June 19, 1951 I. J. NEWMAN ET AL 2,557,307

FILM DEVELOPING APPARATUS

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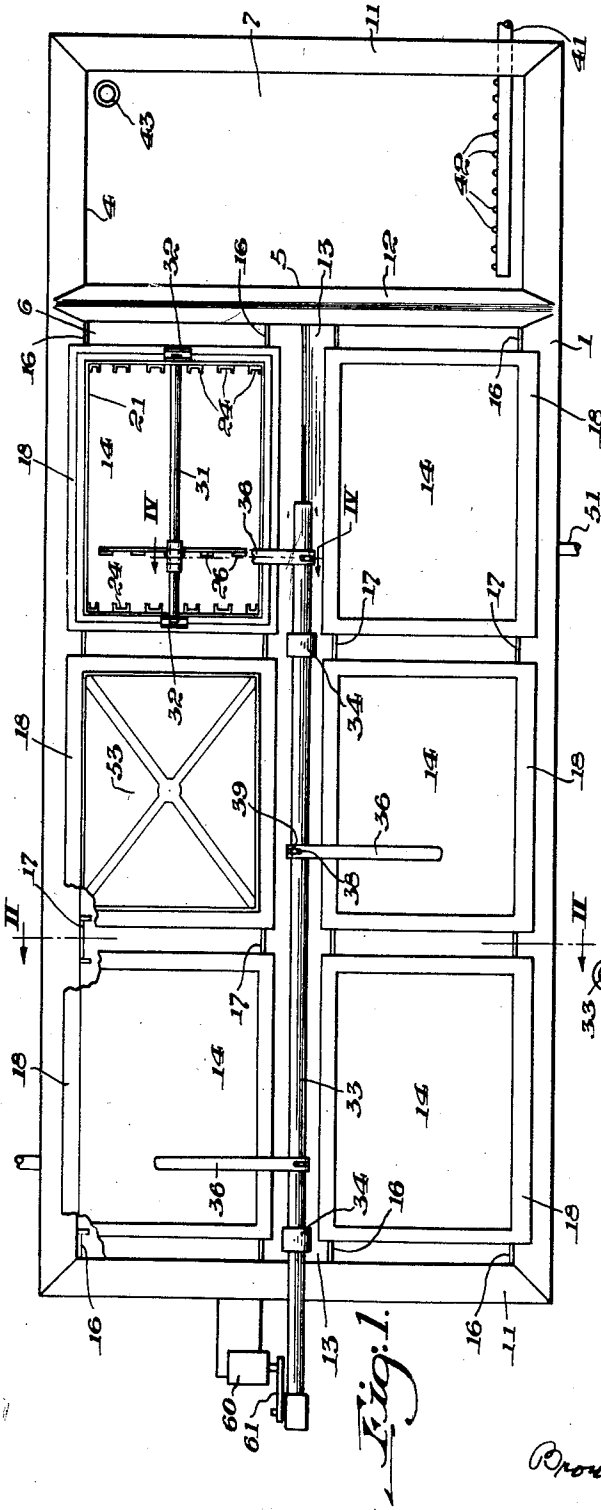


Fig. 1.

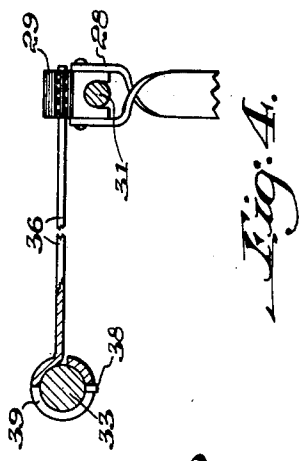


Fig. 4.

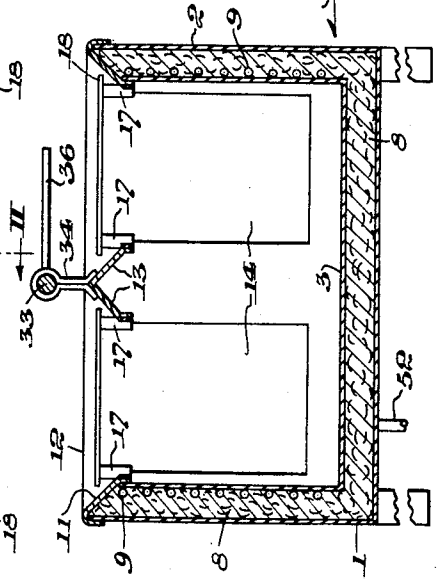


Fig. 2.

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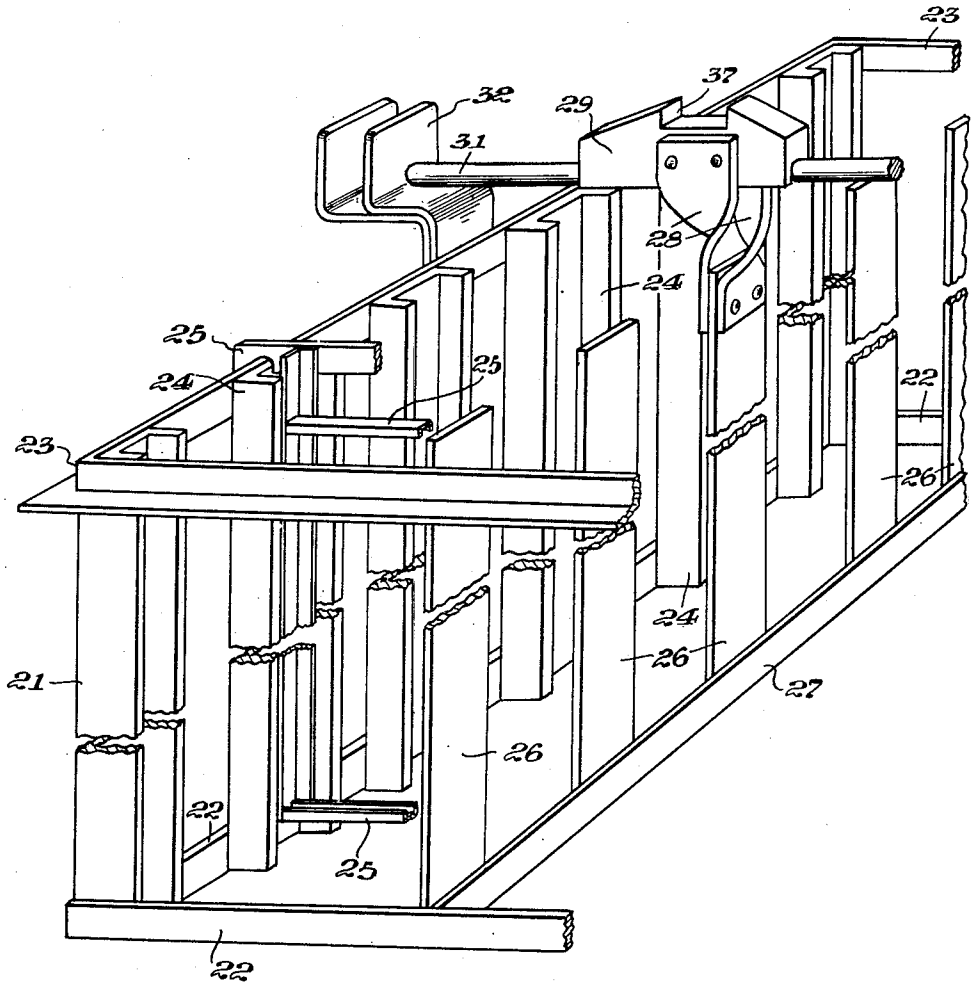


Fig. 3.

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FILM DEVELOPING APPARATUS

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11 Claims. (Cl. 95—98)

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This invention relates to apparatus for developing and processing photographic film in a plurality of film treating baths.

In the commercial development of photographic film, particularly color film, it is essential that successive batches of film be identically processed, so that films similarly exposed will result in negatives having the same gradations of tone, color, etc. To obtain such consistent results, the variables in the developing process that affect the quality of the negative must be reduced to a minimum. The most important of those variables are (1) the agitation of the developing and treating solutions with which the film is successively brought into contact and (2) the temperature of those solutions. For best results, the solutions should be continuously and uniformly agitated over the entire emulsion surface of the film, and the temperature of the solutions should be kept constant within a range of 1° F.

In one type of developing apparatus in general use, agitation is provided by periodically lifting the film from and then immersing it into the film treating baths. This procedure unduly exposes the developing solutions to the air, resulting in their rapid deterioration through oxidation. It also makes difficult a determination of the proper length of time, often a critical factor in photographic development, for processing the film in any given solution, because each time that the film is lifted from the bath the solution drains away at a rate dependent on its surface tension and that rate will vary for different solutions. Again, with such a procedure it is difficult to maintain the bath at the proper constant temperature, since a large surface of liquid is periodically exposed to the ambient air, the temperature of which is seldom the same as the desired temperature (usually 68° F. ±½° F.) of the bath. Other types of developing apparatus that leave the film in the solution do not provide convenient and satisfactory means for agitating it when the film is to be processed in a plurality of baths.

It is accordingly among the objects of this invention to provide a film developing apparatus for successively processing photographic film in a plurality of film treating baths, in which the solution in contact with the film will be continuously and uniformly agitated while being maintained at a substantially constant temperature with minimum exposure to the air, and in which a large number of films may be conveniently processed in a short period of time.

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Other objects will be apparent from the following description of the invention in connection with the accompanying drawings, in which Fig. 1 is a plan view of the apparatus; Fig. 2, a section along the line II—II in Fig. 1; Fig. 3, an enlarged perspective view of a portion of the film rack and agitator; and Fig. 4, an enlarged section along the line IV—IV in Fig. 1.

The film developing apparatus in accordance with this invention includes a rectangular double-walled tank holder of considerable depth, in which are removably disposed a plurality of interchangeable rectangular tanks containing various developing and processing solutions. These tanks are suitably supported within the tank holder at a spaced distance from each other and from the inner walls and bottom of the tank holder to form an enclosed chamber therebetween, which may be filled with water at a controlled temperature to maintain substantially constant the temperature of the solution in each tank. For carrying the conventional film hangers that support the film to be processed, there is provided a rack of generally rectangular shape and so dimensioned as to fit in each of the tanks. The two ends of the rack are provided with opposed vertically extending U-shaped channels, which are spaced from each other and adapted to receive a plurality of film hangers. The films supported by the hangers are thereby held with their emulsion surfaces in spaced parallel relation and fully immersed in the film treating solution. For agitating the solution, there is an agitator comprising a plurality of spaced paddles slidably supported by the rack in a vertical plane and adapted to be horizontally reciprocated longitudinally of the rack in the spaces between and adjacent to the emulsion surfaces of the films. In operation, the rack with its supported film hangers, film, and agitator is placed successively in different tanks, where the films are exposed for the proper length of time to the action of a particular developing or treating solution. The solution in each of the tanks, while in contact with the film, is continuously and uniformly agitated by suitable engaging means between the agitator and a single reciprocating shaft.

Referring to the drawings, an elongated rectangular tank holder 1 is provided with double walls, consisting of an outer casing 2 and two inner linings 3 and 4 spaced from each other. These, as well as all other exposed parts of the apparatus, are preferably made of stainless steel to afford maximum protection against the cor-

rosive action of the chemical solutions used in processing photographic film. The adjacent walls of the two linings form a partition 5 that divides the tank holder transversely into two rectangular compartments 6 and 7. The space between the walls of the tank holder and between the walls of the partition is filled with insulating material 8. Additionally, inside and in contact with the inner walls of the larger compartment 6 is placed a coil of tubing 9, through which can be circulated a cooling fluid from an external source of refrigeration. The outer double walls of each compartment are covered by inwardly sloping closure members 11, which overlap the edges of the casing and linings. Similarly, the partition walls are covered by an inverted V-shaped member 12. Above the longitudinal axis of the larger compartment 6 extends an inverted V-shaped support member 13, the ends of which are fastened to member 12 and to one of the closure members 11. The cross-sectional shape of the members 11, 12, and 13 facilitates the drainage of any liquid spilled thereon into one of the compartments 6 or 7.

Within the larger compartment 6 are removably disposed a plurality of rectangular tanks 14 for holding the various film treating and developing solutions. At least two tanks will always be required, and in the embodiment here illustrated there are six, which is a sufficient number for completely processing color film, or other films requiring special treatment. To support the tanks in spaced relation to each other and to the walls and bottom of the compartment, angle brackets 16 are fastened to members 11 and 13 near the ends of the compartment, and channel brackets 17 are fastened to the same members intermediate those points. The inwardly extending flange portions of these brackets are adapted to engage the flanged rim 18 around the top of the tanks and hold them in parallel rows as illustrated. All of the brackets extend above the inner sides of members 11 and 13 to provide adequate clearance for draining away into compartment 6 any developing solution spilled on those members. To reduce to a minimum any obstruction to such drainage, only the inwardly extending flanges of brackets 16 and 17 need project above the members 11 and 13, as shown in Fig. 2.

The chamber that is formed between the tanks and the walls and bottom of the compartment is adapted to be filled with water, which will be cooled by the refrigerator coil 9 to the proper temperature and will maintain substantially constant the temperature of the solution in each tank.

For supporting the film when it is immersed in the developing and treating solutions, we provide a film rack 21, formed of lower and upper rectangular frame sections 22 and 23, respectively, which are joined by a plurality of spaced U-shaped channels 24. The rack is so dimensioned as to fit into any one of the tanks, being supported therein above the bottom of the tanks by the outwardly extending flanges of the upper rectangular frame section 23. The U-shaped channels 24 provide a plurality of opposed vertically extending grooves, in which may be slidably inserted conventional film hangers with their supported film, the projecting ends at the top of the hangers resting on the top edges of the channels. A portion 25 of a typical hanger is shown in Fig. 3. The centrally located channels are preferably wide enough to accommodate two hangers each, and the two outer channels are somewhat narrower to accommodate but one hanger each. When a pair of hangers occupy the same channels, the films thereon are arranged back to back, i. e., with their emulsion surfaces facing outward. On the single hangers in the outer channels, the supported film has its emulsion surface facing inward. When the films are so arranged in the rack, they are supported with the emulsion surface of one film facing that of an adjacent film but spaced from it by the distance between adjacent channels.

In the spaces between adjacent emulsion surfaces of the film when so supported in the rack, but not touching those surfaces, are vertically extending agitator paddles 26, the lower ends of which are joined together below the bottoms of the film holders by a strip 27. The paddles are supported by an extension 28 of the center paddle, which is rigidly attached to a slide 29 supported by a rod 31 held by brackets 32 mounted on either end of the rack. The paddles may accordingly be moved back and forth longitudinally of the rack to agitate the film treating solution over the entire area of the emulsion surface of each film.

To effect horizontal reciprocation of the paddles, a shaft 33 is slidably mounted in bearings 34 above the closure member 13, so that the shaft is parallel to the longitudinal axis of the tank holder. This shaft is connected to an electric motor 60, which may be mounted on the end of the tank receptacle, by a crank 61 or other conventional means of translating rotary to reciprocal motion. Rotatably mounted on the shaft are three straps 36, one for each laterally adjacent pair of tanks, which extend at right angles to the shaft and are adapted to engage a notch 37 on the top of the slide 29. Each strap is normally held in a horizontal plane on either side of the shaft by a pin 38 on the bottom of the shaft, which engages a slot 39 extending half around each strap, so that the rotation of the latter is limited to an arc of 180° above the axis of the shaft (see Fig. 4). The reciprocal motion of the shaft is communicated to the agitator paddles through one of these straps, thereby providing effective and convenient means for agitating the various film treating solutions during the entire period in which the films are processed.

The smaller compartment 7 in the tank holder is provided for convenience in washing the films while they are supported in the film rack. The compartment is filled with continuously flowing water at the proper temperature, which is introduced through an inlet pipe 41 extending across the bottom at one end of the compartment. Since the temperature of this water need not be held within the narrow range required for the developing and treating solutions in the tanks, its temperature may usually be controlled by connecting the inlet pipe to sources of hot and cold water through conventional thermostatically actuated valves. The water is discharged from the side of the inlet pipe through numerous openings 42 and flows generally lengthwise of the compartment to an overflow pipe 43 at the other end thereof, so that the film rack may be placed in the compartment with its supported films parallel to this general line of flow to increase the effectiveness of the washing. The overflow pipe 43 is of sufficient height to permit the film hangers and the entire rack to be fully immersed in the water, for although they are not

so immersed when the rack is in one of the tanks, the solutions therein tend to be splashed onto the tops of those hangers and the rack and should desirably be removed in the washing operation.

In operation, the rack is loaded outside the tanks with its burden of film, manually lifted by rod **31**, and placed in the tank containing the initial developing solution. If one of the straps **36** should obstruct the opening of that tank, the strap is merely lifted out of the way and then engaged in the top of the slide **29** when the rack is in place. The motor for reciprocating the shaft is then turned on, and the film is subjected to the action of the agitated solution for the required length of time. When that time has elapsed, the motor may be shut off (it is not necessary, however, to do so), the strap is raised to a vertical position, the rack is lifted from the tank and allowed to drain over it momentarily, and then may be washed in compartment **7** before it is moved to the second treating solution in one of the other receptacles, where the operation is repeated.

When employing unskilled operators, it will be found most convenient to arrange the various tanks in compartment **6** in such a way that the racked film is moved successively from one of the tanks next to the washing compartment to the laterally adjacent tank, and so on, in alternate progression to the other end of the apparatus, with brief washing between some or all of these transitions.

While the embodiment of the invention herein described as a single unit with six tanks, it will be readily understood that the number of tanks may vary and that one or more units may be employed, depending on the type of processing that is to be done and the desired conditions for carrying it out. Since the first two tanks in which the film is processed will almost always contain developing and "short stopping" solutions, respectively, and since color film and other sensitive emulsion films must be processed in total darkness through those solutions, it may be desirable in some cases to use two developing units instead of the single unit herein described. One of those units would then contain only the two tanks mentioned above and a washing compartment for processing the film in complete darkness. The other unit, which could be placed in a separate room, would contain the necessary additional tanks and a washing compartment for subsequent processing of the film.

While the cooling water in compartment **6** need not be mechanically circulated, it is desirable to provide an inlet pipe **51** and a drain pipe **52** for periodically changing the water therein. It is also desirable to provide floating lids **53** for each tank to reduce exposure of the film treating solution therein to the air when the tank is not in actual use, thereby prolonging the life of the solution.

In some cases, it may be desirable to suspend from the slide **29** one or more additional rows of agitator paddles **26**, longitudinally spaced from the single row shown in Figs. 1 and 3, thereby shortening the required stroke of the reciprocating shaft while still obtaining effective agitation of the film treating solutions over the entire emulsion surfaces of the racked films.

It is among the advantages of this invention that it provides a flexible apparatus for processing photographic film of any type. In addition, the film treating solution adjacent the emulsion surface of each film is continuously and uniformly agitated, thereby continually bringing fresh solution into contact with those surfaces to assure their uniform development. The effectiveness of this agitation is increased at the ends of the rack by the open spaces between adjacent channels **24**, through which the solution may circulate. This agitation, by circulating the solution within the tank, also promotes effective heat exchange between the solution and the cooling water around the tank to maintain the former at a constant temperature. Because the bottom of the rack is spaced from the bottom of the tank when the rack is inserted therein, any sediment precipitated from the film treating solution collects at the bottom of the tank remote from the paddles and films. It is also an advantage of this invention that the film and film hangers, once they have been loaded in the rack need not be touched by hand during the entire period of its processing. It is an additional advantage that more than one batch of film may be successively processed at the same time by using a plurality of racks; as one rack is removed from the first tank another loaded rack takes its place, so that a large number of films may be processed in a short period.

As a matter of definition, the term "photographic film" or "film" as used herein is intended to include any photographic emulsion coated surface, such as negatives, color transparencies, and positive prints.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. Film developing apparatus comprising a tank receptacle, a plurality of tanks supported by the receptacle for holding various film treating solutions, a film rack comprising a rigid box-like frame having two sides and two ends adapted to be removably disposed in any one of the tanks for holding in an immersed condition therein a plurality of photographic films, the rack having opposed vertically extending spaced grooves in its two ends for slidably receiving a plurality of film hangers with their supported films and for holding the emulsion surfaces of said films in spaced vertical planes, spaced agitator paddles slidably supported on the rack in a vertical plane perpendicular to the planes of said emulsion surfaces and adjacent to those surfaces, and means operatively connected to the paddles for imparting reciprocating motion to the paddles longitudinally of the rack for agitating the solution in the tank adjacent the emulsion surfaces of the films, whereby the film rack together with its supported film and agitator paddles may be disposed as a unit in any one of the tanks and then successively moved as a unit to other tanks without handling the individual films supported in the rack.

2. Film developing apparatus comprising a tank receptacle, a plurality of tanks supported by the receptacle for holding various film treating solutions, a film rack comprising a rigid box-like frame having two sides and two ends adapted to be removably disposed in any one of the tanks for holding in an immersed condition therein a plurality of photographic films, the rack having opposed vertically extending spaced grooves in its two ends

for slidably receiving a plurality of film hangers with their supported films and for holding the emulsion surfaces of said films in spaced vertical planes, a slide rod mounted on and above the rack parallel to the sides of the rack, a slide slidably received on the rod, spaced agitator paddles dependingly supported by the slide in a vertical plane perpendicular to the planes of said emulsion surfaces and adjacent to those surfaces, and means operatively connected to the slide for imparting reciprocating motion to the slide and its attached paddles longitudinally of the rack for agitating the solution in the tank adjacent the emulsion surfaces of the films, whereby the film rack together with its supoprted film and agitator paddles may be disposed as a unit in any one of the tanks and then successively moved as a unit to other tanks without handling the individual films supported in the rack.

3. Apparatus according to claim 2, in which said means for imparting reciprocating motion to the slide and its attached agitator paddles includes a shaft slidably mounted on the tank receptacle laterally of the tanks therein, connecting means mounted on the shaft and extending laterally thereto for engaging the slide mounted on the rack when the rack is disposed in one of the tanks, and means for reciprocating the shaft.

4. Apparatus according to claim 3, said tanks being spaced from each other and from the walls and bottom of the receptacle to form a chamber therebetween for holding water at a controlled temperature.

5. Film developing apparatus comprising an elongated rectangular tank receptacle of considerable depth, a plurality of rectangular tanks for holding various film treating solutions removably supported within the receptacle at a spaced distance from each other and from the walls and bottom of the receptacle to form an enclosed chamber therebetween for holding water at a controlled temperature, a film rack comprising a rigid box-like frame open at the top and bottom and having two sides and two ends adapted to be removably disposed within any one of the tanks for holding in an immersed condition therein a plurality of photographic films, the two ends of the rack being provided with a plurality of opposed vertically extending U-shaped channels with their grooved surfaces facing inward for slidably receiving a plurality of film hangers with their supported film and for holding the emulsion surfaces of said films in spaced vertical planes longitudinally of the receptacle, a slide rod mounted horizontally on the rack parallel to the sides of the rack and above the level of film treating liquids in the tanks, a slide slidably mounted on the rod, a plurality of spaced agitator paddles suspended from the slide in a vertical plane perpendicular to the planes of said emulsion surfaces and adjacent to those surfaces for agitating the film treating liquid therebetween, a reciprocating shaft mounted longitudinally of the receptacle and laterally of the tanks, a laterally extending strap rotatably mounted on the shaft and adapted to engage the slide carried by the rack, and means for reciprocating the shaft longitudinally to cause the agitator paddles to agitate the film treating solution in the tank, whereby the film rack together with its supported film and agitator paddles may be disposed as a unit in any one of the tanks and then successively moved as a unit to other tanks without handling the individual films supported in the rack.

6. Film developing apparatus comprising a rectangular tank receptacle, a plurality of rectangular tanks removably supported within the receptacle for holding various film-treating solutions, a film rack comprising a rigid box-like frame open at the bottom and sides and top, the top of the rack being provided with outwardly extending flanges adapted to rest on the tops of the tanks so that the rack may be removably disposed in any one of the tanks and be supported therein in spaced relation from the bottom and sides of the tank, the ends of the rack being provided with a plurality of opposed vertically extending spaced grooves for slidably receiving a plurality of film hangers with their supported films and for holding those films in an immersed condition in any of the tanks with the emulsion surfaces of the films in spaced vertical planes, a slide rod mounted on the rack perpendicular to the ends thereof and extending horizontally across the top of the rack above the films supported therein, a slide slidably mounted on the slide rod, an agitator paddle attached to the slide and depending therefrom in a vertical plane perpendicular to the emulsion surfaces of the supported films, the paddle being of sufficient length and so positioned as to extend between but not to touch those surfaces, a reciprocating shaft slidably mounted on top of the tank receptacle and extending laterally of the tanks therein and parallel to the sides of the tanks, connecting means mounted on the shaft and adapted to extend laterally over the tanks to engage the slide carried by the rack when the rack is positioned in any one of the tanks to impart to the agitator paddles a reciprocating motion for agitating the film-treating solution adjacent to the emulsion surfaces of the films immersed therein, and an electric motor mounted on the receptacle and provided with a crank that is connected to the shaft for reciprocating the shaft; whereby the films rack, together with its supported films, slide rod, slide and agitator paddle, may be disposed as a unit in any one of the tanks and then successively moved as a unit to one or more of the other tanks without at any time handling the individual films supported in the rack, and whereby the film treating solution in each of said tanks may be uniformly agitated when said unit is disposed therein.

7. Apparatus according to claim 6, in which said reciprocating shaft extends between two rows of tanks positioned opposite each other, and in which said connecting means comprises a plurality of straps each of which is rotatably mounted on the shaft at a point laterally adjacent to an opposed pair of said tanks, whereby each strap may be swung into and out of engagement with the slide when the rack is disposed in either one of said pair of tanks.

8. Apparatus according to claim 6, in which said reciprocating shaft extends laterally of a row of tanks, and in which said connecting means comprises a plurality of straps each of which is rotatably mounted on the shaft at a point laterally adjacent to a tank, whereby each strap may be swung into and out of engagement with the slide when the rack is disposed in the laterally adjacent tank.

9. Apparatus according to claim 6, in which said reciprocating shaft extends between two oppositely positioned tanks, and in which said connecting means comprises a strap rotatably mounted on the shaft at a point laterally adjacent to said two tanks, whereby the strap may be swung into and out of engagement with the

slide when the rack is disposed in either one of said two tanks.

10. Apparatus according to claim 6, in which said two ends of the rack are provided with a plurality of opposed vertically extending U-shaped channels to form said plurality of opposed vertically extending spaced grooves for slidably receiving a plurality of film hangers and their supported film.

11. Film developing apparatus comprising an elongated rectangular tank receptacle having sides of considerable depth, a plurality of rectangular tanks for holding various film-treating solutions removably supported within the receptacle and having their sides parallel to the sides of the receptacle at a spaced distance from each other and from the sides and bottom of the receptacle to form an enclosed chamber therebetween for holding a liquid at a controlled temperature, a film rack comprising a rigid rectangular box-like frame open at the bottom and sides and top, the rack being provided at its top with outwardly extending flanges adapted to rest on the top edges of the tanks so that the rack may be removably disposed in any one of the tanks with the sides of the rack parallel to those of the tank and be supported therein in spaced relation from the bottom and walls of the tank, the ends of the rack being provided with a plurality of opposed vertically extending spaced U-shaped channels with their grooved surfaces facing inward for slidably receiving a plurality of film hangers with their supported films and for holding those films with their emulsion surfaces in spaced vertical planes in an immersed condition in any one of the tanks, a slide rod mounted horizontally on the rack perpendicular to the ends thereof and extending across the top of the rack above the films supported therein, a slide slidably mounted on the slide rod, spaced agitator paddles attached to the slide and depending therefrom in a vertical plane perpendicular to the emulsion surfaces of the supported films, the paddles being of sufficient length and so spaced that they depend between but do not touch those emulsion surfaces, a reciprocating shaft slidably mounted on top of the tank receptacle and extending longitudinally of the receptacle and laterally of the tanks disposed therein, a plurality of connecting straps rotatably mounted on the shaft, each strap being adapted to extend over a laterally adjacent tank and engage the slide carried by the rack when the rack is positioned in said tank and to impart to the agitator paddles attached to the slide a reciprocating motion for agitating the film-treating solution in the tank adjacent to the emulsion surfaces of the films immersed therein, and an electric motor mounted on the tank receptacle and provided with a crank that is connected to the shaft for reciprocating the shaft, whereby the film rack, together with its supported films, slide rod, slide, and agitator paddles may be disposed as a unit in any one of the tanks and then successively moved as a unit to one or more of the other tanks without at any time handling the individual films supported in the rack and whereby the film treating solution in each of the tanks may be uniformly agitated when said unit is disposed therein.

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