

A RACK AND A TANK FOR A PHOTOGRAPHIC PROCESSING APPARATUS

Field of the Invention

The invention relates to the field of
5 photography, and particularly to a photosensitive
material processing apparatus.

Background of the Invention

The processing of photographic film involves
a series of steps such as developing, bleaching,
10 fixing, washing, and drying. These steps lend
themselves to mechanisation by conveying a continuous
web of film or cut sheets of film or photographic
paper sequentially through a series of stations or
tanks, each one containing a different processing
15 liquid appropriate to the process step at that
station.

There are various sizes of photographic film
processing apparatus, i.e., large photofinishing
apparatus and microlabs. A large photofinishing
20 apparatus utilizes tanks that contain approximately
100 liters of each processing solution. A small
photofinishing apparatus or microlab utilizes tanks
that may contain less than 10 liters of processing
solution.

25 The chemicals contained in the photographic
solution: cost money to purchase; change in activity
and leach out or season during the photographic
process; and after the chemicals are used the
chemicals must be disposed of in an environmentally
30 safe manner. Thus, it is important in all sizes of
photofinishing apparatus to reduce the volume of
processing solution. The prior art suggest various
types of replenishing systems that add or subtract
specific chemicals to the photographic solution to
35 maintain a consistency of photographic characteristics

in the material developed. It is possible to maintain reasonable consistency of photographic characteristics only for a certain period of replenishment. After a photographic solution has been used a given number of
5 times, the solution is discarded and a new photographic solution is added to the tank.

Activity degradation due to instability of the chemistry, or chemical contamination, after the components of the photographic solution are mixed
10 together causes one to discard the photographic solution in smaller volume tanks more frequently than larger volume tanks. Some of the steps in the photographic process utilise photographic solutions that contain chemicals that are unstable, i.e., they
15 have a short process life. Thus, photographic solutions in tanks that contain unstable chemicals are discarded more frequently than photographic solutions in tanks that contain stable chemicals.

Photographic processing apparatus which
20 operates using smaller volume tanks are described in US-A-5 311 235 entitled A DRIVING MECHANISM FOR A PHOTOGRAPHIC PROCESSING APPARATUS; US-A-5 179 404 entitled ANTI-WEB ADHERING CONTOUR SURFACE FOR A PHOTOGRAPHIC PROCESSING APPARATUS; US-A-5 270 762
25 entitled A SLOT IMPINGEMENT FOR A PHOTOGRAPHIC PROCESSING APPARATUS; and US-A-5 309 191 entitled RECIRCULATION, REPLENISHMENT, REFRESH, RECHARGE AND BACKFLUSH FOR A PHOTOGRAPHIC PROCESSING APPARATUS.

Problem to be solved by the Invention

30 The prior art suggest that if the volume of the various tanks contained within various sizes of photographic processing apparatus were reduced the same amount of film or photographic paper may be processed, while reducing the volume of photographic
35 solution that was used and subsequently discarded.

One of the problems in using smaller volume tanks is that the inner and outer sections of the tank typically are fixed and not separable. Another problem in using low volume tanks is that the material
5 being processed typically has a tendency to jam. Hence, it was difficult and time-consuming to separate the rack from the tank for cleaning and maintenance purposes.

Summary of the Invention

10 This invention overcomes the disadvantages of the prior art by providing a low volume photographic material processing apparatus that utilizes photographic tanks having an inner rack section and an outer tank section that are easily
15 separated. The processing apparatus will contain a smaller volume of the same photographic solution that was previously used in regular-sized processing tanks. In fact, in some instances, the volume of photographic solution utilised in regular-sized tanks may be
20 reduced by as much as 90%. Hence, the apparatus of this invention is capable of reducing the volume of photographic solution that is used and subsequently discarded by photographic processing apparatus while permitting the inner rack section of the tank to be
25 easily separated from the outer tank.

In accordance with one aspect of the present invention, there is provided apparatus for processing photosensitive materials, which comprises:

30 a tank through which a processing solution flows;

a rack having integral means to facilitate its insertion and removal from the tank, the rack and the tank being relatively dimensioned so that a processing channel having a small volume for holding
35 processing solution and photosensitive material is

formed between the rack and the tank, the processing channel comprising at least 40% of the total volume of the processing solution available for processing the photosensitive material and having a thickness equal
5 to or less than about 100 times the thickness of the photosensitive material to be processed in the processing apparatus;

means for circulating the processing solution through the processing channel; and
10 means coupled to the rack for moving the photosensitive material through the processing channel.

In accordance with a second aspect of the present invention, there is provided apparatus for
15 processing photosensitive materials, which comprises:

a tank through which a processing solution flows;

a rack having integral means to facilitate its insertion and removal from said tank, said rack
20 and said tank are relatively dimensioned so that a processing channel having a small volume for holding processing solution and photosensitive material is formed between said rack and said tank, said processing channel comprising at least 40% of the
25 total volume of processing solution available;

wherein at least one discharge opening for introducing processing solution into said channel is provided;

means for circulating the processing
30 solution through said processing channel; and

said at least one discharge opening has a configuration in accordance with the following relationship:

$$1 \leq F/A \leq 40$$

35 wherein:

F is the flow rate of the solution through the discharge opening in gallons per minute; and

A is the cross-sectional area of the discharge opening provided in square inches.

5 **Brief Description of the Drawings**

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

Figure 1 is a schematic drawing of the
10 apparatus of this invention;

Figure 2 is a schematic drawing showing rack 11 and tank 12 of Figure 1 in greater detail;

Figure 3 is a drawing of a side view of driving roller 51 of Figure 2;

15 Figure 4 is a drawing of a side view of driven roller 74 of Figure 2;

Figure 4A is a drawing showing the gears of rollers 60 and 74;

Figure 5 is a perspective drawing of
20 textured fluid bearing surface 301 which is affixed to rack 11 of Figure 2; and

Figure 6 is a perspective drawing of textured fluid bearing surface 300 which is affixed to tank 12 of Figure 2.

25 **Detailed Description of the Invention**

Referring now to the drawings in detail, and more particularly to Figure 1, a rack 11 is shown, which may be easily inserted and removed from tank 12. Rack 11 and tank 12 form a low volume photosensitive
30 material processing vessel 13.

When rack 11 is inserted in tank 12, a space 10 is formed. Rack 11 and tank 12 are designed in a manner to minimise the volume of space 10. The outlet 6 of vessel 13 is connected to recirculating pump 17
35 via conduit 16. Recirculating pump 17 is connected to

manifold 20 via conduit 5 and manifold 20 is coupled to filter 25 via conduit 24. Filter 25 is connected to heat exchanger 26 and heat exchanger 26 is connected to control logic 29 via wire 9. Control
5 logic 29 is connected to heat exchanger 26 via wire 8 and sensor 27 is connected to control logic 29 via wire 28. Metering pumps 7, 18 and 19 are respectively connected to manifold 20 via conduits 21, 22 and 23.

The photographic processing chemicals that
10 comprise the photographic solution are placed in metering pumps 7, 18 and 19. Pumps 7, 18 and 19 are used to place the correct amount of chemicals in manifold 20. Manifold 20 introduces the photographic processing solution into conduit 24.

15 The photographic processing solution flows into filter 25 via conduit 24. Filter 25 removes particulate matter and dirt that may be contained in the photographic processing solution. After the photographic processing solution has been filtered,
20 the solution enters heat exchanger 26.

Sensor 27 senses the temperature of the solution and transmits the temperature of the solution to control logic 29 via wire 28. For example, control logic 29 is the series CN 310 solid state temperature
25 controller manufactured by Omega Engineering, Inc. of 1 Omega Drive, Stamford, Connecticut 06907. Logic 29 compares the solution temperature sensed by sensor 27 and the temperature that exchanger 26 transmitted to logic 29 via wire 8. Logic 29 will inform exchanger
30 26 to add or remove heat from the solution. Thus, logic 29 and heat exchanger 26 modify the temperature of the solution and maintain the solution temperature at the desired level.

At this point the solution enters vessel 13
35 via inlet 4. When vessel 13 contains too much

solution the excess solution will be removed by drain 14 and flow into reservoir 15. The remaining solution will circulate through space 10 and reach outlet line 6. Thereupon, the solution will pass from outlet line 5 6 to conduit line 16 to recirculation pump 17. The photographic solution contained in the apparatus of this invention, when exposed to the photosensitive material, will reach a seasoned state more rapidly than prior art systems, because the volume of the 10 photographic processing solution is less.

Figure 2 is a schematic diagram showing rack 11 positioned within tank 12. Handle section 11a of rack 11 includes a panel 40. Panel 40 has a cut-out section 41 which allows driven roller 43 of rack 15 section 11a to rotate in the vicinity of panel 40. Panel 40 also has a cut-out section 44 which allows driving roller 51 of rack section 11b to rotate in the vicinity of panel 40. Driving roller 45 engages roller 43. Driving roller 46 drives driven roller 47. 20 Rollers 46 and 47 are attached to section 11a. Bottom plate 48 is connected to panel 40 and side plates 49. Handle 50 is connected to side plates 49 so that an individual may be able to grasp handle 50 and move rack 11 in the direction indicated by arrow X, thereby inserting rack 11 into tank 12. This is the position 25 shown in Figure 2. Handle 50 may also be grasped and moved in the direction indicated by arrow Y to remove rack 11 from tank 12.

Top section 11b of rack 11 includes panel 52 30 and driving roller 51 and center section 11c of rack 11 includes panels 53 and 54 and driving roller 60. Bottom section 11d of rack 11 includes panels 61 and 62, driving roller 34 and driven roller 33.

Tank section 12a includes a housing section 35 65. Tank section 12b includes sides 71. Tank section

12c includes driven rollers 73 and 74 and sides 325. Roller 73 is connected to plate 85 and driven roller 74 is connected to plate 76. Plates 85 and 76 are connected to sides 325. Bottom section 12d of tank 12 includes bottom panel 77 and sides 78. Outlet conduit 6 passes through panel 77 and inlet conduit 4 passes through side 71.

Photosensitive material 80 may be a continuous web or cut sheets of film or photographic paper. The emulsion side of material 80 may face either rack 11 or tank 12. Material 80 passes in space 10 between rollers 45 and 43, roller 51 and side 71, rollers 73 and 60, rollers 34 and 33, rollers 60 and 74, roller 51 and side 71 and between rollers 46 and 47. Photographic processing solution 75 reaches a level 86 within tank 12. Photographic solution 75 will be contained between level 86, space 10 and photosensitive material 80. Thus, a small volume of photographic solution 75 will be on both sides of photosensitive material 80 between rack 11 and tank 12.

Rack 11 and tank 12 respectively comprise: handle sections 11a and 12a; top sections 11b and 12b; center sections 11c and 12c; and bottom sections 11d and 12d.

Tank 12 and rack 11 respectively have textured surfaces 300 and 301. The manner in which surfaces 300 and 301 function will be more fully set forth in the description of Figure 5 and Figure 6.

The length of rack 11 and tank 12 may be adjusted for different processing steps in the photographic process. If a vessel shorter than vessel 13 of Figure 2 is required, center rack section 11c and center tank section 12c may be respectively deleted from rack 11 and tank 12. If a longer vessel

than vessel 13 of Figure 2 is required, one or more
top sections 11b and 12b and one or more center
sections 11c and 12c may be respectively connected
between present sections 11c and 12c and present
5 sections 11d and 12d.

Figure 3 is a side view of roller 51 and
textured surface 301 of rack 11. Rollers 60 and 34
are connected in a manner similar to the connection of
roller 51 of Figure 3.

10 Panels 40 and 52 of rack 11 respectively
have curved portions 83 and 84. Curves 83 and 84 are
shaped so that they will match the curvature of the
outer surface of roller 51 and minimise the volume of
solution 75 that will be contained between roller 51
15 and portions 83 and 84. Thus, the least amount of
solution 75 is used to fill the voids around roller
51.

Figure 4 is a side view of roller 74 and
roller 60 respectively of tank section 12c and rack
20 section 11c of Figure 2. Panel 53 and panel 54 with
textured surface 301 are shaped so that they will
match the curvature of the outer surface of roller 60
and minimise the volume of solution 75 that will be
contained between the shaped portions of panels 53 and
25 54 and roller 60. Panel 52 with textured surface 301
butts against panel 53 and panel 61 with textured
surface 301 butts against panel 54. Roller 73 of
Figure 2 is connected in the same manner as roller 74.
Retainer 88 has a notch 89. One end of spring 90 is
30 connected to notch 89 and the other end of spring 90
is connected to the hub of roller 74. One end of
plate 91 is connected to retainer 88 and the other end
of plate 91 is connected to textured surface 300. One
end of plate 92 is connected to retainer 88 and the
35 other end of plate 92 is connected to textured surface

300. Plates 91 and 92 are connected to retainer 88 and surface 300 in a manner to minimise the amount of surface contact roller 74 has with space 10. Retainer 88 is connected to back plate 76 by any known fastening means, i.e., bolts, screws, etc. Plate 76 is connected to side 325 (Figure 2) of tank section 12c to minimise the volume of solution 75 that exists in the voids between the above surfaces, plates, rollers and tank. Photosensitive material 80 passes between rollers 60 and 74 so that driving roller 60 may move photosensitive material 80 in space 10 between textured surfaces 300 and 301. Roller 74 is spring loaded towards space 10 so that roller 74 may be compressed out of the way when rack 11 is inserted in tank 12.

Figure 4A depicts gears 176 and 177 attached respectively to rollers 60 and 74 in such a manner that when roller 74 engages the surface of roller 60 gear 177 engages gear 176 so that gear 176 drives gear 177. When rack 11 is properly seated in tank 12, roller 74 will move in the direction shown by arrow A until it engages driving roller 60 and gears 176 and 177 will mesh. When rack 11 is removed from tank 12 roller 74 will move in the direction shown by arrow B compressing out of the way until rack 11 is removed from tank 12. At this juncture roller 74 will move in the direction shown by arrow A.

Figure 5 is a perspective drawing of textured fluid-bearing surface 301 which is affixed to rack 11 of Figure 2. Textured surface 301 is textured by any known process, e.g., knurling, moulded, EDM electro-discharged machined or applied. Knurls 95 are shown on surface 301. The texturing improves the flow of solution 75 between the photosensitive material and the rack. This yields a bearing of fluid aiding

photosensitive material transport through the rack arrangement. It also allows for improved circulation of solution 75 and makes it easier for particulate matter to escape direct and damaging contact with photosensitive material 80. Textured surface 301 provides space between rack 11 and space 10 to prevent particulate matter from scratching, abrading or pressure sensitising photosensitive material 80.

Figure 6 is a perspective drawing of textured fluid bearing surface 300 of tank 12. Textured surface 300 is textured by any known process, e.g., knurling, moulded, EDM electro-discharged machined or applied. Knurls 96 are shown on surface 300. Texturing improves the flow of solution 75 between photosensitive material 80 and tank 12. This yields a bearing of fluid aiding photosensitive material transport through tank 12. It also allows for improved circulation of the solution 75 and makes it easier for particulate matter to escape direct and damaging contact with photosensitive material 80. Textured surface 300 provides space between tank 12 and space 10 to prevent particulate matter from scratching, abrading or pressure sensitising photosensitive material 80.

A processor made in accordance with the present invention provides a small volume for holding processing solution. As a part of limiting the volume of the processing solution, a narrow processing space 10 is provided.

The processing space 10, for a processor used for photographic paper, should have a cross sectioned thickness t , Figure 1, equal to or less than about 50 times the thickness of paper being processed, preferably a thickness t equal to or less than about 10 times the paper thickness.

In a processor for processing photographic film, the thickness t of the processing space 10 should be equal to or less than about 100 times the thickness of photosensitive film, preferably, equal to or less than about 18 times the thickness of the photographic film. An example of a processor made in accordance with the present invention which processes paper having a thickness of about 0.2mm (0.008in) would have a channel thickness t of about 2mm (0.080in) and a processor which process film having a thickness of about 0.14mm (0.0055in) would have a channel thickness t of about 2.54mm (0.10in).

The total volume of the processing solution within the processing space 10 and recirculation system is relatively small as compared to prior art processors. In particular, the total amount of processing solution in the entire processing system for a particular module is such that the total volume in the processing space 10 is at least 40% of the total volume of processing solution available in the system. Preferably, the volume of the processing space 10 is at least about 50% of the total volume of the processing solution available in the system. In the particular embodiment illustrated, the volume of the processing space 10 is about 60% of total volume of the processing solution available in the system.

Typically the amount of processing solution available in the system will vary on the size of the processor, that is, the amount of photosensitive material the processor is capable of processing. For example, a typical prior art microlab processor, a processor that processes up to about $0.46\text{m}^2/\text{min}$ ($5\text{ft}^2/\text{min}$) of photosensitive material (which generally has a transport speed less than about $1.26\text{m}/\text{min}$ ($50\text{in}/\text{min}$) has about 17 liters of processing solution

as compared to about 5 liters for a processor made in accordance with the present invention. With respect to typical prior art minilabs, a processor that processes from about $0.46\text{m}^2/\text{min}$ ($5\text{ft}^2/\text{min}$) to about
5 $1.39\text{m}^2/\text{min}$ ($15\text{ft}^2/\text{min}$) of photosensitive material (which generally has a transport speed from about $1.27\text{m}/\text{min}$ ($50\text{in}/\text{min}$) to about $3.05\text{m}/\text{min}$ ($120\text{in}/\text{min}$) has about 100 liters of processing solution as compared to about 10 liters for a processor made in
10 accordance with the present invention. With respect to large prior art lab processors that process up to $4.6\text{m}^2/\text{min}$ ($50\text{ft}^2/\text{min}$) of photosensitive material (which generally have transport speeds of about 2.13 to $18.3\text{m}/\text{min}$ (7 to $60\text{ft}/\text{min}$) typically have from about
15 150 to 300 liters of processing solution as compared to a range of about 15 to 100 liters for a large processor made in accordance with the present invention. In a minilab size processor made in accordance with the present invention designed to
20 process 1.39m^2 (15ft^2) of photosensitive material per minute would have about 7 liters of processing solution as compared to about 17 liters for a typical prior art processor.

In certain situations it may be appropriate
25 to provide a sump (not shown) in outlet 6 or conduit 16 so that vortexing of the processing solution will not occur. The size and configuration of the sump will, of course, be dependent upon the rate at which the processing solution is recirculated and the size
30 of the connecting passages which form part of the recirculatory system. It is desirable to make the connecting passages, for example, outlet 6 is preferably as small as possible, yet, the smaller the size of the outlet 6, the greater likelihood that
35 vortexing may occur. For example, in a processor

having a recirculatory rate of approximately 11.36 to 15.14dm³/min (3 to 4 gals/min), there is preferably provided a sump such that a head pressure of approximately 100mm (4in) at the exit of the tray to
5 the recirculating pump can be maintained without causing vortexing. The sump need only be provided in a localised area adjacent the exit of the space 10. Thus, it is important to try to balance the low amount of volume of the processing solution available to the
10 flow rate required of the processor.

In order to provide efficient flow of the processing solution through the nozzles into the processing space 10, it is desirable that the nozzles/openings that deliver the processing solution
15 to the processing space 10 have a configuration in accordance with the following relationship:

$$1 \leq F/A \leq 40$$

wherein:

F is the flow rate of the solution into
20 space 10 in gallons per minute; and

A is the cross-sectional area of the nozzle or opening through which the processing solution flows into space 10 measured in square inches.

The above specification describes a new and
25 improved apparatus for processing photosensitive materials. It is realised that the above description may indicate to those skilled in the art additional ways in which the principles of this invention may be used without departing from the spirit. It is,
30 therefore, intended that this invention be limited only by the scope of the appended claims.



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Claims:

1. Apparatus for processing photosensitive materials (80), which comprises:

a tank (12) through which a processing solution (75) flows;

a rack (11) arranged to be disposed within the tank (12), the rack (11) and tank (12) being such that a processing channel (10) for holding processing solution (75) and photosensitive material (80) is formed therebetween;

means (17, 20, 25, 26) for circulating the processing solution (75) through the processing channel (10); and

means (33, 34, 43, 45, 51, 60, 73, 74) coupled to the rack (11) for moving the photosensitive material (80) through the processing channel (10);

characterised in that the rack (11) has integral means (50) to facilitate its insertion and removal from the tank (12), and in that the rack (11) and the tank (12) are relatively dimensioned so that the processing channel (10) (a) has a small volume comprising at least 40% of the total volume of the processing solution (75) available for processing the photosensitive material (80), and (b) has a thickness (t) equal to or less than about 100 times the thickness of the photosensitive material (80) to be processed in the processing apparatus.

2. Apparatus according to claim 1, wherein the processing channel (10) holds at least 50% of the total volume of the processing solution (75) available.

3. Apparatus according to claim 1 or 2, wherein the processing channel (10) holds at least 60%

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of the total volume of the processing solution (75) available.

4. Apparatus according to any one of claims 1 to 3, wherein the processing channel (10) has a thickness (t) equal to or less than about 50 times the thickness of the photosensitive material (80).

5. Apparatus according to claim 4, wherein the processing channel (10) has a thickness (t) equal to or less than about 18 times the thickness of the photosensitive material (80).

6. Apparatus according to claim 4 or 5, wherein the processing channel (10) has a thickness (t) equal to or less than about 10 times the thickness of the photosensitive material (80).

7. Apparatus according to any one of the preceding claims, wherein at least one discharge opening is provided for recirculating processing solution (75) to the processing channel (10), each discharge opening having a configuration in accordance with the following relationship:

$$1 \leq F/A \leq 40$$

wherein:

F is the flow rate of the solution through the discharge opening in gallons per minute; and

A is the cross-sectional area of the discharge opening provided in square inches.

8. Apparatus for processing photosensitive materials (80), which comprises:

a tank (12) through which a processing solution (75) flows;



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a rack (11) arranged to be disposed within the tank (12), the rack (11) and tank (12) being such that a processing channel (10) for holding processing solution (75) and photosensitive material (80) is formed therebetween;

means (17, 20, 25, 26) for circulating the processing solution (75) through the processing channel (10);

characterised in that the rack (11) has integral means (50) to facilitate its insertion and removal from the tank (12), in that the rack (11) and the tank (12) are relatively dimensioned so that the processing channel (10) has a small volume comprising at least 40% of the total volume of processing solution (75) available; and in that at least one discharge opening is provided for introducing processing solution (75) into the processing channel (10), each discharge opening having a configuration in accordance with the following relationship:

$$1 \leq F/A \leq 40$$

wherein:

F is the flow rate of the solution through the discharge opening in gallons per minute; and

A is the cross-sectional area of the discharge opening provided in square inches.

9. Apparatus according to claim 8, wherein the processing channel (10) has a thickness (t) equal to or less than about 100 times the thickness of the photosensitive material (80) to be processed in the processing channel (10).

10. Apparatus for processing photosensitive materials (80), which comprises:



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a tank (12) through which a processing solution (75) flows;

a rack (11) arranged to be disposed within the tank (12), the rack (11) and tank (12) being such that a processing channel (10) for holding processing solution (75) and photosensitive material (80) is formed therebetween;

means (17, 20, 25, 26) for circulating the processing solution (75) through the processing channel (10); and

means (33, 34, 43, 45, 51, 60, 73, 74) coupled to the rack (11) for moving the photosensitive material (80) through the processing channel (10);

characterised in that the rack (11) has integral means (50) to facilitate its insertion and removal from the tank (12), and in that the rack (11) and the tank (12) are relatively dimensioned so that the processing channel (10) has a small volume comprising at least 40% of the total volume of the processing solution (75) available for processing the photosensitive material (80).