lacking both in contrast and brightness. An emulsion of exceedingly low turbidity can be achieved by the employment of silver halide particles of materially reduced grain size. If, in addition, such an emulsion is spread upon the film base to a thickness of about one-third of that customarily employed, the resultant layer, even in its unfixed state, scatters and absorbs so little light that when placed in a suitable optical projection system, the transmitted screen light will be at least one-half as intense as would be the case if the emulsion were thoroughly fixed. In addition, such an emulsion possesses other qualities advantageous to the requirements of our inven-

tion. The small grain size makes it amenable to an exceedingly short development time, and with an exceedingly small expenditure of chemical solution, while its less than normal thickness makes it possible to dry the film surface with great rapidity.

As an example of a film F suitable for use in our new system, it may be a chloro-bromide type of light sensitive emulsion. Specifically, the film base may be coated with an emulsion layer having a thickness of the order of 0.0003 inch and the emulsion layer may consist of silver halide particles having a grain size of the order of 0.00002 inch.

We claim:

1. Apparatus for rapid processing of photographic film, which comprises a processing head having a recess forming a processing station for the film, the head having inlet and outlet ports communicating with said recess at opposite sides thereof, a backing platen opposite the head, a film conveyor means operable to move the film in a path between the platen and the head, means for moving the head back and forth relative to the platen to clamp the film against the platen and disengage the film in the area of the recess, a closed supply line connected to said inlet port for delivering a developing fluid thereto, a source of sub-atmospheric pressure connected to said outlet port for drawing the fluid through the supply line and the recess along the film, and venting means connected to the supply line for intermittently admitting air thereto, thereby interrupting the flow of developer fluid through the head and causing air flow across said recess from the venting means to dry the film.

2. Apparatus according to claim 1 in which said means for moving the head include a pneumatically operable member partly defining a chamber, the apparatus also comprising a conduit connecting the chamber to the sub-atmospheric pressure source, and a second venting means connected to said source for intermittently admitting air thereto, whereby the pneumatically operable member is actuated to retract the head from the film.

3. Apparatus, according to claim 1, comprising also a porous member in the platen engageable with the film, a conduit connecting the porous member to the sub-atmospheric pressure source to hold the film against displacement into said recess, and a second venting means connected to said source for intermittently admitting air thereto, thereby releasing the suction in the porous member and in said recess.

4. Apparatus according to claim 1, in which said means for moving the head include a pneumatically operable member partly defining a chamber, the apparatus also comprising a conduit connecting the chamber to the sub-atmospheric pressure source, a porous member in the platen engageable with the film, a conduit connecting the porous member to the sub-atmospheric pressure source to hold the film against displacement into said recess, and a second venting means connected to said source for intermittently admitting air thereto, thereby releasing the suction in the porous member and in said recess, and actuating the pneumatically operable member to retract the head from the film.

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