United States Patent

Ratowsky

[15] **3,705,544**

[45] **Dec. 12, 1972**

[54] **METHOD OF PROCESSING PHOTOGRAPHIC MATERIAL**

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[73] Assignee: **Ontario Development Corporation**

[22] Filed: **Nov. 5, 1971**

[21] Appl. No.: **196,075**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 848,042, Aug. 6, 1969.

[30] **Foreign Application Priority Data**

Aug. 10, 1968 Great Britain.....38,333/68
March 11, 1969 Great Britain.....12,655/69

[52] **U.S. Cl.**.....**95/93**, 95/89 R, 95/99, 259/72

[51] **Int. Cl.**.....**G03d 3/08**

[58] **Field of Search**.....95/89 R, 93, 99; 259/72

[56] **References Cited**

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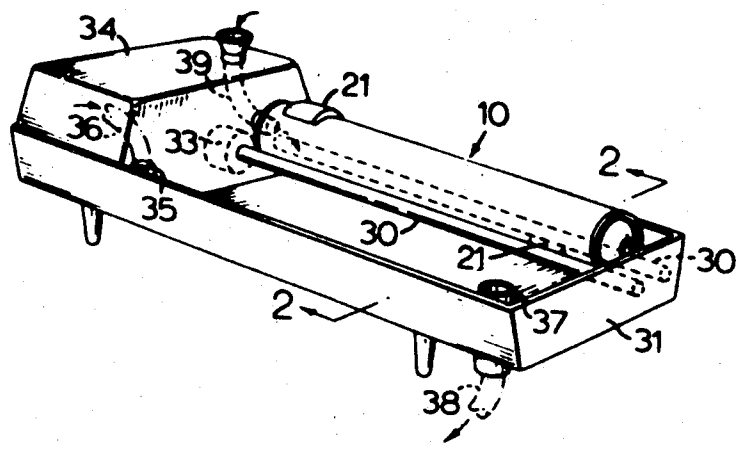
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Primary Examiner—Samuel S. Matthews
Assistant Examiner—Alan A. Mathews
Attorney—Westell & Hanley

[57] **ABSTRACT**

A method of processing photographic material of the sheet or roll type including the steps of mounting the photographic material arcuately in a cylindrical carrier which is horizontally disposed with respect to the axis of arcuation, introducing a predetermined quantity of processing liquid into the lower portion of the cylindrical carrier, rotating the carrier abouts its longitudinal axis, and simultaneously oscillating the carrier (a) in a non-horizontal plane passing through its longitudinal axis, and (b) about a fulcrum centrally located on the longitudinal axis, to produce a continuous wave form in the liquid traveling back and forth along the carrier.

7 Claims, 11 Drawing Figures



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SHEET 1 OF 3

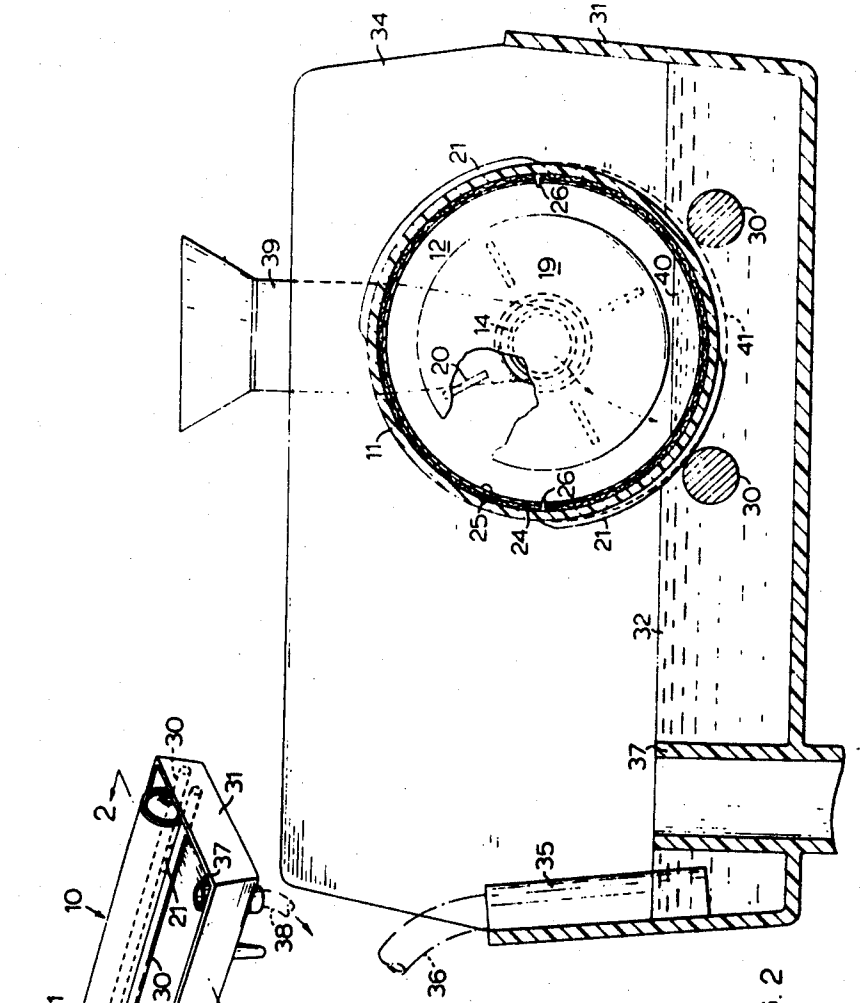


FIG. 2

FIG. 1

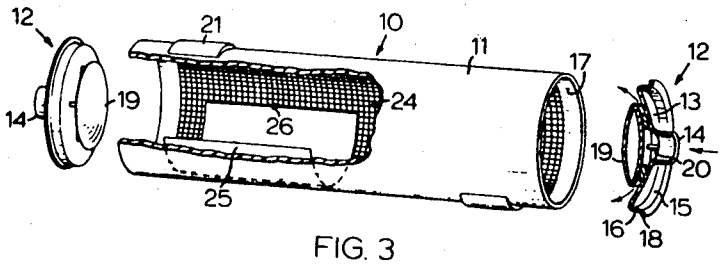


FIG. 3

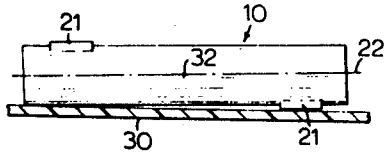


FIG. 4a

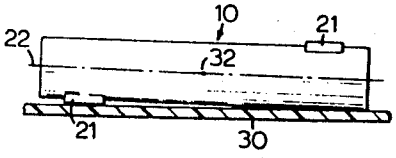


FIG. 4b

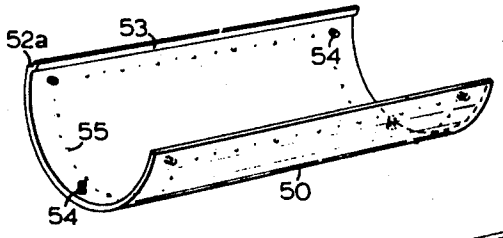


FIG. 5

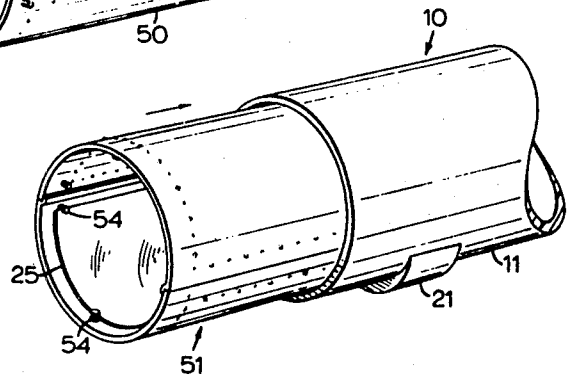


FIG. 6

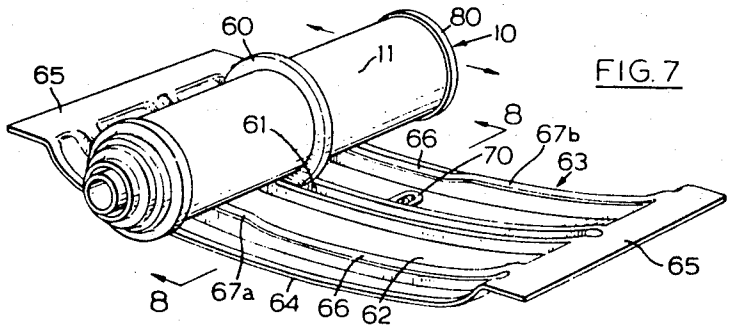


FIG. 7

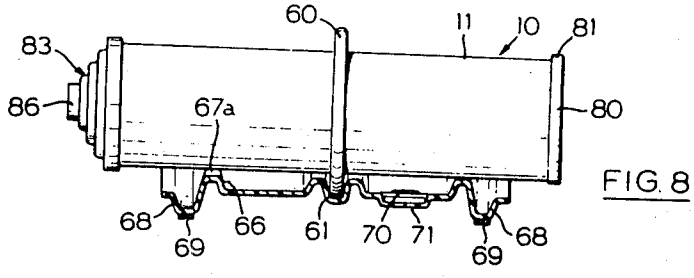


FIG. 8

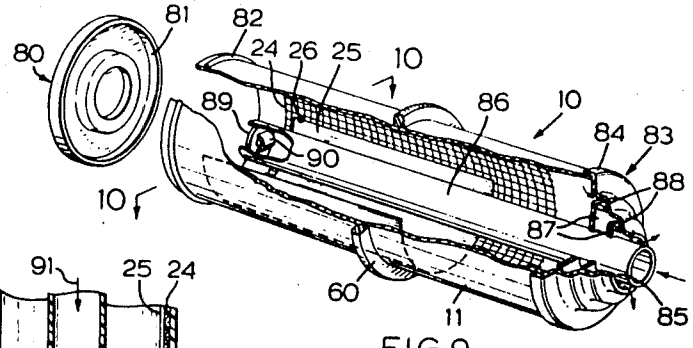


FIG. 9

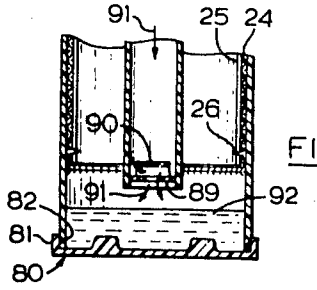


FIG. 10

METHOD OF PROCESSING PHOTOGRAPHIC MATERIAL

This application is a continuation in part of my copending U.S. Patent application Ser. No. 848,042 filed Aug. 6, 1969.

The present invention relates to a method and apparatus for the processing of photographic material, either in sheet or roll form.

Methods now commonly in use for processing photographic material employ dishes or tanks holding liquid chemicals or water into which the exposed material is successively submerged. In these tanks the liquid is agitated manually or by suitable mechanical means. Since this operation uses large quantities of chemicals, smaller units in the form of rotatable containers or carriers have been employed to reduce these chemical quantities. An example of such a carrier is to be found in U.S. Pat. No. 2,947,236 issued Aug. 2, 1960 in the name of H. Siegel. However, the Siegel type of apparatus suffers from the disadvantage that the liquid chemical within the carrier is not agitated sufficiently during rotation and may cause streaking of the film or print. To overcome this problem, external agitating means have been employed to reciprocate the carrier axially, but this makes the apparatus more complex and expensive to produce. Vertical agitation of itself does not provide a satisfactory result.

The present invention overcomes the above mentioned disadvantage by providing a simple method for processing photographic material in a carrier, which results in photographic products of improved quality. This is achieved by providing increased agitation of the liquid chemical within the carrier by upward and downward oscillation of the body of liquid about a fulcrum centrally located in the axis of the carrier to produce a wave moving back and forth along the carrier.

Example embodiments of the invention are shown in the accompanying drawings in which:

FIG. 1 is a view in perspective of one embodiment;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1 (the tilt of the carrier being denoted only schematically);

FIG. 3 is a perspective view of the photographic sheet material insert carrier, partly broken away;

FIGS. 4*a* and 4*b* are schematic views of the mounted carrier in two different rotational positions;

FIG. 5 is a view in perspective showing a modified sheet material insert member;

FIG. 6 shows insert member of FIG. 5 holding sheet material and being changed into the carrier of the invention;

FIG. 7 is a perspective view of another embodiment of the invention;

FIG. 8 is a cross-sectional view taken along the line 8—8 of FIG. 7;

FIG. 9 is a view in perspective, partially broken away and exploded, showing the carrier of FIGS. 7 and 8; and

FIG. 10 is a partial view in cross-section of the carrier of FIG. 8 taken along the line 10—10.

The embodiment of the invention shown in FIGS. 1 to 4 of the drawings consists of a cylindrical carrier 10 comprising an elongated tubular body or drum 11 carrying a pair of removable end caps 12, each of which

press-fits into the drum tube. Each end cap 12 consists of a concave disc 13 having an outwardly projecting central funnel aperture 14 and a circumscribing flange 15 providing a cylindrical, slightly sloping surface 16 for press fitting engagement with inside surface 17 of drum 11, and an end lip 18. The inside surface of disc 13 carries a second, double concave disc 19 fixed to disc 13 by a plurality of vanes 20.

The outer surface of drum 11 carries a pair of raised cam shoulders 21, one located adjacent each end of the drum. Each cam 21 partially circumscribes drum 11 and the two cams are juxtaposed one with another with respect to a longitudinal axis 22 of the drum.

Drum 11 is preferably formed of Plexiglas, a trade mark of Rohm and Haas Corporation used in association with polymethacrylate, while end caps 12 and cams 21 are preferably formed of acrylonitrile butydiene styrene (ABS).

Inside surface 17 of drum 11 carries a mount in the form of a cylindrical web 24 which is adapted to receive one or more sheets 25 of exposed photographic material for processing. Web 24 is adapted to be inserted into, and removed from, drum 11 but does not slip on inside surface 17 of the drum. Web 24 is shorter in length than the length of drum 11 to allow end caps 12 to engage the drum. The material from which web 24 is woven is preferably Fluoroglas, a trade mark of Dodge Industries Limited, Hoosick Falls, New York, U.S.A., used in association glass fibers coated and impregnated with polytetrafluoroethylene. The optimum mesh size (i.e. the openings between the threads) of web 24 is three-sixteenths inch, the thread thickness being 0.020 inch. Cylindrical web 24 may be formed from a flat sheet with the opposing edges preferably joined on a bias to the longitudinal axis of the web. Positioning pins 26 may be located at selected points in web 24, the pins projecting inwardly through the web and being removably mounted on the web.

Carrier 10 is adapted to be placed on a pair of parallel, spaced apart, horizontal roller shafts 30 whereby the carrier is horizontally disposed. Rollers 30 are preferably disposed within a tank 31 containing water or other liquid 32 which contacts carrier 10 for temperature control purposes. Rollers 30 are journally mounted in tank 31 and at least one of the rollers are driven by suitable means such as a motor 33 located within a protective housing 34 integral with the tank. Tank 31 has an annular ring 35 for inserting an inlet conduit 36, and a standpipe 37 for coupling with an outlet conduit 38. The upper edge of stand pipe 37 is below the lowermost portions of the rim of apertures 14 of end caps 12 when carrier 10 is positioned on rollers 30, as shown in FIG. 2 of the drawings. When carrier 10 is thus resting on rollers 30 a pipe 39 projects from housing 34 into the carrier through aperture 14 of one of end caps 12.

In the operation of the device at least one sheet of photographic material 25 is mounted in web 24 with the sheet being bounded by pins 26 pushed through the web which is then slid into drum 11 of carrier 10. Carrier 10 is closed by fitting end cap 12 (or one end cap along if the other cap is fixed to the tube) into the ends of drum 11.

Carrier 10 is then placed on rollers 30 as outlined above, with pipe 39 projecting into the carrier through

aperture 14 of one of end caps 12. A predetermined amount of liquid chemical is introduced into carrier 10 through pipe 39 and this liquid chemical lies at the bottom of the carrier in a pool 40 having its surface below the level of apertures 14 in both end caps 12. One roller 30 is then rotated at a constant speed by motor 24, causing carrier 10 to rotate constantly. As carrier 10 rotates, first one cam 21 and then the other cam comes into contact with rollers 30, the cams contacting the rollers intermittently and causing the carrier to oscillate about a fulcrum 32 centrally located on longitudinal axis 22 of the carrier, as shown in FIGS. 4*a* and 4*b* of the drawings. As a result of this oscillation the liquid chemical in pool 40 is oscillated in a non-horizontal plane and moves back and forth longitudinally along inner surface 17 of drum 11, as well as circumferentially about the inner surface, thus giving even contact of the liquid chemical in two directions, one normal to the other, on the surface of photographic sheet material 25. The open weave of web 24 allows the liquid chemical of pool 40 to move longitudinally and laterally behind sheet material 25. Moreover, where sheet material 25 is paper and the web is Fluoroglas, the sheet will lift off web 24 at the lower portion of its rotation in pool 40 and adhere again to the web in the upper portion of its rotation out of the pool, without rolling the sheet, thus aiding the flow of liquid chemical about the sheet. To prevent detracting from the clarity of FIG. 2 of the drawings, the longitudinal tilt of carrier 10 has been denoted only by dotted line 41 representing the far end of the carrier.

When sheet 25 mounted in carrier 10 within drum 11 has been fully processed, the carrier is removed from rollers 30 and tank 31, and the liquid chemical within the carrier is drained away either by removing one of end caps 12 or by upending the carrier. Carrier 10 is then repositioned on rollers 30 as before and, while the carrier is being rotated, the chemical treatment step is repeated or the photographic sheet material 25 is rinsed by introducing wash water continuously through conduit 39 into the carrier with the excess water flowing out of the carrier through apertures 14 into tank 31. When removing or repositioning carrier 10 it is not necessary to stop motor 33. After the rinsing step, carrier 10 is removed as before, the carrier is emptied of rinse water, web 24 is removed from drum 11, and sheet (or sheets) 25 is removed from the web.

In a specific construction of the described embodiment a drum 11 having a length of 22 inches, an outer diameter of 6 inches and a ⅛-inch wall was used. The cam shoulders were one-fourth inch deep, 3 inches wide (i.e. longitudinally of drum 11), and 8½ inches in lateral transverse measurement (i.e. circumferentially of the drum) and were spaced 1 inch from each end of the drum. Web 24 was 20¾ inches long. Carrier 10 was rotated at twenty-three revolutions per minute and the agitation of the liquid chemical caused by rotation, and by oscillation, of the tube achieved a photographic product of high quality. With this specific construction and operating the apparatus at this specific speed of rotation and oscillation a wave form in pool 40 of the liquid chemical travels spirally back and forth through the length of carrier 10 and provides optimum agitation of the liquid chemical.

While the temperature control in the described embodiment is preferred, it may be omitted or replaced by other suitable temperature control means such as warm air.

If it is desired to process roll film using the present invention, the film may be spirally wound on a cage which rolls on the bottom of drum 11, the film being spaced from contact with inside surface 17 of the drum by circumferential end shoulders on the ends of the cage, as is known.

It will be appreciated that rotation of carrier 10 allows a minimum amount of liquid chemical to contact all portions of sheet material 25 mounted arcuately in the carrier, while oscillation of the carrier provides the agitation necessary to prevent streaking of the sheet material. Hence a product of acceptable quality is obtained with a simplified method and an apparatus of simple construction.

It should be noted that the shallowness of cams 21 allows the liquid chemical of pool 41 to flow along drum 11 without spilling over apertures 14 of end caps 12, while the length of each cam (circumferentially with respect to the tube) provides a sufficient interval of time for the flow, initiated at the raised end of the tube, to travel the full length of the tube (spirally because of the simultaneous rotation of the tube).

In an alternate embodiment of the invention, carrier 10 could consist solely of web 24 mounted horizontally on a coaxial, longitudinally rotatable shaft with the lowermost portion of the web resting in a pool of liquid chemical contained in an open tray which could be oscillated vertically about a fulcrum intermediate the ends of the tray and located on the bottom thereof, the tray being oscillated by a pair of spaced, rotatable cams, one cam positioned below the tray on each side of the fulcrum. This embodiment would be advantageous for larger carriers where their emptying would be more difficult.

In the alternate embodiment shown in FIGS. 5 and 6 of the drawings, a pair of arcuate segments 50 of sheet material semi-circular in cross-section and having an outer diameter slightly smaller than the inner diameter of carrier 10 fit together to form a mounting cylinder 51 for removable insertion into carrier 10. One edge 52*a* of each segment 50 carries an inturned lip 53 which aides in orienting the two segments to form cylinder 51. Each segment 50 carries on its convex side a pair of inwardly projecting positioning pins 54, one adjacent each end of the segment. Segments 50 are also dimpled to carry, on each face, rows of inwardly projecting raised portions 55 parallel to each edge of the segment. Mounting cylinder 51 is preferably moulded of a thermoplastic such as polyvinylchloride (PVC).

In the operation of the embodiment shown in FIGS. 5 and 6, a sheet 25 of exposed photographic material is mounted on the inside (convex) surface of a segment 50 by flexing the sheet to engage its opposed edges with pins 54. In its mounted position, sheet 25 rides on raised portions 55 out of contact with the surface of segment 50. A pair of segments 50, one or more of them carrying a sheet 25, are then fitted together to form cylinder 51 which is charged snugly into carrier 10 for the processing operation described above.

In the embodiment of the invention shown in FIGS. 7 to 10 of the drawings, carrier 10 does not carry circum-

ferential spaced cams but instead has an annular guide ring **60** mounted circumferentially midway between its ends. Ring **60** is adapted to be engaged in a slot **61** longitudinally disposed in the upper face **62** of a rocker tray **63** which consists of a rectangular sheet longitudinally actuated in its central portion **64** with the end sills **65**. A pair of spaced, parallel risers **66** are also disposed on upper face **62** of rocker tray **63**, one on each side of slot **61**. One riser **66** is contoured to have a uniformly raised portion **67***a* extending from one of sills **65** to a point near the mid-section of central portion **64** of tray **60** and tapering off to said mid-section. The other riser **66** is similarly contoured to have a raised portion **67***b* extending from the other of sills **65**. A pair of spaced ribs **68** are longitudinally disposed on the lower face of central portion **64** of tray **63** and carry bearing strips **69**. Rocker tray **63** also carries a spirit level **70** on its upper face **62** normal to slot **61** and risers **66**. Preferably tray **60** is of plastic such as polyvinylchloride (PVC) which is moulded to form slot **61**, risers **66** with raised portions **67**, ribs **68** and cup **71**.

Elongated tubular drum **11** of carrier **10** carries at one end a removable end cap **80** having a circumferential flange **81** which engages an O-ring **82** adjacent the end of the drum to provide a watertight press fit. The other end of drum **11** carries a fixed end cap **83** which is stepped from a circumferential flange **84** to a central aperture **85**. An inlet pipe or conduit **86** extends concentrically into drum **11** from end cap **83** and terminated adjacent end cap **80**. Pipe **86** projects outwardly from aperture **85** in end cap **83** and is concentrically positioned in the aperture to define an, annular outlet passage through the aperture. A pair of light traps, each consisting of annular disc **87** mounted on the inside of end cap **83** by dowels **88**, hold pipe **86** in fixed position. The end of pipe **86** adjacent end cap **80** carries a third light trap consisting of an apertured disc **89** having an arcuate, open-ended cap **90**. All the components of carrier **10** may be suitably moulded of plastic such as polyvinylchloride (PVC) except O-ring **82** which may be of rubber. Ring **60** may be press-fitted on drum **11** before end cap **84** is fixed to the drum as by gluing.

In the operation of the embodiment shown in FIGS. **7** to **10**, one or more sheets of paper **25** is mounted on cylindrical web **24** with positioning pins **26** and the web is inserted in drum **11**, after which end cap **80** is press-fitted onto the drum to close it. Carrier **10** is then turned upright as shown in FIG. **10** and a predetermined quantity of liquid processing chemical is charged into pipe **86** as indicated by arrows **91**, passing down through disc **90** to collect in a pool **92** on end cap **80**. Rocker tray **63** is transversely levelled using level **70** and carrier **10** is then turned into a horizontal position and placed on tray **63** with ring **60** located in slot **61**, the liquid chemical taking a position in the bottom portion of the carrier. Pipe **86** must terminate at a point sufficiently spaced from end cap **80** to prevent liquid chemical from reentering the pipe through disc **89** when carrier **10** is tipped into a horizontal position. Paper **25** is processed by alternately pressing on sills **65** of tray **63** (or moving one sill up and down) to rock the tray on strips **69** and roll carrier **10** along risers **66** from one end of arcuate central portion **54** of the tray to the other end of the central portion. This movement of carrier **10** along risers **66** caused first one end portion of the carrier and then the other end portion to be lifted by raised portions **67** of the risers, thus oscillating the carrier about a fulcrum centrally located on its longitudinal axis. This upward and downward oscillation of carrier **10** produces a wave in the liquid chemical lying in the bottom portion of the carrier, and the wave moves back and forth along the carrier to produce the required agitation of the liquid. When a prescribed time has elapsed, carrier **10** is removed from rocker tray **63** and upended with end cap **83** downward, allowing the liquid chemical to drain out through aperture **85** into a suitable receiving vessel. The operation may then be repeated using rinsing water, after which end cap **80** is removed and web **24** withdrawn to remove processed paper **25**.

The invention may be applied to an open rocker processing tray or vessel of the type which holds the photographic sheet material arcuately on its inside bottom surface, with the liquid chemical being moved over the surface of the sheet material as the tray is rocked. By mounting a pair of risers adjacent the opposed lateral edges of the outside bottom surfaces of the tray, offset one on each side of its axis of arcuation (equivalent to the longitudinal horizontal axis of the cylindrical carrier), the desired wave form may be produced parallel to that axis. If desired, of course, the rocker tray or vessel just described could include a closure cap to form a housing for light impermeability. It will be appreciated that in the embodiment shown in FIGS. **7** to **10** of the drawings the rocker tray **66** could carry raised portions **67** on ribs **68** in its underside, instead of on raisers **66**, to achieve the desired result.

It will also be appreciated that carrier **10** of FIG. **3** could be modified for use on any level surface by mounting cams **21** on a pair of fixed end caps **12** and providing suitable stops projecting from drum **10** on the end caps to allow for rolling of the carrier back and forth about its central axis but preventing full rotation of the carrier. By providing an opening in the upper portion of at least one end cap (as viewed when the carrier is horizontally disposed), processing liquid and paper could be inserted and removed from the interior of the drum.

In further explanation of the method of the invention, the wave moving back and forth along drum **11** and carrier **10** is continuous and in the form of a crest which is oriented substantially at right angles to, and displaced radially from, the longitudinal axis of the drum as it moves in a direction parallel to that axis. In other words, the crest lies as a chord in a plane normal to the longitudinal axis of the drum. The length of the crest, i.e. the length of the chord, is substantially uniform as it travels along the drum, forming a substantially square-ended rectangular pool of liquid behind it. The crest is destroyed and re-formed when the end drum **11** reaches the lower limit of its oscillatory travel and begins travelling upwardly again. With a longer drum **11** cam shoulders **21** or **67** are preferably longer and flatter to allow time for the continuous wave or crest to reach the end of the drum.

The relationship between the rate of rotation of carrier **10** and the amplitude of oscillation caused by cam shoulders **21** or **67** must be such as to allow the wave form to traverse sheet material **25** but to prevent undue

turbulence which would destroy the wave form. The rate of rotation in inches per minute is preferably kept constant (which means less revolutions per minute with a drum **11** of larger diameter) while the amplitude of oscillation is related to the depth of cam shoulders **21** or **67** and the length of drum **11** where the cam shoulders are located near the ends of the drum. In the specific construction of the described embodiment of FIGS. **1** to **4** mentioned above the rate of rotation of carrier **10** was about **445** inches per minute (i.e. the outer circumference of drum **11**, including cam shoulders **21** or **67** multiplied by the revolution per minute) and the amplitude of oscillation (i.e. the depth of cam shoulders **21** or **67**) was one eighty-eighth the length of drum **11**.

It will be appreciated that carrier **10** may be rotated continuously in one direction as in the embodiment shown in FIGS. **1** to **4** of the drawings or it may be rotated reciprocally in opposite directions as in the embodiment shown in FIGS. **7** and **8** of the drawings.

I claim:

1. A method of processing photographic material of the sheet or roll type, comprising the steps of:

mounting the photographic material arcuately, emulsion side facing inwardly, in a cylindrical carrier closable at each end;

closing the carrier and disposing the carrier and the material substantially horizontal with respect to the longitudinal axis of the carrier and the axis of arcuation of the material;

introducing a predetermined quantity of processing liquid into the lower portion of the horizontally disposed carrier whereby the emulsion side of the photographic material is contacted by the liquid on rotation of the carrier about its longitudinal axis;

rotating the carrier about its longitudinal axis, and simultaneously oscillating the carrier (a) in a non-horizontal plane passing through said longitudinal axis, and (b) about a fulcrum centrally located on said longitudinal axis with respect to the ends of the cylinder and fixed in said plane, to produce a continuous wave form in the liquid travelling back and forth along the carrier parallel to said longitudinal axis; and

after a predetermined time interval, removing the processing liquid from the carrier.

2. A method as claimed in claim **1** including the step of flowing water through the rotating and oscillating carrier to remove the processing liquid therefrom and to rinse the photographic material.

3. A method as claimed in claim **1** in which the carrier is oscillated at a frequency to produce said wave form travelling back and forth substantially the length of the carrier.

4. A method as claimed in claim **3** including the additional step of flowing water through the carrier to rinse the photographic material, the carrier being oscillated at a frequency to produce said wave form travelling back and forth substantially the length of the carrier.

5. A method as claimed in claim **1** in which the material is mounted arcuately within a cylindrical means and the cylindrical means is charged into the carrier.

6. A method as claimed in claim **1** including the step of externally water cooling the carrier during oscillation thereof.

7. A method as claimed in claim **1** wherein the amplitude of oscillation at each end of the carrier is approximately one eighty-eighth the length of the carrier and the speed of rotation of the carrier is approximately 445 inches per minute.

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