Feb. 13, 1951 H. G. GOETZ ET AL 2,541,353

SOLUTION AGITATING DEVICE

Filed Aug. 14, 1948 4 Sheets-Sheet 1

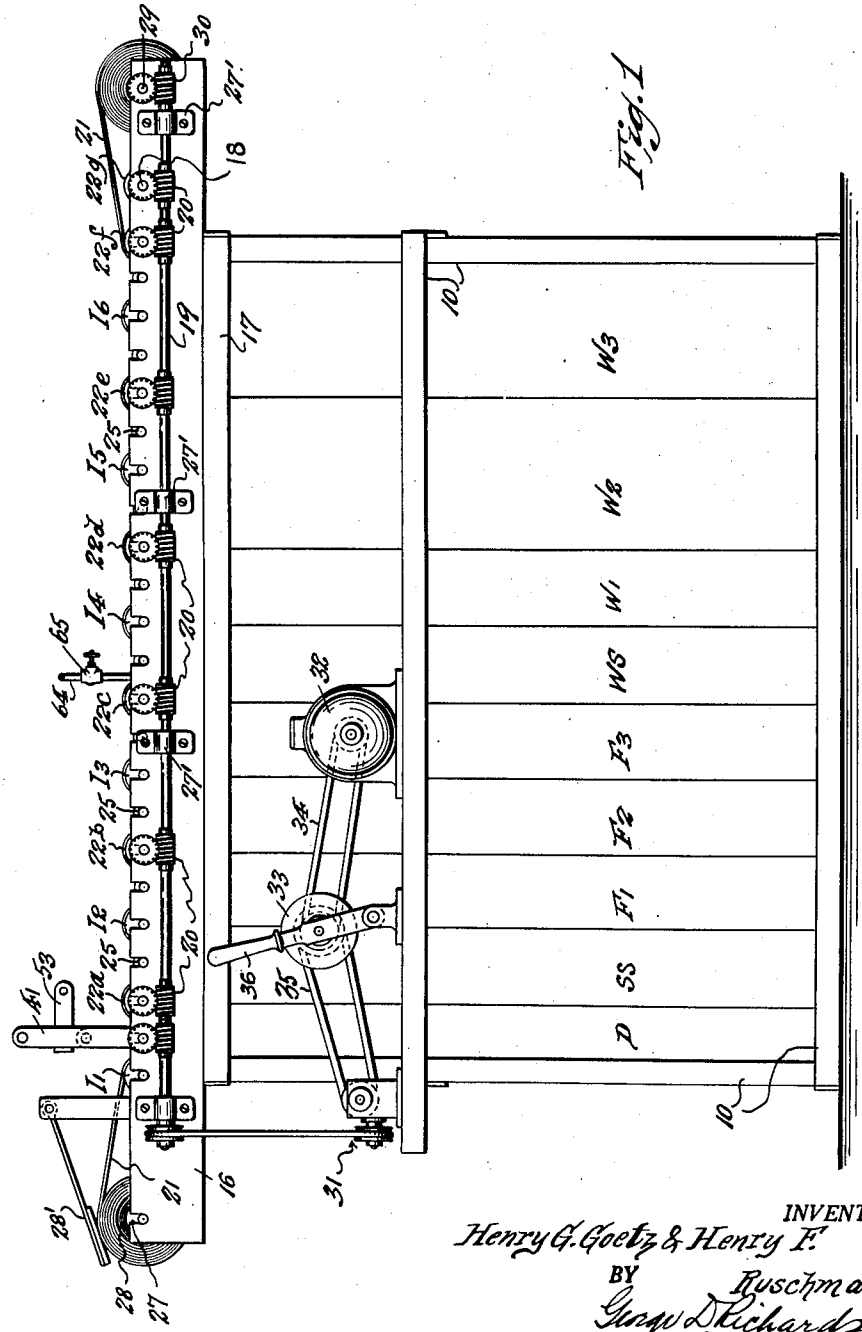


Fig. 1

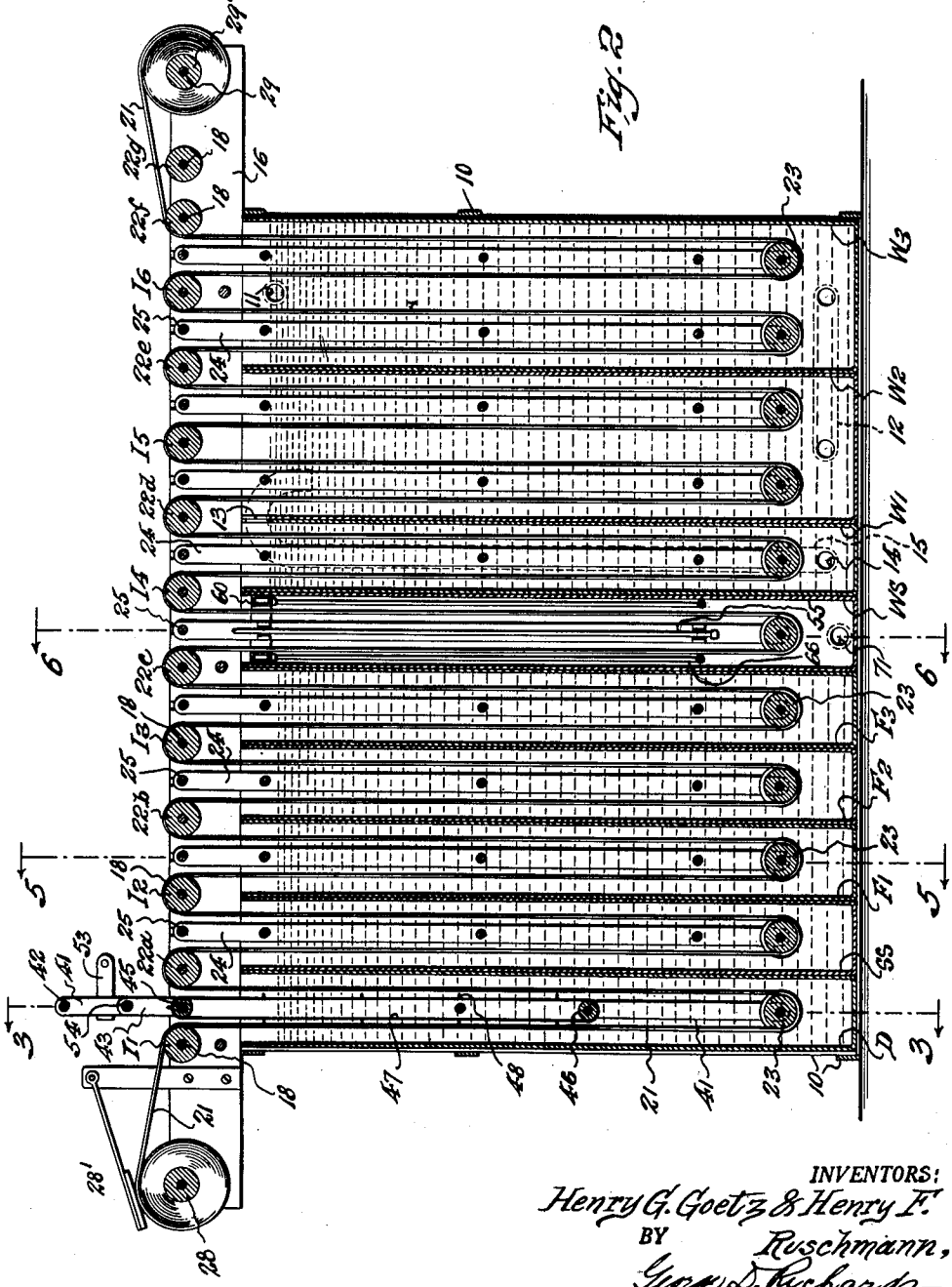
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Filed Aug. 14, 1948 4 Sheets-Sheet 2

Fig. 2



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SOLUTION AGITATING DEVICE

Filed Aug. 14, 1948 4 Sheets-Sheet 3

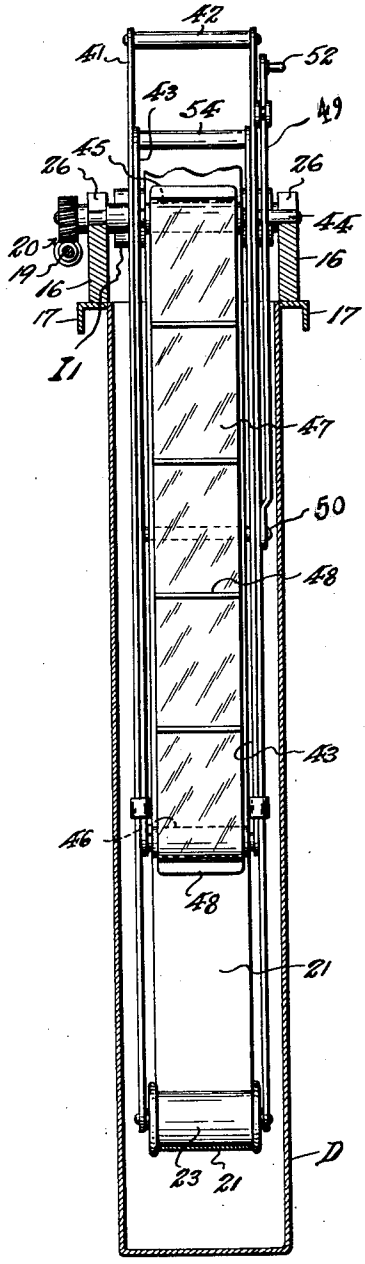


Fig. 3

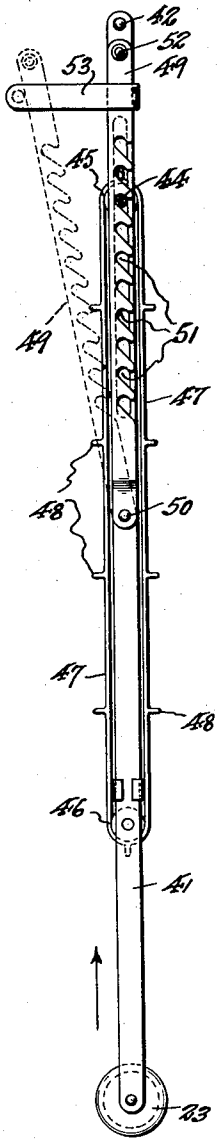


Fig. 4

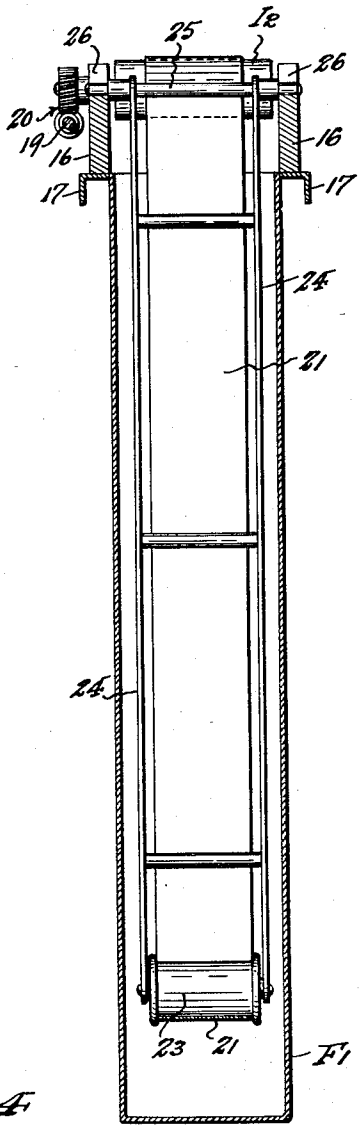


Fig. 5

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Feb. 13, 1951 H. G. GOETZ ET AL 2,541,353

SOLUTION AGITATING DEVICE

Filed Aug. 14, 1948 4 Sheets-Sheet 4

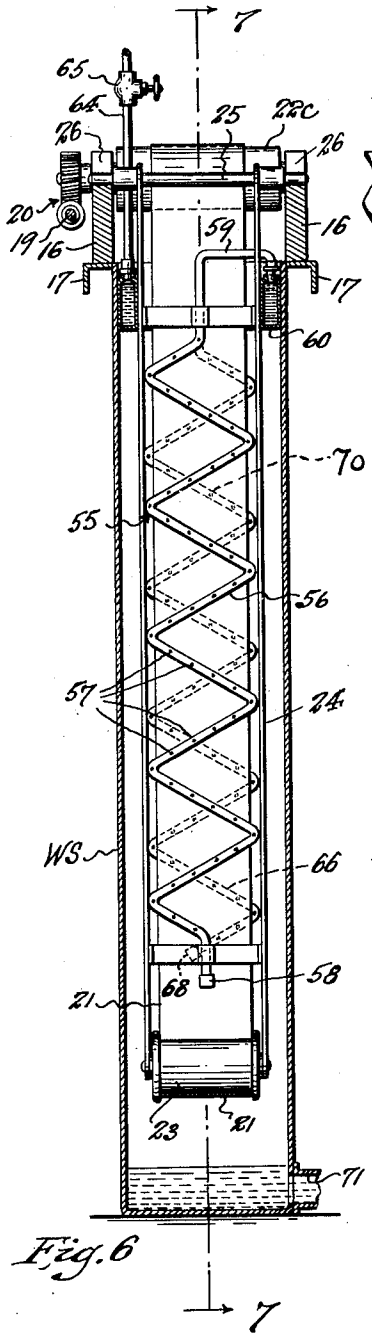


Fig. 6

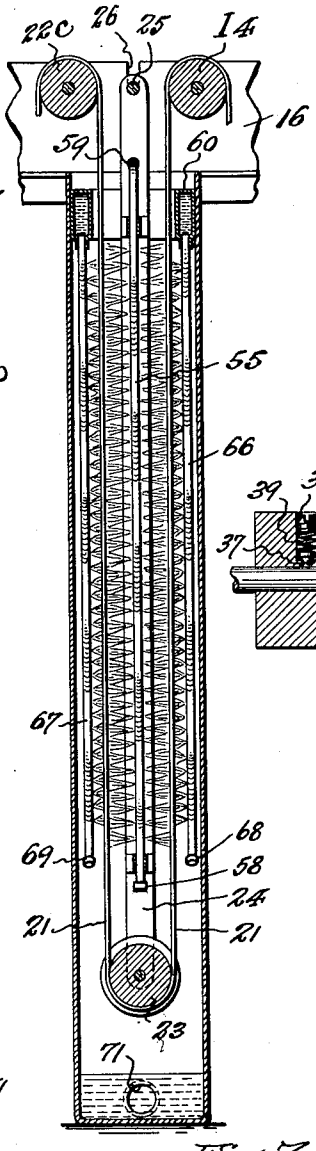


Fig. 7

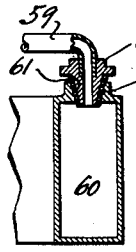


Fig. 8

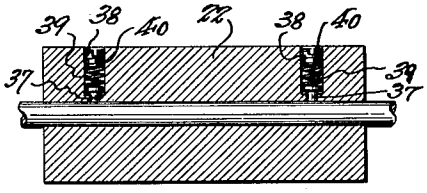


Fig. 9

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Patented Feb. 13, 1951 2,541,353

UNITED STATES PATENT OFFICE

2,541,353

SOLUTION AGITATING DEVICE

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Application August 14, 1948, Serial No. 44,288

4 Claims. (Cl. 95—94)

1

This invention relates to the development of photographic prints and has particular reference to the processing of printed strips such as are produced by printing from a series of negatives or a film strip onto a single long strip of sensitized paper.

The primary object of our invention is to provide a processing machine which includes the essential tanks for the various baths arranged in proper sequence together with improved means for propelling and guiding the printed strip through the successive baths in a manner which permits carefully regulated timing of the different steps which make up the process as a whole.

More specifically, it is our object to provide in a machine of this character timing control means which enables the operator, who has to judge the quality of development from observation of the photographic images as they become exposed to view after emergence from the initial developing tank, to make the following timing adjustments with great ease and without interrupting the operation of the machine: (1) increase or decrease the timing of the entire process; (2) vary the time of passage of the strip through the developing tank alone and without affecting the overall timing of the process; and (3) vary the over-all timing while maintaining the time in the developing tank at a predetermined constant value.

A further object is to include in the strip propulsion means a series of driven rollers engageable with the strip at intervals in its travel through the machine which serve to apply progressively increasing driving impulses at successive points to assure constant traction on the strip throughout the extent thereof undergoing processing in spite of slack induced by moisture-expansion, inequalities in size of the guiding rollers, or other causes.

An object closely related to the last-mentioned object is the provision of safety means designed to permit slippage of each driven roller whenever the strip becomes dangerously taut in the stretch extending between it and the next preceding roller.

A still further object is to maintain the constant photographic characteristic activity of the developer solution in the process by providing novel agitator means in the developing tank.

Another object is to increase the effectiveness of the strip washing step in the process by introducing a novel water spray device which causes balanced jets to impinge upon both sides of the strip.

2

Further objects and advantages of our invention will appear from the following description when read in connection with the accompanying drawings, in which—

Fig. 1 is a side elevation of the complete machine, showing a printed strip of sensitized paper being processed;

Fig. 2 is a longitudinal vertical section through the machine as shown in Fig. 1;

Fig. 3 is a transverse section on line 3—3 in Fig. 2;

Fig. 4 is a side elevation of the agitator device for the developing tank, showing the adjustable supporting member of the associated depth-determining roller frame in set operative position in full lines and in operative position subject to adjustment in dotted lines;

Fig. 5 is a transverse section on line 5—5 in Fig. 2;

Fig. 6 is a transverse section on line 6—6 in Fig. 2;

Fig. 7 is a fragmentary longitudinal vertical section on line 7—7 in Fig. 6;

Fig. 8 is a fragmentary vertical sectional view of the water manifold for the spray device and the automatic coupling therefor; and

Fig. 9 is a longitudinal sectional view of one of the driven rollers mounted on its shaft, the latter being broken away.

Similar characters of reference are employed in all of the above described views to indicate corresponding parts.

Referring now to Figs. 1 and 2 of the drawings, reference character 10 indicates the open framework of our processing machine. This framework closely confines the series of tanks which are to contain the various liquid baths appropriate to the successive steps in the print developing process. The complete series comprises, in normal order from the starting end to the finishing end: developing tank D; short-stop tank SS; fixing tanks F1, F2 and F3; water spray tanks Ws; and water wash tanks W1, W2 and W3. For convenience of reference, the end of the machine at which the tank D is located (left in Figs. 1 and 2) will be termed the front end. To economize space, the tanks are rectangular in cross-section, but changes in form may be made without departing from the scope of the invention. Also, for convenience in shipment of a unit and to permit individual replacement of defective tanks, each tank is complete in itself, but it is to be understood that we do not intend to be restricted to the use of separable tanks. Under some conditions of practice, it may be

found more desirable to divide one large tank into a series of compartments corresponding to the several tanks of the present disclosure by the use of partitions integral with the side and bottom walls (not shown).

The last of the wash tanks W3 has a water inlet 11 at its top for connection with the water supply system (not shown). The bottom of tank W3 is connected to the bottom of adjacent tank W2 by outside water pipe 12 (dotted lines) to permit free flow from one to the other. The contiguous walls of tanks W1 and W2 are cut away at their upper edges to provide an overflow sluiceway 13 for passage of water from tank W2 into tank W1. At the bottom of tank W1, an outlet 14 connects with a standpipe 15 (dotted lines) which in turn serves to drain the tanks, so that water flows continuously through said tanks. In order to maintain the water contents of the three tanks at constant level, the inlet and outlet and both pipes preferably have the same internal diameter; also inlet 11, sluiceways 13 and the gooseneck of the standpipe should be on a level with each other.

A supporting bed for the strip propelling and guiding means and for all mechanism to be suspended in the tanks is mounted in superposed relation to the row of tanks and consists of a pair of parallel side members 16, which preferably rest upon ledges formed by channel irons 17 employed in the construction of framework 10, and are suitably secured in place.

The propelling and guiding means includes a row of horizontal rollers substantially coextensive with the top of the row of tanks. The pivotal shafts 18 of these rollers are journaled in bed members 16. It will be understood any suitable bearing support may be used. Some of the rollers are idlers and the others are live rollers which are driven from a line shaft 19 through the medium of worm-gear means 20. The line shaft 19 is journaled in bearings 27'. The idlers and live rollers have been alternated in distribution along the row so that there will be continuous traction on the printed strip which is running over the rollers. Such a strip is designated by the reference character 21. It being desired to run suspended loops of the strip through the baths contained in the successive tanks, a roller has been mounted directly above the front wall of tank D, the rear wall of tank W3, and the abutting walls of the intermediate tanks. An additional roller has been mounted above the center of tank W2, above the center of tank W3, and in rear of the top of the last-mentioned tank. For convenience of reference when describing the operation of the machine, the idler rollers have been designated by individual reference characters I—1 to I—6 inclusive from front to rear. Similarly, the live rollers have been designated 22*a* to 22*g* inclusive. The depth of immersion of each suspended loop of the printed strip is determined by a normally submerged roller 23 around which the loop passes in its movement through the machine. With the exception of the roller in tank D, it is intended that the same depth shall be maintained. It is also intended that each of the depth-determination rollers may be readily removable from its particular tank independently of the others. These requirements have been met by journaling the rollers for tanks SS through W3 at the lower ends of elongated vertical frames 24. The frame for each tank is suspended by a cross-rod 25 at its upper end, which is adapted to fit removably in substantially U-shaped sockets 26 provided in the upper edges of bed members 16. (See Fig. 5.) Rod 25 also serves as a handle by which the frame and its roller may be lifted out of the tank when so desired. The weight of each frame and its roller is sufficient to maintain its normal operative position in spite of upward thrust exerted by the moving strip. To afford adequate washing action in the larger tanks W2 and W3, two depth-determination rollers are suspended in each of these tanks.

At the front end of the bed which supports the entire organization of propelling and guiding rollers, journal means 27 is provided for the feed reel 28 of each printed strip as it comes from the printer. The means employed should be of a type which permits quick attachment and detachment of the reel. Means for removably supporting and driving a wind-up reel 29' identical with the feed reel 28 is provided at the rear end of the bed. This means includes a spindle 29 which derives power from line shaft 19 through worm-gear means 30. The wind-up reel is frictionally clutched to the spindle 29 in any well known manner, whereas the feed reel is freely rotatable except for the retarding effect of momentum brake 28'.

Line shaft 19 is shown connected by a simple means of power transmission 31 with a prime mover, which in this instance is the constant speed electric motor 32 having the usual switching means (not shown). In order that the speed of the live rollers may be regulated, a manual control device has been incorporated in the transmission mechanism. It is the well known floating cone variable-speed pulley 33 operative between a driving V-belt 34 and a driven V-belt 35. The pulley may be shifted by means of handle 36.

With reference to the means for driving the live rollers and wind-up spool, we want it to be understood that we do not intend to be restricted to the use of any particular types of power transmission or speed controlling means. In the course of future developments, equivalent means which may be found to be more suitable may be adopted without departing from the scope of the invention. In fact, one such modification has already been made. In an earlier experimental model of our machine, a sprocket and chain transmission was used, but it was later replaced by the line shaft and worm-gear drive for the reason that the last-mentioned means provides a more efficient transmission. In its present embodiment, the transmission and speed control means satisfies the essential requirements of: (1) uniform drive of all driven elements at variable speeds; and (2) rapid assembling and disassembling of driven elements.

Having satisfied the requirement of uniform drive of all the live rollers, i. e., rotation of all of them at the same shaft speed with one setting of the controller, we have gone a step further and introduced means for progressively increasing the peripheral speed of these rollers from front to rear of the machine. Our purpose has been to assure constant traction on the printed strip being processed in spite of the slack to be expected at various points along the line due to moisture-induced expansion or to inequalities in the external diameters of standard idler rollers as they come from factory. Since there are two or more idlers interposed between each two adjacent live rollers and quite an extent of intervening strip, the opportunities for creation of

slack are usually present. Referring now to Figs. 1 and 2, the manner in which we have accomplished our purpose has been to make live roller 22b .025 in. larger in outside diameter than roller 22a, and to make each succeeding live roller 0.10 in. larger than the preceding one. The reason for the greater step-up from roller 22a to roller 22b will become apparent presently.

Because of the progressively increasing pull on the strip as it moves from one live roller to the next, a break in the strip could occur if, instead of the expected slack, there happened to be tautness in advance of one of these rollers. That is, it could occur if the live rollers were positively driven. We have guarded against accidents of that kind by making it possible for nearly all of the live rollers to yield when subjected to dangerous strip drag. This has been done by mounting each of these rollers rotatably on its positively driven shaft and by providing means whereby the frictional grip of the roller on its shaft may be adjusted to permit slippage under a predetermined amount of drag. In Fig. 9, the means which we are using for this purpose is shown. It comprises one or more gripping members 37 of suitable material which are movable with the roller and adapted to bear against the peripheral surface of the supporting shaft. Each gripping member is disposed in a radial recess 38 in the roller and is pressed against the shaft by a compression spring 39, which is backed by a screw plug 40. By adjusting the screw plug, the tension of spring 39 may be varied to regulate the pressure of the gripping member against the shaft.

Figs. 3 and 4 disclose a modified supporting device for the depth-determining roller 23 in tank D. A frame 41 similar to frames 24 is used, but its handle-forming rod 42 is not engaged with the supporting sockets 26. Instead, frame 41 is slidably mounted for vertical adjustment on a parallel frame 43 which is suspended from the bed members 16 by a driven shaft 44 journaled at the upper end of the last-mentioned frame, the ends of shaft 44 being engaged with sockets 26. A roller 45 affixed to shaft 44 cooperates with an idler roller 46 journaled at the lower end of frame 43 to support and propel an agitator belt 47 which has suitably spaced transverse vanes 48 on its outer face. These vanes should project from the belt to a distance which will bring those which are moving through the vertical stretches of the belt very close to the adjacent stretches of the printed paper strip. Shaft 44 is driven from line shaft 19 through worm-gear means 20 just like the other live roller shafts and in the same direction. Therefore, the agitator vanes will travel counter to the direction of movement of the printed strip, which is necessary to the creation of desired turbulence in the developer solution along the emulsion side of the strip. In order that the depth-determination roller in tank D may be secured in any one of several vertically adjusted positions for a purpose to be explained hereinafter in connection with the operation of the machine as a whole, a horizontally swingable supporting bar 49 is pivoted at its lower end as at 50 to frame 41. Bar 49 has regularly spaced, downwardly inclined notches 51 for interchangeable engagement with shaft 44 of the agitator device to suspend frame 41 from that shaft. The upper end of bar 49 is provided with a handle 52 and is fitted slidably in a slotted guiding and restraining bracket 53 affixed to frame 41 near its upper end. In Fig. 4, the supporting bar for

frame 41 is shown in one of its selected operative set positions in full lines and in inoperative position subject to adjustment in dotted lines. When bar 49 is in inoperative position, frame 41 with its depth-determining roller may be adjusted up or down as desired without affecting the position of the agitator frame. When, however, it is desired to lift the entire assembly from tank D, this may be done by grasping the handle constituted by cross rod 54 located at the upper end of frame 43.

Figs. 6 to 8 inclusive disclose details of the special water spray device located in tank Ws. The frame 24 for removably suspending depth-determination roller 23 in the tank is unchanged except for the attachment of a vertically extending preferably zig-zag tube 55 whose legs 56 lie in a plane parallel to the descending and ascending stretches of printed strip 21. Uniformly spaced perforations 57 are provided in the front and rear portions of tube 55 for the purpose of producing oppositely directed needle-sprays of water which will be directed against the emulsion side of the strip in both stretches of the loop. The lower end of the tube is closed by a removable cap 58, but the upper end is formed into a downwardly directed gooseneck 59 and fitted with terminal coupling means for connecting the tube with a water manifold 60 which is fitted in the upper end of tank Ws. The coupling means may take any desired form, but we have adopted for convenience the device disclosed most clearly in Fig. 8. Our object being to afford a coupling which will be automatically united when frame 24 is lowered into place in the tank and similarly disconnected upon removal of the frame, the manifold is provided with a top opening 61 having a tapered inner surface and a hollow plug 62 having a correspondingly tapered external surface is attached to the extremity of the spray tube gooseneck. Plug 62 is positioned so that it will be in vertical alignment with the manifold opening when frame 24 is being lowered into the tank. A gasket 63 of suitable sealing material has been applied to the external surface of plug 62 in order to assure a completely watertight connection. The manifold is connected with a source of water supply (not shown) by means of pipe 64 and shut-off valve 65. In addition to the internal spray tube carried by the removable frame, a pair of similar preferably zig-zag spray tubes 66 and 67 have been installed permanently in parallel relation to the inner faces of the front and rear walls of tank Ws and consequently will be parallel to tube 55 when in position. These tubes are connected with manifold 60 and are supported thereby. Their lower ends are closed by removable caps 68 and 69. Uniformly spaced perforations 70 are provided in the inwardly facing portions of tubes 66 and 67 to direct a needle-spray against the outer face of each stretch of the strip loop. For clarity of disclosure in Fig. 6, the interior tube 55 and the front exterior tube 66 have been shown in vertically staggered relation, but it is considered to be more effective to have the diagonal legs of all spray tubes in horizontal parallelism in order that the spray jets will be directly opposed to each other at opposite sides of the printed strip. Otherwise, distortion of the strip may be caused by unbalanced impingement of the jets. As shown in the drawings, there will be balanced opposition of jets at the points where the tube legs cross. By imagining tube 66 represented by the dotted lines in Fig. 6 as being

moved downward until it is obscured by tube 55, the balanced jet organization employed in practice may be visualized. While opposite sides of the strip being processed are being vigorously sprayed to remove the surface film of fixing solution before the strip is subjected to the smoothly flowing current of water in tanks W1, W2 and W3, it will not be buckled or otherwise distorted from its normal flat shape. The waste water from the spray device is disposed of through outlet 71 located substantially flush with the bottom of tank Ws.

Before proceeding to the description of the operation of our machine, the adjustment of the friction-slip means for the various live rollers and the reason for the irregular step-up in external diameter of live roller 22b should be mentioned.

It is practicable to regulate the friction-slip of rollers 22b, 22c, 22d and 22e so low that they will slip on their shafts in response to dangerous strip drag, but roller 22a at the front of the machine and rollers 22f and 22g at the rear must be made so tight on their shafts that they may be caused to slip only through forceful manual effort. They are thus virtually positively driven and this is necessary in order that positive traction may be exerted on the strip at these points in its progress. The provision for manually produced slip takes care of certain emergencies likely to arise and which will be discussed later. It is because live roller 22a is positively driven insofar as strip 21 is concerned that roller 22b is .025 in. larger in diameter than roller 22a instead of having been given the regular increase of .010 in. as in the case of the other succeeding live rollers. More slack is likely to be given to the strip in advance of roller 22b by the positive driving action of roller 22a so the peripheral speed of roller 22b must be stepped-up proportionately. After passing over roller 22b, slack in the strip may be expected to be less and can be taken care of by the .010 in. diameter increase.

The operation of the machine is as follows: In the first place, it is the usual practice to attach a leader strip to the trailing end of the last printed strip at the end of each day, or other termination of uninterrupted processing, and to let it be drawn into the machine to fill all rollers. This leader is severed from the said last printed strip and left in the machine until operations are resumed, whereupon its trailing end is attached to the leading end of the first strip to be processed after its feed reel has been operatively mounted beneath the momentum brake. Then, assuming that tanks D, SS and F1, F2 and F3 have been filled with the essential chemical solutions and that the water has been turned on for the spray device in tank Ws and for wash tanks W1, W2 and W3 the leading end of the leader is attached to a wind-up reel at the rear end of the machine and the power is turned on. By using a leading, it is not necessary to thread a lengthy unprinted end portion of the strip through the machine by hand. After the first strip has been run through to the point where only a few feet thereof remain wound on the feed reel, the reel is lifted from its bearings quickly without stopping the machine. The remaining length of the strip is unwound by hand and released so that it hangs down in front of the machine. Before the slowly climbing trailing end of the strip has time to pass over idler roller I—1, a fresh reel is inserted in place and the free end of the new strip is joined to the trailing end of the first-mentioned strip. When it is desired to remove an arbitrary length of the rolled up finished strip, the composite strip is cut at a point close to where the strip emerges from tank W3 at the rear of the machine. Then, the filled reel is removed from its spindle, an empty reel is inserted in place, and the leading end of the new strip is attached to the new reel. All of this is done without stopping the machine. It is at this juncture that additional live roller 22g comes into action. When the strip is cut, the leading end portion of the new strip will fall into contact with the roller just mentioned. The weight of the wet strip and the friction of contact with both live rollers 22f and 22g will be sufficient to cause them to continue to propel the strip. If it were not for the assistance of the additional virtually positively driven roller, the loose end of the strip would slip over roller 22f and back into tank W3. In this event, it would be necessary to stop the machine for the purpose of preventing creation of machine-clogging slack by continued motion of live roller 22a.

From the outset of operations, the person who is operating the machine closely observes the exposed emulsion side of the strip after it emerges from the developing tank for indications of the quality of development. If slight overdevelopment is detected, the operator can correct for this condition by manipulation of control handle 36 in the proper direction to increase the speed of passage of the strip through developing tank D. Minor variations in speed ordinarily will not have a detrimental effect on the subsequent steps in the process. Under some conditions, it may even be necessary to speed up the entire process by use of the controller, or to accelerate the steps subsequent to development in tank D. The last-mentioned action may be performed without affecting development time, if the operator will first push frame 41 downward in tank D to an extent sufficient to lengthen the immersion path of the strip in that tank and thereby counteract the speed increase. If, on the contrary, it should become evident that the washing step needs lengthening, that can be accomplished by retarding the strip speed, but, in this case, frame 41 must be raised to an appropriate degree. Major variations in development time may be effected, without objectionable alteration of the timing of the other steps, by appropriate vertical adjustment of frame 41. In that case, the controller is not touched.

Allusion has been made hereinbefore to emergencies which are likely to occur in the course of normal operations and which have been anticipated by certain features of the machine design which will facilitate the action required by such occurrences. An example of an emergency and the corrective action which can be taken without serious delay in the use of our equipment will be cited. Just suppose that the printed strip breaks somewhere in tank Ws. The operator, who is continually scanning the exposed areas of the strip, should detect cessation of motion of the strip between the feed reel and live roller 22c in time to shut off the power before the broken trailing end of the remainder of the strip has time to pass over idler I—4 and thereby involve one more tank. He then closes water shut-off valve 65 and lifts frame 24 completely out of tank Ws. In this act, the connection between spray tube 55 and manifold 60 will be opened automatically. The broken ends of the strip are pulled out of the tank and reunited; the mended

loop is re-inserted in the tank; frame **24** is replaced with automatic restoration of the water connection; valve **65** is again opened; and the power is turned on. The most serious consequence of the interruption of motion of the strip would be slight overdevelopment in tank D or possible loss of a few prints. If the operator be sufficiently skilled in his work and dexterous, he may be able to mend the break and resume operations in from ten to fifteen seconds, in which case there should be no loss of prints. Breaks at any point along the line can be repaired just as easily.

As an instance of an emergency which demonstrates the desirability of having certain live rollers yieldable on their shafts when forcibly rotated by hand although otherwise virtually positively driven, let it be supposed that for some reason an excessive amount of slack occurs in the strip just after it has passed over live roller **22***a*. The strip is highly adhesive in its wet condition and will stick to roller **22***a* so as to become rewound and doubled under the oncoming portion of the strip emerging from tank D. Without stopping the machine, this emergency is met by seizing the ends of roller **22***a* and backing it up carefully until the doubled under portion of the strip has been released. Then, the roller is held against rotation while the said portion is pulled away from roller **22***a* by action of live roller **22***f*. When this has been accomplished and the strip has lost its objectionable slackness, roller **22***a* is released for normal operation. Great care must be exercised in the release of the doubled under portion of the strip, for, if allowed to come loose from roller **22***a* too soon, the bottom portion of the strip loop in tank SS may drop into contact with the bottom and possibly even the rear and front walls of the tank. The tenacity with which the strip will become adhered to those surfaces will almost certainly cause it to break under the tension produced by roller **22***f*. A skilled operator, however, should be able to avert any such consequences of the original emergency.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A solution agitating device for the developing tank of a photographic processing machine, wherein a photographic record strip is propelled through the tank in a depending loop, said agitating device comprising a frame adapted to be mounted in the developing tank between the vertical stretches of the strip loop, a pair of rollers journaled in the frame one above the other with their axes substantially in a vertical plane, an endless agitator member mounted to run over and between said rollers, and means to drive said agitator member.

2. A solution agitating device as defined in claim 1, wherein the said endless agitator member comprises a flat belt and longitudinally spaced transverse vanes on the exterior face of said belt.

3. A solution agitating device as defined in claim 1, which includes a second frame supported by the first-mentioned frame, and a depth-determination roller for the strip loop journaled on the lower portion of said second frame on an axis substantially in the plane of the axes of the mounting rollers for the agitator member, said depth-determination roller being so constructed and arranged as to maintain the vertical stretches of the strip loop substantially parallel to the corresponding stretches of the agitator belt and suitably spaced therefrom.

4. A solution agitating device as defined in claim 1, which includes a second frame mounted on the first-mentioned frame within the strip loop and being vertically adjustable thereon, means for securing said second frame in selected vertically adjusted positions, and a depth-determination roller for the strip loop journaled on the lower portion of said second frame on an axis disposed substantially in the plane of the axis of the mounting rollers for the agitator member, said depth-determination roller being so constructed and arranged as to maintain the vertical stretches of the strip loop substantially parallel to the corresponding stretches of the agitator member and suitably spaced therefrom in any adjusted position of said second frame.

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HENRY F. RUSCHMANN.

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