

Jan. 12, 1971

S. JEFFEE ET AL

3,554,641

APPARATUS AND PROCESS FOR THE LIQUID GATE PRINTING
OF A PHOTOGRAPHIC FILM

Filed Aug. 8, 1968

2 Sheets-Sheet 1

FIG. 1

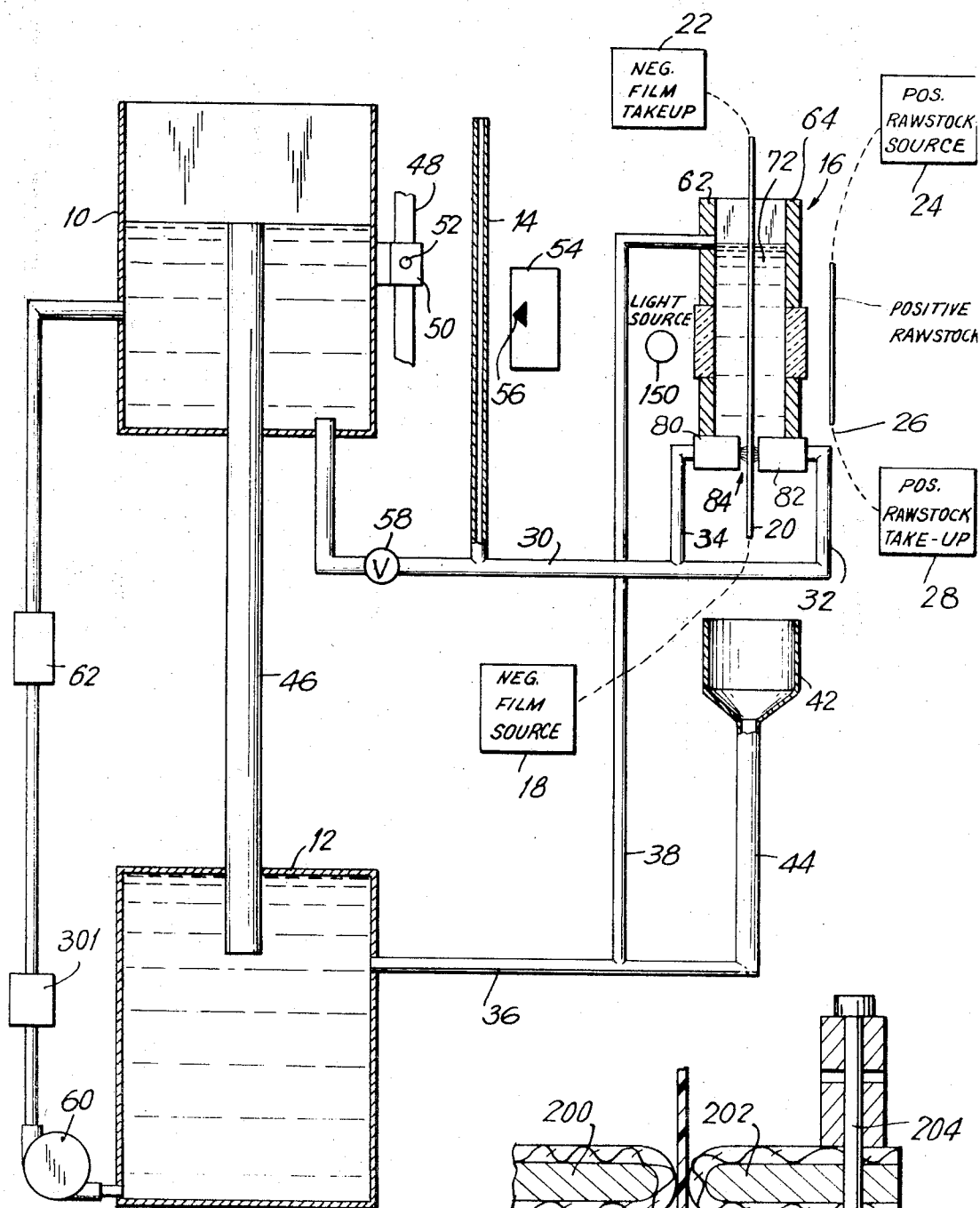
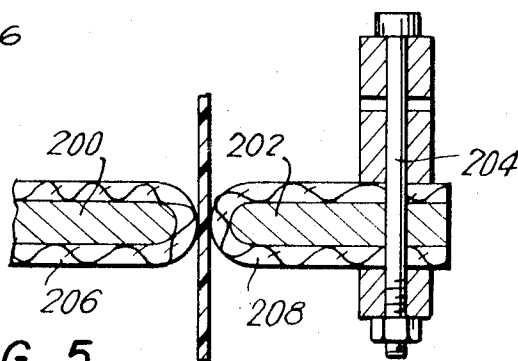


FIG. 5



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2 Sheets-Sheet 2

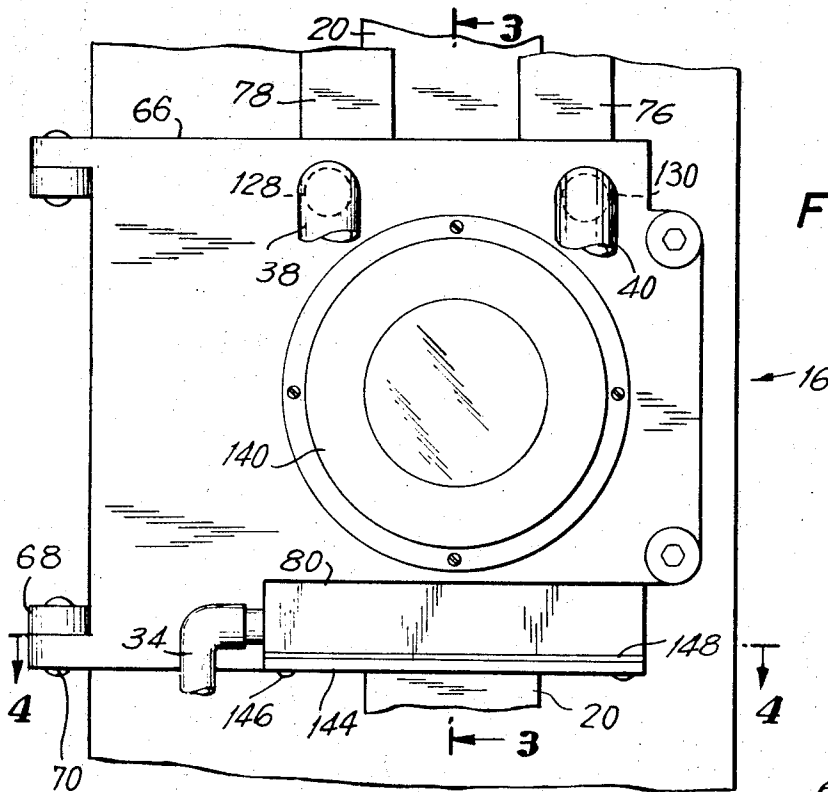


FIG. 2

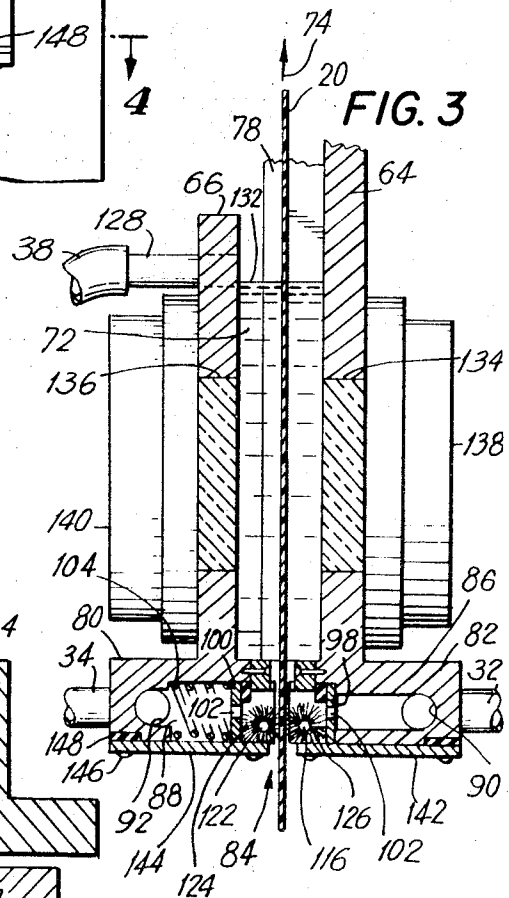


FIG. 3

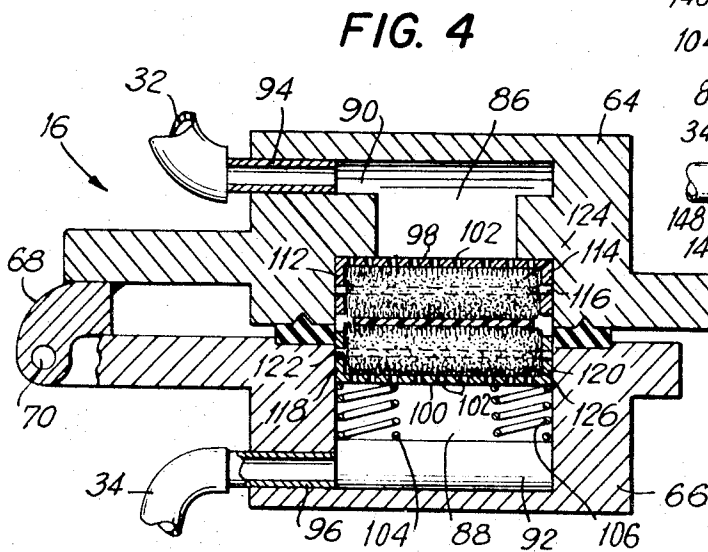


FIG. 4

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**APPARATUS AND PROCESS FOR THE LIQUID
GATE PRINTING OF A PHOTOGRAPHIC FILM**
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10 Claims

ABSTRACT OF THE DISCLOSURE

A device is provided for the liquid gate printing of photographic negatives. The device includes a liquid gate into which fluid is supplied in such a manner that the fluid flows from the bottom to the top of the gate. The flow rate and level of the fluid is controlled by adjusting the height of a liquid source relative to the gate. In addition, a valve is employed for controlling the input of the fluid into the gate and still further it is possible to exercise a control by means of controlling the escape of fluid from the entrance opening into the gate. A closed fluid circuit is provided by means of which overflow from the gate is returned to a reservoir from which the fluid is pumped into an open vessel, the height of which is controlled relative to that of the gate. A receptacle is, moreover, provided to receive fluid leaking from the entrance opening, this fluid being returned to the aforesaid reservoir. An open sight tube is connected in the fluid circuit between the aforesaid vessel and the gate and constitutes a device by which the flow rate of the fluid in the gate as well as the level of the fluid in the gate is gauged.

DRAWING

FIG. 1 is a diagrammatic view of a fluid circuit including a liquid gate device provided in accordance with the invention;

FIG. 2 is a front view, on enlarged scale, of a detail of the apparatus illustrated in FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 2; and

FIG. 5 shows a modification of a detail of FIG. 3.

DETAILED DESCRIPTION

This invention relates to liquid circulation systems for "liquid gate" printing, and to systems and methods based on the maintenance of liquid level and liquid flow by hydrostatic pressure.

It is known that by application of a suitable liquid layer to one or both sides of a developed motion picture negative, or also to the emulsion side of a print film, or by immersion of a negative alone or together with a print film in a suitable liquid, while printing negative onto the print film, a superior printing image can be obtained, since by this type of procedure almost all negative scratch marks are rendered completely invisible or deleted.

The present invention relates to immersion techniques for liquid gate printing, wherein a film is pulled vertically upwards or downwards or sideways through an enclosure or chamber provided with suitable glass windows, within and between which a suitable liquid is confined in such a way as to cover the negative image in its entirety. Such an enclosure is generally known in the trade as an "aquarium." Film usually enters this aquarium through an opening where some of the liquid is lost and must, accordingly, be replaced at a rate which makes up for this loss.

Proposed in accordance with the invention is a liquid circulating system which by hydrostatic pressure (a) fills

the gate or aquarium to any desired and adjustable level, (b) compensates for the loss of liquid through film entrance opening and maintains thus the established level and (c) generates a flow of liquid through the gate or aquarium in a controlled manner, thereby maintaining in motion any foreign particles of matter which accidentally might be present in the gate or aquarium or which are drawn in one film. This latter function prevents thus that the foreign particles or matter might impair the printed image quality, since while in movement at a suitable rate, such foreign particles cannot be imaged on a print film.

In accordance with a specific embodiment of the invention, apparatus is provided comprising a constant level vessel which is adjustable in height and into which leads an influx tube for a liquid which is brought in by a pump. An overflow tube maintains a constant level within the vessel and an outflow pipe is provided through which the liquid flows into the gate or aquarium. Since the outflow rate is always less than the influx rate, excess liquid is continuously discharged through a tube into a sump tank which is provided and from which the fluid starts its cycle again through the pump. A transparent standpipe, whose use is based on the Pitot tube principle, and which indicates standby and working levels is also employed, the height of the column of liquid within this tube being proportional to manometric or gauge pressure. By adjusting the height of the aforesaid vessel by suitable means, different standpipe levels, pressure levels or hydrostatic heads can be obtained.

In the aforementioned aquarium is an entrance opening for a film. It is provided with adjustable or self-regulating lips or the like for control of the amount of escaping liquid. Entrance pipes are provided through which the liquid flows into the aquarium. The aquarium itself also acts on a Pitot tube principle and the height of the liquid level within the aquarium can be easily adjusted to any desired height by adjusting the outflow from the entrance opening and the height of the said vessel with respect to the height of the influx level or by adjusting one or more valves.

Preferably, adjustment is made so that a reasonable amount of overflow through overflow pipes is obtained. This overflow is essential for obtaining a flow pattern through the aquarium, thereby preventing particles of foreign matter from becoming stationary and imaging on the print film.

The invention will be more clearly understood from the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying drawing, the figures of which have been listed above.

In FIG. 1 is illustrated a system comprising an open vessel 10, a reservoir 12, a sight tube 14 and a printing gate 16.

Also included in the apparatus of FIG. 1 is a source 18 of negative film, the film 20 and the negative film take-up 22. The apparatus moreover includes a source 24 of positive rawstock, the positive rawstock 26 and the rawstock take-up 28.

The vessel 10 is coupled to the gate 16 via a conduit 30 having branches 32 and 34. Overflow from the gate 16 is returned to reservoir 12 via a pipe or conduit 36 having branches 38 and 40, both connecting to section 62 of a chamber 72, as explained hereinafter; other overflow branches may be connected to section 64. In addition, fluid escaping from gate 16 via the lower entrance opening into the gate is captured by a receptacle 42 and returned via a pipe 44 into the conduit 36 to return to the reservoir 12. Branches 38 and 40 may feel, if desired, directly into the receptacle 42.

An overflow pipe or conduit 46 is provided extending internally into the vessel 10 to maintain a certain height of fluid therein. This overflow pipe 46 extends into the

3

reservoir 12 so that the overflow of fluid from vessel 10 is returned to said reservoir.

The vessel 10 is vertically displaceable and for this purpose there is provided, for example, a post 48 to which the vessel 10 is adjustably connected by means of a clamp 50, a set screw 52 or any other suitable means providing for holding the vessel 10 in a selected position. The elements 48, 50 and 52 are exemplary only of a wide variety of devices, by means of which the height of vessel 10 can be adjusted relative to the gate 16.

The height of the fluid in gate 16, as well as the flow rate therethrough, is adjusted at least in part by adjustment of the height of vessel 10, and an indication of the height of the fluid and its rate of flow is given by the open sight tube 14 which operates in conjunction with an index mechanism 54 having an index 56 which is positioned in order to correspond to the desired liquid level and flow rate in the gate 16. Thus the height of the vessel 10 is selected in order to bring the liquid level in tube 14 to a height indicated by index 56.

Since the possibility is afforded for adjustment of the rate of escape of fluid through the bottom opening in the gate 16, there are thus constituted two possible adjustments for the control of fluid in the gate 16, these two possibilities including adjustment of the height of vessel 10 and adjustment of the escape of fluid from the bottom of gate 16. A third possible adjustment exists in the form of the valve 58 which is typical of one of a number of such valves which may be employed. Thus there are actually at least three adjustments of the fluid parameters noted hereinabove.

To provide for movement of fluid from the reservoir 12 to the vessel 10, there is employed a pump 60 which generally will be continuously operating. A filter 62 can be provided in series with the pump 60 in order to remove foreign particles and various types of small size impurities from the liquid before it is transmitted into the vessel 10. Such impurities may, for example, originate on the negative film itself and may be constituted by particles of dust and the like. Also a check valve 301 can be used in series with the pump to establish shorter start-up times.

Before explanation is given as to the operation of the apparatus illustrated in FIG. 1, a detailed description will next be provided with respect to the elements constituting the gate 16. These details are presented in FIGS. 2-4, to which reference is next made.

In FIGS. 2-4 it is seen that the gate 16 consists of two sections 64 and 66. These two sections are hingedly connected by means of a hinge 68 defining an axis for pivotal movement about a pin 70.

The sections 64 and 66 cooperatively define a chamber 72 and thus each section 64 and 66 includes a portion of such chamber. It is through this chamber that the film 20 passes for purposes of, for example, a printing operation and in the illustrated embodiment the film 20 passes in the form of a strip in a vertically upwards direction, as indicated by arrow 74. This film is accommodated in a conventional guide consisting of two peripheral elements 76 and 78 which engage the peripheral and lateral edge portions of the film and therefore rigorously define a path for the film to travel in moving through the gate and particularly through the chamber 72 thereof.

The sections 64 and 66 each include a bottom part 80 or 82 which cooperatively define the entrance opening 84. It is through this entrance opening that the film 20 passes on its way to and through the chamber 72.

The entrance opening 84 includes a supplemental chamber sections 86 and 88 and in these supplemental sections are provided two inlet couplings 90 and 92 in the form of open tubes to which are connected nipples 94 and 96 to which are connected inlet conduit branches 32 and 34 which have been noted hereinabove. Thus it is seen that influx fluid passes via tube 32 into nipple 94 and thence into inlet coupling 90 wherefrom it passes into supplemental chamber section 86. At the same time fluid passes

4

from input conduit 34 through nipple 96 into inlet coupling 92 and thence into supplemental chamber section 88.

In the chamber sections 86 and 88 are provided perforated partitions 98 and 100, each being provided with a plurality of openings 102 through which the aforesaid fluid can pass.

Springs 104, 106 are also located in supplemental chamber section 88. These springs operate against the partition 100 and urge the movable partition 100 towards the fixed partition 98. These springs can be replaced by springs of greater or lesser strength and thus control the force with which the partitions are urged towards one another for a purpose which will be indicated hereinafter.

Partition 98 is provided with flanges 112 and 114 in which is mounted a pin 116. Partition 100 is provided with flanges 118 and 120 in which is installed a pin 122. Pins 116 and 122 are maintained in parallel relationship and the aforesaid flanges are arranged so that in addition to supporting pins 116 and 122 they provide for guided displacement of partitions 98 and 100 so that the latter are always maintained in parallel relationship.

Mounted on the supports 116 and 122 are seal elements 124 and 126. These seal elements may be rolls of velvet, felt or other similar material or brushes or the like fabricated of cloth or bristles suitable for engaging the film 20 without scratching it, while at the same time providing for a substantial seal against leakage of fluid from the chamber 72. The primary function of the elements 124 and 126 is to permit the entry of the film 20 into and through the chamber 72, while at the same time maintaining a preponderance of the fluid in chamber 72.

The effectiveness of the elements 124 and 126 in maintaining fluid within the chamber 72 is less than 100% and use is made of this feature by having the elements 124 and 126 act in concert with entrance opening 84 to provide a regulatable escape for fluid which is received by receptacle 42 (FIG. 1) and returned to the reservoir 12. Regulation is effected by appropriate replacement of the springs 104 and 106. As an alternative, adjustment screws can be provided in the section 66 to control the force which the springs exert against the partition 100. By appropriate adjustment of the force with which the movable brush or roller element 126 is urged towards the brush or roller element 124, adjustment is concomitantly made of the leakage or escape rate of the fluid from chamber 72 and this contributes one of the three elements of control noted hereinabove.

At the top of section 66 of chamber 72 are located two overflow pipes or conduits 128 and 130. These have the function of establishing the fixed overflow level 132 of the fluid in chamber 72. To the overflow pipes 128 and 130 are respectively connected the outlet conduit branches 38 and 40 referred to hereinabove with respect to FIG. 1.

The sections 64 and 66 are furthermore provided with windows 134 and 136. With these windows are associated lens mounts 138 and 140, within which are installed such lenses as are necessary to effect a photographic printing operation. The lens mounts 138 and 140, as well as windows 134 and 136, define a path for light to traverse the chamber 72 within which the film 20 is surrounded by fluid.

To facilitate removal and replacement of the above-noted springs, as well as of the above-noted roller elements, sections 80 and 82 are provided with removable bottom portions 142 and 144, these being held in position by screw elements 146. In connection with the screw elements, there are provided washer elements 148, in order to provide a fluid seal. Similarly, washer-like elements can be provided elsewhere throughout the gate as required, in order to provide for fluid seals wherever these might be required.

FIG. 5 illustrates another form of seal which can be employed. In this case, horizontal plates 200 and 202 extending through respective of the perforated plates are held in place such as by bolts 204 and are covered by

velvet covers 206 and 208. The negative passes between these elements which form a seal as aforesaid.

Referring now to FIG. 1 in addition to FIGS. 2-4, for a printing operation, the desired roll of negative film is installed in the source 18 which is of conventional construction. The film 20 is then passed upwardly through the entrance opening 84 and is passed through guide elements 76 and 78 and is connected with negative film take-up 22, which is also a device of conventional construction. The rawstock onto which a printing is to be made is installed in source 24 and the rawstock 26 is connected with take-up 28, it then being possible to displace these two film strips longitudinally at equal rates in accordance with well known printing techniques. The printing techniques can be effected by the use of a light source 150 diagrammatically illustrated in FIG. 1.

The fluid employed can be any suitable chlorinated hydrocarbon, such as trichloroethylene, provided that the index of refraction is suitable and further provided that the fluid is inert with respect to the film which will be contacted thereby.

The height of the vessel 10 is adjusted until the desired fluid level is obtained in the sight tube 14 and in accordance with the position of the index 56. At the same time adjustments of the valve 58 are possible and fluid flow will be taking place via conduit 30 and branches 32 and 34 into the chamber 72 and thence via branches 38 and 40 into conduit 36 which returns to the reservoir 12. Fluid will escape via the entrance openings 84 into the receptacle 42 so that adjustments of the valve 58 and the height of vessel 10 will be made which take into account such escape of fluid into the receptacle 42.

The position of index 56 is empirically selected to avoid the possibility of foreign particles in the fluid in chamber 72 from imaging on the rawstock 26. This can be determined visually or by running one or two negatives, and the determination of the necessary hydrostatic head and position of index 56 can thus be readily determined for the printing of films.

When the vessel 10 has been elevated to the height necessary to make the liquid level in column 14 correspond with index 56 taking into account also the adjustment of the valve 58, the running of the film can be commenced and the film 20 and rawstock 26 will be passed along their respective paths at corresponding rates, whereupon a printing will be effected on the rawstock by virtue of the use of light source 150. This is an operation which is per se conventional and requires no explanation in this text.

The presence of the fluid in chamber 72 will have the effect of rendering invisible all scratches and other such imperfections appearing on the surface of the film 20. If desired, the technique can also be applied to the rawstock 26 separately or in combination with the negative film 20. The speed of movement of foreign particles in the fluid of chamber 72 will control whether or not these particles image on the rawstock 26 and the speed of flow of the fluid to chamber 72 can be so adjusted as to avoid this undesirable imaging.

The particles may be present in the fluid itself, in which event passage through the filter 62 will serve to remove them when the fluid has made a complete cycle. However, foreign particles can also be introduced on the film itself and it is essential to account for such foreign particles if a high quality product is to be obtained.

The fluid from reservoir 12 will be recirculated by means of the pump 60 and the overflow conduit 46, the latter being effective to maintain a certain height of fluid within the vessel 10, thereby rendering the positioning of the vessel 10 meaningful. Recirculation of the fluid continues, aside from the amount which is tapped off via conduit 30, to the valve 58 to be used in the gate and then the fluid is returned via one of the previously described routes.

From what has been stated hereinabove, it will now be

appreciated that there is provided in accordance with the invention an adjustable hydrostatic pressure to maintain a level of and an overflow of desired magnitude in a liquid printing gate, the adjustment of the hydrostatic pressure being possible by adjusting the height of vessel 10, adjusting the valve 58, or such other similar valves as may be incorporated into the system, or by adjustment of the escape of fluid via entrance opening 84.

The aforescribed system obtains and maintains a constant flow pattern of desired direction, distribution and flow rate within and throughout the chamber 72, or as is otherwise known in the field, the "aquarium."

The apparatus affords opportunity for removing particles of foreign matter, while at the same time preventing them from being imaged on the positive rawstock.

The method of the invention is that of rendering invisible scratches in a film by passing the film through an entrance opening in and through a chamber, applying a fluid into the chamber at a lower part thereof, and removing excess fluid from the chamber at an upper part thereof, so that the film and fluid move in the same direction through the chamber.

There will now be obvious to those skilled in the art many modifications and variations of the apparatus and technique set forth hereinabove. These modifications and variations will not, however, depart from the scope of the invention if defined by the following claims.

What is claimed is:

1. For use in the processing of a strip of film having images thereon, apparatus comprising first means defining a chamber and adapted for having said strip of film move through said chamber in a longitudinal direction and second means to supply fluid to the chamber and receive fluid from the chamber in such manner that scratches in the film are rendered invisible and foreign particles on the fluid are moved at a rate to avoid substantial imaging of the particles in images produced from said strip of film; said second means including a source of said fluid and support means to support said source at an adjustable height relative to said chamber, a conduit coupling said source to said chamber, and an adjustable valve in the conduit, said first means being provided with a bottom opening via which the film enters the chamber, said first means including means regulatably obturating said opening to adjust the loss of fluid through the said bottom opening whereby the rate of flow of the fluid through the chamber is adjusted.

2. Apparatus as claimed in claim 1 comprising an open sight tube coupled to said conduit and thereby to said chamber and source of fluid and being thus adapted to indicate fluid flow rate through the chamber.

3. Apparatus as claimed in claim 2, wherein said second means includes a reservoir, overflow pipes leading from said chamber to said reservoir, an open receptacle below said bottom opening to receive fluid therefrom and being coupled to said reservoir, and a pump for pumping fluid from the reservoir to said source.

4. Apparatus as claimed in claim 2 wherein said source includes an overflow conduit leading to said reservoir, said apparatus further including index means adjacent said open sight tube.

5. Apparatus as claimed in claim 4 further comprising sources of and takeups for said film and for positive rawstock operatively associated with said first means, said first means including windows providing a light passage through said chamber, and a light source aligned with said window to project the film photographically on said rawstock.

6. Apparatus as claimed in claim 1, wherein said first means includes two sections cooperatively defining said chamber and a bottom entrance opening leading into the chamber and a top exit opening leading out of the chamber, and hinge means connecting said sections.

7. Apparatus as claimed in claim 6, wherein said

7

sections include lower parts which define respective positions of said entrance opening and include therein couplings for connection to said second means, said second means including, in said portions, perforated partitions including end flanges, brush elements supported in parallel relation on said flanges, and springs acting against the partitions to urge the brush elements together, the film passing between the brush elements.

8. Apparatus as claimed in claim 7, wherein the couplings include perforated tubes in said portions in parallel relation with said brush elements and wherein the sections include overflow connections opening into the chamber adjacent said exit opening.

9. Apparatus as claimed in claim 7, wherein the sections include windows cooperatively defining a light passage through the chamber and lens mountings operatively associated with said windows.

10. A method comprising passing the film upwardly via an entrance opening into and through a chamber, supplying a fluid into the chamber at a lower part thereof, removing excess fluid from the chamber at an upper part thereof, so that the film and fluid move in the same direction through the chamber, and adjusting the rela-

8

tive rates of movement of the film and fluid through the chamber so that images of foreign particles in the fluid are not combined with images on the film during photographic printing processes.

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