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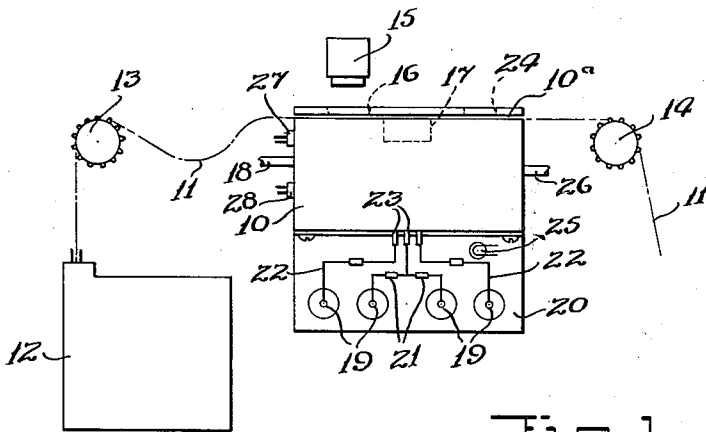
C. M. TUTTLE ET AL

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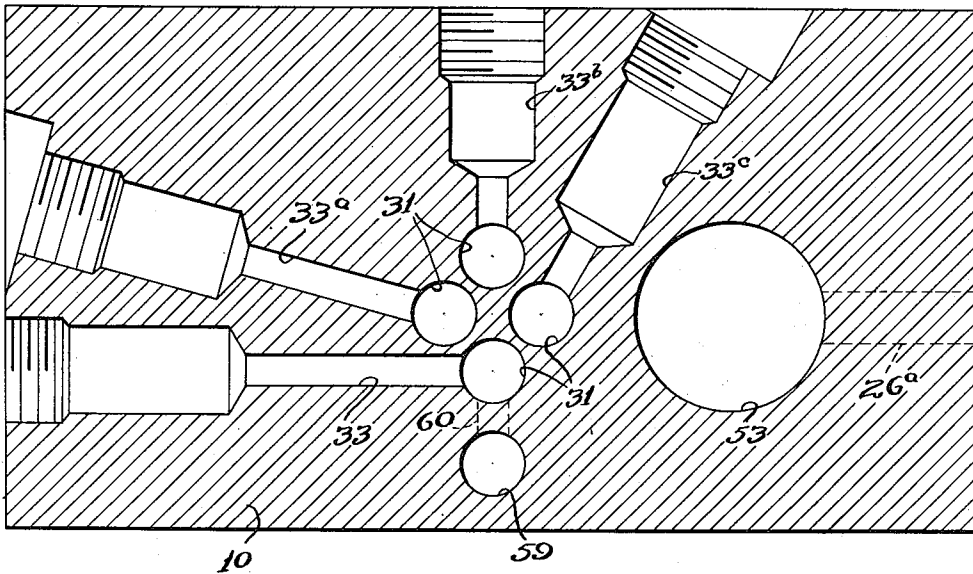
APPARATUS FOR PROCESSING PHOTOGRAPHIC FILM

Filed Sept. 9, 1949

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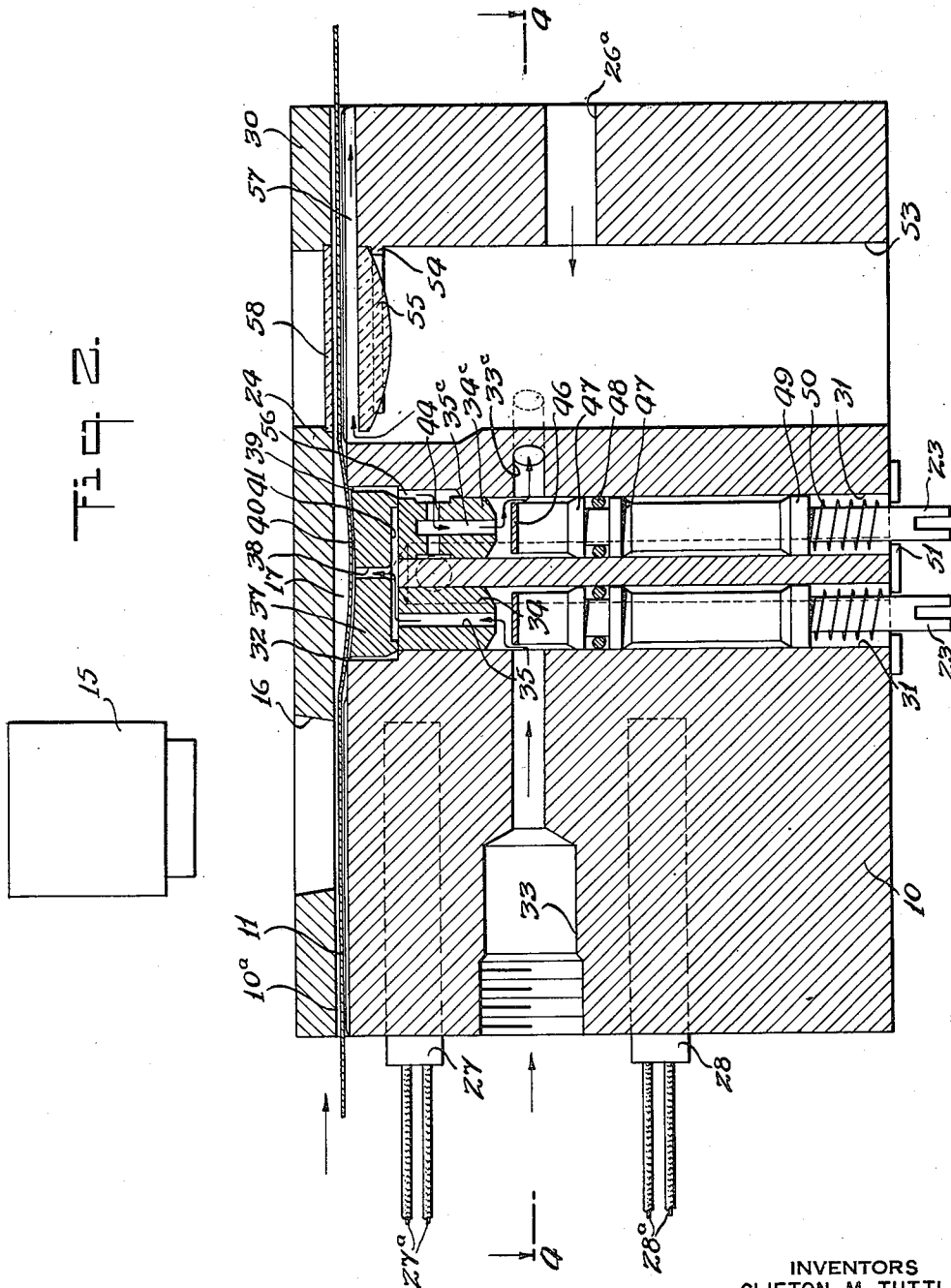
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Filed Sept. 9, 1949

3 Sheets-Sheet 2



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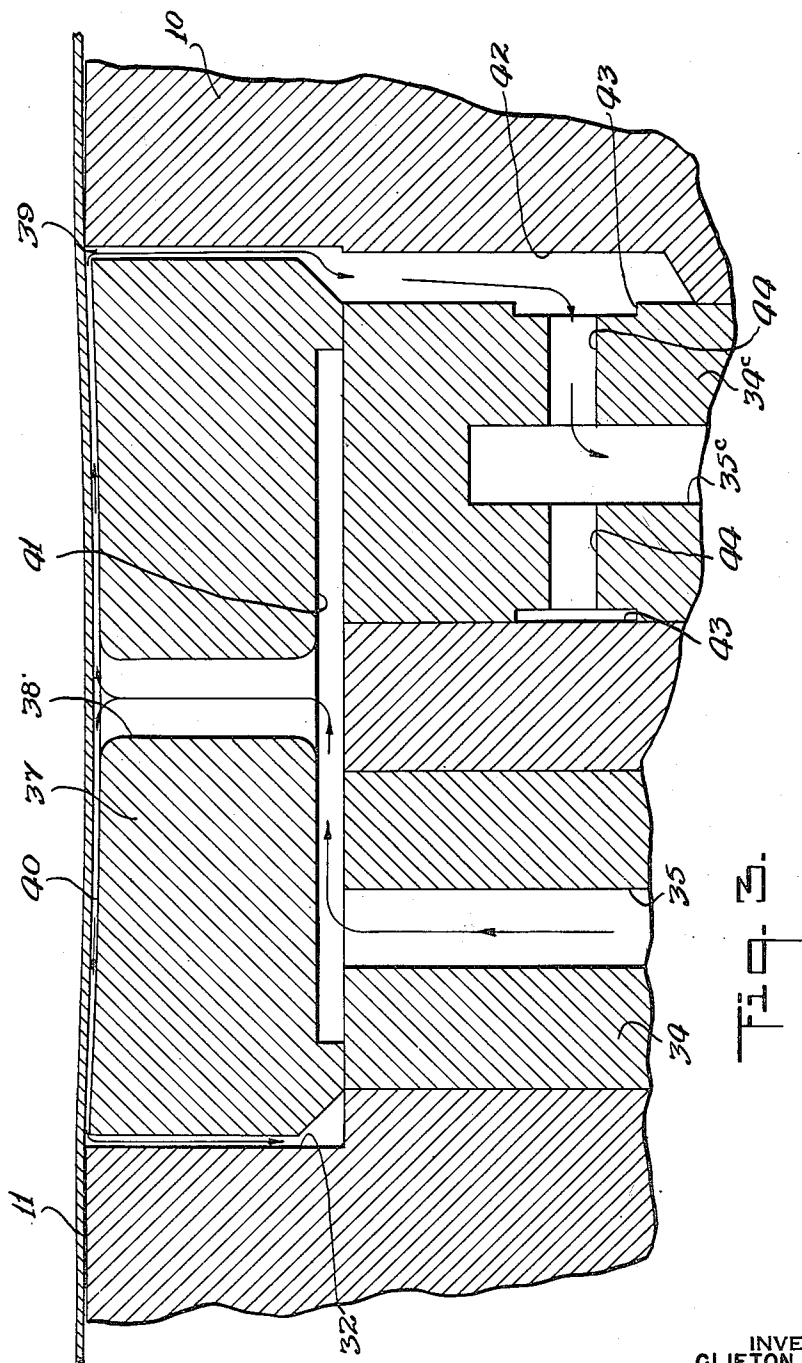
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2,665,619

APPARATUS FOR PROCESSING
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Application September 9, 1949, Serial No. 114,701

7 Claims. (Cl. 95—14)

1

This invention relates to the processing of photographic film. It has for its principal object the provision of an improved apparatus by which such film can be processed more rapidly than has been possible heretofore.

While the invention is applicable generally to the processing of photographic film, it will be described, for illustrative purposes, in connection with the recording and projection of radar images as they appear on the cathode ray screen of a radar receiver, as in such operations it is important to process the film in a relatively short time after its exposure.

In our Patent No. 2,446,668, dated August 10, 1948, we have disclosed a method and apparatus applicable to the processing of photographic areas approximately one-quarter inch in diameter on 16 mm. film in 13.5 seconds, in connection with the photographic recording of radar images. According to the disclosure of this patent, a strip of film is pulled intermittently along a track within a light-tight housing past a station where the image is produced and where the exposed film is processed, and thence past a station outside the housing where the image is projected, one image being formed and processed while the one previously formed and processed is being projected. The film has its emulsion side uppermost, and the exposure is made through the film base by focusing the face of the cathode ray tube, located below, through an aperture in the track. A fairly rapid processing cycle is effected by delivering hot chemicals in sequence to an open plastic cup in the form of two concentric cylinders arranged to drop upon the film at the processing station so that the film forms the bottom of the cup and a seal is provided by the lip or rim of the outer cylinder. After each hot chemical (developer, fixer, and wash) has been delivered to the space within the inner cylinder and has had its effect on the emulsion, suction is applied at the space between the cylinders to remove the chemical and draw air rapidly over the film surface to dry it; whereupon through action of a controlling cam mechanism the delivery of the next chemical to the cup is initiated. The whole operation, including film movement and delivery and exhaust of the chemicals and drying air, takes place in about 13.5 seconds.

Advances in radar techniques have resulted in a need for improvement in the processing of the film on which the radar images are photographed for subsequent projection. For example, the scanning rate of the radar antenna has been increased to 15 R. P. M., so that a complete 360°

2

image is formed in four seconds. If photographic processing requires more than four seconds, important data cannot be recorded. Thus, with a processing cycle of 13.5 seconds, only about one of every three sweeps of the antenna can be recorded.

Another advance in radar techniques has made possible the accumulation of much more finely delineated data on the radar screen. To obtain visual perception of the total of these data, it is desirable, if not necessary, that the projected diameter of the image be at least 10', and this projected image should have a brightness greater than that obtainable with the prior apparatus. It is well known in the art of projection optics that the screen brightness is a function of the area of the film image. The brightness obtainable with the film image of the prior apparatus is marginal with the 7' picture and completely inadequate with a 10' picture, which would require twice the amount of light flux. Additionally, the photographic resolving power obtainable in the one-quarter inch image of the prior apparatus (approximately 700 lines) is inadequate to record all of the information presented to the apparatus. Also, the registration of successively projected images should be more accurate, by a factor or two, than in the prior apparatus.

By the practice of the present invention, more rapid processing and handling of the film are possible, so that the apparatus is adapted for the faster presentation rates of improved radar systems wherein a film processing cycle of four seconds is required. Moreover, the increased speed of processing is made possible by the present invention even when larger films are used, as may be necessary to fulfill the optical conditions imposed by improved radar equipment.

According to the invention, the film in strip form is moved step-by-step to a processing station, where each of the processing fluids (developer, fixer, etc.) is fed to the central part of the film at the station and thence radially outward along the emulsion side of the film, the fluid being finally withdrawn from the outer part of the film at the processing station. The fluid is maintained in a thin, radially-flowing stream between the film and a concave surface forming part of a processing head, the fluid being fed to the film through a central aperture in the concave surface and being withdrawn from the film at the periphery of this surface. During the flow of the fluid, the film at the processing station is stressed to form it into a dish shape which is convex on the emulsion side of the film, the convex

film part extending into the space formed by the concave surface of the processing head. The film is stressed to produce the convex form by applying suction to the emulsion side of the film at the processing station, the suction also serving to withdraw the processing fluid from the film. The suction and fluid flow are interrupted intermittently, that is, during the step-by-step movements of the film to present subsequent portions of the film to the processing station. The suction applied to the emulsion side of the film at the processing station is sufficient to cause this portion of the film to assume the shape of the concave surface at the processing head, whereby the fluid flows in a thin radial stream of substantially uniform thickness between the film and the concave surface. This enables a rapid flow of the fluid, with considerable turbulence, in an intimate and closely confined relation to the film, whereby more efficient chemical results are achieved.

In the preferred form of the apparatus, the processing head also comprises a heating element which preheats the film passing to the processing station. Thus, when the film arrives at this station, it is at approximately the temperature of the processing fluids (generally between 135–150° F.). The heating element is preferably in heat conducting relation to the film at an exposure station forming part of the head and to which the film is fed before it reaches the processing station. By mounting the heater element directly on or within the processing head, some of the heat is also conducted to the fluids as they pass through the head to the processing station, whereby the fluids are maintained at their desired operating temperature. The flow of the processing fluids is preferably controlled by valves located in the processing head near the processing station, whereby the change from one processing fluid to another at this station is effected rapidly.

The preferred form of the new apparatus also comprises a projecting station forming part of the processing head, into which the film passes after development of the image at the processing station. The projecting station includes a light-conducting port opening into the film path and containing a suitable lens through which light from a projection lamp passes to the developed film for projecting the image on a screen. By feeding a current of warm air into the light-transmitting port and along the emulsion side of the film at the projection station, moisture remaining on the film from the processing operations is removed. The drying air may be heated from the projection lamp.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which:

Fig. 1 is a schematic view in front elevation of a preferred form of the new apparatus;

Fig. 2 is a vertical sectional view of the processing head illustrated in Fig. 1, showing also the photographic objective;

Fig. 3 is an enlarged vertical sectional view of part of the processing head illustrated in Fig. 2, showing the path of one of the processing fluids, and

Fig. 4 is a sectional view on the line 4—4 in Fig. 2.

Referring to Fig. 1, the apparatus there shown comprises a processing head 10 having a film path or track 10a along which the photographic film 11 is fed with a step-by-step movement. The unexposed film is mounted on a suitable reel

in a container 12, from which it passes over a sprocket 13 to the processing head 10. From the latter, the film passes over a pull-down sprocket 14, which is driven intermittently to provide the step-by-step movement of the film, to a suitable storage receptacle (not shown).

The photographic objective 15, which is here assumed to direct the image from a radar screen upon the film, is located above the processing head and on the base side of the film 11. The film is first exposed at an exposure station 16 of the processing head, whereby a latent image of the radar screen (not shown) is formed through the transparent base of the film by the photographic objective 15. The exposure station 16 is formed by a light-conducting aperture in one of the surfaces defining the path 10a for the film. Suitable means (not shown) are provided to prevent light-exposure of the film in its passage from the container 12 to the processing head 10.

After the film has been exposed at the first station 16, it is moved to a processing station 17 of the head 10, where the processing fluids are fed in succession along the emulsion side of the film, to develop and fix the image and dry the film. The processing fluids are fed to the head 10 through piping, such as the pipe 18 for the developer fluid, and are withdrawn through a common discharge passage to which suction is applied, as will be described in greater detail presently. The flow of the processing fluids is controlled by valves located in the head 10 and operated by suitable actuating mechanism, such as solenoids 19 mounted on a bracket 20 secured to the head. As shown schematically in Fig. 1, the plungers of the solenoids 19 are connected through linkages 21 and 22 to the stems 23 of the valves located in the head.

From the processing station 17, the film is moved to a projection station 24 of the head, where light from a projection lamp 25 is passed through the head and the developed image on the film, to project the image on a screen (not shown). At the instant when the developed image of the film is moved to the projection station 24, the emulsion layer of the film may contain some absorbed moisture. However, at the projection station 24, the emulsion under the action of radiant heat from the projection lamp 25 releases some of this moisture, and additional moisture is released by feeding dry heated air through a pipe 26 into the light-transmitting passage in the head between the lamp 25 and the projection station 24, whereby the heated air passes along the emulsion side of the film while the image is being projected.

Referring now to Figs. 2, 3 and 4, the head 10 contains electric heating elements 27 and 28 adapted to be energized through wires 27a and 28a, respectively. The heating elements are preferably energized under control of a thermostat (not shown) located in the head so as to maintain the head at the desired operating temperature of the processing fluids. As shown, the heating elements are in heat-conducting relation with the film path 10a. The latter is formed between the main body of the head 10 and a guide 30, which may be pivotally mounted on top of the head and contains the light-transmitting aperture 16 forming the exposure station, and the light-transmitting aperture 24 forming the projection station. The apertures 16 and 24 open into the film path 10a at the upper or base side of the film and at opposite sides of the proc-

5

essing station 17, the film passing first to the exposure station 16, then to the processing station 17, and then to the projection station 24, after which it leaves the head and passes over sprocket 14 to the storage container.

The head 10 is provided with four parallel bores 31 extending vertically from the bottom of the head to a central port 32 opening into the film path 10a. The bores 31 are intersected intermediate their ends by horizontal passages 33, 33a, 33b and 33c (Fig. 4). The passages 33, 33a and 33b, together with the upper portions of their corresponding bores 31, form fluid passages for delivering a developer, a fixer and a wash liquid, respectively, to the film 11 at the processing station; while the passage 33c and the upper portion of the corresponding bore 31 constitutes a waste passage or port for discharging the processing fluids. The waste passage 33c is connected to a vacuum source (not shown) whereby suction is applied to the processing station 17. In the upper part of the bore 31 for each of the supply passages 33, 33a and 33b is an insert 34 having a relatively small passage 35 opening into the bottom of port 32. The upper part of the bore 31 for the vacuum or exhaust passage 33c also contains a hollow insert 34c which, however, is closed at its upper end, thereby blocking direct communication between the passage 35c in the latter insert and the central part of port 32.

A filler block 37 is mounted in the port 32 and is provided with a central feed aperture 38 opening into the film path 11. At its periphery, the filler block 37 defines with the surrounding wall of recess 32 an annular passage 39 concentric to the feed passage 38. The filler block 37 is held in its centered position in recess 32 in any suitable manner, as by means of radial projections (not shown) engaging the wall of recess 32. The upper face 40 of the filler block is machined to provide a concave curvature, the concave surface 40 being highly polished. In its lower part, the filler block 37 is formed with a central manifold space 41 through which communication is afforded between each supply passage 35 and the central feed passage 38 at the processing station. From the feed passage 38, the processing fluids flow radially outward between the film 11 and the concave surface 40 to the surrounding passage 39 and thence downward to a channel 42 adjacent the insert 34c. The latter is formed with an annular groove 43 through which the waste fluids pass from channel 42 into lateral passages 44 in the insert 34c, and thence into the central passage 35c, the corresponding bore 31, and the suction passage 33c.

Each bore 31 contains a valve element 46 located below the inserts 34—34c, the stems 23 of the valves projecting from the bottom of the processing head 10. Below the valve element 46, each valve stem is provided with spaced guide shoulders 47, and a sealing ring 48 is located in the annular space between the guide shoulders. Near the lower end of each valve stem 23 is a third guide shoulder 49 engaging the upper end of a spring 50 coiled around the stem. The lower ends of the springs 50 engage a plate 51 at the bottom of the processing head, whereby the springs urge the valve stems upwardly to seat the valve elements 46 against the lower ends of the inserts 34—34c, thus closing the supply passages 35 and exhaust passage 35c.

The processing head is also provided with a

6

vertical light-transmitting passage 53 aligned with the projection station formed by the aperture 24, the passage 53 opening at its upper end into the film path 10a. Near its upper end, the passage 53 is formed with a shoulder 54 supporting a condensing lens 55. At one edge of the lens 55, the passage 53 is enlarged to form a channel 56 through which the space below the lens communicates with the space between the upper face of the lens and the emulsion side of the overlying film. Heated air from the pipe 26 (Fig. 1) passes through a port 26a into the light-transmitting passage 53 and then upward through channel 56 into the space between the film and the lens 55, from which the air is discharged through an exhaust channel 57 in the processing head. A glass disc 58 is mounted in the projection aperture 24 above the film 11.

In the operation of the apparatus, the film is fed to the processing station 17 after having been exposed at the preceding station 16 and simultaneously heated by conduction from the heating elements 27—28 to the film path 10a. Thus, when the exposed film arrives at the processing station, it is at the optimum operating temperature to which the processing fluids are heated, whereby cooling of the heated solutions contacting the film surface is avoided. At the processing station 17, suction is applied from vacuum passage 33c by opening the corresponding poppet valve 36 through the energizing of its solenoid 19. The developer feed is initiated from passage 33 by opening the corresponding poppet valve 46, whereupon the developer solution flows by way of the manifold space 41 into the central feed passage 38 and thence outward along the concave surface 40 in a thin radial stream, as previously described, so that the emulsion side of the film is subjected throughout its previously exposed area to a thin, rapidly flowing stream. The reaction products of the developer solution are withdrawn by the suction through the annular passage 39, insert passage 35c and suction passage 33c. The suction applied to the passage 33c is carefully controlled so that the film overlying the concave surface 40 is sucked downward to assume the curvature of the surface 40, whereby the concave fluid space between the machined surface 40 and the overlying film 11 is of uniform thickness.

When the developing operation is completed, the valve 46 for the developer solution is closed and the control valve 46 for the fixer solution from passage 33a is opened. By reason of the close proximity of the valves 46 to the manifold 41, the fixer solution will arrive at the processing station 17 almost immediately upon closing the developer valve and opening the fixer valve. The developer solution moves in intimate contact with the film in a rapid stream, as previously described in connection with the developer fluid, and is discharged through the common exhaust passage 33c. Upon completion of the fixing operation, the fixer valve 46 is closed and the flow of washing liquid is initiated from passage 33b by opening the corresponding valve 46, the washing liquid being likewise discharged through the vacuum passage 33c after its passage along the emulsion surface of the film. Thus, there is a continuous flow of fluids (first developer, then fixer, then washing liquid) along the film at the processing station 17, during which time the film is flexed by the suction from passage 33c to cause it to assume the curvature of the closely adjacent concave surface 40. When the wash-

7

ing operation is completed, the corresponding valve 46 is closed. Heated air is then supplied to the emulsion side of the film through the central feed passage 38, by means of a bore 59 in the head communicating with one of the supply bores 31 through a channel 60, the supply of heated air to the bore 59 being controlled by a suitable valve (not shown).

At the end of the drying operation, the suction on the film is interrupted by closing the valve 46 communicating with the vacuum passage 33c, which causes the film to assume its normal unstressed form by reason of a relatively small leakage of air from path 10a to the annular passage 39, between the film and the adjacent edge of recess 32. The film is then moved another step along the path 10a, so that the part of the film being exposed at station 16 during the aforementioned processing operation is now moved to the processing station, where the processing cycle is repeated. At the same time, the previously processed film moves to the projection station 24 where the developed image is projected upon a screen (not shown) by a light beam from lamp 25 (Fig. 1). While the last operation at the processing station 17 removes all surface moisture from the emulsion side of the film by the action of the heated air, the emulsion layer itself may still retain a certain amount of absorbed moisture when it passes to the projection station. This remaining moisture is removed partly by the action of radiant heat from the projection lamp 25 and partly by the air admitted through port 26a and passing between the lens 55 and the overlying part of the film.

The new apparatus thus embodies several features which, in combination, enable the processing operations to be effected quickly in rapid succession. The radial flow of the processing fluids while drawing the film into a convex form toward the closely adjacent concave surface 49 makes it possible to pass the fluids at very high velocity in intimate contact with the emulsion surface of the film, so as to accelerate the chemical actions. The arrangement of the valve 46 in close proximity to the processing station enables rapid changes from one processing fluid to another at the processing station 17. The heating elements 27—28 not only preheat the film to the optimum operating temperature before it reaches the processing station, but also supplies heat by conduction to the fluid supply passages in the head to prevent cooling of the fluids before they reach the processing station. Accordingly, the processing operations can be effected under closely controlled temperature conditions.

We claim:

1. Apparatus for rapid processing of photographic film, which comprises a processing head having opposing surfaces defining a path for movement of the film along the head, one of the surfaces having a fluid-conducting port and a separate light-conducting port spaced along said path and opening into the path on the emulsion side of the film, and the other surface having two light-conducting apertures opening into said path on the base side of the film and on opposite sides of the fluid-conducting port, one of said apertures being located in advance of the fluid-conducting port, reckoned in the direction of the film movement along the path, and forming an exposure station for the film, and the other aperture being aligned with said light-conducting port and forming therewith an image projecting station, the head also containing a fluid supply

8

passage leading to said fluid-conducting port, and valve means mounted within the head and in said supply passage for controlling the flow of a processing fluid to said fluid conducting port.

2. Apparatus according to claim 1, in which the head is provided with air passages leading to and from said projecting station, for conducting a drying medium along the processed film at said last station.

3. Apparatus for rapid processing of photographic film, which comprises a processing head having opposing surfaces defining a path for movement of the film along the head, the head also having a light-conducting aperture opening into said path and forming an exposure station, and a fluid-conducting port opening into the path beyond said aperture, reckoned in the direction of the film movement along the path, and forming a processing station, the head also having a supply passage leading to the fluid-conducting port, valve means for controlling the flow of a processing fluid through said passage, and a heating element supported by the head in heat-conducting relation to said passage and to one of said surfaces at the exposure station.

4. Apparatus for rapid processing of photographic film, which comprises a processing head having opposing surfaces defining a path for movement of the film along the head, one of the surfaces having a fluid-conducting port and a separate light-conducting port spaced along said path and opening into the path on the emulsion side of the film, and the other surface having two light-conducting apertures opening into said path on the base side of the film and on opposite sides of the fluid-conducting port, one of said apertures being located in advance of the fluid-conducting port, reckoned in the direction of the film movement along the path, and forming an exposure station for the film, and the other aperture being aligned with said light-conducting port and forming therewith an image projecting station, valve means for controlling the passage of a processing fluid to said fluid-conducting port, and a heating element disposed in heat-conducting relation with said path for preheating the film at said exposure station.

5. Apparatus for rapid processing of photographic film, which comprises a processing head having opposing surfaces defining a path for movement of the film along the head, one of the surfaces having a fluid-conducting port and a separate light-conducting port spaced along said path and opening into the path on the emulsion side of the film, and the other surface having two light-conducting apertures opening into said path on the base side of the film and on opposite sides of the fluid-conducting port, one of said apertures being located in advance of the fluid-conducting port, reckoned in the direction of the film movement along the path, and forming an exposure station for the film, and the other aperture being aligned with said light-conducting port and forming therewith an image projection station, valve means for controlling the passage of a processing fluid to said fluid-conducting port, and a lens in the head at said projecting station and partly defining an air passage for conducting a drying medium along the processed film at said last station.

6. Apparatus for rapid processing of photographic film, which comprises a processing head having opposing surfaces defining a path for movement of the film along the head, one of the surfaces having a fluid-conducting port and a

separate light-conducting port spaced along said path and opening into the path on the emulsion side of the film, and the other surface having two light-conducting apertures opening into said path on the base side of the film and on opposite sides of the fluid-conducting port, one of said apertures being located in advance of the fluid-conducting port, reckoned in the direction of the film movement along the path, and forming an exposure station for the film, and the other aperture being aligned with said light-conducting port and forming therewith an image projecting station, and valve means for controlling the passage of a processing fluid to said fluid-conducting port, said fluid-conducting port being divided into a central passage and an annular passage surrounding the central passage, the head having a concave surface facing the film path and separating said last passages, whereby the processing fluid is delivered from the valve means through one of said last passages and then flows between the film and the concave surface radially with

respect to the central passage and is discharged from the film path through the other of said passages.

7. Apparatus according to claim 6, in which the head also contains a vacuum port communicating with said discharge passage for creating a partial vacuum in the space formed by said concave surface.

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References Cited in the file of this patent
UNITED STATES PATENTS

Number	Name	Date
1,841,653	Grinten et al.	Jan. 19, 1932
1,907,252	Debrie	May 2, 1933
2,221,055	Lundegardh	Nov. 12, 1940
2,380,378	Allen	July 31, 1945
2,397,763	Streich	Apr. 2, 1946
2,431,041	Hassler	Nov. 18 1947
2,446,668	Tuttle et al.	Aug. 10, 1948