

Oct. 11, 1966

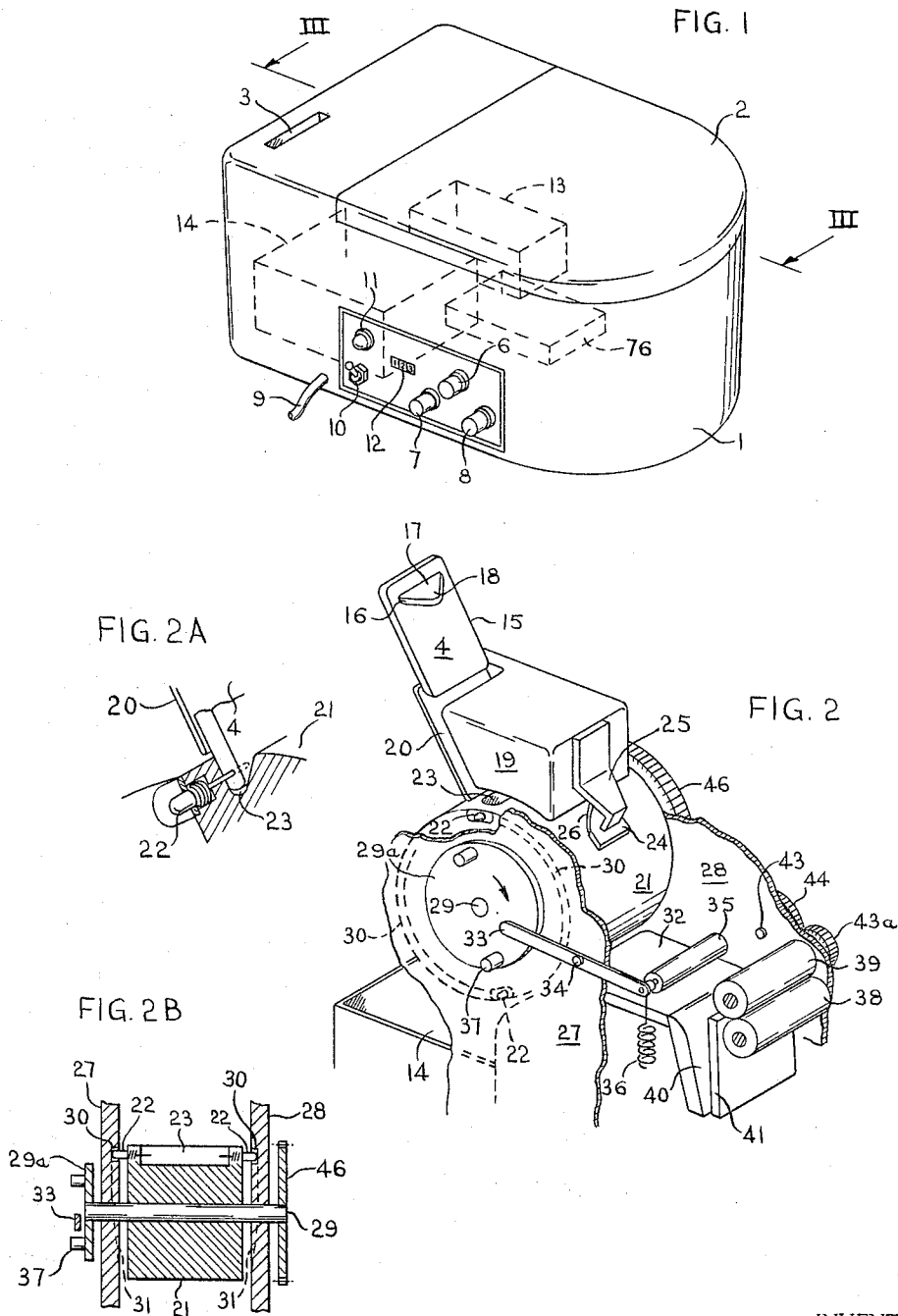
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3,277,809

DAYLIGHT DENTAL X-RAY FILM PROCESSING APPARATUS

Filed April 16, 1964

3 Sheets-Sheet 1



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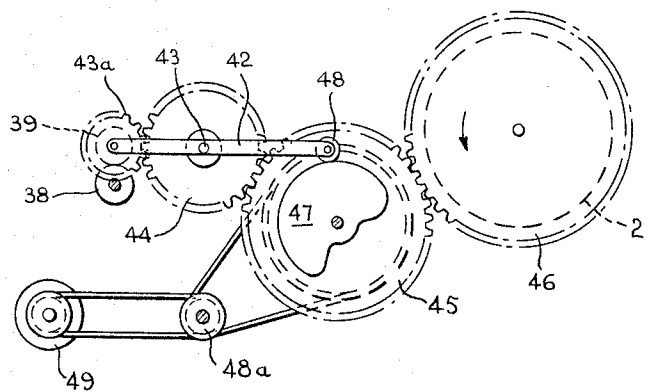
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FIG. 3



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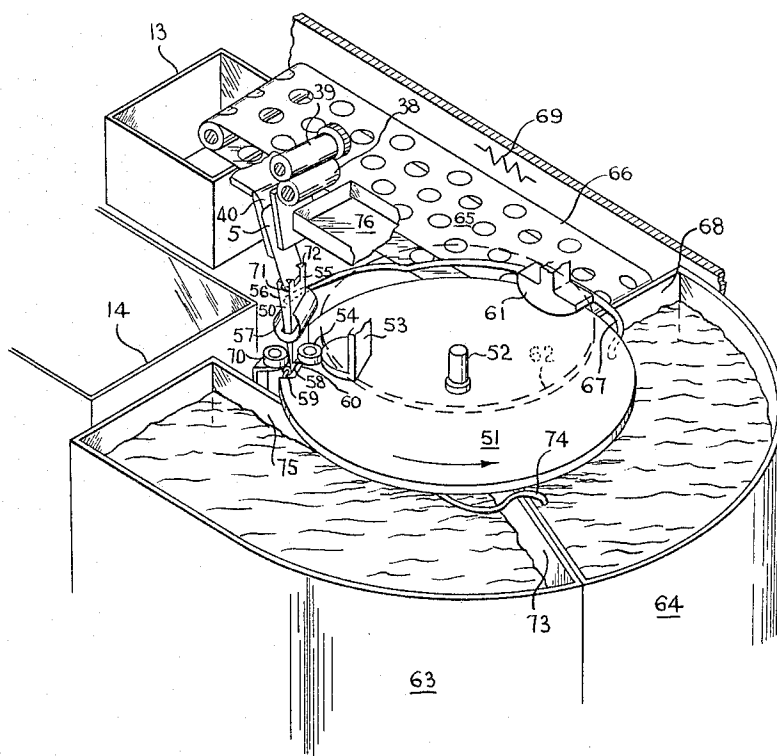
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FIG. 4



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3,277,809 DAYLIGHT DENTAL X-RAY FILM PROCESSING APPARATUS

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Filed Apr. 16, 1964, Ser. No. 360,357

5 Claims. (Cl. 95—94)

This invention relates broadly to the application of rapid processing techniques to the photographic processing of exposed film, and more particularly of exposed dental X-ray plates.

An object of the invention is to provide a continuous method and unitary apparatus for removing exposed X-ray dental plates from their packets and protective contents, discarding the opened and removed packet and contents other than the exposed film, and immediately feeding the exposed and unpacked plates into a mechanism in which the plates are developed, fixed, rinsed and dried, and then stacked in the same order in which the packets containing exposed film were correctly fed into the mechanism.

Still a further object is to provide a lightweight unitary apparatus in which exposed X-ray dental plates on correct insertion are unwrapped from their packets, photographically processed and then stored in such order of correct insertion.

Still another object is to provide a daylight processing unit in which the exposed X-ray dental film plates are automatically, and in a continuous cycle, removed from their packets, completely photographically processed and assembled in definite order, at higher speeds than ever before.

Another object is to provide an apparatus for high speed processing of film, for example by using a monobath solution, requiring none of the usual auxiliary equipment of dark rooms.

The foregoing, and other, objects and features of our invention will be more readily understood from the following description of an illustrative embodiment thereof, when read in conjunction with the drawing, in which:

FIGURE 1 is a perspective view of the illustrative embodiment of our daylight, field X-ray film processor unit;

FIGURE 2 is a somewhat simplified perspective view of the unwrapping mechanism into which the unopened packet containing the exposed X-ray dental film is inserted and in which successively the packet cover is opened, the protective insert removed, the exposed plate separated from the protective insert, and the exposed plate fed into one hopper while the removed cover and protective insert are discarded at other points;

FIGURES 2A and 2B are details of the unwrapping mechanism;

FIGURE 3 is a longitudinal section through the processor of FIGURE 1 along line III—III thereof and viewing the unwrapping mechanism from the side opposite that depicted in FIGURE 2; and

FIGURE 4 is a simplified perspective of the plate photographic processing portion of the processor of FIGURE 1.

Referring to the drawings, the processor unit of our invention is contained in a housing 1, of aluminum for example, having a hinged or removable cover 2 which extends at least over the tanks for the liquids used in the photographic processing of the film including rinsing thereof. The interior of the housing and cover may be lined with a sufficient thickness of lead to prevent fogging of the unwrapped, undeveloped plates by stray X-ray radiations. An integral portion of housing 1, at the end thereof not covered by removable cover 2, is

provided with a slot 3 for the successive insertion into the field processor of our invention, one at a time, of packets 4 of exposed film or plate 5. Below slot 3, the inserted packet is received by a feed mechanism for unwrapping the film, as is below described in detail. Through the lower portions of a convenient wall of housing 1 the necessary connections for the liquids used in the photographic processing performed within our processor field unit, are provided, that is, water inlet 6, developing tank drain 7 and rinse tank drain 8, as also the electric power line connection 9 for an electric motor driving certain of the mechanism housed in our daylight processor. A conveniently accessible off-on switch 10 is included in electric line 9 and, preferably, an indicator or light 11 by which the temperature prevailing within the developer solutions in the processor may be read from externally the closed unit, as also a multi-digit scale 12 of a resettable counter connected to an appropriate portion of the unwrapping mechanism for quickly ascertaining the number of film plates that have been processed in a run. For simplicity of showing such connection is not, however, shown in the drawing but, for example, the counter may be connected to a lever or finger actuated by the unwrapped exposed film as it slides into the hopper leading to the processing mechanism of the processor unit. As indicated by the dashed lines in FIGURE 1, the end wall of housing 1 adjacent to its integral cover portion through which slot 3 passes, contains both a developed and dried plate retrieval drawer 13 and a packet discard drawer 14, which are respectively so located, relative to the drying belt of our processor unit and to the packet unwrapping mechanism, as to receive only the intended contents, as will below appear, while tray 15, is likewise indicated by dashed lines in FIGURE 1, is located below cover 2 above the drying belt to receive the protective inner wrapper of the packet from the unwrapping mechanism. Obviously, the other elements of our daylight field processor are likewise contained within housing 1 but have been omitted from such FIGURE 1 since the here omitted elements are shown in at least some of the other figures. To protect the extending ends of inlet 6 and of drains 7 and 8 during transportation, etc., each may be provided with a protective removable sealing cap.

X-ray dental film packet 4 consists, as is known, of an outer wrapper 15 (FIGURE 2), of relatively stiff paper and is completely closed except for an aperture 16 in its rectangular wall opposite the face of the packet which, for proper exposure of film or plate 5 therein contained, is to be positioned facing the X-ray tube. The inner wrapper 17, of light-shielding paper, is folded or creased about the plate, with its angle fold at and about the edge of the plate which, within the packet, is remote from aperture 16, and has an integral tab 18 extending externally from aperture 16. A protective thin lead plate is positioned between the outer and inner packet wrappers at the wall of the packet having aperture 16 through the outer wrapper. The outer wrapper 15 is generally of a neutral color, namely white, whereas the inner light-shielding wrapper 17 is of a contrasting color, generally black. It is here to be noted that packets 4 must be inserted into slot 3 with their apertured wall facing away from the housing wall adjacent to the slot, as shown in FIGURE 2, for the unwrapping mechanism of our processor unit to function properly to discard the packet wrappings and feed the exposed film to the photographic processing mechanism of the unit. Should a packet 4 be inserted incorrectly, such packet is passed unopened into the discard drawer 14 by the unwrapping mechanism, where it can readily be retrieved for correct insertion into slot 3.

The packet unwrapping mechanism of our field or daylight processor unit is located directly below slot 3. A packet guide 19 has inclined chute 20 immediately below slot 3 to guide packet 4 obliquely to a rotating drum 21 of a width exceeding that of packets 4. On both its lateral end faces, drum 21 carries at least one spring-pressed pin 22 registering with groove 23 extending laterally across its cylindrical surface and parallel to the axis of rotation of the drum. Each pin 22 is so spring biased that normally it extends but a relatively short distance into its associated groove 23, (FIGURES 2A and 2B) leaving a gap between the ends of a pair of pins 22 cooperating at opposite ends of the associated groove 23 somewhat in excess of the width of packets 4. There may be a plurality of grooves 23 spaced circumferentially from each other on drum 21 somewhat more than the length of a packet, each groove 23 having a pin 22 at each end; but only two are shown in FIGURE 2 of our illustrative embodiment due to weight and volume considerations, the two being 180° apart. Hence, as a packet 4 slides down chute 20 and reaches drum 21, the end of such packet will enter the next unoccupied groove 23 when it comes into registry with the bottom of the chute and will so enter, unimpeded by the ends of pins 22 at either end of the groove.

An arcuate member 24, mounted on support 25 axially central of drum 21, which support 25 is in turn affixed to packet guide 19, extends about a region of the rotating drum in the direction of its rotation, indicated by the arcuate arrows in FIGURES 2 and 3, beyond packet guide 19 and carries a formed triangular cutting blade 26 extending towards the cylindrical surface of the drum and radially spaced therefrom a distance substantially equal to the thickness of a closed packet 4. Spatially fixed lateral walls 27 and 28, which support the ends of shaft 29 on which drum 21 is rotatable, each have a circular groove 30 concentric with shaft 29 and of such width as to slidably accommodate the extending ends of spring-pressed pins 22 on the adjacent end face of the drum. The depth of each circular groove 30 varies from a maximum at the region where a drum groove 23 registers with the bottom of chute 20 to a minimum, extending from an incline 31 adjacent to its maximum depth in the direction of drum rotation to the commencement of the next region of its maximum depth at the region of registration of the next drum groove 23 with the bottom of chute 20. Thus as the drum rotates, and the packet inserted in slot 3 slides down chute 20, packet 4 will push its leading end into a groove 23 as it passes the lower end of the chute, pins 22 extending a maximum from the ends of the drum which, as above stated, leaves a gap in the groove greater than the width of the packet. As the drum continues to rotate, pins 22 of the drum groove 23 which has just received a packet are immediately pressed inwardly into the drum groove against the bias of their springs as the pins slide in circular grooves 30 to the minimum depth portion of the latter grooves, piercing the packet end in the drum groove. The pins are so maintained in their packet penetrating position during the subsequent rotation of the drum, and pull the packet completely out of chute 20 with the continued rotation of the drum, package guide 19 pressing the other and free end of the packet against the cylindrical surface of the drum. In so forcing the packet against the drum cylindrical surface, if the packet was correctly inserted in slot 3, tab 18, which theretofore had been flat against the outer wrapper of the packet with its free end extending downwardly, will of itself assume a position extending outwardly and substantially tangential to the now curved package. It will be noted that support 25 is angularly shaped and so supported on packet guide 19 that there is an open space between the end of guide 19 and the cutting edge of blade 26 to permit tab 18 unimpededly to assume such position. With continued drum rota-

tion, blade 26 now inserts itself beneath the tangentially protruding tab 18 and cuts outer wrapper 15 open. When the so severed and opened packet then passes beyond arcuate member 24 and blade 26, it is no longer confined to the curvature of the cylindrical drum surface, although it is still hinged at end region which was in groove 23 to the pair of grip pins 22 associated with the particular groove 23. The packet thus swings outwardly and downwardly to lie flat on parting plate 32 positioned adjacent to the drum and at a level somewhat below the axis of rotation of the drum.

A lever 33 is pivotally mounted on fixed pin 34 in wall 27 at a distance from the drum and at its end remote from the drum carries a hold-down roller 35 biased against the parting plate 32 by a spring 36 having one end anchored in the housing and its other end in lever 33. The end of lever 33 adjacent to the drum extends into the rotary path of actuating pins 37 extending laterally from hold-down roller lifting cam 29A on drum shaft 29. A lever actuating pin 37 is associated with each grip pin 22, so that in the illustrative embodiment two actuating pins 37 are shown, each actuating pin being aligned with, though it need not necessarily be, and radially inward of, a grip pin 22. When an actuating pin 37 engages lever 33 at its free end, the lever carries hold-down roller 35 upwardly against the bias of spring 36 a sufficient distance so that the cut packet 4 can swing about pins 22 and position itself horizontally flat on parting plate 32, tab 18 of packet inner wrapper 17 extending therebeyond on a fixed roller 38 of which its cooperating roller 39 has been moved upwardly at this time. It will be noted that as the cut open packet 4 begins to swing, lever 33 under the action of an actuating pin 37 has raised hold-down roller 35 up beyond the path taken by the free end of the packet, and, as the actuating pin leaves the lever, spring 36 pulls the lever back and presses the hold-down roller against the now flat inner wrapper 17 on parting plate 32. The location of roller 35 on lever 33 is so predetermined that in so doing the hold-down roller presses against the crease or fold of the inner wrapper thus pressing it flat.

Stationary roller 38 and its cooperating movable roller 39 are positioned beyond parting plate 32 and beyond a film plate hopper chute 40, the latter having a deflector guide 41 just beyond the parting plate, remote from drum 21 and extending somewhat upwardly from the level of the parting plate. Movable roller 39 of this pair of rollers normally rests on stationary roller 38 and is rotatably mounted on a shaft extending laterally from a second lever 42 (FIGURE 3) pivoted on pin 43 from opposite lateral wall 28 at about the same level as pin 34 in lateral wall 27 about which lever 33 is pivoted. Movable roller 39 at its end adjacent to lever 42 is provided with a gear 43A meshing with an intermediate gear 44 rotatable on pin 43 which latter gear is driven by a drive gear 45 which also drives drum gear 46 to rotate drum 21. Drive gear 45 is integral with plate cam 47 which is of such configuration that cam follower 48, on the end of second lever 42 opposite to that carrying gear 43A, will lift roller 39 from stationary roller 38 at the appropriate time during the rotation of drum 21 when a cut-open packet 4 swings outwardly and downwardly as above stated, and to restore roller 39 to its cooperating position roller 38 when the cut packet lies flat on parting plane 32. In FIGURE 3 we have shown an intermediate pulley assembly 48A belt driven by motor 49 connected to power line 9 by way of switch 10, but obviously the drive of the mechanism of our daylight processor unit is not limited to any particular driving arrangement.

Now, with inner wrapper tab 18 resting on stationary roller 38, and movable roller 39 restored to its normal position on roller 38, on continued rotation of drive gear 45, the inner wrapper 17, by the rotation of contacting rollers 38 and 39 by gear 43A on roller 39, is pulled toward this pair of clamping rollers 38 and 39 and over

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roller 38 to be passed into the inner wrapper discard region which may, as in our illustrative embodiment, be an elongated discard tray 76. It will be noted that with inner wrapper 17 of the opened packet flat on parting plate 32, exposed film plate 5 from the opened packet is below the portion of the inner wrapper having tab 18 thereon. As both drum 21, as also rollers 38 and 39, continue rotating, the drum pulls outer wrapper 15 which is still hinged thereto by pins 22, toward the drum while rollers 38 and 39 pull the inner wrapper in the opposite direction, separating the outer from the inner wrapper. In so doing, exposed film plate 5 leaves inner wrapper 17 and, due to the inner wrapper being pulled slightly upward to pass over roller 38 as also the relative inflexibility of the exposed plate as compared to the flexibility of the inner wrapper, exposed plate 5 striking against deflector 41 with its leading edge and being deflected downwardly into chute 40 while inner wrapper 17 moves up and over the upper end of deflector 41 between the rollers clamping it and then into discard tray 76.

At about this time in the rotation of drum 21, the depth of circular grooves 30 in walls 27 and 28 suddenly drop to their maximum depth with the result that outer wrapper 15, now pulled completely clear of inner wrapper 17, is unhinged from the drum by pins 22 restoring to their normal positions under the bias of their springs, the unhinged outer wrapper moving downwardly before such unhinging and continuing such downward movement to drop into packet discard drawer 14 after such unhinging. In that, as stated, the illustrative embodiment has but two pairs of pins 22, the length of each portion of minimum depth of grooves 30 from incline 31 to its point of drop-off to the maximum depth is about 160°.

Turning now to the mechanism for photographically processing unwrapped film plate 5, chute 40 is so located as to deliver the unwrapped film substantially vertically, or at a slight inclination from the vertical, to an open clip or clamp 50 which is swingingly mounted in the peripheral region of a rotatable disc 51 on vertical shaft 52 which is rotated by motor 49 of our field processor unit. The speed at which disc 51 is driven is such that as an unwrapped film plate 5 descends in chute 40, clip 50 is vertically upstanding with its clamping end open below the delivery end of chute 40. Obviously the rotary speed of disc 51 depends primarily on the time required to develop and fix the exposed film plate, and, to a somewhat lesser degree, on the time required to rinse the fixed film plate. To the side of chute 40 radially the nearer to drive shaft 52, a fixed semi-circular horizontal cam 53 is supported from a convenient portion of a housing wall, preferably the integrally cover portion of housing 1, at such radial distance from shaft 52 as to be in the rotary path of a roller 54 on an arm of clip 50 when the latter is swung up to about disc 51 to a substantially erect vertical position. Clip 50 comprises two arms, outer arm 55 and inner arm 56, both extending through cylindrical spring 57 and biased thereby always to engage the portions of its arms below the spring to each other, in the usual manner of spring clips or clamps. The upper portion of outer arm 55 at its upper end carries roller 54 rotatable about an axis parallel to the outer arm and spaced at such distance from clip spring 57 that when the clip is swung vertically upward, roller 54 is so positioned on and above the top face of disc 51 as to be engaged by horizontal cam 53 during the rotation of the disc. Clip inner arm 56 has a hinge 58 at its upper end region by which the clip is hung from a shaft 59 extending along a chord of the disc across a notch 60 cut from the periphery inwardly in disc 51 and of a width adequate to permit free swinging of clip 50 therein. It follows that any force acting normal to either clip arm, the clip will hang vertically downward from its associated shaft 59. While we have shown but a single clip swingable on disc 51, it will be obvious that a plu-

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ality of clips may be so suspended from the disc at appropriate intervals; in fact, in a practical embodiment we have so hung eight clips from the peripheral region of the rotatable disc. At a predetermined region above disc 51, a spatially fixed vertical acting release cam 61 is likewise affixed. Furthermore, while in our illustrative embodiment, vertical shaft 52 is rotatable, it is obvious that this shaft may be stationary and disc 51 may be driven by means of pulley assembly 48A, in which case horizontal cam 53 and vertical cam 61 may depend from a plate 62 (shown in dashed line in FIGURE 4) supported atop stationary shaft 52.

As clearly shown in FIGURE 4, the peripheral region of rotatable disc 51 overlaps the tanks, developing tank 63 and rinse tank 64, to such extent that a clip 50 will successively suspend the exposed film plate held by the clip in the solutions. Such peripheral region also overlaps a drying belt mechanism 65 beyond the tanks. Together with the packet unwrapping mechanism, the entire mechanism arrangement within our field processor is of horseshoe- or U-shape in plan, with the packet stripping or unwrapping mechanism forming one arm, the solution tanks forming the curved interconnection, and the drying belt mechanism the other arm. In that our illustrative embodiment is intended for utilization of a monobath for the photographic processing, but a single solution tank 63 is required in which the unwrapped exposed film is both developed and fixed, along with rinse tank 64; the tanks being arranged in that order in the direction of disc rotation. Now assume a clip 50 has just been opened to drop a rinsed film plate 5 onto the perforated drying belt 66 of conveyor mechanism 65. By means of a formed guide 67 which has engaged behind inner arm 56 of downwardly hanging clip 50, immersing film plate 5 held therein, in rinse tank 64, clip 50 is swung upwardly to clear rinse tank end wall 68 in the direction of disc rotation so that the clip, and the rinsed film plate held thereby, are substantially horizontal when above belt 66. On continued rotation of the disc, vertical cam 61 engages roller 54 of clip arm 55 to press roller 54 downwardly in this position against the tension of clip spring 57, thus releasing rinsed film plate 5 which drops onto belt 66 on which it dries as it is conveyed toward and drops into retrieval drawer 13. The heating means within the chamber housing drying belt conveyor mechanism 65 may be of any type, and we have indicated our electrical heating means symbolically by resistor 69 in FIGURE 4, which heating means is obviously connected to power line 9 through switch 10 for energization.

Upon leaving the high point of cam 61 and passing therebeyond on continued rotation of the disc, clip 50 recloses and remains horizontal as it slides along guide 67 until the preformed shape of the latter swings the clip upwardly relative to, and inwardly toward, shaft 52. Clip arm roller 54 will not be positioned substantially horizontally to be engaged by fixed horizontal cam 53 positioned, as above stated, at the outlet of chute 40. Simultaneously the other clip arm 56 will engage roller 70 spatially fixed at the periphery of disc 51 at such elevation as to engage arm 56 at its free region beyond spring 57 opposite the hinged end of clip arm 55. Then, as the hinged and now vertically upright clip 50 passes between roller 70 and cam 53, the clip is opened forcing the teeth of clip arm 55 away from clip arm 56, the latter being held immobile by roller 70. Thus the unwrapped film plate 5 descending in chute 40 at this time enters the open clip a predetermined distance, coming to rest on stop 71 somewhat downward on the interior face from the end of the arm, for example, clip arm 56. As soon as the clip passes from between roller 70 and cam 53, it closes under the tension of its spring 57 clamping the film plate 5 therein. Preferably the clip arm not provided with stop 71, has one or more pointed pins 72 extending inwardly in the closed clip, pins 72 on clip closure penetrating film plate 5 at points beyond the

photographic field thereof. The position of the now closed clip with the held film plate being somewhat inclined outwardly from the truly vertical through the periphery of disc 51, the closed clip by gravity will now swing outwardly on hinge 58 to extend downwardly into developing tank 53 positioned immediately beyond, in the direction of disc rotation, cam 53 and roller 70. Thus, as the disc rotates with plate 5 immersed in tank 63, the plate is developed and fixed; the speed of rotation obviously being so predetermined that by the time the immersed plate must be raised to clear wall 73 between developing tank 63 and rinse tank 64, plate 5 is completely developed and fixed. At, or somewhat after, the point at which the film plate is completely developed and fixed, transfer guide 74, attached conveniently to inner wall 75 of tank 63 or to wall 73 between the tanks, engages behind downwardly extending clip arm 56, which arm then rides on transfer guide 74 in accordance with the shape of the latter to swing the clip gradually upwardly and outwardly, the shape of guide 74 being such that as the clip approaches and passes over wall 73, the clip extends horizontally outward. Having passed wall 73, guide 74 abruptly ends and the hinged clip swings downwardly to immerse the developed and fixed film plate in rinse tank 64. The time for which developed and fixed plate 5 is so immersed in rinse tank 64 is such that the film plate is thoroughly rinsed, and as the plate now approaches tank end wall 68, the initial portion of guide 67 engages behind the downwardly hanging closed clip to raise it sufficiently horizontally ultimately to clear wall 68.

Thus, in our daylight field processor there is no interval substantially between unwrapping the exposed film from its packet and completely processing the exposed film. Also where a plurality of clips 50 are hinged at spaced intervals along the periphery of the disc or other conveyor therefor, a plurality of exposed film plates may be advancing in the processing operation simultaneously in successive stages without having to await completion of the photographic processing of an exposed film before starting to process the next exposed film which has been removed from its packet.

The illustrative embodiment of our instant invention herein described is solely by way of illustration and is in no aspect limitative. Various modifications will suggest themselves to the skilled worker in the art, as also applications to other sensitive materials which may be exposed while packaged, without departing from the scope of the claims; the latter being limited only as may be required by the prior art.

What we claim is:

1. A daylight photographic processor device for film exposable in its packet, such as X-ray dental film, comprising
 - a closed unitary housing,
 - mechanism within the housing for removing the packet from the therein contained film,
 - an aperture defined through a top region of the housing for insertion of one packet at a time into the removing mechanism,
 - a first tank within the housing for a photographic processing solution,
 - a second tank within the housing for a rinsing liquid for photographically processed film,
 - a conveyor within the housing for photographically processed and rinsed film,
 - means feeding removed film from the removing mechanism successively to the first tank, the second tank, and the conveyor, and
 - driving means for actuating the removing mechanism and the feeding means.

2. A daylight photographic processor device according to claim 1 in which

heating means are provided within the housing for at least the conveyor region to dry the photographically processed and rinsed film, and

The driving means are electrical and also serve to energize heating means.

3. A daylight photographic processor device according to claim 1 in which the feeding means is a turntable, and

the first and second tanks and the conveyor are located below the level of the turntable.

4. In photographic processing apparatus for film exposed in its packet,

means for opening the packet and removing the film from the open packet,

a turntable carrier rotatable in a predetermined direction;

at least one normally closed film clamp pivotally carried on a peripheral region of the turntable carrier, at least two liquid-containing tanks and a conveyor below the turntable carrier,

the first tank in the direction of carrier rotation containing a photographic processing solution, the second tank a rinsing liquid, with the conveyor disposed after the second tank.

means for feeding the removed film to the turntable carrier,

means attached to the walls of the tanks for positioning the film clamp substantially upward on the turntable carrier in the region of the film feeding means and for pivoting the film clamp from a downward vertical position to a substantially horizontal position between the first and second tanks and between the second tank and the conveyor, and

cam means for opening the clamp in its substantially vertical upward position and in its substantially horizontal position above the conveyor.

5. In a photographic daylight processing apparatus for film exposed in its packet including with the film an outer wrapper and an inner wrapper having a tab which extends to externally of the outer wrapper through an aperture in one wall of the outer wrapper, the improvement of a packet opening and film stripping mechanism comprising

a rotatable drum,

at least one groove in the cylindrical surface of the drum parallel to the axis of rotation of the drum, spatially fixed means for inserting an end region of a packet into the groove,

driving means for rotating the drum,

means actuable on rotation of the drum to hinge and unhinge the packet to the groove at the inserted end region of the packet,

a spatially fixed cutting blade positioned in the direction of drum rotation beyond the inserting means and adapted to engage the extending tab of the inner wrapper on continued rotation of the drum to cut open the outer wrapper of the inserted and hinged packet at the free end region of the packet, and

means for pulling the inner wrapper in the direction opposite to that in which the cut open outer wrapper is moved after passing the cutting blade.

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NORTON ANSHER, *Primary Examiner*.