United States Patent

[11] 3,589,263

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[54] PHOTOGRAPHIC PROCESSING APPARATUS
9 Claims, 5 Drawing Figs.

[52] U.S. Cl. 95/89, 95/94
[51] Int. Cl. G03d 3/00
[50] Field of Search ..... 95/89 F, 89, 89 L, 94, 97, 100

[56] References Cited

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1,728,361	9/1929	Pifer	95/89 X
1,858,888	5/1932	Dye	95/89
2,158,817	5/1939	Doetzel	95/94
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3,263,590	8/1966	Wanielista et al.	95/89 X
3,282,192	11/1966	Chen et al.	95/89

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ABSTRACT: An apparatus for the continuous processing of a film element having an outer, exposed wash-off colloid silver halide photographic emulsion layer having a conveyor for directing the element through an alkaline development activator solution to develop and harden the exposed image areas and a conveyor for directing the element under sprays of washing solution to remove the soft nonexposed areas followed by a light spray to rinse the element leaving the element wet upon exit from the apparatus.

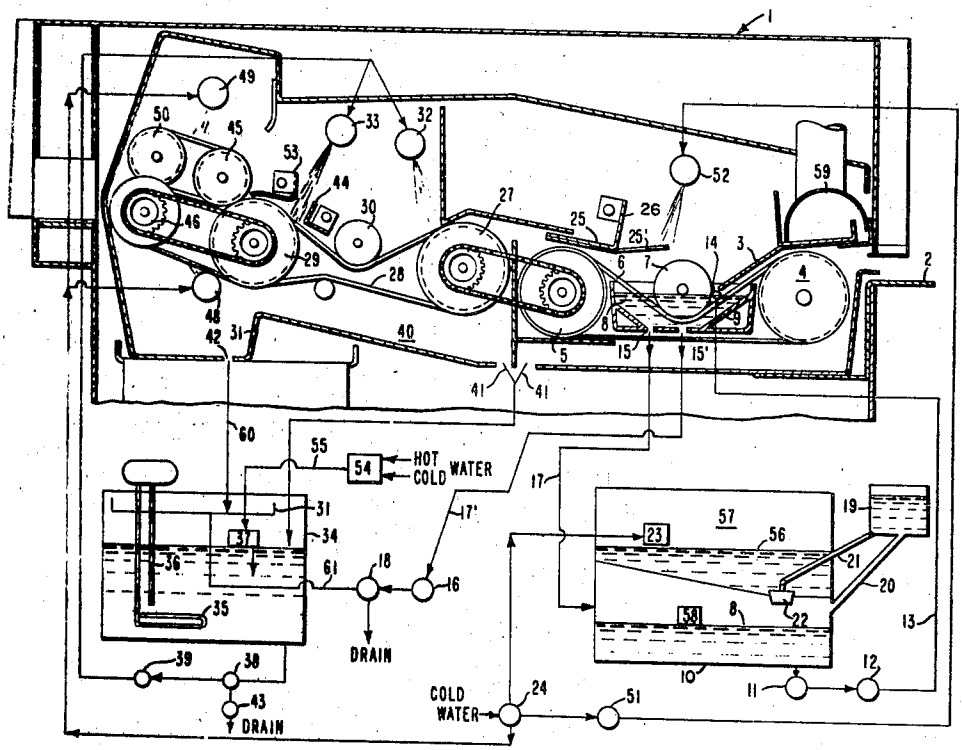


FIG. 1

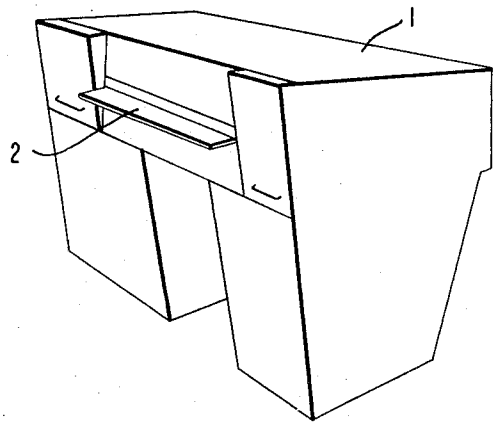
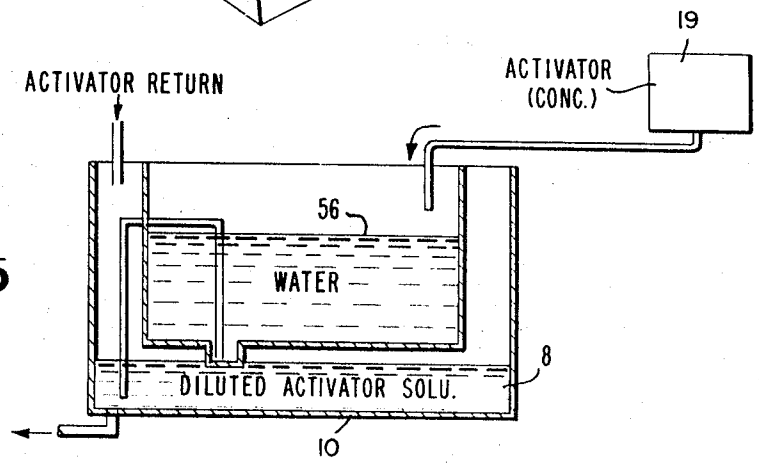


FIG. 5



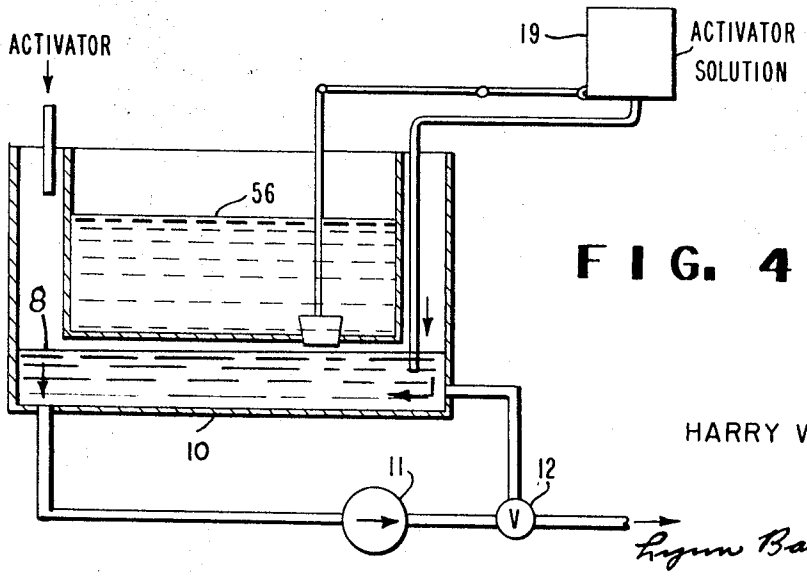


FIG. 4

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FIG. 2

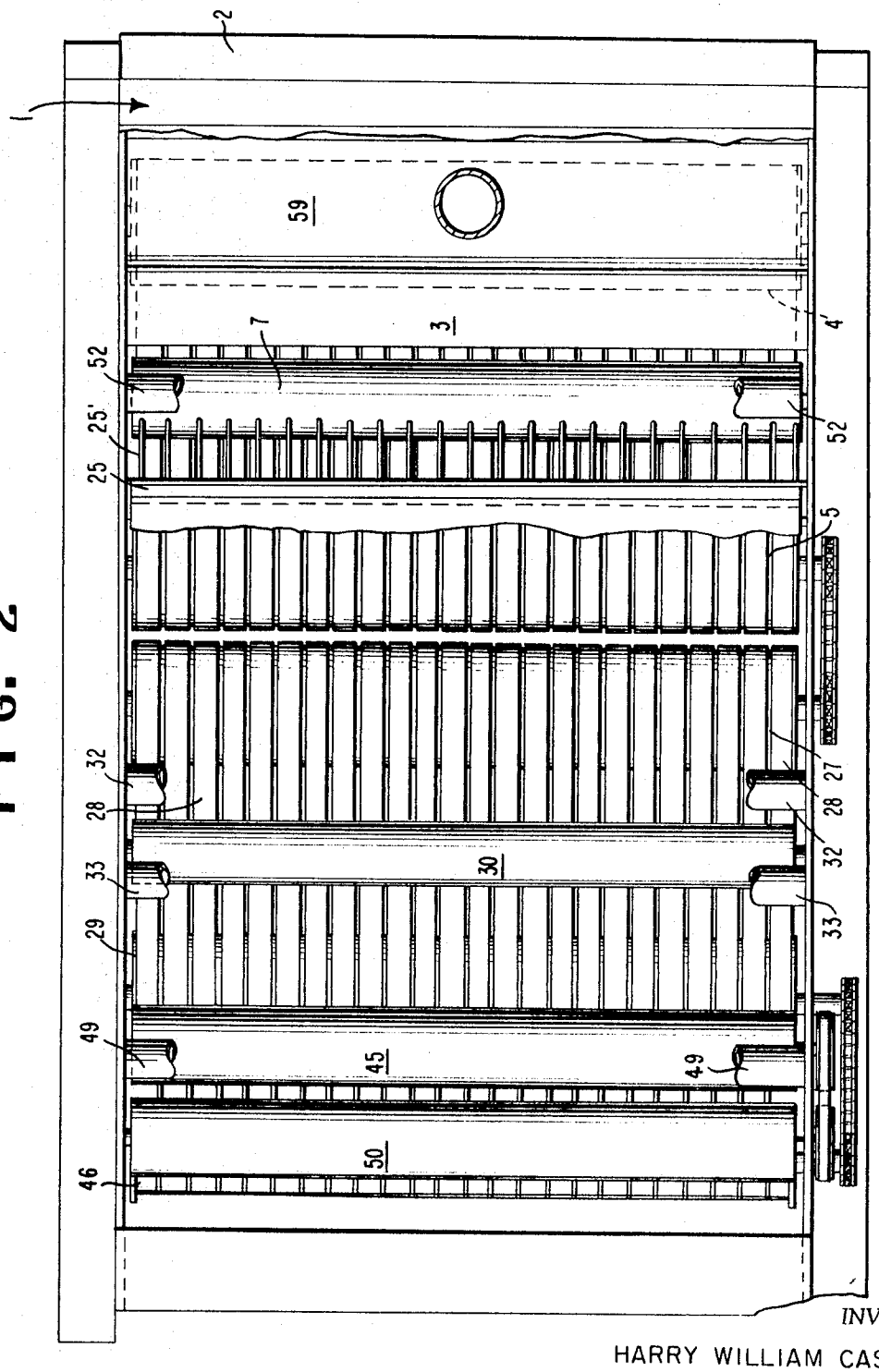

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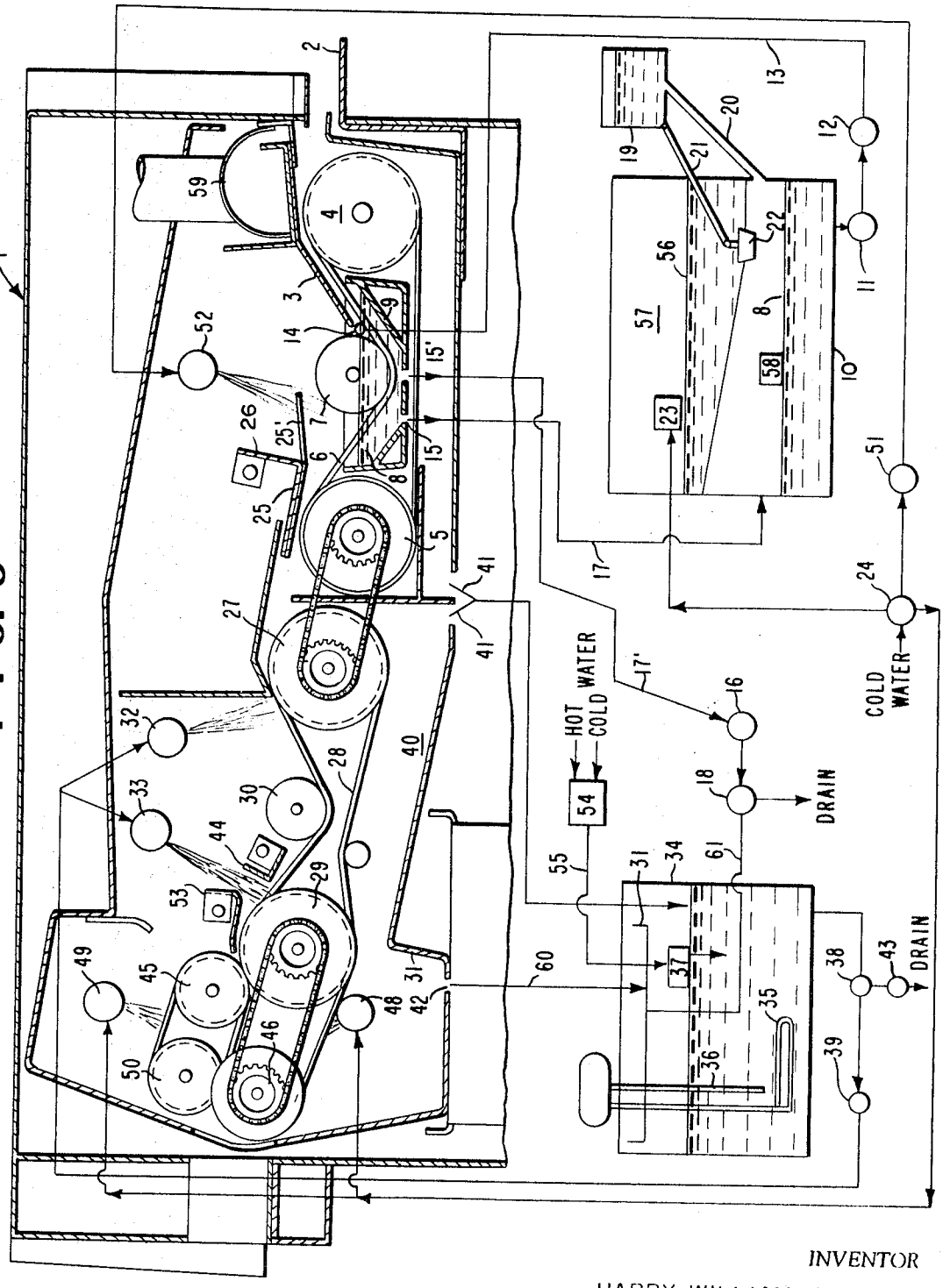
FIG. 3



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PHOTOGRAPHIC PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to photographic processing apparatus, and more particularly to apparatus for developing photographic drafting film elements and washing away areas of the elements to reveal drafting surfaces.

2. Description of the Prior Art

In order to process a film or paper element having on its outer surface an exposed wash-off photographic silver halide layer, e.g., a layer of a gelatino-silver halide emulsion such as the type described in Moede, U.S. Pat. No. 3,353,958, Nov. 21, 1967, an apparatus is needed that will provide an easily controlled, reproducible developing process that can be intermittently or continuously operated. The apparatus of this invention accomplishes this by providing a two-stage process, development and wash-out stages. A reservoir is used for developing the exposed film, with developer recirculation and replenishing capabilities. The wash-out of the unhardened emulsion is accomplished by impact sprays; then the film is subjected to rinsing with a water spray. The excess solution is removed and the element dried or subjected to a further treatment.

The art of photographic processing apparatus is highly developed. Photographic processing apparatus related to this invention are as follows:

Assignee's U.S. Application, Krikelis, U.S. Ser. No. 698,168, filed Jan. 16, 1968, relates to an apparatus for preparing a printing plate from an exposed photopolymerizable element by conveying the film element in a sinusoidal path through a developer bath and spray and a water bath with associated water rinse sprays.

Wanielista, U.S.P. 3,263,590, Aug. 2, 1962, relates to a device for processing photo-direct material characterized by a loading tray, developing tray, stop bath solution tray and a receiving tray aligned in series with means to convey the sensitized printing plate in a sinusoidal path through the trays. No sprays are used.

Doetzel, U.S.P. 2,158,817, May 16, 1939, relates to a developing machine employing wetting means including sprays to cause a sensitized film to adhere to rollers as it moves through its processing sequence where it is treated with chemical solution sprays and then washed and dried. No part of the sensitized film element is washed away.

Mayer, U.S.P. 2,404,138, July 16, 1946, describes an apparatus having a perforated conveyor for moving photographic prints and means for spraying a developer solution onto the image-bearing face of the print, the apparatus having means draining and recirculating the developer.

SUMMARY OF THE INVENTION

A photographic processing apparatus for automatically processing a photographic element having on its outer surface an imagewise-exposed, wash-off colloid (e.g., gelatino-silver halide emulsion layer) by a series of steps arranged in combination to provide a continuous and complete processing of an exposed element which comprises:

a. a developing chamber for a development activator solution for developing and hardening the exposed image areas of a photographic film or paper element inserted into said chamber;

b. means for conveying the exposed element through the solution in the chamber and conveying a developed element from the chamber; and

c. adjacent the developing chamber a washing chamber, the latter having in combination

i. entry means for receiving the developed film;

ii. means for conveying the film through a washing zone;

iii. jet sprays in the washing zone;

iv. final rinse jets

v. a film pressure applying means for removing rinse and wash solutions from the film and for passing the resulting film from the washing chamber to an exit.

Alternated embodiments include means for recirculating both the developer solution and rinsing solution and means for replenishing the developer solution.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The machine of the present invention consists in the construction and arrangement of parts that will clearly appear from the following description when read in conjunction with the accompanying drawings.

In the Drawings:

FIG. **1** is an isometric front view of the apparatus;

FIG. **2** is a plan view of the apparatus;

FIG. **3** is a side elevation, with parts in section;

FIG. **4** is a schematic view of a modified system for water and activator solutions;

FIG. **5** is a schematic view of a siphon system for the tank of activator solution.

The apparatus of this invention will be described with reference to processing a photosensitive drafting film element such as that described in Example I of Moede, U.S. Pat. No. 3,353,958, Nov. 21, 1967. The film element thus may have a polyester film support bearing, in order, the following layers: (a) a tricomponent copolymer of vinylidene chloride methyl acrylate and itaconic acid, (b) a matte layer of methyl methacrylate polymer containing a matting agent, (c) a layer which is the polymerization product of a single monomer, and (d) an unhardened or wash-off gelatino-silver halide photographic emulsion layer. When this film is exposed, it is developed by (1) subjecting the exposed film to an alkaline solution, e.g., sodium carbonate, to harden and develop the exposed areas then (2) washing-off the unexposed soft areas with warm water leaving behind a relief image on the support. The apparatus of this invention is designed to process this film element and therefore provides both the developing and wash-off steps in an automatic and continuous manner.

In general terms, the film is fed into the apparatus from a loading platform and is guided into a reservoir containing the development activator. The exposed areas harden and develop and the film is carried into the washing stage. In the washing stage, the film is subjected to (1) high pressure, hot water, impact sprays, (2) pressure means to wring the water from the film, (3) low pressure rinsing sprays, and (4) a final set of squeegee rolls to remove water.

A more particular description of the apparatus now follows. Referring to FIG. **1**, an outside casing **1**, is used to house all of the component parts. A loading platform **2** is provided to aid the operator in directing a film element into the machine.

Referring to FIGS. **2** and **3**, the film is guided by means **3** which may be a plastic or metal sheet or a wire mesh plate to direct the film onto the element conveyor system. The guide means may be kept free from condensed water vapor by an air manifold, **59**, and air blower (not shown) combination, which directs dry air along the guide surface. The conveyor system is made up of two rolls **4** and **5** and passing around each roll is a plurality of narrow belts **6** located side-by-side, but with a small gap between them to allow activator to drain from the film. The tension of these belts is maintained by tension roll **7** which is biased against the belts. The element conveyor means is partially immersed in development activator solution **8** contained in reservoir **9** so that the film passes through the solution.

Development activator solution is fed to reservoir **9**, from the lower section of tank **10**, through pump **11**, valve **12**, conduit **13** and port **14**. The solution **8** is then recirculated through drain port **15**, conduit **17** and back into the lower portion of tank **10**. When it is desired to drain the solution, valve **16** is opened and the solution passes through port **15'**, conduit **17'**, and pump **18**, which forces the solution to a drain. The development activator solution can be replenished by tilting

replenisher pail 19 and pouring in a predetermined amount of concentrated development activator directly into the lower portion of tank 10 through conduit 20. When replenisher pail 19 is tilted, it activates a mechanical link 21 which pulls out stopper 22 permitting a given amount of water to pass from the upper portion of tank 10 to the lower portion. The amount of water is controlled by float valve 23. Tap water is used and enters the upper section of tank 10 through solenoid valve 24 and float valve 23. A machine cleaning cycle is provided. Water leaves solenoid valve 24, passes through valve 51 and exits through cleaning jets 52 for spraying a cleaning solution, e.g., water, into the developing chamber. As the film leaves the developing chamber, it is guided under metal guide 25, by fingers 25'. Horizontally disposed guide 25 is in fixed relation to a vertical splash panel 26 used to prevent contaminating material from reaching the development activator section. Roll 27 receives the film to be washed and conveys the film through the wash-off cycle by a plurality of narrow belts 28 encircling rolls 27 and 29. Belts 28 are spaced side-by-side with a small gap between them to allow wash water to drain from the film. The tension of these belts are maintained by tension roll 30 which is biased against the belts.

During the wash-off stage, the film is subjected to a high pressure, hot water spray before and after passing under roll 30. Spray 32 impinges hot water on the film with roll 27 and belts 28 acting as film backup support and spray 33 directs hot water onto the film with roll 29 and belts 28 acting as film backup support. Impact sprays 32 and 33 take their supply of hot water from hot water tank 34. Tank 34 has an electric heater 35 and a thermostat 36 to maintain a constant source of supply of hot water. A constant supply of water is maintained by float valve 37 which has attached to it means (not shown) for shutting off the power to the water heater when the water is below a prescribed level in the tank. With the float valve in the open position water flows through it from the two-way valve, 54, through conduit 55. The two-way valve, 54, can allow either hot, cold, or a mixture of hot and cold water into conduit 55. Water leaves tank 34 and flows into pump 38, through filter 39, and on to impact nozzles 32 and 33. The hot water is collected in container 40 and drains out through port 41, and into tank 34. When it is desireable to drain the hot water system, tank 34 is drained through pump 38 and automatic valve 43. Rinse section reservoir 31 is drained through port 42, conduit 60, to the foam tray, 31. The water thus introduced washes the foam through conduit, 61, to pump, 18, and the drain.

Once the unhardened emulsion is washed off the film, the film is guided by L-shaped metal guides 44, 53, between roll 29 and roll 45, into the rinse area. The film is now transported on a series of belts or O-rings (belts with a generally circular cross section of small diameter) stretched between roll 29 and bottom exit roll 46 and fitting into grooves in roll 46 so that the outermost periphery of the O-rings is approximately flush with the surface of roll 46. The O-rings are spaced apart by the width of the narrow belts 28. The belts may be 1⅛ to 3 inches wide and spaced apart one-quarter to three-eights inch apart. The diameter of the O-rings thus may vary from about one-sixteenth to three-eighths inch in diameter. The O-ring cross section may not be completely round but may have a flattened upper segment so that the O-ring surface is flush with the surface of roll 46 and the belt surface around roll 29. The arrangement of O-rings and belts is like that shown in Samandji U.S. Pat. No. 2,154,585.

The spacing between the belts facilitates rinsing which is effected by spraying the film, top and bottom, by sprays from nozzles 49 and 48. The water for rinsing is supplied through solenoid-actuated valve 24. Excess water is removed by passing the film through pressure rolls 46 and 50 and then to an exit or drying zone or chamber or to a further processing stage.

All of the rolls can be driven by one motor (not shown). The rolls in the film conveyor system, namely, rolls 4, 5, 27, and 29, can be driven by chain and sprocket means (not shown) while the other rolls idle or are driven by a pulley-belt system. The machine function time sequence is provided by a conventional motor and timing drum (not shown).

The operation of the machine will now be explained. The machine has three operating modes, (1) stand-by (2) processing, and (3) cleaning. Each is initiated by opening and closing an electrical circuit.

WASH-OFF PROCESSOR - FUNCTION SEQUENCE

1. Stand-by Condition

In this condition, the water tank 34 is heated up to processing temperature and maintained in such condition. Thermostat 36 inside heater 35 automatically actuates the heater should the water temperature drop below a certain level.

In this stand-by condition, hot or cold water is directed into the machine from the two-way valve, 54. Flow is controlled by float valve 37.

If, while in this stand-by condition, the water level in the hot water tank 34 lowers by evaporation, an equal amount of water will be let into the tank through float valve 37.

Replenishment of the activator solution can be accomplished in various manners. The system shown is an automatic dilution system. When replenisher pail 19 is pivoted towards rear of machine, a plunger mechanism allows water to be transferred from the top of tank 10 to the lower section of the tank. Activator is then poured into the replenisher pail which goes directly to the lower tank mixing with the water.

2. Process Function

When the process function is turned on, water, 56, enters into the water reserve section, 57, of tank 10 through a float valve 23 which is set to a predetermined quantity. The purpose of the water reserve section, 57, is to allow ambient conditions within the processor to bring reserve water to operating temperature without external temperature control means, and to serve as a volumetric measuring device for reserve water.

The initiation of the process function also allows the following chain of events to occur simultaneously:

a. Water comes through the solenoid valve 24 and through the upper and lower final rinse jets 49 and 48. The jets run continuously as long as the apparatus is in a "Process" mode.

b. The main pump drive motor (not shown) is activated and through belts drives the activator pump 11, the impact jet pump 38, and the drain pump 18.

c. The transport drive motor is started and through belt and chain drives moves film through the apparatus.

After the above events occur simultaneously, the following events occur as required:

d. Any hot water loss is compensated for directly through a float valve 37 in the hot water tank.

e. An indicator light (not shown) actuated by float 58 in tank 10 will show when the activator is low and requires replenishment.

f. If for any reason the water level in the hot water tank 34 should drop below the level of the heating elements 35, the heater is automatically shut off.

3. Processor Cleaning Function

The following sequence is initiated:

a. The transport drive motor (not shown) is started. This, in turn, moves all of the belts and rotates all of the rollers.

b. A gear motor inside the sequencer (not shown) starts turning a timing drum and valve bank. The first electrical function of the timing drum occurs after the process cleaning cycle is initiated. This electrical function is to energize the solenoid 24 valve and allow water to enter the apparatus. During the time before the solenoid valve is activated, all of the valves in the sequence can have their functions reversed physically through a gear train and geneva drive (not shown) simultaneously.

The valve change functions are as follows:

c. Valve **12** between the activator pump and the activator tray is turned from normally open to the closed position. Therefore when the pumps start later in clean cycle, activator will be stopped from flowing to the activator tray.

d. Valve **51** between the solenoid valve **24** and the activator cleaning jet **52** changes from normally closed to the open position. Therefore, when the solenoid valve opens later in the cycle, water will be directed at the activator roller and tray, draining through ports **41** and **15'**.

e. Valve **16** between the activator tray drain and the drain pump changes from normally closed to the open position. This allows the old activator in the bottom of the tray and the water that will be pumped through the activator cleaning jets later in the cycle to be pumped down the drain.

f. Valve **43** following hot water pump **38** changes from normally closed to the open position. When the pumps are turned on later in the cycle this will allow the contaminated wash water to be pumped to a drain.

g. The pump drive motor is actuated sometime after the cleaning cycle is initiated and after the solenoid valve **24** allows tap water to flow to the top and bottom final rinse jets **49** and **48** and the activator cleaning jet **52**.

While the pump drive motor is operating, the belts and rollers are sprayed and the cleaning solution is forced to a drain.

h. The third electrical function is to close the solenoid valve. This occurs before the main drive motor running the pumps is stopped in order to allow accumulated cleaning solution to drain.

i. The remaining time is used to change all of the valves back to their normal positions. The remaining few seconds allows special pins on a conventional timing drum to activate microswitches and relays to set up a "make before break" situation which readies the timing sequence for another cleaning cycle when the system is activated. At this time, the transport drive motor moving the belts and rollers is shut off.

j. After the cleaning sequence is complete, the hot water tank **34** is brought to level through float valve, **37**. When the proper level is reached in this tank, the heater **35** is turned on to bring the incoming water up to temperature.

An alternative cleaning cycle may sequence the cleaning spray in the activator, wash and rinse sections in order to maintain adequate head pressure to the spray jets.

The developing chamber can be provided with suitable means for agitating the solution to insure uniformity. In place of the tiltable replenishing device, other means, e.g., a siphon system can be employed.

Since the timing devices or mechanisms are available on the market and the electrical circuits vary, the details of these items have not been included and would complicate rather than aid in the interpretation of the drawings.

In general, the chambers structural parts will be made of various chemical resistant plastics and noncorrodible metals or metal alloys, e.g., steel, stainless steel, brass, copper, bronze, aluminum, etc., where appropriate. The belts can be made of rubber, synthetic elastomers, silicone resins, etc. The rollers can be made of the foregoing structural materials, and they may be coated with the latter materials.

In FIG. 4 there is shown schematically a modified activator tank **10**, means for feeding concentrated activator solution to the tank. By turning valve **12**, pump **11** will mix the activator solution from various points.

In FIG. 5 there is shown schematically a modified system for feeding activator solution and the interconnected pumping system and siphon means. Obviously, other modifications can be made by persons skilled in the art.

The apparatus of this invention has the following advantages. It provides an apparatus which is automatic and it will develop, wash-off, rinse and remove excess solution from a film element having a wash-off type emulsion layer. It will process small cut-sheets or long-length sheets without any modifications. The conveyor system employs resilient belts looped over rollers which provides a good surface on which the wet film may ride yielding good tracking and reducing film damage. Efficient and uniform development results from the method employed of film immersion for development and a uniform spray for emulsion wash-off. The temperature control features and self-contained pumps have advantages. Large trays and sinks needed for hand processing are eliminated and the automatic cleaning cycle has obvious advantages.

If desired, means can be supplied for drying the processed film or paper near the exit of the apparatus. For example, a forced hot air chamber with conventional roller transport system can be disposed near the exit of the apparatus to dry the developed and washed photographic element.

The embodiments of the invention in which an exclusive property or privilege I claim are defined as follows:

1. A photographic processing apparatus for treating an exposed photographic film or paper element having an outer silver halide emulsion layer which comprises

a. a developing chamber providing a bath of a development activator solution for developing and hardening the exposed image areas of a photographic element inserted into said chamber;

b. means for conveying the exposed element through the solution in the chamber and conveying a developed element from the chamber; and

c. adjacent the developing chamber a washing chamber, the latter having in combination

i. entry means for receiving the developed element;

ii. means for conveying the element through a washing zone;

iii. jet sprays in the washing zone;

iv. final rinse jets;

v. a film pressure applying means for removing rinse and wash solutions from the element and for passing the resulting element from the washing chamber to an exit;

said means for conveying in chambers (*a*) and (*c*) comprising rollers and spaced, flexible, flat belts coacting with and traveling about said rollers, and the pressure applying means comprising opposed rollers, one of which has grooves to receive continuous belts of small cross section which are disposed between and coact with the flat belts as they pass around the roller driving said flat belts.

2. An apparatus as in claim **1** provided with means for supplying development activator to and removing it from the development chamber during the processor function, and means for supplying cleaning fluid to and removing it from the development chamber during the processor cleaning function.

3. An apparatus as in claim **1** provided with an air manifold for directing air along the entrance guide between the point of entry of the photographic element and the development section of the processor.

4. An apparatus according to claim **1** having a guide plate extending from a location near the means for conveying in the developing chamber to a location near the means for conveying in the washing chamber.

5. An apparatus according to claim **1** comprising means for recirculating development activator solution.

6. An apparatus according to claim **1** having a guide plate extending from a location near the means for conveying in the developing chamber to a location near the means for conveying in the washing chamber and means for recirculating the washing solution.

7. An apparatus according to claim **1** provided with means for regulating the temperature of the washing solution.

8. An apparatus according to claim **1** provided with means for removing the development activator solution and a cleaning solution from the developing chamber.

9. An apparatus according to claim **1** provided with means for supplying a cleaning fluid to the development chamber during the processor cleaning function.