

[54] **APPARATUS FOR PROCESSING
STRIPS OF PHOTOGRAPHIC
MATERIAL OR THE LIKE**

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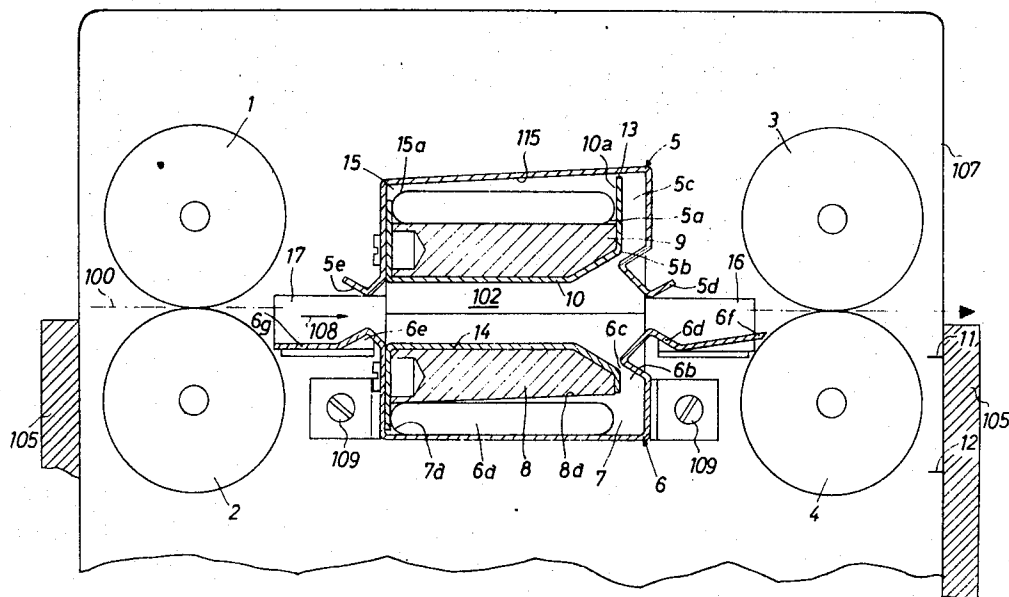
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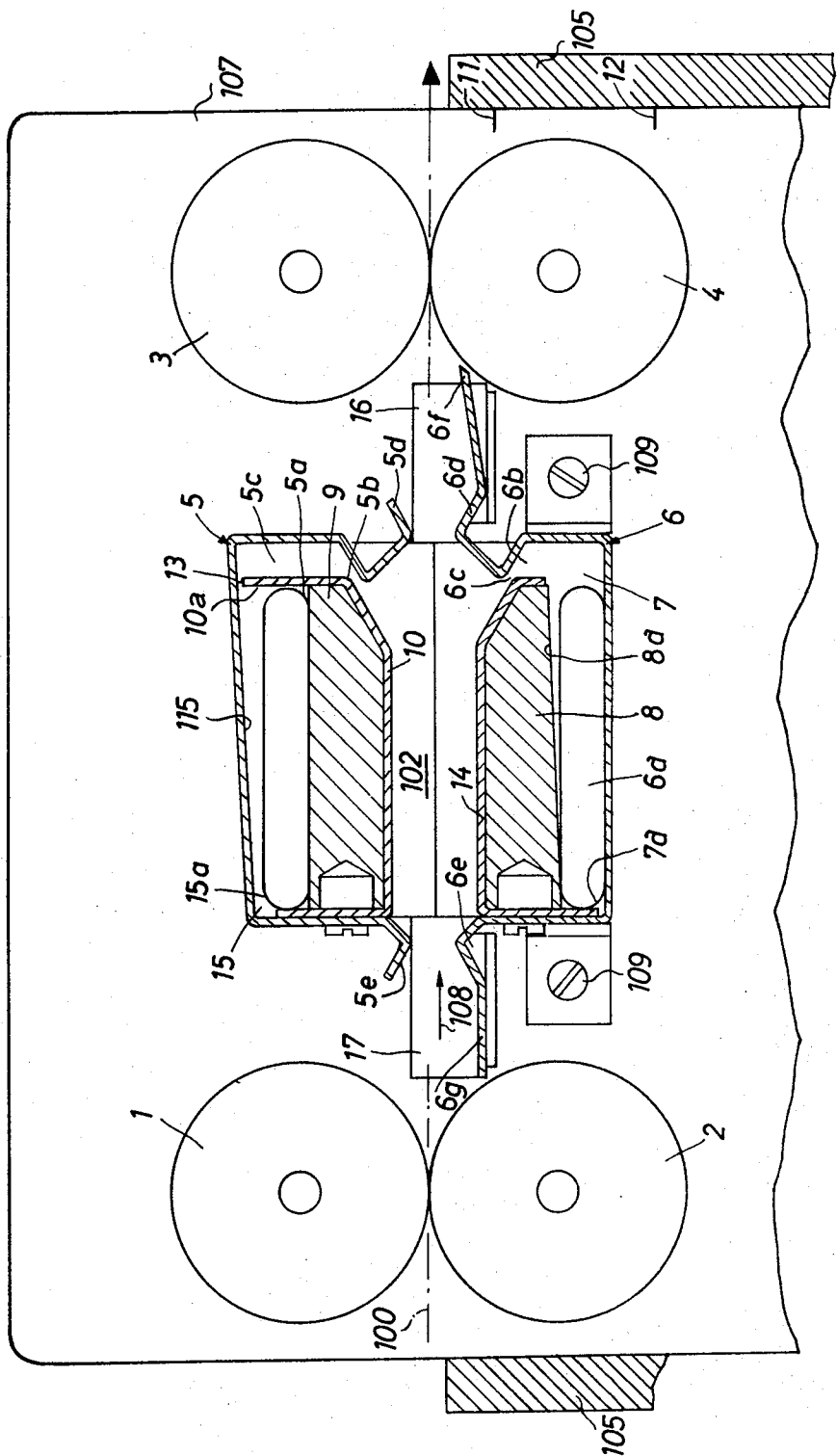
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ABSTRACT

Apparatus for treating strips of photographic material with a developing solution which reacts with oxygen has upper and lower chambers defining a channel for lengthwise transport of strips and orifices which discharge streams of developing solution against the respective sides of strips. The chambers further have passages which receive developing solution from a pump and are bounded by upper surfaces which slope upwardly in the direction of liquid flow toward the respective orifices. Such orifices receive liquid upon complete filling of the respective passages so that the passages are free of air bubbles when the apparatus is in use.

10 Claims, 1 Drawing Figure





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APPARATUS FOR PROCESSING STRIPS OF PHOTOGRAPHIC MATERIAL OR THE LIKE

CROSS-REFERENCE TO RELATED APPLICATIONS

The apparatus which is disclosed in the present application constitutes an improvement over and a further development of apparatus disclosed in the copending application Ser. No. 737,561 filed June 17, 1968, now U.S. Pat. No. 3,610,131, by Hans-Dieter Frick et al. and assigned to the same assignee.

Certain features which are claimed in the present application are disclosed in our copending application Ser. No. 97,272, filed of even date herewith, entitled "Apparatus For Processing Photographic Material Or The Like" and having the same filing date.

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for wet treatment of strips of photographic material or the like. More particularly, the invention relates to improvements in apparatus wherein strips of photographic material are treated with liquids which are adversely affected by oxygen.

It is well known that developing solutions for exposed photographic film undergo rapid oxidation on exposure to air and that oxidation reduces their effectiveness. Thus, it is of utmost importance for an economical operation to prevent oxidation or at least to slow down the oxidation of developing solution. Heretofore known developing apparatus are not entirely satisfactory because the solution which flows off the film is permitted to descend directly into the main supply by gravity with resulting splashing and introduction of large quantities of air into the main body of solution. On the other hand, the apparatus wherein the developing solution is not circulated at all or is agitated only below the surface are much less efficient than those wherein the entire solution is in motion during treatment of photographic material.

Another drawback of presently known developing apparatus for strips of photographic film is that they are likely to entrap bubbles of air during introduction of developing solution. Thus, when a developing apparatus comprises an upper liquid discharging chamber which serves to supply one or more liquid streams for treatment of the upper side of a travelling strip and a lower chamber which discharges liquid for the treatment of the underside of such strip, air is likely to be entrapped in the chambers to come into intimate contact with circulating solution and to bring about premature oxidation.

SUMMARY OF THE INVENTION

An object of the invention is to provide an improved apparatus for treatment of strips of photographic material with a liquid which reacts with oxygen and which, therefore, should be kept out of or in minimal contact with atmospheric air.

Another object of the invention is to provide developing or analogous processing apparatus for photographic film with novel means for expelling air from those portions which serve to confine the developing solution during circulation of such solution between the main supply and the path along which the film or films are moved through the apparatus.

A further object of the invention is to provide an apparatus wherein all traces of air or other gases can be expelled from the path for circulating liquid when the apparatus receives a fresh supply of liquid as well as when the apparatus is started.

An additional object of the invention is to provide the apparatus with novel means for automatically expelling air from the path for circulating developing solution or another processing liquid.

The apparatus of the present invention is utilized for wet treatment of strips of photographic material, particularly for treatment of films in a developing solution, and comprises spaced first and second pairs of preferably roller-shaped transporting members defining a substantially horizontal path for lengthwise transport of strips, and upper and lower liquid discharging chambers disposed in the space between the two pairs of transporting members and respectively located above and below the path for the strips. Each of the chambers has at least one preferably wide but narrow liquid-admitting inlet and preferably slit-shaped outlet orifice which discharges one or more liquid streams against the respective side of the strip between the two pairs of transporting members. The chambers are further provided with preferably narrow but wide passages along which the liquid flows from the respective inlets toward the respective outlets, and internal surfaces flanking the passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets. The outlets are positioned in such a way that they receive liquid from the inlets only in response to complete filling of the respective passages with liquid. This insures that the passages are totally free of air before the liquid reaches the respective outlets.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a schematic fragmentary longitudinal vertical sectional view of an apparatus which embodies the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawing illustrates a portion of an apparatus for wet treatment of strips of photographic material, particularly for treatment of exposed roll film or the like with a developing solution. The apparatus comprises a vessel or tank 105 which removably supports a frame including two vertical platens 107 (only one shown). These platens support the shafts of four transporting rollers 1 to 4. The front pair of rollers 3,4 is spaced from the rear pair of rollers 1, 2 as considered in the direction of strip transport (arrow 108), and these rollers define a preferably horizontal path 100 for lengthwise transport of successive strips through an elongated channel 102 between an upper liquid discharging chamber 5 and a lower liquid discharging chamber 6. The chambers 5, 6 can form a rigid one-

piece unit and are secured to the platens 107 by screws 109 or analogous fasteners. The vessel 105 contains a supply of processing liquid which normally fills the vessel to the level 12. A pump or a like liquid pressurizing and circulating device (not shown) is employed to draw liquid from the supply in the vessel 105 and to pump pressurized liquid into the chambers 5, 6. The manner in which the liquid can be circulated in the vessel 105 and chambers 5, 6 is disclosed in our aforementioned copending application of even date. Another suitable liquid pressurizing system is disclosed in German Pat. No. 1,293,586. The liquid which issues from the chambers 5, 6 and treats the strip in the channel 102 flows back into the vessel 105. When the pump is idle, the chambers 5, 6 are empty and the liquid in the vessel 105 rises to the level 11.

The chambers 5, 6 preferably consist of one or more suitably deformed sheets of stainless steel or other material which can resist the corrosive action of processing liquid. These chambers respectively comprise pairs of lateral walls or end walls 7, 15 (only one shown) which can be separably secured to the steel portions by screws or the like and preferably consist of synthetic plastic material. The walls 7, 15 flank the channel 102 which is open at both ends, namely, in the region of the rollers 1, 2 and in the region of the rollers 3, 4. The width of the channel 102 is preferably constant. The lower walls 7 are provided with elongated slit-shaped inlet openings 7a having rounded corner portions and a height which is but a small fraction of their width. The upper walls 15 are provided with similar inlet openings 15a. The openings 7a, 15a admit processing liquid which is being drawn from the supply in the vessel 105, and such liquid thereupon flows into and fills substantially horizontal narrow passages 5a, 6a in the respective chambers. The chambers 5, 6 are further provided with narrow slit-shaped outlet openings or orifices 5b, 6c which discharge streams of processing liquid against the respective sides of the strip advancing along the path 100. The orifices 5b, 6c are preferably designed in such a way that they discharge streams of liquid at an angle of about 30° with reference to the plane of the path 100 and counter to the direction (arrow 108) of strip travel in the channel 102.

The channel 102 is flanked from below by the top wall 14 of the lower chamber 6; this wall 14 overlies a block-shaped insert 8 which is installed in the chamber 6 above the inlets 7a. The lower surface 8a of the insert 8 slopes upwardly in a direction toward the orifice 6c. This insures that the liquid which is admitted into the chamber 6 by way of the inlets 7a must completely fill the passage 6a before it can reach the orifice 6c so that the passage 6a is totally free of air. The surface 8a of the insert 8 is a smooth, uninterrupted plane surface and serves as an upper boundary for the passages 6a. The latter discharges liquid into a substantially vertical passage 6b which is close to the lower front roller 4 and admits liquid into the orifice 6c. The surfaces bounding the orifice 6c are preferably rounded. The channel 102 has a trough-shaped portion whose bottom part receives liquid from the orifice 6c.

The upper part of the passage 5a in the upper chamber 5 is bounded by an internal surface 115 which slopes upwardly in the direction of liquid flow toward

the orifice 5b. The upper side of the channel 102 is flanked by a bottom wall 10 of the upper chamber 5; this bottom wall surrounds a portion of a block-shaped insert 9 which is secured to the sheet metal part of the chamber 5 by screws or analogous fasteners and has a horizontal top surface bounding the passage 5a from below. The bottom wall 10 has a vertical extension 10a which extends close to the internal surface 115 and defines therewith a narrow clearance or gap 13 for the flow of liquid from the passage 5a into a vertical passage 5c which extends downwardly from the gap 13 and supplies liquid to the orifice 5b. The width of the passage 5c is a multiple of the width of the orifice 5b or 6c or gap 13; as a rule, the width of the passage 5c is more than five times the width of the orifices 5b, 6c and gap 13. The gap 13 communicates with the uppermost part of the passage 5a so that the passage 5c begins to receive liquid only upon complete filling of the passage 5a; this insures that the passage 5a is completely free of air when the orifice 5b receives liquid. The width of the gap 13 preferably equals or approximates the width of the orifice 5b.

The lower chamber 6 is provided with forwardly and rearwardly projecting extensions 6f, 6g which extend close to the peripheral surfaces of the lower transporting rollers 4, 2. The upper chamber 5 has similar extensions 5d, 5e which are shorter than the extensions 6f and 6g. The extensions 5d, 5e are located opposite roof-shaped portions 6d, 6e of the lower extensions 6f, 6g to form therewith constrictions at the open ends of the channel 102 which slow down the outflow of liquid from the channel. The lower front extension 6f constitutes a guide or ramp along which the leader of a fresh strip can slide toward the nip between the rollers 3, 4. Thus, when the leader of a fresh strip is introduced into the nip between the rollers 1, 2 and enters the channel 102 between the extensions 5e, 6g, it automatically advances through the channel and can slide along the ramp or extension 6f to find its way into the nip between the rollers 3, 4. From then on, the strip is held away from contact with the extension 6f by a cushion of liquid which issues from the orifice 6c. The leader of a freshly inserted strip tends to bend downwardly under the weight of liquid which is discharged by the orifice 5b of the chamber 5.

The apparatus further comprises pairs of vertically extending lateral panels 16, 17 which respectively flank the extensions 6f and 6g and define therewith troughs which guide the liquid toward the peripheries of the rollers 4, 2. The panels 16, 17 prevent direct gravitational descent of processing liquid into the supply of liquid in the vessel 105; this could cause splashing and introduction of excessive quantities of oxygen into the main supply of liquid.

The operation:

When the apparatus is not in use, the aforementioned pump is idle and the chambers 5, 6 are empty so that the liquid fills the vessel 105 to the upper level 11. When the pump is started, the supply of liquid in the vessel 105 descends to the level 12 which is still high enough to insure that the lower portions of the rollers 2, 4 permanently dip into liquid in the vessel 105. This feature is claimed in our aforementioned copending application of even date. The pump is preferably a vane pump which permits some return flow of liquid from

the upper chamber 5 into the vessel 105 when the pump is idle; therefore, the upper chamber is invariably at least nearly empty when the apparatus is not in use. It will be noted that the upper level 11 of liquid in the vessel 105 is located below the level of the path 100 and well below the lowermost part of the internal space in the upper chamber 5 so that the latter can be completely evacuated during a period of idleness of the pump.

As the pump is started, it delivers pressurized liquid to the inlets 7a, 15a of the walls 7, 15 and such liquid rises in the passages 6a, 5a. The liquid which is admitted into the passage 5a rises toward the gap 13, i.e., along the internal surface 115, and can overflow into the vertical passage 5c only when the passage 5a is filled with liquid (i.e., totally free of air). The expelled air flows through the gap 13, passage 5c, orifice 5b, channel 102 and into the atmosphere. Any bubbles of air which might adhere to the internal surface 115 are immediately entrained by inflowing liquid to pass through the gap 13 and into the vertical passage 5c. The orifice 5b is substantially narrower than the passage 5c; therefore, this orifice acts as a flow restrictor and insures that the passage 5c is completely filled with liquid shortly after the liquid begins to overflow the wall portion 10a. This insures complete expulsion of air from the passage 5c. Thus, the liquid which circulates through the chamber 5 cannot come into appreciable contact with air so that the oxidation is negligible.

The width of the orifices 5b, 6c can be about 1 millimeter. The lower orifice 6c receives liquid upon complete filling of the passages 6a, 6b, i.e., after complete evacuation of air from such passages. This reduces the likelihood of rapid oxidation of liquid which is circulated through the lower chamber 6. The orifices 5b, 6c discharge streams of processing liquid at a constant rate, and such liquid forms in the channel 102 two cushions which treat the emulsion on the strip advancing along the path 100. The streams which issue from the orifices 5b, 6c are preferably mirror symmetrical with reference to the plane of the path 100 and a substantial part of each of these streams flows rearwardly toward the rollers 1 and 2. The upper cushion of liquid flows along the upper side of the strip and against the periphery of the upper roller 1. This roller serves as a barrier to further rearward flow of liquid so that the liquid overflows along the marginal portions of the strip and descends onto the peripheral surface of the lower roller 2 to be returned into the main supply of liquid in the vessel 105 without appreciable splashing. The extension 6g of the lower chamber 6 guides the lower cushion of processing liquid directly toward the periphery of the lower rear roller 2 along which the liquid forms a film and flows back into the vessel 105. The front extension 6f guides the front part of the lower cushion against the periphery of the lower front roller 4 whereby such liquid forms a film or layer and flows along the periphery of the roller 4 to return into the main supply of liquid in the vessel 105. The rollers 2, 4 serve as effective braking means to reduce the speed of returning liquid, and this also contributes to elimination of turbulence and to a reduction of oxidation. The extensions 6f, 6g insure that the strip is carried by a lower cushion of processing liquid substantially all the

way from the roller 2 to the roller 4. Since the upper cushion also extends substantially all the way between the rollers 1 and 3, both sides of the strip in the channel 102 are treated with the same degree of intensity.

The upwardly sloping surface 8a of the insert 8 in the lower chamber 5 is not absolutely needed for expulsion of air from the passage 6a when the upper surface of liquid in the vessel 105 (level 11) is above the level of the topmost part of the surface 8a while the pump is idle. Such situation is shown in the drawing. However, the surface 8a plays an important role in connection with rapid expulsion of bubbles of air or other gases which enter the circulating liquid when the apparatus is in use. Such bubbles are caused to move along the upwardly inclined surface 8a and to enter the channel 102 by way of the passage 6b and orifice 6c. Furthermore, the lower chamber 6 is completely empty when the main supply of liquid is introduced into or replaced in the vessel 105. The ascending bubbles of air are then expelled by travelling along the inclined surface 8a and into the channel 102.

The novel apparatus can be modified in a number of ways without departing from the spirit of the invention. Thus, the vessel 105 can contain a supply of fixer or other liquid. Furthermore, inclined surfaces corresponding to the surfaces 8a, 115 can be employed with equal advantage for expulsion of air from the conduits which convey liquid from the pump to the inlet openings 7a, 15a. Moreover, the entire chamber 5 and/or 6 may consist of metallic or synthetic plastic material.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets, said outlets being located at the highest points of the corresponding upwardly sloping surfaces and communicating with said passages at said highest points so that said passages are completely filled with liquid before the liquid enters said outlets.

2. A combination as defined in claim 1, wherein the internal surface of said lower chamber is an uninterrupted surface.

3. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having substantially horizontal first passages and substantially vertical second passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets, said first passages communicating with the respective second passages in the regions of the highest points of the respective sloping surfaces.

4. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having first passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets, the width of said first passage of said upper chamber substantially exceeding the height thereof and said upper chamber further comprising a substantially vertical second passage communicating with the respective outlet and a partition disposed between the passages of said upper chamber and defining a narrow throttling gap for overflow of liquid from said first into said second passage of said upper chamber.

5. A combination as defined in claim 4, wherein said vertical passage extends downwardly from said gap and said gap communicates with the topmost portion of the first mentioned passage of said upper chamber.

6. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having first passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets, the width of said first passage of said upper chamber substantially exceeding the height thereof and said upper chamber

further comprising a substantially vertical second passage communicating with the respective outlet and a partition disposed between the passages of said upper chamber and defining a narrow throttling gap for overflow of liquid from said first into said second passage of said upper chamber, the width of said gap being at most equal to the width of the outlet of said upper chamber.

7. A combination as defined in claim 6, wherein the outlet of said upper chamber and said gap constitute narrow slits.

8. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having first passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passages from above and sloping upwardly in the direction of liquid flow toward the respective outlets the width of said first passage of said upper chamber substantially exceeding the height thereof and said upper chamber further comprising a substantially vertical second passage communicating with the respective outlet and a partition disposed between the passages of said upper chamber and defining a narrow throttling gap for overflow of liquid from said first into said second passage of said upper chamber, the width of said second passage being a multiple of the width of at least one of said outlets.

9. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having first passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passage from above and sloping upwardly in the direction of liquid flow toward the respective outlets, the width of the said first passage of said upper chamber substantially exceeding the height thereof and said upper chamber further comprising a substantially vertical second passage communicating with the respective outlet and a partition disposed between the passages of said upper chamber and defining a narrow throttling gap for overflow of liquid from said first into said second passage of said upper chamber, the width of said second passage being a multiple of the width of said gap.

10. In an apparatus for wet treatment of strips of photographic material, a combination comprising spaced first and second pairs of rotary transporting

members defining a substantially horizontal path for lengthwise travel of strips; and upper and lower liquid discharging chambers disposed between said pairs of transporting members and respectively located above and below said path, each of said chambers having at least one liquid admitting inlet and at least one outlet for discharging a stream of liquid against the respective side of a strip advancing along said path, said chambers further having first passages along which the liquid flows from the respective inlets toward the respective outlets and internal surfaces flanking said first passages from above and sloping upwardly in the direction of

liquid flow toward the respective outlets, the width of said first passage of said upper chamber substantially exceeding the height thereof and said upper chamber further comprising substantially vertical second passage communicating with the respective outlet and a partition disposed between the passages of said upper chamber and defining a narrow throttling gap for overflow of liquid from said first into said second passage of said upper chamber, the width of said second passage exceeding five times the width of said outlets and said gap.

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