

May 19, 1970

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3,512,467

X-RAY FILM DEVELOPING ARRANGEMENT

Filed July 23, 1968

3 Sheets-Sheet 1

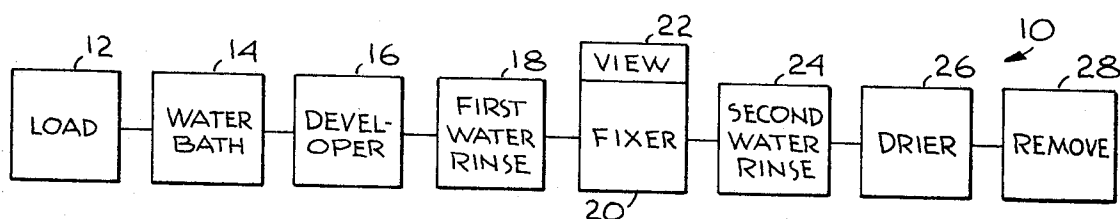


Fig. 1

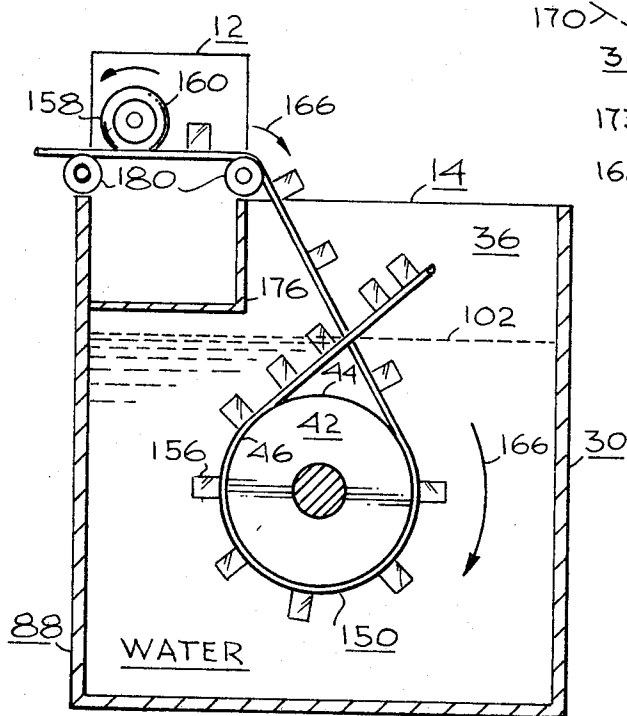


Fig. 4

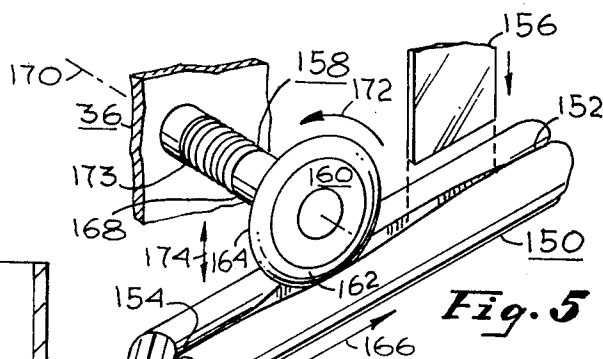


Fig. 5

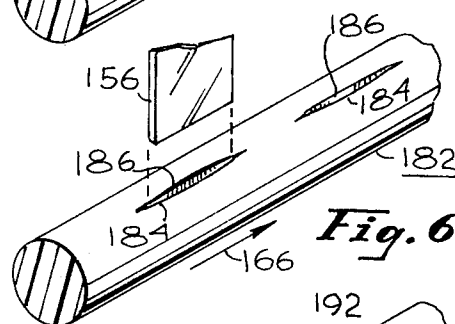


Fig. 6

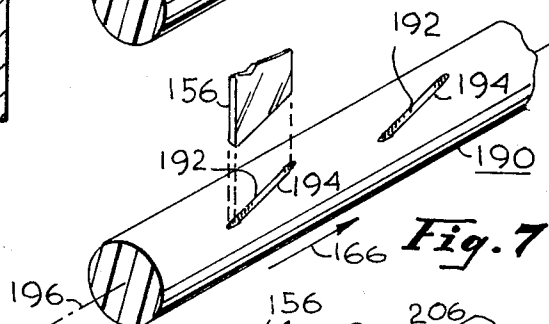


Fig. 7

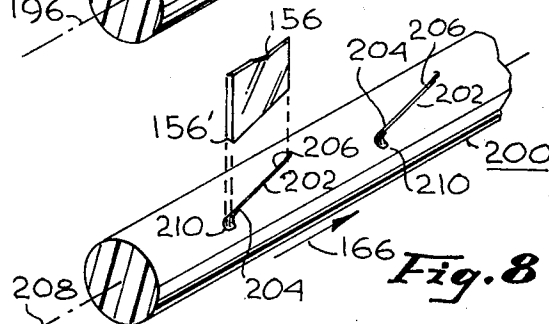


Fig. 8

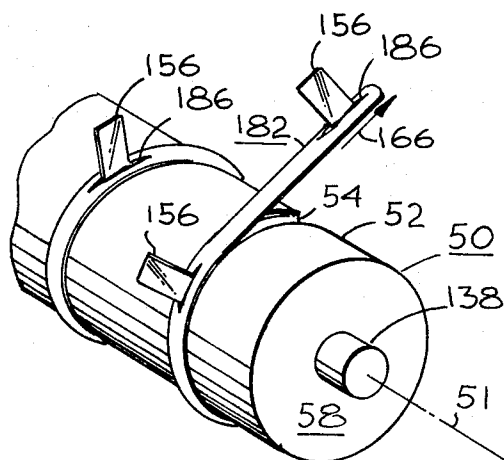


Fig. 9

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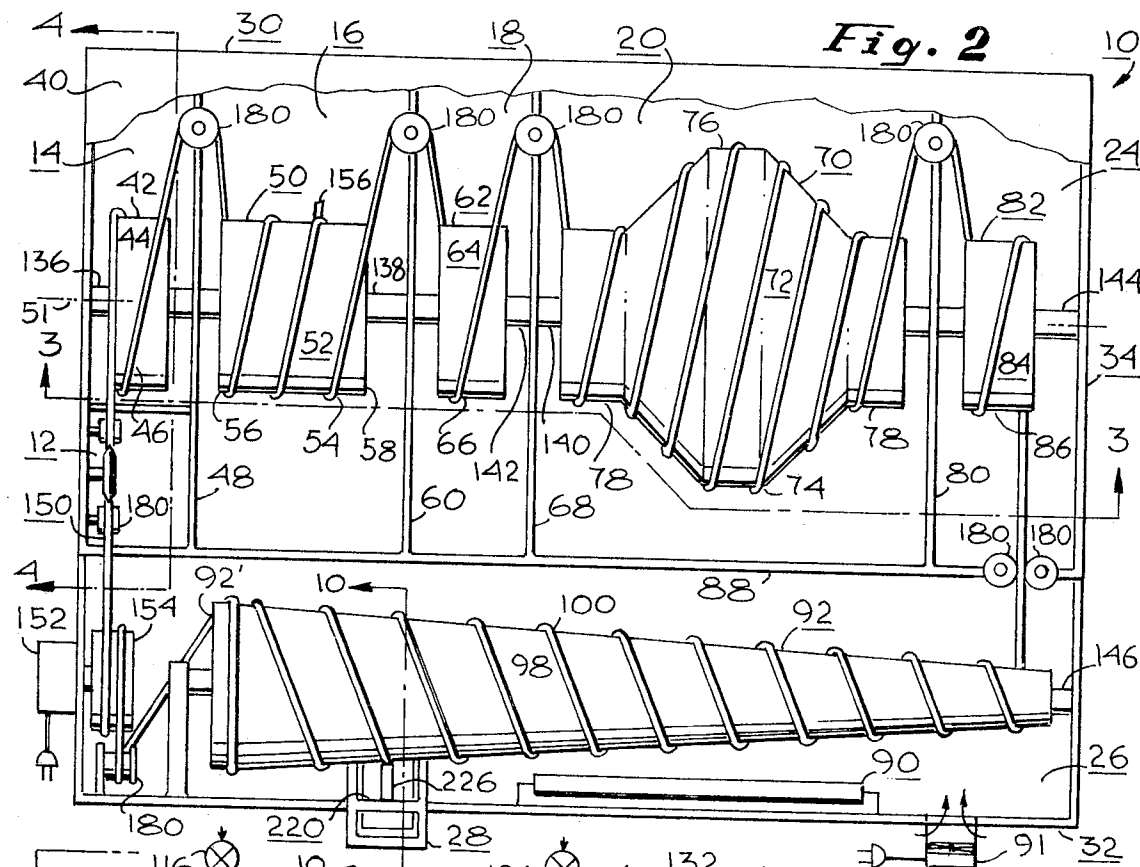
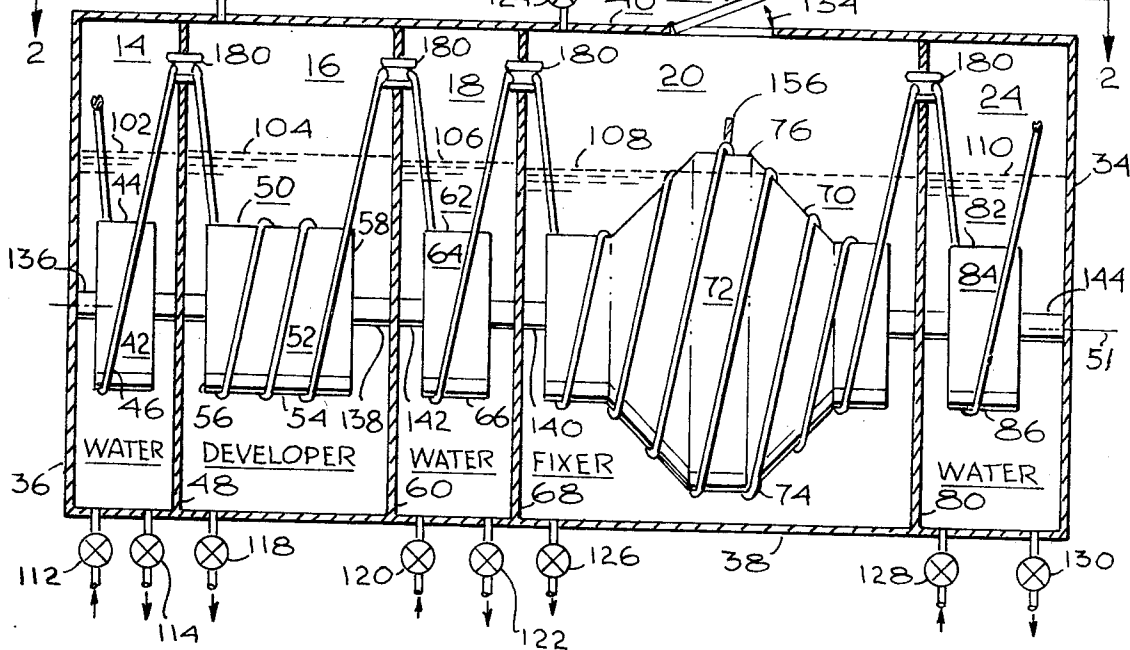


Fig. 3

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Fig. 10

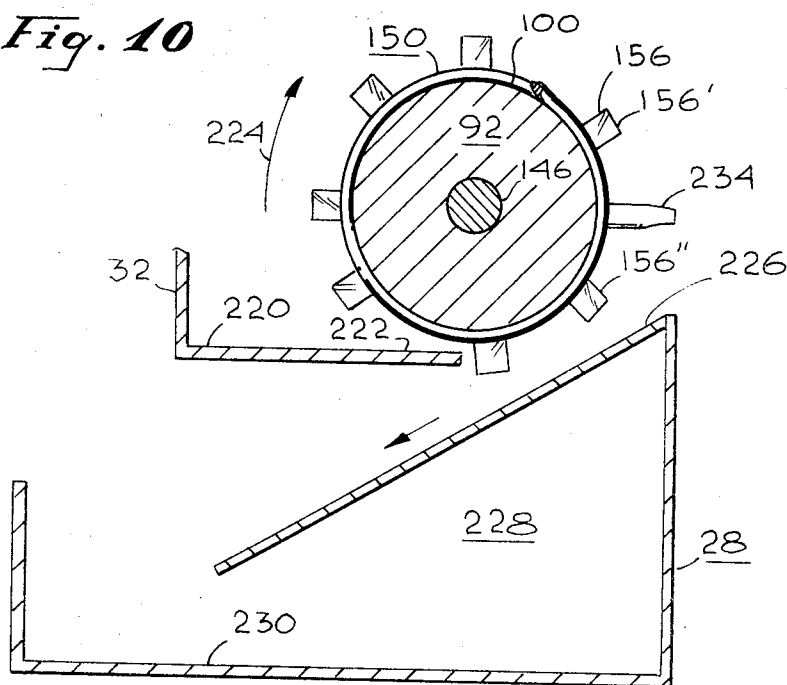


Fig. 11

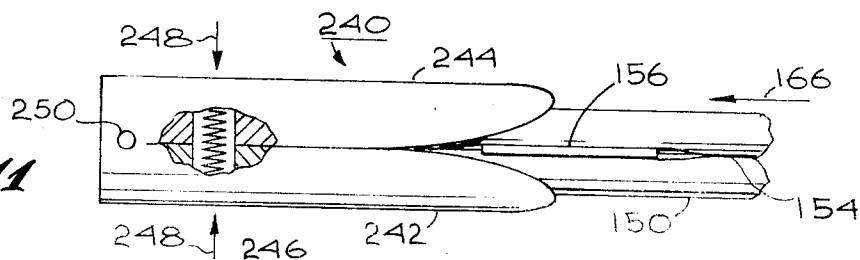
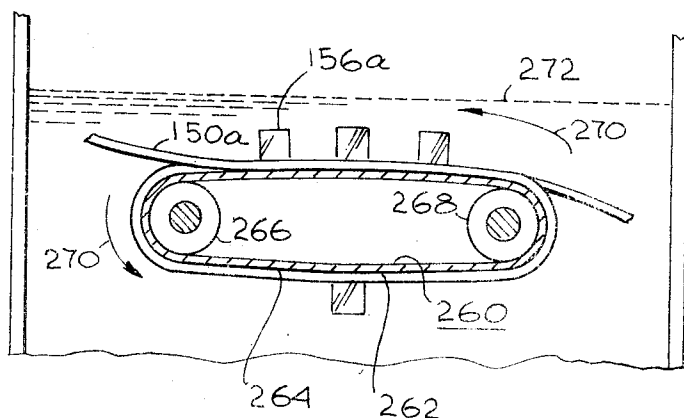


Fig. 12

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X-RAY FILM DEVELOPING ARRANGEMENT

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Filed July 23, 1968, Ser. No. 746,856

Int. Cl. G03d 3/10

U.S. Cl. 95—93

14 Claims

ABSTRACT OF THE DISCLOSURE

A continuous, automatic X-ray film developer, particularly adapted to rapid processing of a large number of X-ray films, in which there is provided a plurality of liquid containing tanks positioned adjacent each other. A first of these tanks may contain a preliminary water bath; the second, X-ray film developer fluid; the third, a water rinse; the fourth, X-ray film fixer fluid; and the fifth, a second water rinse. A drying chamber may be positioned adjacent to the plurality of tanks. Each of the tanks may have a rotatably mounted drum therein, and each of the drums may be provided with a spiral, belt accepting groove thereon. A continuous, flexible resilient, belt is wound around each of the drums in the spiral grooves thereon, and a drive means rotates the belt to rotate each of the drums. Slits for holding X-ray films are provided on the belt, and, as the belt is rotated, it drives each of the rotating drums and is sequentially exposed, in order, to the above-mentioned fluid baths and to the drying chamber. Suitable heater means are provided in the drying chamber for drying the developed X-ray film. The number of grooves in each of the drums determines the length of time that the X-ray films are exposed to each of the different liquids contained in the plurality of tanks. Means for loading the film onto the belt and means for removing the developed film after it has passed through the complete cycle are also provided.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to the X-ray film developing art and, more particularly, to a continuous, automatic X-ray film developing arrangement.

Description of the prior art

In many applications, it is desirable to process as rapidly as possible exposed X-ray films. Such applications, of course, include medical offices, dental offices and certain industrial establishments. In dental offices and dental clinics, of course, exposed X-rays are often required to be developed in a comparatively short time so that immediate treatment, based upon the results shown in the X-rays, may be defined and/or commenced. It will be appreciated, of course, that while such requirements for urgency may also exist in many medical facilities, these generally are more of an emergency nature and are not part of the normal treatment of patients. In dental offices and dental clinics, on the other hand, such X-rays are generally part of the standard office routine and are required by the dentist for evaluation of the particular characteristics shown on the X-ray.

Accordingly, there has long been a need for an automatic X-ray film developer that will enable the rapid processing on a continuous basis of exposed X-ray films. Further, such an automatic X-ray film developer should be comparatively low in cost, small in size, and operable by a minimum amount of help. Preferably, the automatic X-ray film developer should be operable by one person, and virtually all operations required for the development of an exposed X-ray film should be automatic in the machine. Accordingly, it is an object of applicant's inven-

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tion herein to provide an improved automatic X-ray film developing arrangement.

It is another object of applicant's invention herein to provide an automatic X-ray film developing arrangement for automatic processing of exposed X-ray films.

It is yet another object of applicant's invention herein to provide an automatic X-ray film developing arrangement that may be conveniently fabricated in comparatively small size and comparatively easily operated.

The above and other objects of applicant's invention herein are achieved, according to one embodiment of applicant's invention, by providing a plurality of adjacent, closed, liquid containing tanks. In each of the tank means, a drum is rotatably mounted, and the external surface of the drum is provided with a spiral groove extending from one end of the drum to the other and having a predetermined length.

A flexible resilient continuous belt means extends in the spiral grooves on each of the drum means, and the belt means have a plurality of X-ray film receiving means and acts as both a means for holding the exposed X-ray film and also for rotating each of the drums in the liquid tanks. Means are provided for driving the flexible resilient belt means at a predetermined velocity so that the belt means extends in the spiral grooves in each of the drums and rotates them while it is being driven.

In this embodiment of applicant's invention, there may be provided in the plurality of tank means, in sequential order as traversed by the flexible belt means, a water bath means, developer tank, a first water rinse, a fixer tank and second water rinse tank. Each of the tanks have a predetermined liquid level for containing the appropriate liquid therein, and the drums are rotatably positioned within each of the tanks so that during each revolution thereof, at least a portion of the drum is below the liquid level. Thus, the belt and exposed X-ray film contained in the belt is sequentially exposed to first a water bath to remove any extraneous foreign material that may be present on the X-ray film after it is loaded onto the belt, then to the X-ray film developer in the developer tank means, then to a first water rinse for rinsing off the developer, then to the X-ray film fixer in the fixer tank means, and then to a second water rinse means to rinse any retainer fixer from the now developed film. The length of the grooves in the external peripheral surface of each of the drums determines the length of time that exposed X-ray film is subjected to the particular liquid in that tank. That is, the determining of the length of the groove that is below the predetermined liquid level at accurate timing of the X-ray film in the particular liquid may be obtained since the belt is driven at a known predetermined velocity.

Adjacent the second water rinse tank means, there is provided a dryer chamber which also has a drum rotatably mounted therein in this embodiment of applicant's invention. The dryer drum also is provided with grooves on the external surface thereof, and the belt means is contained in the dryer drum and extends therearound from one end of the dryer drum to the other in a predetermined path in the spiral grooves. A heater means such as a conventional electrical resistance heater or the like is provided in the dryer chamber, and the X-ray film contained within the belt is thus exposed to the drying action of the heater. The belt rotates the dryer drum also. The belt extends, as noted above, sequentially through all of the above-mentioned liquid tank means in the order specified, and then is exposed to the dryer and the belt then continuously cycles back to the water bath means.

Adjacent the end of the dryer chamber there is provided an X-ray film removing means for removing the now dry and developed X-ray film from the belt.

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Intermediate the removal means and the water bath means, in those embodiments of applicant's invention wherein the water bath is provided, there is provided a loading zone in which the operator of the machine may appropriately load exposed X-ray films onto the belt.

In some embodiments of applicant's invention, a view zone is provided in the fixer tank means. In this embodiment of applicant's invention, there is at least a portion of the fixer drum that is above the predetermined fixer level in the fixer tank means during each rotation thereof, and a door or other access arrangement is provided in the closed top of the fixer tank means so that X-ray film may be quickly viewed or removed after exposure to the fixer for a predetermined time before the film has completed the above-described cycle through the automatic X-ray film developer arrangement of applicant's invention and, of course, replaced at this position after observation, if desired. This allows the doctor or other interested person to have a rapid processing of an X-ray film where emergency or other requirements dictate the necessity for such speed.

This embodiment of applicant's invention allows continuous processing of X-ray film for developing, rather than a batch process as is currently utilized.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other embodiments of applicant's invention may be more completely understood from the following detailed description taken together with the accompanying drawings, wherein similar reference characters refer to similar elements throughout and in which:

FIG. 1 is a block diagram illustrating the sequential operations of applicant's automatic X-ray film developer arrangement;

FIG. 2 is a plan view of one embodiment of applicant's invention;

FIG. 3 is a view along the line 3—3 of FIG. 2;

FIG. 4 is a view along the line 4—4 of FIG. 2;

FIG. 5 illustrates a belt means useful in the practice of applicant's invention;

FIG. 6 illustrates another belt means useful in the practice of applicant's invention;

FIG. 7 illustrates another belt means useful in the practice of applicant's invention;

FIG. 8 illustrates another belt means useful in the practice of applicant's invention;

FIG. 9 illustrates a rotating drum means useful in the practice of applicant's invention;

FIG. 10 illustrates a removal means useful in the practice of applicant's invention;

FIG. 11 illustrates another removal means useful in the practice of applicant's invention; and

FIG. 12 illustrates another embodiment of a drum means useful in the practice of applicant's invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown in block diagram form one embodiment of applicant's invention generally designated 10. The embodiment of applicant's invention 10 of an improved automatic X-ray film developer arrangement has a load zone 12 in which X-ray film to be developed is loaded onto an appropriate belt means (not shown in FIG. 1) that extends continuously and sequentially through each of the stages shown on FIG. 1.

Following the load zone 12, there may be provided, if desired, a water bath 14 in which the exposed X-ray film to be developed is exposed to a water bath to remove any foreign substances that might be on the film. After leaving the water bath 14, the exposed X-ray film to be developed is subjected to a predetermined time period in a developer contained within a developer tank means 16. The time period for subjection to the developer within the developer tank means 16 may be as recommended by the manufacturer of the X-ray film.

After leaving the developer tank means 16, the ex-

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posed X-ray film goes through a first water rinse in a first water rinse tank means 18 and then into an X-ray film fixer in an X-ray film fixer tank means 20. If desired, as described below in greater detail, a view zone 22 may be provided adjacent the fixer tank means 20 to allow viewing and/or removal of the exposed X-ray film at a predetermined position within the fixer tank means 20.

X-ray film not removed from the fixer tank means 20 proceeds to a second water rinse tank 24 to a second water rinse and from there into a dryer chamber 26, where it is exposed to heat from a conventional heater to dry the now developed X-ray film. After a predetermined time period in the dryer chamber 26, the developed X-ray film passes into a removal zone 28 where the now dry developed X-ray film is removed from the belt means. The belt, of course, then continuously returns to the load zone 12 where additional X-ray films may be loaded therein for processing in the automatic X-ray film developer arrangement 10.

The above block diagram presentation of one embodiment of applicant's invention illustrates the basic sequential operations of applicant's improved automatic X-ray film developer arrangement 10.

Referring now to FIGS. 2, 3 and 4, there is shown various details of the structural arrangement of applicant's invention. FIG. 2 shows a plan view of one embodiment of applicant's invention in which there is provided the plurality of adjacent closed liquid containing tank means. That is, in this embodiment of applicant's invention, there is provided in adjacent relationship the closed water bath tank means 14, developer tank means 16, first water rinse tank means 18, fixer tank means 20, and second water rinse tank means 24. Similarly, the dryer chamber 26 is adjacent the second water rinse tank means 24. In the embodiment of applicant's invention shown in FIG. 2, the structure is fabricated in a comparatively unitary arrangement so that there is provided external side walls 30 and 32, end walls 34 and 36, bottom 38 and top 40. It will be appreciated that the top 40 may be desired in some embodiments of applicant's invention to prevent the possibility of subjecting the exposed X-ray film to light during the processing in the automatic X-ray film developer arrangement 10. However, in those embodiments of applicant's invention wherein the automatic X-ray film developer arrangement 10 is entirely closed within a darkroom or other suitable developing environment, a top 40 may not be needed. However, in many instances the top 40 is also desired to minimize the amount of fumes and vapors that would be emitted from the various chemicals that may be contained in, for example, the developer tank means 16 or fixer tank means 20.

As shown in FIG. 2, in this embodiment of applicant's invention, there is provided a water bath tank means 14 in which a water bath drum means 42 having an external peripheral surface 44 in which there is provided a spiral groove 46 extending around the external peripheral surface for a pre-selected distance. A wall means 48 is provided to separate the contents of the water bath tank means 14 from the contents of the developer tank means 16. The water bath drum means 42 is rotatably mounted in the end wall 36 and wall means 48 for rotational movement about an axis 51. In this preferred embodiment of applicant's invention, each of the rotating drum means, as hereinafter described, are mounted for rotational movement about the axis 51.

A developer drum means 50 is rotatably mounted in the developer tank means 16 and has an external surface 52 provided with a spiral groove 54 extending therearound from a first end 56 to a second end 58 thereof for a predetermined length. Another wall means 60 separates the contents of the developer tank means 16 from the contents of the first water rinse tank means 18.

A first means for subjecting exposed X-ray film to the first water bath is provided in the first water rinse tank

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means 18, and, in this embodiment of applicant's invention, comprises a first water rinse drum means 62 rotatably mounted in the first water rinse tank means 18. The first water rinsed drum means 62 has an external peripheral surfaces 64 provided with a groove 66 therein extending around the first water rinse drum means 62 a predetermined distance. A wall means 68 separates the contents of the first water rinse tank means 18 from the contents of the fixer tank means 20.

A fixer drum means 70 is rotatably mounted in the fixer tank means 20 and has an external surface 72 having a spiral groove 74 therein, and the spiral groove 74 has a predetermined length. In this embodiment of applicant's invention, for reasons hereinafter set forth, the fixer drum means 70 has a portion 76 that is at a larger diameter than other portions such as portions 78. A wall means 80 separates the contents of the fixer tank means 20 from the contents of the second water rinse means tank 24. A second water exposure means such as the second water rinse drum means 82 is rotatably mounted in the second water rinse tank means 24 and has an external surface 84 having a spiral groove 86 therein, and the spiral groove 86 has a predetermined length.

A wall means 88 separates the plurality of liquid containing tank means 14, 16, 18, 20 and 24 from the drying chamber 26. Electrical heater means 90 which, for example, may be a conventional electrical resistance heater or the like, and, if desired, a fan and motor 91 for induced air flow into the drying chamber 26 are positioned in the drying chamber 26. A drying drum means 92 is rotatably mounted in the drying chamber 26 and has an external surface 98 provided with a groove means 100. The electrical heater means 90 is oriented to expose at least a portion of the dryer drum means 92 to thermal radiation emitted from the electrical heater means 90.

As seen more clearly in FIG. 3, the water bath tank means 14 has a preselected volume of water contained therein to a predetermined water level 102. The developer tank 16 contains a preselected amount of developer fluid to a predetermined developer level 104 therein. The first water rinse tank means 18 contains water to a predetermined water rinse level 106 therein.

The fixer tank means 20 has a preselected quantity of X-ray film fixer fluid therein to a predetermined X-ray film fixer level 108. As shown on FIG. 3, the X-ray film fixer level 108 is lower than at least a part of the portion 76, for reasons hereinafter set forth. In the second water rinse tank means 24, there is a preselected quantity of water contained therein to a predetermined level 110.

While, as shown on FIG. 3, the liquid levels in each of the plurality of liquid containing tank means 14, 16, 18, 20 and 24 are the same, it will be appreciated that different levels may be contained in each tank as desired. Further, while each of the drum means contained within the above-mentioned plurality of liquid containing tank means is shown journaled for rotary motion at a level below the selected liquid level, it will be appreciated that it is only necessary that at least a portion of each of the drum means be positioned below the liquid level. That is, it is only necessary that the drum means in each of the plurality of liquid containing tank means exposes the groove on the external surface thereof to the respective liquids contained within the liquid containing tank means to the liquid for a known, predetermined portion of each rotation thereof.

As is well known in the X-ray film developing art, it is necessary that the exposed X-ray film that is to be developed be exposed to the developer for a first predetermined time period and to the fixer for a second predetermined time period. For example, with many types of X-ray films commonly utilized by, for example, dentists, the time period for which the exposed X-ray film should be subjected to the developer is on the order of four minutes, whereas the time for the subjection of the ex-

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posed X-ray film to the fixer may be on the order of eleven minutes. By adjusting the preselected length of the groove in each of the drums, for at least that portion that is positioned below the liquid level within the plurality of liquid containing tank means, it is possible to, as described below in greater detail, precisely determine the amount of time to which the X-ray film is subjected to each of the liquids.

Further, while the first water bath drum means 44, developer drum means 50, first water rinse drum means 62, and second water rinse drum means 82 are shown as having a substantially constant external diameter and therefore a cylindrical external peripheral surface, it will be appreciated that any of the drums mentioned herein may have any desired geometric shape. That is, they may be conical, as shown for example with the dryer drum 92, or they may have tapered surfaces, as shown, for example, on the fixer drum 70. As noted above, in general, the critical time periods are those associated with the developer in the developer tank 16 and the fixer in the fixer tank 20. Time periods for exposure to the water in the water bath tank 14, first water rinse tank 18 and second water rinse tank 24 may be as selected, and their times are not critical.

As shown more clearly on FIG. 3, for convenience, appropriate valve connections may be incorporated in the plurality of liquid containing tank means of applicant's invention. Thus, on the water bath tank 14, where such a water bath tank is utilized, there may be provided an inlet valve 112 and outlet valve 114 through which water may be appropriately inserted and removed from the water bath tank means 14. Similarly, an inlet valve 116 and outlet valve 118 may be provided on the developer tank means 16 to aid in replenishing the supply of developer or removing used developer. Inlet and outlet valves 120 and 122, respectively, may also be installed in the first water rinse tank means 18, and a fixer inlet valve 124 and a fixer outlet valve 126 may be installed in the fixer tank means 20. A water inlet valve 128 and a water outlet valve 130 may be installed in the second water rinse tank means 24, respectively. Thus, according to the principles of applicant's invention herein, the automatic X-ray film developer arrangement 10 may, if desired, be permanently connected to a source of water and a water drain so that the water bath tank means 14, first water rinse tank means 18 and second water rinse tank means 24 may be continually supplied with fresh water or, if desired, the connections may be made on a temporary basis.

In the fixer tank means 20, there is provided a view door 132 that is adapted to move, with respect to the top means 40, in the direction indicated by the arrow 134 so that access to the portion 76 of the fixer drum 70 which, as noted above, is above the fixer level 108, may be achieved. It may be desired merely to observe phenomena through the open door 132, or, on the other hand, to remove X-ray film at this particular point.

The water bath drum means 42 is journaled for rotary motion in the water bath tank 14 on water bath drum shaft 136. The developer drum means 50 is journaled for rotary motion in the developer tank means 16 on developer drum shaft 138. The fixer tank drum means 70 is journaled for rotary motion in the fixer tank means 20 on fixer drum shaft 140. The first water rinse drum means 62 and second water rinse drum means 82 are journaled for rotary motion in the first water rinse tank means 18 and second water rinse tank means 24, respectively, on first water rinse drum shaft 142 and second water rinse drum shaft 144, respectively. Similarly, the dryer drum means 92 is journaled for rotary motion in the dryer chamber 26 on dryer drum shaft 146. Thus, each of the drum means in applicant's automatic X-ray film developer arrangement is free to rotate about its respective shaft within its appropriate tank. As noted above, while the timing for exposure to the developer in the developer

tank means 16 and the fixer in the fixer tank means 20 may be critical or may be specified times, as indicated by the manufacturer of the particular X-ray film, the remaining drums in the water bath tank means 14, first water rinse tank means 18 and second water rinse tank means 24 may be replaced by any suitable structural arrangement of a water exposure means that has at least a portion below the respective water levels therein.

Applicant provides a flexible resilient elongate continuous belt means positioned in the belt accepting groove 46 of the water bath drum means 42, the belt accepting groove 54 of the developer drum 50, the belt accepting groove 66 of the first water rinse drum means 62, the belt accepting groove 74 of the fixer drum 70, the belt accepting groove 86 of the second water rinse drum means 82, and the belt accepting groove 100 of the dryer drum 92. The flexible resilient elongate continuous belt means 150 is the power transmission means for rotating each of the drums in the plurality of liquid containing tank means, as well as the dryer drums, in this embodiment of applicant's invention. Thus, the belt means 150 is sequentially exposed to the water in the water bath 14, the developer in the developer tank means 16, water in the first water rinse tank means 18, fixer in the fixer tank means 20, water in the second water rinse tank means 24, and thermal drying radiation from the heater means 90 in the drying chamber 26.

In this embodiment of applicant's invention, applicant provides a drive means 152 which, for example, may comprise an electric motor and/or any associated gear reductions as required, to drive a pulley 154 that rotates the flexible resilient continuous belt means 150. While applicant has shown in this embodiment of applicant's improved X-ray film developer arrangement 10 the belt means 150 rotating each of the drums, it will be appreciated that one or more of the drums may be utilized as the means for driving the belt means and, further, it will be appreciated that the rotational speeds of the drums need not be the same but may be varied depending upon their diameter and the desired exposure time in each of the stations of applicant's improved X-ray film developer arrangement 10.

The flexible resilient continuous belt means 150 is also provided with a plurality of X-ray film accepting means therein for receiving and retaining X-ray films in a preselected orientation with respect to the belt means.

FIG. 5 illustrates a detail of the belt means 150. As shown on FIG. 5, the belt means 150 has walls 152 defining an elongate continuous X-ray film accepting slit means 154 extending longitudinally on the belt means substantially continuously throughout the length thereof. The slit 154 may be straight, as shown, or may extend spirally around the belt means 150, as desired. Further, the walls 152 have a preselected radius of curvature adjacent to the slit means 154 so that X-ray films such as X-ray film 156 may be inserted therein.

To aid in the insertion of the X-ray film 156 in the X-ray film accepting slit 154, there may be provided a loader means 158 which, in this embodiment of applicant's invention may comprise a rotatably mounted wheel 160 having tapered walls 162 defining a tapered edge 164. The tapered edge 164 and walls 162 are positioned in the slit means 154 to spread the walls 152 defining the slit means 154 to allow more rapid and easier insertion of the X-ray film 156 into the slit means 154. In the preferred embodiment of applicant's invention, the belt means 150 is a resilient belt means and, when the X-ray film 156 has been inserted into the slit means 154, the X-ray film 156 will be frictionally retained therein due to the resilient nature of the X-ray belt 150. Further, it will be appreciated that since the belt is moving in the direction indicated by the arrow 166, the belt means 150 is pulled into longitudinal tension and, therefore, the belt means 150 gently and resiliently engages the X-ray film 156 to retain the X-ray film 156 in the slit 154 until it

is desired to remove the X-ray film 156 therefrom. It will be appreciated that the generally flexible nature of the belt means 150, together with the resilient characteristics allows the spreading by the tapered wheel means 160 and the frictional retention of the X-ray film 156 in the slit 154.

The loader 158 also comprises a shaft 168 having an axis 170 about which the shaft and wheel 160 are free to rotate in the direction indicated by the arrow 172 under the driving influence of the belt 150. If desired, the wheel 160 may be spring mounted by, for example, a spring means 172 inserted in the shaft 168 to allow motion of the wheel means 160 in the directions indicated by the arrow 174, as may be required due to irregularities in the motion of the belt 150. As shown more clearly on FIG. 4, the load region 12, in addition to comprising the loader means 158 to allow insertion of the X-ray film 156 in the belt 150, also comprises a tray means 176. The tray 176 is positioned above the water level 102 in the water bath tank means 14 so that if, through inadvertence, an X-ray film 156 should slip during the loading operation, it would fall into the tray means 176 rather than into the water contained within the water bath tank means 14. It will be appreciated, of course, that in other embodiments of applicant's invention, the loading region 12 may be positioned separate and apart from the plurality of liquid containing tank means at any desired location. However, in general, it is preferable that the loading of the X-ray film onto the belt 150 be accomplished intermediate the drying chamber 26 and the plurality of liquid containing tank means so that each X-ray film may be sequentially subjected to the required and necessary sequence of operations for automatic X-ray film developing.

As the flexible elongate continuous belt means 150 moves from the water bath tank means 14 to the developer tank means 16 and then sequentially through the remainder of the liquid containing tanks and into the drying chamber 26, it is contained within the grooves in the individual drum means. Therefore, the length of the spiral belt accepting groove means in each individual drum determines the length of time that the X-ray film to be developed is subjected to each of the operations in each tank and/or the drying chamber 26. By adjusting the length of the spiral belt accepting groove means, it will be appreciated that, for a given belt velocity imparted thereto by the belt drive means 152, a very economical as well as a precise time measurement for exposure may be achieved.

Appropriate supporting rotatable pulley means such as pulley means 180 may be positioned intermediate each of the tank means for appropriate directional control and support of the belt 150 between the drums. Further, the drive means 152 may comprise a variable speed drive arrangement so that speed adjustments may be made for different developing and/or fixing times.

FIG. 6 illustrates a flexible resilient elongate continuous belt means 182 that is also useful in the practice of applicant's invention herein. As shown on FIG. 6, the belt means 182 is similar to the belt means 150 except that the belt means 182 has walls 184 defining a plurality of discrete separate X-ray receiving slit means 186 for receiving X-ray film 156. The same loader means 158 may be utilized to aid in the loading of the X-ray film 156 into the slits 186. In this embodiment of applicant's invention, it will be appreciated, the vertical movement as indicated by the arrow 174 of the wheel means 160 is necessary due to the spacing between the X-ray receiving slit means 186.

FIG. 7 illustrates another flexible resilient elongate continuous belt means 190 useful in the practice of applicant's invention herein. As shown on FIG. 7, the belt means 190 may be similar to the belt means 150 and 182 described above, except that the belt means 190 has walls 192 defining a plurality of separate discrete slit

means 194 that are aligned at an angle to the longitudinal dimension of the belt means along the long axis 196 thereof. Since the belt means 190, in the practice of applicant's invention herein, is in tension due to the driving nature of the belt means 190, providing the slits 194 at an angle to the axis 196, the slits will be slightly spread due to the tension in the belt 190. The angle at which the slits 192 are oriented with respect to the axis 196 is selected so that for the particular resiliency and flexibility of the belt 190, the slits 194 are spread so that when the X-ray film 156 is inserted therein, there is still sufficient resilient frictional retention thereof to maintain the X-ray films in the belt means 190 throughout the progression of the belt means through the various stations of applicant's invention herein.

FIG. 8 illustrates still another embodiment of a belt means 200 useful in the practice of applicant's invention herein. In this embodiment of applicant's invention, the belt means 200 has walls 202 defining a plurality of X-ray film receiving slit means 204. In this embodiment of applicant's invention, the X-ray receiving slit means 204 has a first portion 206 that is aligned, for example, substantially parallel to the longitudinal or long axis 208 of the belt 202 and another portion 210 that is aligned substantially transverse to the axis 208. Because of the tension in the belt means 202 due to the driving nature thereof, the transverse portion 210 of each of the slit means 204 is slightly spread apart so that a corner 156' of the X-ray film 156 may be inserted into the portion 210, and then the remainder of the X-ray film 156 may be inserted in the remainder of the slit 204 for frictional retention therein by the resilient nature of the belt means 200 since, as noted above, the belt means 200 is in longitudinal tension and therefore the portions 206 of each of the slit means 204 are generally squeezed together.

The above variations of the flexible resilient elongate continuous belt means and, more particularly, the positioning of the X-ray film receiving slits therein are indicative of the many variations of belt means that may be utilized according to the principles of applicant's invention herein.

FIG. 9 is a perspective view of the developer drum 50 when utilized with a flexible belt 182, according to the principles of applicant's invention herein.

As shown on FIG. 9, the spiral belt accepting groove 54 in the external peripheral surface 52 of the drum 50 receives the belt means 182 which, as indicated above, has the X-ray films 156 frictionally retained therein. The belt is constrained to travel in the spiral belt accepting groove 54 and, thus, as the drum 50 rotates on the shaft 138 about the axis 51, each portion of the belt 182 and each X-ray film 156 progressively move from the first end 56 to the second end 58 of the developer drum 50 and, in this progressional movement, is exposed to the developer in the developer tank means 16 for the predetermined time period as dependent upon the length of the spiral groove 54 and the rotational speed of the drum 50. Since the drum 50 is driven by the belt 182, it will be appreciated that the velocity of the belt 182 in the direction of the arrow 166 is the fundamental determining velocity characteristic for calculating the exposure times and the length of each groove required in the practice of applicant's invention herein.

The removal zone 28 of applicant's invention herein is provided adjacent the end 92' of the dryer drum 92. As shown more clearly on FIG. 10, in this embodiment of applicant's invention, removal station 28 is the station where the X-ray films 156 are removed from the belt 150. In this embodiment of applicant's invention, the removal of the X-ray films 156 which, by the time they arrive at the removal station 128 are fully developed and dry, may be accomplished by a knockoff bar 220 having an X-ray film engaging end portion 222 that is positioned to pass within X-ray film dislodging relationship to the belt 150 as the dryer drum 92 rotates in a direction in-

indicated by the arrow 224. Thus, each X-ray film 156 hits the end 222 of the knockoff bar 220 and is dislodged from its frictional retention in the slit 154 in the belt 150 and falls upon the ramp means 226. The ramp means is inclined downwardly so that under the influence of gravity, the dislodged X-ray films 156 fall into the chamber 228 upon the base plate 230 and are stacked thereat.

As shown on FIG. 10, it may be desired to separate the X-rays of one patient from the X-rays of another patient. An indicating means 234, for example, may be provided to achieve this purpose. That is, the indicating means 234 may comprise a colored pad means insertable into the slit 154 of the belt 150 that is positioned between the group of X-ray films 156' from one patient from the group of X-ray films 156'' from another patient. As the X-ray films are sequentially knocked off by the knockoff bar 220 and stacked on the base plate 230, the indicating means 234 will similarly be knocked off by the knockoff bar 220 and fall upon the last of the X-ray films 156', and, therefore, intermediate the two separate groups of X-ray films. It will be appreciated though, however, that any other type of indicating means may be utilized as desired in the practice of applicant's invention herein.

As noted above, the fixer tank means 20 is provided with the view of door 132 so that, after a preselected time period in the fixer, the X-ray films 156 may be either viewed by stopping the location of the drum and belt 150, or may be removed at this point for those occasions when it is necessary to provide an extremely short time period between the exposure of the X-ray and observing of the picture depicted thereon. Therefore, the portion 76 of the fixer drum 70 that projects above the liquid level line 108 allows convenient removal of the X-ray films 156 at this point. Further, it will be appreciated, that the particular time periods for exposure to, for example, the developer in the developer tank 16, the fixer in the fixer tank 20 and/or any other fluids and baths may vary as dependent upon the particular type of X-ray film and the X-ray film manufacturer's recommendations thereof.

FIG. 11 illustrates another removal means 240 useful in the practice of applicant's invention herein. The removal means 240 may be positioned in the location of, for example, the knockoff bar 220 shown in FIG. 10, and in this embodiment of applicant's invention may comprise a pair of spring loaded jaw means 242 and 244 that are spring loaded by spring means 246 in the directions indicated by the arrow 248. The X-ray films 156 contained within the slit means 154 of the flexible resilient belt means 150 move in the direction indicated by the arrow 166 until they are engaged by the jaw means 242 and 244 and are frictionally retained therebetween due to the action of the spring means 246. Thus, each of the jaws 242 and 244 are free to pivot about the pivot pin 250 to allow the insertion of the X-ray films 156 therebetween.

In the above embodiments of applicant's invention, generally each of the drum means has been shown as a rigid drum means having generally cylindrical external peripheral surfaces.

FIG. 12 illustrates an embodiment of applicant's invention in which the drum means may be provided other than in cylindrical form.

As shown on FIG. 12, there is illustrated a drum means 260 which, in this embodiment of applicant's invention, may comprise a flexible shell means such as a flexible plastic elongate shell. The shell has an external surface 262 that is provided with a belt accepting groove means 264 therein. In this embodiment of applicant's invention, however, the flexible drum 260 is mounted for rotary motion over a pair of rollers 266 and 268, and in the rotation thereof in the direction indicated by the arrow 270, is in the form of an oval or any other desired

geometric shape. A belt 150A, which, for example, may be similar to the belt 150 described above, may be provided with X-ray film retaining slit means holding a plurality of X-ray films 156A therein, is contained within the belt receiving groove means 264 and rotates the flexible drum 260. Thus, the X-ray films 156A may be exposed to a particular liquid below the liquid level 272. Thus, as shown, applicant's invention herein may utilize a flexible drum, as well as a rigid drum.

This concludes the description of applicant's invention of an improved automatic X-ray film developing arrangement. From the above, it can be seen that applicant has provided a comparatively economical and easily operated continuous automatic X-ray film developer particularly adapted to those facilities wherein a large number of X-ray films are generally required to be rapidly developed after exposure thereof.

Those skilled in the art may find many variations and adaptations of applicant's invention.

What is claimed is:

1. An improved automatic X-ray film developer comprising in combination:
 - a plurality of adjacent tank means, and said plurality of tank means comprising at least:
 - a developer tank means having a preselected X-ray film developer capacity to a predetermined developer level therein;
 - a first water rinse tank means having a preselected water capacity to a first predetermined water rinse level therein;
 - a fixer tank means having a preselected X-ray film fixer capacity to a predetermined fixer level therein;
 - a second water rinse tank means having a second preselected water capacity to a second predetermined water level therein;
 - an X-ray film drying chamber adjacent said second water rinse tank means;
 - a developer drum means rotatably mounted in said developer tank means and said developer drum having an external peripheral surface and at least a portion of said external peripheral surface of said developer drum means positioned below said predetermined developer level for the condition of said developer drum rotating in said developer tank means, and said external peripheral surface of said developer drum having walls defining a spiral, belt-accepting groove therein and said belt-accepting groove having a first preselected length;
 - a fixer drum means rotatably mounted in said fixer tank means and said fixer drum means having an external peripheral surface and at least a portion of said fixer drum means external peripheral surface positioned below said predetermined fixer level for the condition of said fixer drum rotating in said fixer tank means, and said external peripheral surface of said fixer drum means having walls defining a spiral belt-accepting groove therein and said spiral belt-accepting groove in said fixer drum having a second predetermined length;
 - a dryer drum means rotatably mounted in said drying chamber, and said dryer drum means having an external peripheral surface having walls defining a spiral belt accepting groove therein, and said belt accepting groove in said dryer drum means having a third preselected length;
 - a flexible, resilient, elongate, continuous belt means positioned in said belt accepting groove of said developer drum means, fixer drum means and dryer drum means for rotating said developer drum means, fixer drum means and dryer drum means to expose said belt means sequentially to regions in said developer tank means below said predetermined developer level, to regions in said fixer tank means below said predetermined fixer level, and to said dryer chambers, and said belt means having a plu-

- ality of X-ray film accepting means therein for receiving and retaining X-ray films in a preselected orientation with respect to said belt means;
- first water exposure means in said first water rinse tank means, and said belt means drivingly engaging said water exposure means to expose said belt means to regions in said first water rinse tank means below said first predetermined water rinse level therein;
- second water exposure means in said second water rinse tank means, and said belt means drivingly engaging said second water exposure means for sequentially exposing said belt means to regions in said second water rinse tank means below said second water rinse level therein;
- removal means adjacent said drying chamber for removing dry X-ray films from said belt means;
- heat source means in said drying chamber for providing thermal energy to said belt means and to X-ray films contained therein in said drying chamber; and
- drive means drivingly engaging said belt means for moving said belt means at a preselected velocity.
2. The arrangement defined in claim 1 wherein: said X-ray film accepting means comprises walls defining a continuous elongate slit in said belt means and extending longitudinally thereon, and said walls having a preselected radius of curvature adjacent said slit means, whereby X-ray film placed in said slit means is frictionally retained therein.
 3. The arrangement defined in claim 2 and further comprising:
 - loader means positioned intermediate said drying chamber and said developer tank means for allowing loading of X-ray film in said continuous slit means and said loader means comprising:
 - a tapered edge rotating wheel means having at least a portion positioned in said continuous slit for spreading said slit to X-ray film accepting condition, and said tapered edge wheel means rotatable about a preselected axis.
 4. The arrangement defined in claim 1 wherein: said X-ray film accepting means in said belt means comprises walls defining a plurality of discontinuous slits extending from an external peripheral surface of said belt means a preselected depth towards the center thereof.
 5. The arrangement defined in claim 4 wherein: said plurality of discontinuous slits are longitudinally aligned with the long dimension of said belt means.
 6. The arrangement defined in claim 4 wherein: said plurality of discontinuous slits have a first portion longitudinally aligned with the long dimension of said belt means and a second portion diagonal thereto.
 7. The arrangement defined in claim 4 wherein: said plurality of discontinuous slits are diagonally aligned with respect to the long dimension of said belt means.
 8. The arrangement defined in claim 4 and further comprising:
 - loader means positioned intermediate said dryer chamber and said developer tank means for allowing loading of X-ray film in said plurality of slit means and comprising:
 - a tapered edge rotating wheel means having at least a portion sequentially positioned in each of said slit means in slit spreading relationship to said belt means for sequentially spreading each of said plurality of slit means to X-ray film accepting condition, and said tapered edge rotating wheel means rotatable about a preselected axis; and
 - spring means for resiliently resisting linear motion of said axis of said wheel means.
 9. The arrangement defined in claim 1 wherein: said removal means comprises a knock-off bar posi-

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tioned adjacent said belt means and in said drying chamber, and said knock-off bar having an end portion in X-ray film dislodging relationship to said belt means for removing X-ray film from said belt means;

ramp means adjacent said end portion of said knock-off bar for receiving X-ray film dislodged from said belt means; and

tray means adjacent said ramp means for receiving X-ray film from said ramp means.

10. The arrangement defined in claim 1 wherein:

said removal means comprises a pair of spring loaded jaw means in X-ray film engaging relationship to said belt means for engaging X-ray film frictionally retained in said belt means to remove the X-ray film from said belt means and retain the X-ray film in said spring loaded jaw means.

11. The arrangement defined in claim 1 wherein:

at least one of said developer drum means, fixer drum means and dryer drum means comprises a rigid drum means.

12. The arrangement defined in claim 1 wherein:

at least one of said first and second water exposure means comprises a rotatably mounted water exposure drum means having an external peripheral surface, and at least a portion of said external peripheral surface of said water drum means positioned below said first predetermined water level in said first water rinse tank means for the condition of said water drum means rotating therein, and said water exposure drum means having walls defining a plurality of belt accepting groove means therein, and said belt means positioned in said belt accepting groove means of said at least a first water exposure drum means.

13. The arrangement defined in claim 1 and further comprising:

a closed water bath tank means positioned adjacent said developer tank means and intermediate said developer tank means and said drying chamber,

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and said developer tank means having a preferred preselected water bath capacity to a third predetermined water bath level therein;

a water bath drum means rotatably mounted in said water bath tank means and said water bath drum means having an external peripheral surface, and at least a portion of said water bath drum means external peripheral surface positioned below said third predetermined water level in said water bath tank means for the continuation of said water bath drum means rotating, and said external peripheral surface of said water bath drum means having walls defining a spiral belt accepting groove therein for receiving said belt means, and said spiral belt accepting groove in said water bath drum means having a fourth preselected length; and

said belt means positioned in said spiral belt accepting groove of said water bath drum means for sequentially exposing portions of said belt means to a level in said water bath means below said third predetermined water level.

14. The arrangement defined in claim 1 wherein:

said fixer drum means has a second portion above said predetermined fixer level in said fixer tank means; and

said fixer tank means has view means for allowing the removal of X-ray films from said belt means at said second portion of said fixer drum means.

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