United States Patent

[11] **3,554,108**

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[45] Patented **Jan. 12, 1971**

[54] **APPARATUS AND METHOD FOR PROCESSING PHOTOGRAPHIC MATERIALS**
8 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **95/93,** 95/90.5
[51] **Int. Cl.** **G03d 3/06,** G03d 3/02
[50] **Field of Search** 95/93, 89, 94, 90.5, 14

[56] **References Cited**

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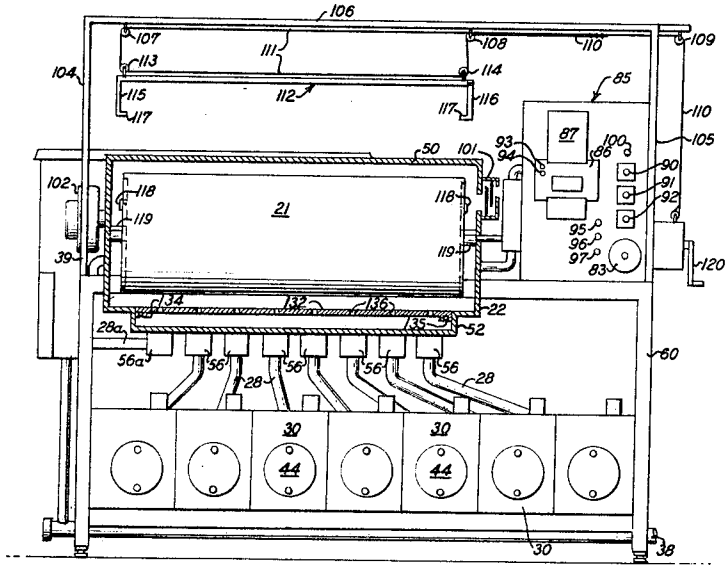
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Primary Examiner—John M. Horan
Assistant Examiner—Robert P. Greiner
Attorney—Mason, Mason & Albright

ABSTRACT: A drum-carrying photographic film is rotated in a housing in which developing solutions and wash water are introduced and withdrawn in a predetermined sequence with high rapidity through the same conduit. A baffle is provided in the housing to prevent splattering. Wash and rinse water is introduced at a rate exceeding that which is otherwise practicable by accumulating a reserve of water as the process continues and simultaneously discharging the accumulated wash water together with rinse water from normal outlets into the drum housing during the wash and rinse cycle. Color film rotated on the drum is subjected to reexposure lights disposed at the top of the drum. Polygonal drums are provided for photogrammetric plates. Expandible holding rods with spaced intermediate resilient means automatically adjust for expansion of the film which takes place during the processing. Exceedingly large paper prints are wound loosely about the drum and developed in such position while the drum rotates. A modified drum with a helical path provided about its periphery receives long strips of film such as movie film. The drum housing is selectively ventilated by means of a programmed exhaust fan, air being drawn into the housing through a light trap affixed adjacent the periphery of the drum.



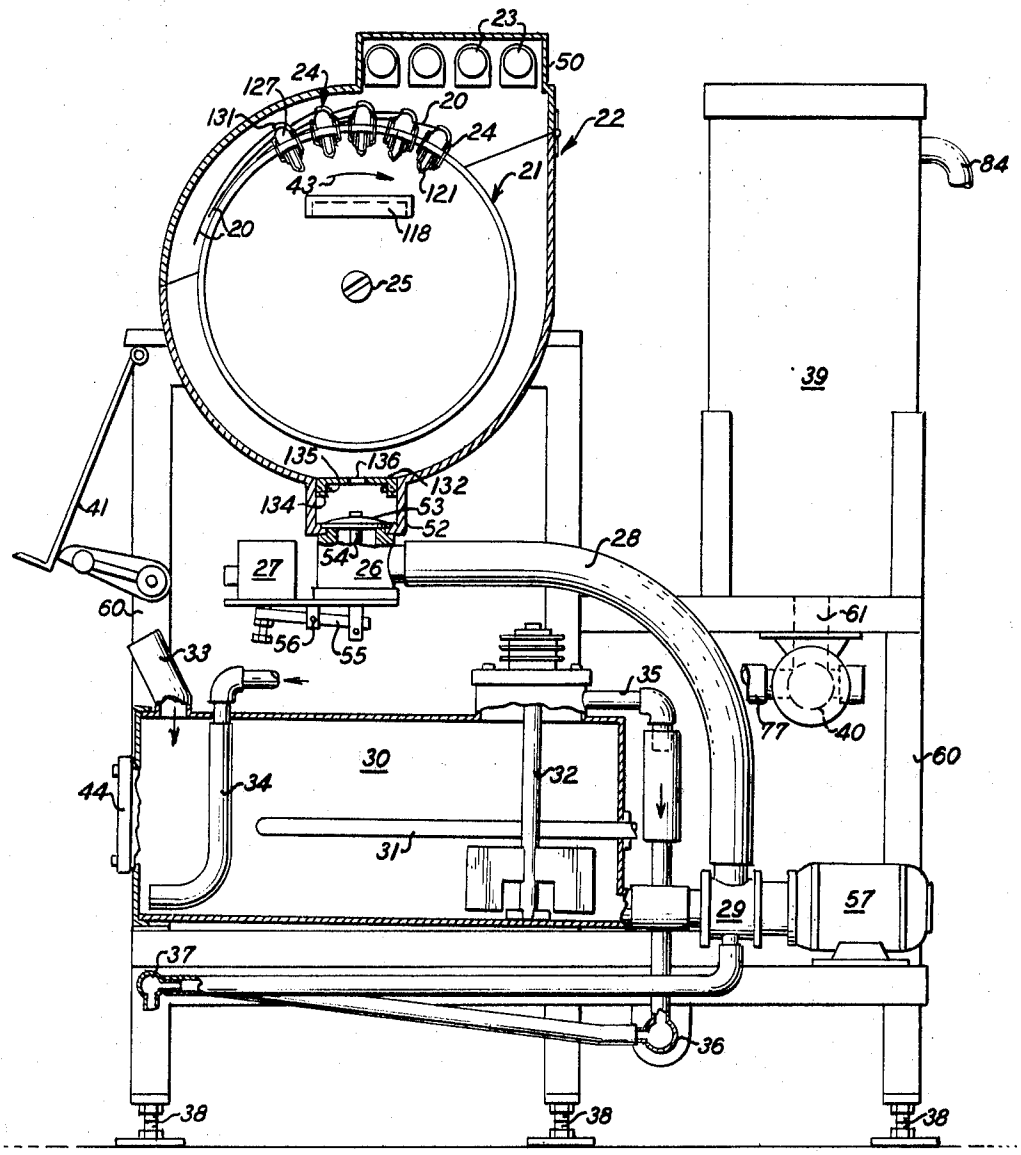


FIG. 1

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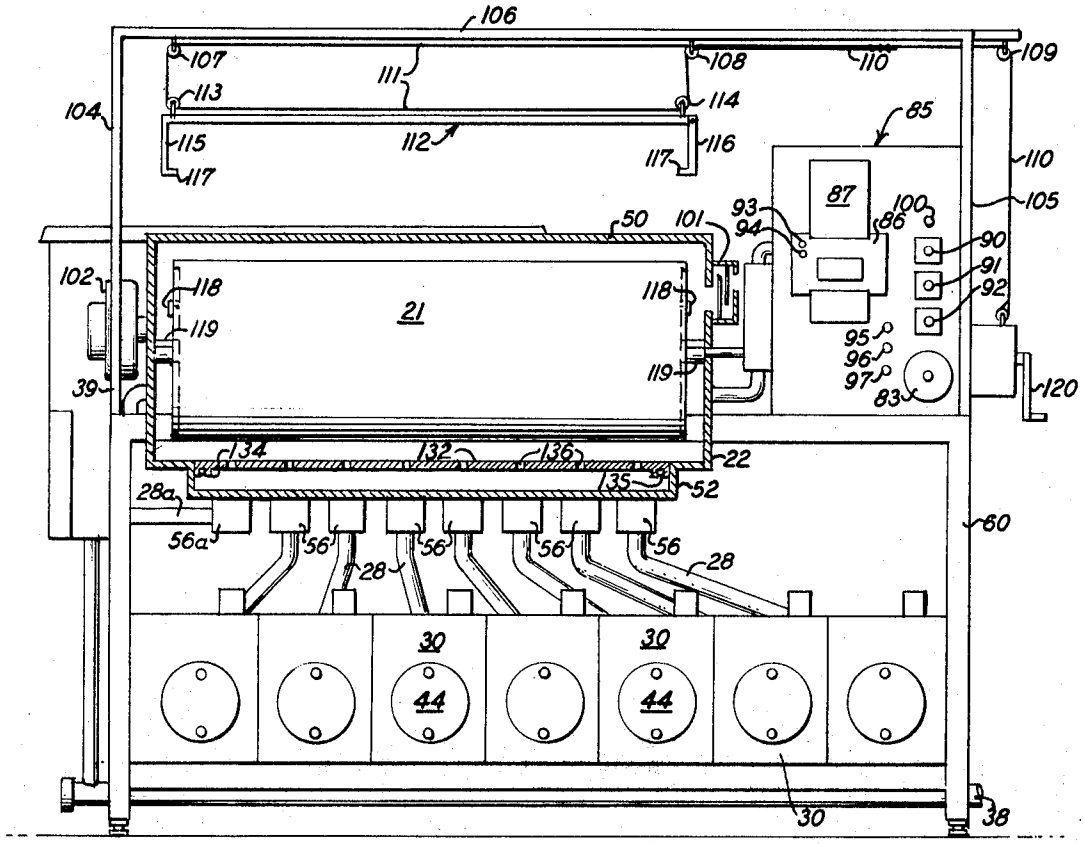


FIG. 2

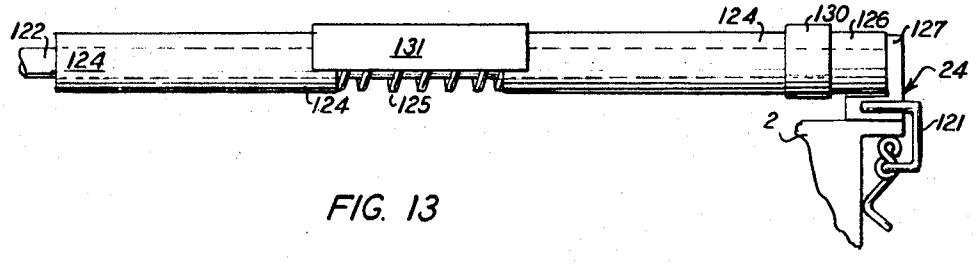


FIG. 13

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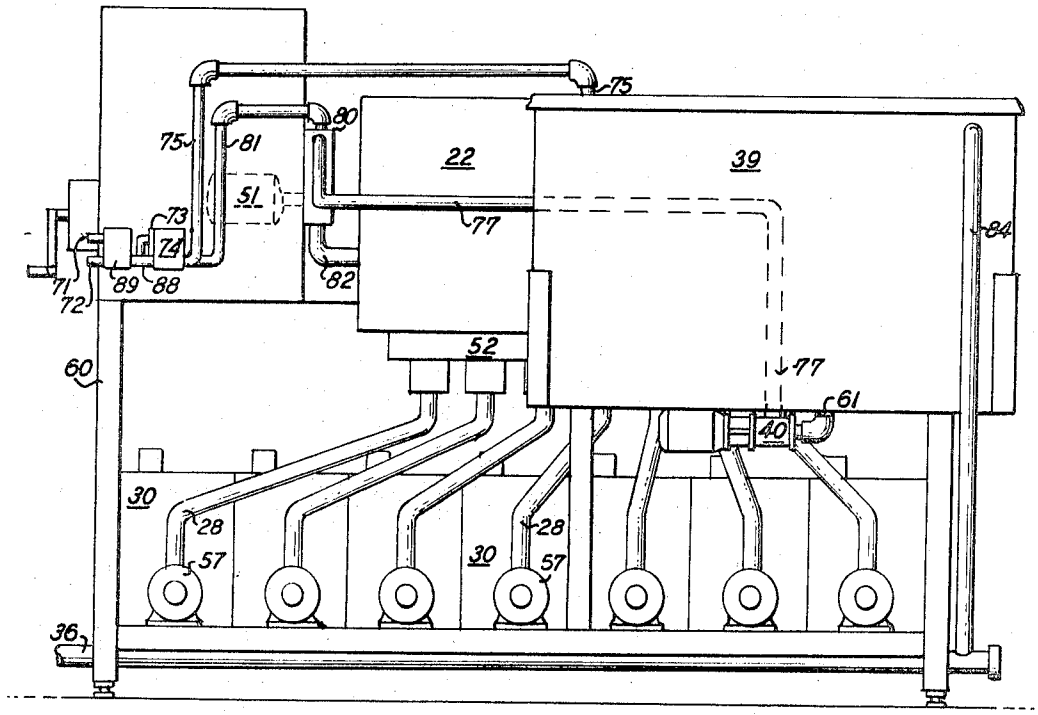


FIG. 4

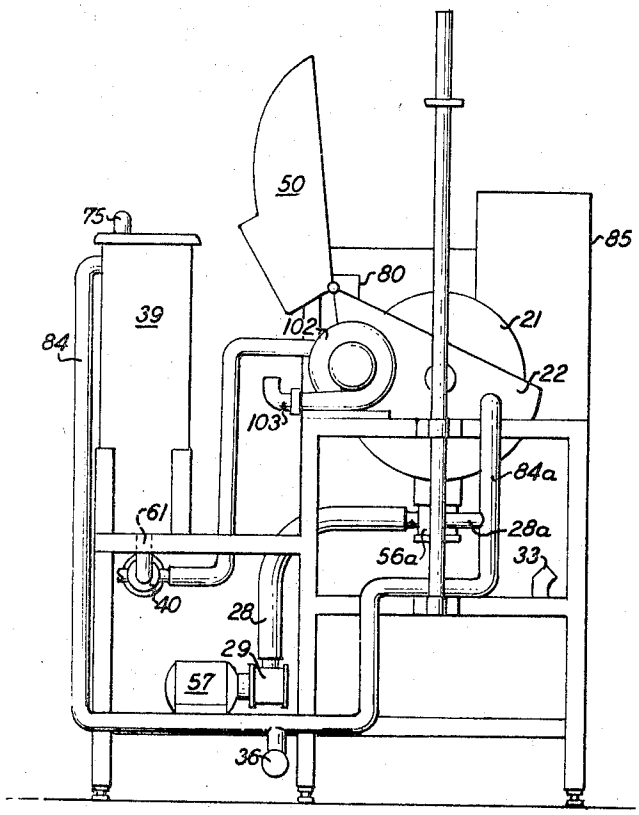


FIG. 3

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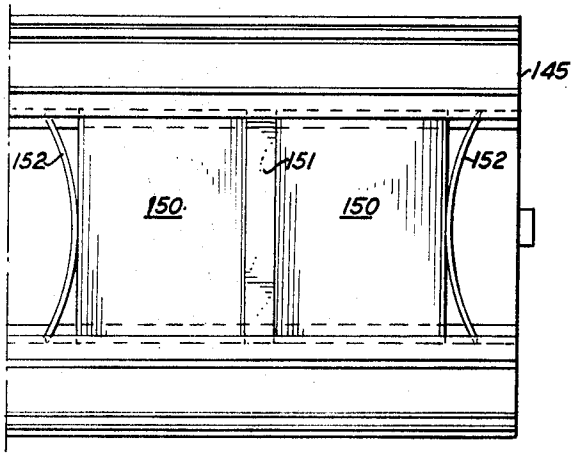


FIG. 5

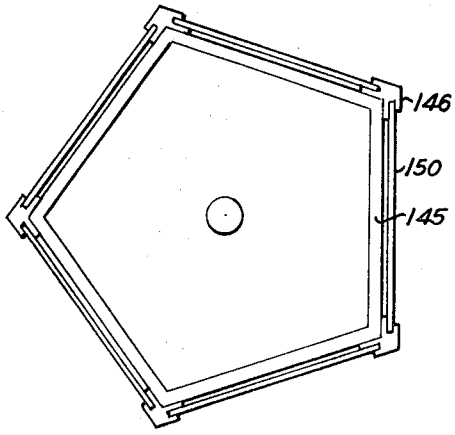


FIG. 6

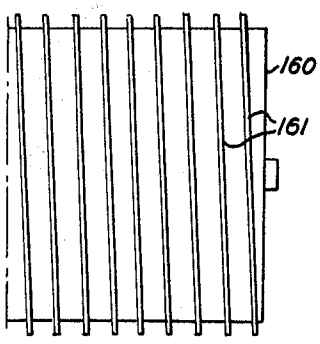


FIG. 8

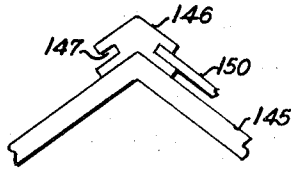


FIG. 7

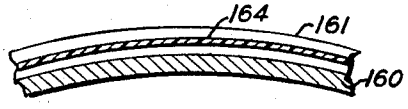


FIG. 10

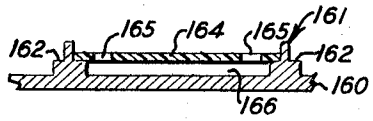


FIG. 9

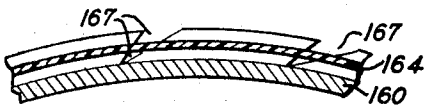


FIG. 11

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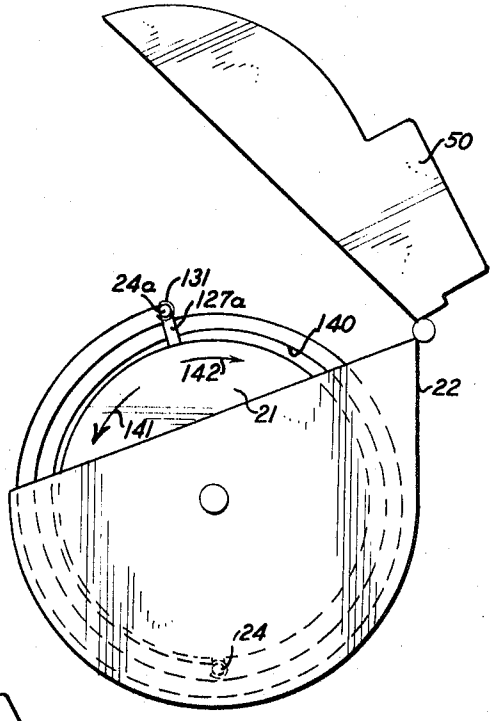


FIG. 14

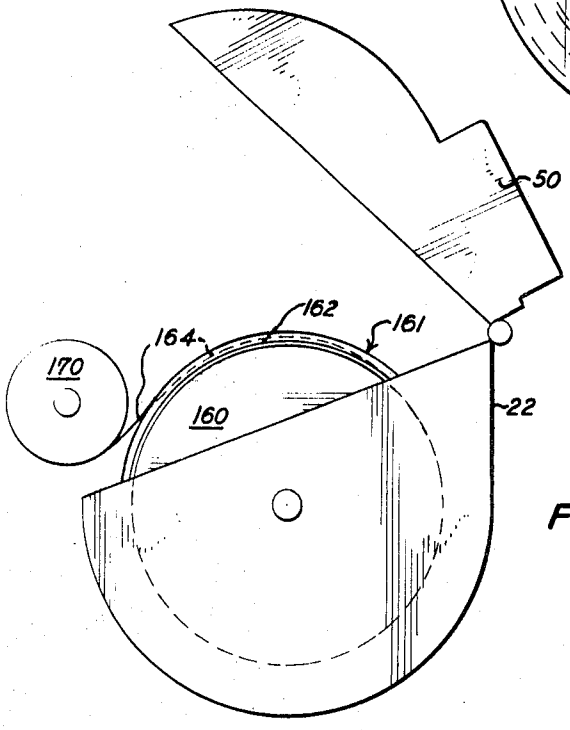


FIG. 12

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APPARATUS AND METHOD FOR PROCESSING PHOTOGRAPHIC MATERIALS

BACKGROUND OF THE INVENTION

I have previously conceived and reduced to practice apparatus for processing photographic materials wherein developing solutions and water rinses are sequentially pumped into a housing containing a drum having film attached thereto, the drum being rotated through the developing and rinsing solutions. In such apparatus the sequence of the operating cycle is controlled by a timing device such as a card which includes means to activate pump switches, solenoid valves, etc. to cause the various solutions, washes and rinses, to be pumped into the housing and drained therefrom in a selected sequence. Rods attached to and disposed across the drum serve to hold the photographic material spaced above the drum so that upon rotation of same the developing solution has a relative flow both above and under the photographic material. This is disclosed in my U.S. Pat. No. 3,280,716 of Oct. 25, 1966 and No. 3,304,850 of Feb. 1, 1967. Although the apparatus and method of these patents has been commercially successful, certain problems have arisen particularly concerning the capability of the apparatus to process divers types of photographic materials. Also, for a relatively large volume of the drum housing, the process becomes unduly slow unless developing solutions and particularly wash and rinse water can be introduced and withdrawn with increased rapidity without causing the fluid within the drum to be splashed by the ingress of the fluid. In addition to the foregoing, effective ventilation of the drum housing which will operate at selective times without introducing light therein is desirable on the larger installations.

There are many types of photographic materials which my prior apparatus is not adapted to handle. Specifically, photogrammetric plates, large prints of sizes such as, for example, 4½ by 16 feet, and long strips of film such as 35 millimeter movie film. Still further, problems have been encountered because of expansion of the photographic material which takes place during the developing process.

The primary objects of the instant invention are efficient and economical solutions to the above problems whereby the capabilities, effectiveness and efficiency of apparatus and methods of the kind set forth are substantially improved.

SUMMARY OF THE INVENTION

In order to increase the adaptability of the apparatus two approaches have been taken. For photogrammetric plates, a polygonal drum is provided on which the plates are secured so as to be spaced outwardly of the drum whereby developing solutions are received on both sides of the plates. For long strips of film such as movie film a drum having a helical pathway about its periphery has been provided wherein the film is spaced slightly above the drum so that the flow of developing fluid thereunder is obtained without undue difficulty. For the large prints such as for example the 4½ by 16 foot print, it has been found possible to spiral the photographic paper around the drum several times and by rotating the drum so that a solution is received into the interior of the spiral large prints have been developed in a most satisfactory manner.

The premature splashing of developing solution on a film has been practically eliminated by utilizing the same conduit for introducing and withdrawing the various solutions and by placing a baffle over the outlet of such conduit into the housing which has openings therein directly above the valves.

Also in the upper portion of the housing, a light trap air inlet of dimensions compatible with the housing has been provided on one side and an exhaust air pump on the other side which is programmed to exhaust the atmosphere of the drum housing at selected times to carry as away undesirable fumes.

With modifications as set forth above, the scope of the original apparatus and method is greatly increased without commensurate cost increases and the user is enabled to satisfy practically all of his photographic developing needs thereby without the necessity of having a variety of special-use equipment.

Other objects, adaptabilities, and capabilities will appear as the description progresses, reference being had to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side elevational sectional view which illustrates the means utilized to introduce and withdraw solution from the drum housing;

FIG. 2 is a diagrammatic front elevational view of the apparatus with the drum housing shown in cross section for clarity;

FIG. 3 is a diagrammatic side elevational view of the invention illustrating the liquid circuits for the introduction and withdrawal of fluid from the drum housing;

FIG. 4 is a diagrammatic rear elevational view of the apparatus which illustrates the circuits for introducing and withdrawing fluid from the drum housing;

FIG. 5 is a broken side elevational view of a polygonal drum utilized for photogrammetric plates;

FIG. 6 is an end view of the drum shown in FIG. 5;

FIG. 7 is an enlargement of one corner of the drum shown in FIG. 6;

FIG. 8 is a side elevational view of a further drum provided with a helical path for strip film;

FIG. 9 is a sectional view showing a film carried on the helical path shown on FIG. 8;

FIG. 10 is a sectional view illustrating a strip of film as seen from the side disposed in a helical path of the drum as shown in FIG. 8;

FIG. 11 is a view similar to FIG. 10 but shows a modified version of the intervening member;

FIG. 12 illustrates diagrammatically the method of introducing movie film on a drum of the type illustrated in FIG. 8;

FIG. 13 shows a holding rod secured to a drum, the holding rod having the capacity to expand with expansion of film being processed thereon; and

FIG. 14 is a diagrammatic view of a drum having a large print received thereon for developing DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, it will be noted that a processing drum 21 is rotatably carried in a drum housing 22 having reexposure lights 23 in the upper part of lid 50. Holding rods 24 secure a plurality of films 20 in overlapping relationship. A drum shaft 25 is rotated by means of a motor 51 (FIG. 4) normally in a direction of rotation shown by arrow 43. A valve 26 disposed in a valve trough 52 of housing 22 include a cap 53 and a stem 54 which is actuated through lever 55 by a solenoid 27, lever 55 turning about a pivot 56. A solution tube 28 provides a conduit for developing fluid between valve 26 and a solution pump 29 actuated by motor 57.

The solution tank 30 has a temperature control pipe 31 through which temperature-controlled water is selectively introduced to maintain the solution at the desired temperature. Tank 30 is filled through a funnel 33 and replenished as necessary through a replenishment pipe 34. An overflow pipe 35 is provided whereby overflow may be received by the drain pipe 36. A three-way drain valve 37 is also provided for draining solution in tank 30 into a place other than the drain pipe 36 or, optionally, into drain pipe 36.

The front of each solution tank 30 has a movable tank cap 44 which gives access to the tank for cleaning and other purposes.

The frame for the device, designated generally 60, is provided with adjustable support legs 38. Frame 60 also carries a rapid wash tank 39 which has an outlet 61 leading from its bottom to a rapid wash pump 40. A movable load shelf 41 is provided at the front of frame 60.

As illustrated in FIG. 4, hot and cold water inlets designated 71 and 72 respectively, carry water to a temperature control valve 89 which discharges via a conduit 88 to solenoid valves 73 and 74. Solenoid valve 73 controls the discharge of water to a mixing chamber 80 through conduit 81 and solenoid valve 74 controls the discharge of water from the temperature control valve 89 to the water tank 39 through the conduit 75.

An outlet 61 leads from the bottom of the wash tank 39 to wash pump 40. A discharge conduit 77 carries water from the wash pump 40 to mixing chamber 80 and outlet 82 from the mixing chamber 80 carries water into drum housing 22.

The temperature control valve 89 maintains water discharge therefrom at a uniform desired temperature. The manner in which this control is exercised is conventional and generally widely known in the field in which the invention pertains and a description of its exact nature and type is not considered necessary for an understanding and use of the invention by persons skilled in the art.

A control panel 85 (FIG. 2) provides a receiver 86 for a program card 87 of a type generally described in my U.S. Pat. No. 3,280,716. Also provided is a delay start timer 90, a pump timer switch 91, an additional time switch 92, automatic start and stop buttons 93 and 94, main machine start and stop buttons 95 and 96, a refill temperature indicator 97, and a delay start timer control switch 100. These controls utilize electrical or other suitable circuitry well-known to the art whereby the sequence of operation is controlled. This does not form part of the invention, per se, and it is considered that a detailed description of same would serve to complicate rather than clarify the disclosure.

The following, however, will give a general concept of the operation of the apparatus. In the event that it is desired for the process to commence in say 12 hours, the drum 22 is loaded with photographic material to be processed and lid 50 is closed. The switch 100 is turned on and switch 90 is set for twelve hours delay. A program card 87 for the desired process is placed into the start position in receiver 86. Button 93 is then pressed to "turn on" the apparatus. At the end of twelve hours the processing solution in each of tanks 30 is automatically brought to a desired temperature as set by temperature regulator 83. When all the solutions in tanks 30 are at the desired temperature, programming of the process is automatically initiated. First, a preselected solution is pumped through conduit 28 and its corresponding valve 26 (which is automatically opened) into the housing 22. The drum 21 starts to rotate at almost the same time and also, in most processes, the rapid wash tank 39 commences to be filled through the conduit 75 by opening the solenoid 74. After a predetermined interval, chemical is withdrawn into its tank 30 by gravity through its conduit 28, the pump 29 being unoperative at this point. Thereafter the next programmed solution is pumped from its tank 30 into the housing 22 via the corresponding conduit 28 and valve 26. This is repeated for the various solutions as programmed. In the wash and rinse cycle (also programmed as desired) wash water from the tank 39 and conduit 77 is admitted with rinse water through the conduit 81 into the housing 22 via the conduit 82 at a rate at which may be 1 ¼ gallon per second more or less. Wash and rinse water are drained from housing 22 into the drain 36 via pipes 28*a* and housing overflow pipe 84*a*. The process continues as controlled by the program card 87 until film, paper or other photographic material on drum 21 is developed. The exhaust fan 102 on housing 22 is also programmed to evacuate undesirable fumes from housing 22 as desired.

When the process is complete, the apparatus shuts down automatically, at which time photographic material on drum 21 is removed for drying.

As may be seen best in FIG. 2, a light trap 101 admits air into the drum housing 22 which is exhausted by the exhaust fan 102 located at the opposite end of drum housing 22. The exhaust pipe 103 is, of course, connected to a further conduit (not shown) to carry the fumes to where they can be safely expelled.

Extending upwardly from the frame 60 are a pair of beams 104 and 105 which support a horizontal load beam 106. The load beam 106 has three pulleys 107, 108 and 109 depending therefrom which receive a cable 110 which forms a loop portion 111 to support a lifting beam 112 on bearings 113 and 114 projecting from beam 112. The lifting beam 112 includes a lifting hook 115 on the left-hand side as seen in FIG. 2 which is rigid therewith and, on the right-hand side, a pivoted lifting hook 116. Each lifting hook 115 and 116 includes a hook portion 117 which is adapted to fit into drum grips 118 extending from either side of the drum 21. The drive axle 25 on the right hand as seen in FIG. 2 of the drum is slotted where it is carried by a supporting bearing 119 connected to housing 22 and the upper portion of bearings 119 are removable so that when the hook portions 117 engage the drum grips 118, the drum can be lifted freely from the drum housing by winding cable 110 by hand crank 120.

Holding rods 24 are secured to edges of the drum 21 by means of toggles 121. As best seen in FIG. 13, the holding rods 24 comprise a central shaft 122 which has alternately disposed thereon spindles 124 and helical compression springs 125. A further spindle 126 which is disposed at and rigidly connected to the end portion 127 of holding rod 24 has interposed between it and spindle 124 a spacer 130 of "C" cross section which is removable whereby compression springs 125 are adjusted to expand to move the spindles 124 to the right as seen in FIG. 13 and to close the gap left by the removal of spacer 130. It will be understood that each end of holder 24 has an end portion 127 and toggle 121.

Photographic material is maintained on the spindles 124 and over compression spring 125 by means of removable C-rings 131. When film or paper is clamped between C-rings 131 and spindles 124, upon removal of the spacer 130, the film or paper is automatically stretched by means of the resilience of the compression springs 125 and the operative portion of the holding rod 24 is thus adapted to expand as the film expands.

A baffle 132 is fitted at the bottom of the drum housing 22 across trough 52 and is secured in place by resilient C-grips 134 depending from baffle 132 which are adapted resiliently to grip studs 135 extending outwardly from the sides of trough 52. Orifices 136 are spaced along the top of the baffle 132 so as to be directly over each valve cap 53. With this construction liquid enters housing 22 through valves 26 evenly without a splashing or splattering effect.

Referring now to FIG. 14, means is disclosed whereby the invention is adapted to process large paper prints, say 4½ by 16 feet in size. In this FIG. the drum 21 has a holding rod 24 to which the paper 140 is initially clamped by means of C-rings 131 and the spacer 130 is removed in order to provide for expansion of the paper 140 as discussed with reference to FIG. 13.

With paper 140 thus clipped to holding rod 24, the drum 21 is rotated in the direction indicated by arrow 141 and paper 140 is permitted loosely to wrap about itself until its end is reached which is secured to a further holding rod 24*a* in the same manner as the opposite end was secured to holding rod 24. Holding rod 24*a* is identical with the holding rod 24, except that the end portion 127*a* is longer so that the holding rod 24*a* is spaced a substantially greater distance from the surface of the drum 21 than is the case with holding rod 24. With the film 140 in position as shown in FIG. 14, the lid 50 is dropped and in operation the drum 21 rotates in the direction shown by arrow 142 whereby the circulation of developing fluid and rinse and wash water between the overlapping layers of film takes place.

The drum 21 has not been found practical for large photogrammetric plates. Color plates of this type may be 9½ by 9½ inches and weigh two or more pounds. Black and white plates may be even larger. In order to adapt the apparatus disclosed to such plates, a polygonal drum 145 (FIGS. 5,6,7) has been provided. Each corner of the drum is provided with an edge strip 146 having grooves 147 which are adapted to receive the photogrammetric plates 150. Spacers 151 also adapted to be

received in grooves **147** may be provided to hold the plates **150** apart. Plates **150** are secured from lateral movement relative to the drum by resilient bars **152** which are bowed against the plates **150** and pointed on their ends to insure firm engagement within grooves **147**. Although the drum **145** is shown in FIG. **5** with photogrammetric plates, it will also be appreciated that with appropriate adapters, as would occur to one skilled in the art, smaller plates can also be utilized. The plates **150** are spaced above the surface of the drum **145** so that developing solution and rinse and wash water can freely circulate on both sides of the plate. Excellent results have been obtained with a drum of this type. Although drum **145** is a regular polygon, balanced somewhat irregular polygon shapes may be utilized to accommodate a greater variety of plate dimensions.

Referring now to FIGS. **8—11**, it will be noted that a drum **160** is wrapped with a helical supporting member **161** which includes shoulders **162** spaced sufficiently apart to carry a film strip **164**. When the film strip **164** includes sprocket holes **165**, developing solution and rinse and wash water circulate in the space **166** between the drum **160** and the film strip **164** so that additional ingress/egress means is not necessary. Even without sprocket holes **165** it has been found generally that sufficient circulation takes place within the space **166** by leakage under shoulders **162** for proper development of the film to take place. However, if desired, notches **167**, as shown in FIG. **11**, may be disposed along the supporting members **161** to provide conduits for fluid between drum housing **22** and space **166**. A film strip **164** with its end taped to drum **160** can be loaded from a reel **170** by turning drum **160** as indicated in FIG. **12**, and developed by continuing the rotation in the same direction. Subsequently, film strip **164** may be removed from the drum **160** merely by reversing the direction of the drum and simultaneously winding the film on reel **170**.

In describing the above embodiment, a detailed description has not been provided for elements or groups of elements and processes which are generally widely known in the field involved and such description is not considered necessary for understanding and use of the invention by persons skilled in the art. Also, although I have described the preferred embodiments of my invention, it is to be understood that it is capable of other adaptations and modifications within the scope of the following claims.

I claim:

1. An apparatus for processing exposed photographic sheet material such as film or prints which comprises:
- a housing (**22**) adapted to receive processing liquid therein;
- a recess (**52**) disposed along the bottom of said housing;
- a horizontally disposed drum (**21**) carried by said housing and adapted to rotate through processing liquid therein;
- a plurality of tanks (**30**) for storing different processing liquids;
- a plurality of valves (**26**) in said recess;
- a conduit (**28**) leading from each of said valves to one of said tanks, said conduit being the sole fluid connection between each of said tanks and said housing; and
- pumping means (**29**) included in each of said conduits, each of said pumping means adapted to cause processing fluid from its corresponding tank to be conveyed into said housing through its respective said conduit and valve and to permit said processing fluid in said housing to return through its respective said valve and conduit to its respective said tank at preselected times whereby processing fluid in each tank flows to and from said housing in the same conduit.

2. Apparatus in accordance with claim **1** wherein said pumping means comprises centrifugal pumps.

3. In an apparatus for processing exposed photographic material such as photogrammetric plates;
- a housing (**22**) adapted to receive processing liquid therein;
- a horizontally disposed drum (**145**) carried by said housing and adapted to rotate through processing liquid therein;
- the sidewalls of said drum presenting a substantially continuous peripheral surface;
- said drum including a flat area along its peripheral surface; and
- means (**146, 147**) mounted over the peripheral surface of said drum holding photographic material (**150**) spaced above said flat area whereby when said drum is rotated through processing liquid in said housing said processing liquid circulates on both sides of said photographic material.

4. A method of processing large exposed photographic prints which comprises:
- securing an end of said print (**140**) to a drum (**21**);
- rotating said drum in a first direction (**141**) while loosely wrapping said print in a spiral over itself about said drum;
- securing the other end of said print to said drum whereby it is spaced above the periphery of said drum and underlying portions of said print; and rotating said drum in an opposite direction (**142**) to said first direction through developing solutions.

5. A holding rod for holding photographic sheet materials for processing in a liquid which causes said materials to expand which comprises:
- a rod (**122**);
- resilient sleeve (**124, 125**) means in compression surrounding said rod;
- removable spacer means (**130**) on said rod holding said sleeve means in compression whereby when said spacer means is removed said sleeve means expands, and fastening means (**131**) for fastening a photographic sheet to said sleeve whereby said sheet is held in tension by said sleeve means, said sleeve means being adapted to expand a sufficient amount to accommodate expansion of said sheet which occurs when it is exposed to processing liquid.

6. A holding rod in accordance with claim **5** wherein said resilient sleeve means comprises compression springs (**125**).

7. An apparatus for processing exposed photographic sheet material such as film or prints which comprises:
- a housing adapted to receive processing liquid therein;
- a recess disposed along said housing;
- a horizontally disposed drum carried by said housing and adapted to rotate through processing liquid therein;
- a plurality of tanks for storing different processing liquids;
- a plurality of valves in said recess;
- said valves including discs which seat in valve seats included in the bottom of said recess;
- a baffle member disposed over said recess;
- a said baffle member including openings from said recess to said housing located directly over said discs;
- a conduit leading from each of said valves to one of said tanks; and
- pumping means included in each of said conduits, each of said pumping means adapted to cause processing fluid from its corresponding tank to be conveyed into said housing through its respective said conduit and valve and to permit the processing fluid in said housing to return through its respective said valve and conduit to its respective said tank at preselected times whereby processing fluid in each tank flows to and from said housing in the same conduit.

8. In an apparatus for processing exposed photographic material such as photogrammetric plates;
- a housing adapted to receive processing liquid therein;
- a horizontally disposed drum carried by said housing and adapted to rotate through processing liquid therein;
- said drum being polygonal in vertical section and including a plurality of said flat areas;
- holding means disposed at the edges of said drum between each of said flat areas for holding photographic material spaced above said flat areas whereby when said drum is rotated through processing liquid in said housing, said processing liquid circulates on both sides of said photographic material.