Dec. 5, 1933. J. R. KELLEY 1,938,455

RADIOGRAPHIC APPARATUS

Filed May 13, 1925 3 Sheets-Sheet 1

Fig. 1.

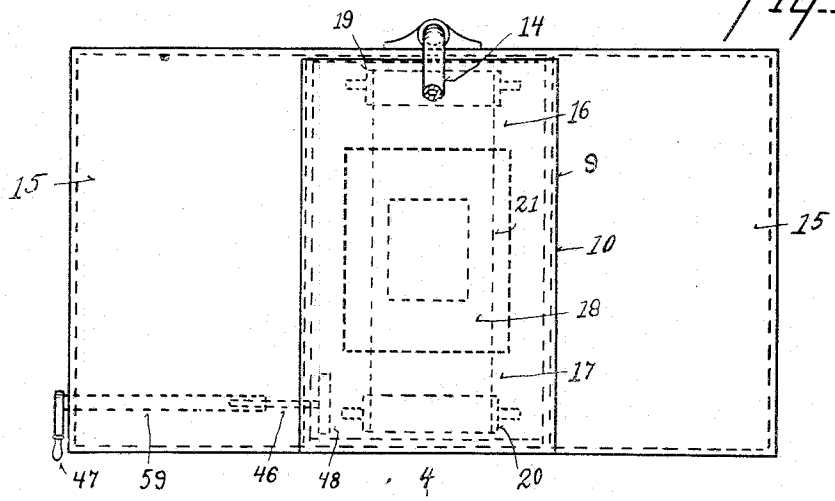
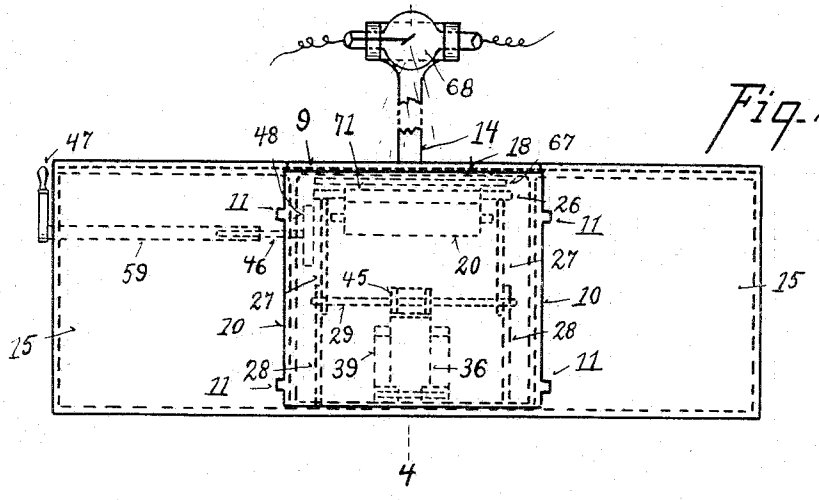


Fig. 2.



Inventor,
John Robert Kelley.
By C. W. Miles.
Attorney.

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RADIOGRAPHIC APPARATUS

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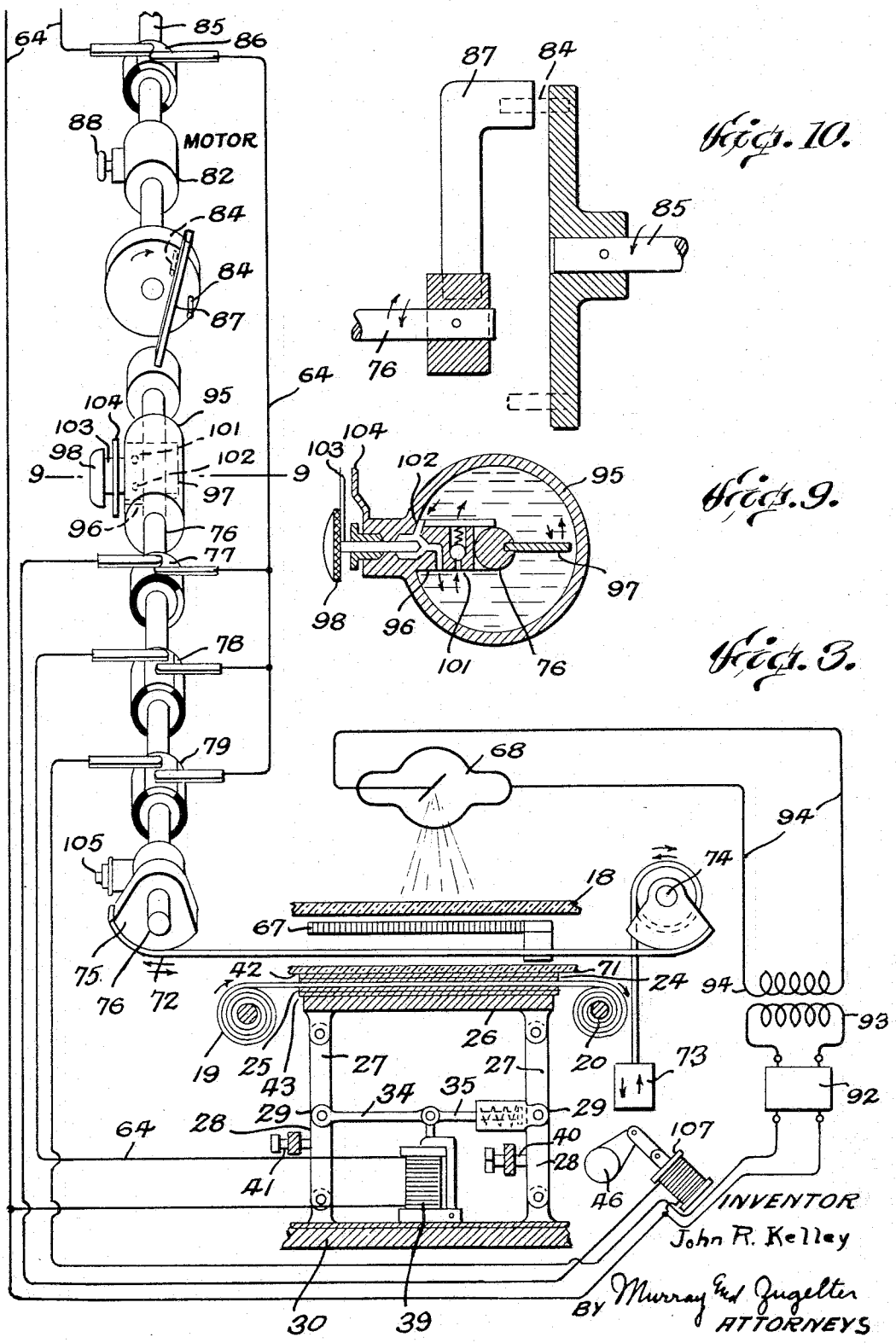


Fig. 10.

Fig. 9.

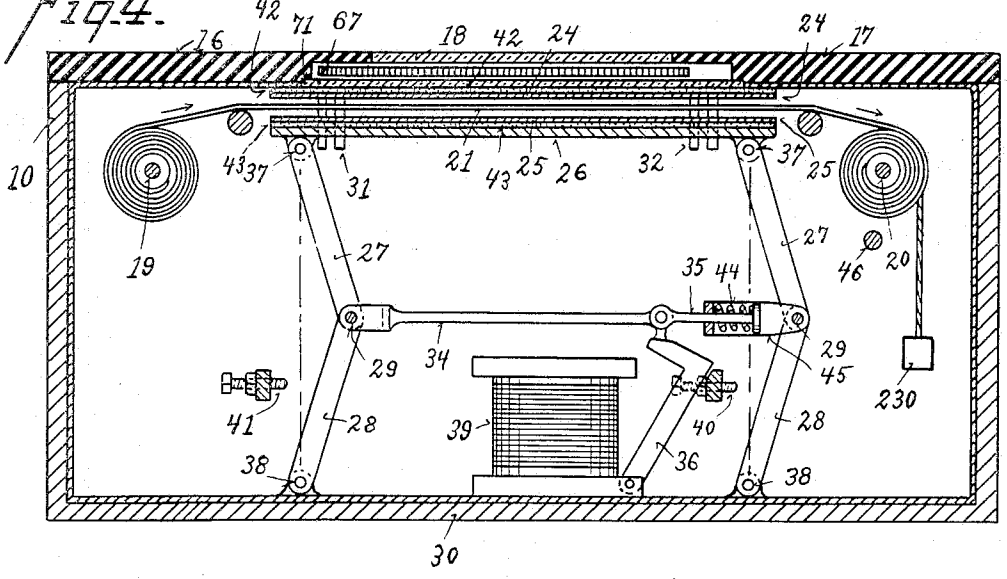
Fig. 8.

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RADIOGRAPHIC APPARATUS

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Fig. 4.



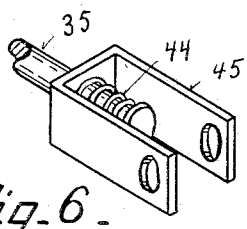


Fig. 6.

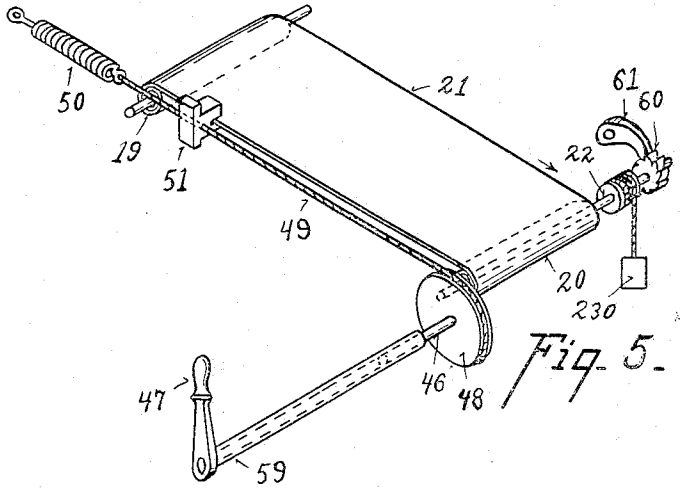
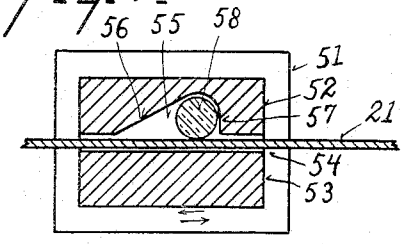


Fig. 5.

Fig. 7.



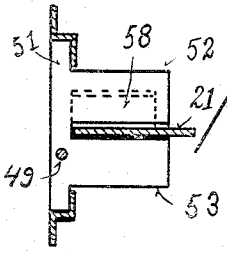


Fig. 8.

Inventor,
John Robert Kelley,
By C. W. Miles,
Attorney

Patented Dec. 5, 1933 1,938,455

UNITED STATES PATENT OFFICE

1,938,455

RADIOGRAPHIC APPARATUS

John Robert Kelley, Covington, Ky., assignor to The Kelley-Koett Manufacturing Company, Covington, Ky., a corporation of Kentucky

Application May 13, 1925. Serial No. 30,012

4 Claims. (Cl. 250—34)

My invention relates to improvements in radiographic apparatus. One of its objects is to provide improved means to enable a sensitive strip or roll of film to be employed and to apply an intensifier at and during the exposure of fractions thereof. Another object is to provide improved strip or film carrying apparatus for radiographic purposes. Another object is to provide for the use in radiographic apparatus of a strip or roll of film to thereby provide for quickly and conveniently making a number of successive exposures. Another object is to provide improved means to intensify the exposure effects or results of radiographic exposures. Another object is to provide improved apparatus to apply an intensifier sheet to a sensitive film or plate. Another object is to provide improved apparatus to feed a strip or roll of sensitive film forward in successive sections and to apply an intensifier to each section when in position to be exposed. Another object is to provide improved apparatus adapted to take radiographic moving pictures, as for instance a series of radiographic pictures showing the movements of internal organs. My invention also comprises certain details of form and combination and arrangement of components, all of which will be fully set forth in the description of the accompanying drawings in which:

Fig. 1 is a plan of a radiographic table or support with my improved apparatus applied thereto.

Fig. 2 is a front elevation of the apparatus shown in Fig. 1.

Fig. 3 is a wiring diagram of my improved apparatus.

Fig. 4 is an enlarged diagrammatic sectional view through a portion of the apparatus of Figs. 1 and 2, taken on line 4—4 of Fig. 2.

Fig. 5 is a perspective view of a film with one type of intermittent film feeding means.

Fig. 6 is a perspective detail of a portion of the apparatus employed to apply the intensifier to the film.

Fig. 7 is a sectional detail of a portion of the film feeding means.

Fig. 8 is an end view of the apparatus of Fig. 7 detached.

Fig. 9 is a sectional detail through the dashpot taken on line 9—9 of Fig. 3.

Fig. 10 is a sectional detail of the driving connection between the shaft 85 and the shaft 76.

The accompanying drawings illustrate the preferred embodiment of my invention in which 15 represents a table or support upon which the patient or subject to be radiographed is designed to be supported during the radiographic exposure and which is preferably provided with a window 9 pervious to X-rays and which also serves to space the patient or subject a predetermined distance from and relative to the film. A film cabinet or container 10 serves as a support for the film, the film operating apparatus, the diaphragm and its actuating apparatus, and the intensifying members. One or more film cabinets acting as self-contained units are adapted to slide upon ways 11 interchangeably into and out of operative relation to the table 15 and preferably beneath the table window 9. The upper face of the cabinet 10 comprises two sections 16 and 17 which are impervious to X-rays and preferably two superimposed intermediate sections 18 and 71 with an intermediate chamber or space to receive the diaphragm 67. The cabinet sections 18 and 71 are pervious to X-rays and impervious to light rays. An X-ray generator or tube 68 is mounted adjustably upon a bracket or pedestal 14 attached to the table 15, with the X-ray generator in position to project X-rays through the sections 18 and 71 upon a sensitive film located within the cabinet 10. Within the cabinet 10 and beneath the impervious section 16 is a rotatably mounted film supporting roll 19, for instance the roll carrying the unexposed film. A roll 20 is rotatably mounted beneath the impervious cabinet section 17, and is designed to receive the exposed portion of the film 21. That portion of the film beneath the cabinet sections 18 and 71 is in position to be radiographically exposed to the influence of rays issuing from the tube 68, after the rays have passed through the subject interposed between the table and the tube 68. The sides and bottom of the film cabinet are metal lined to render them impervious to X-rays and to light rays.

An intensifying member or sheet 24 is positioned between the under face of the cabinet section 71 and the upper face of the sensitive film 21. Another intensifying member or sheet 25 is supported beneath the sensitive film 21 and opposite the sections 18 and 71 upon a platen 26. The platen 26 is supported by means of links 27 and 28, in pairs, one pair at each of the four corners of said platen. The links 27 are pivotally connected at their upper ends to the four corners of the platen, and each at its lower end to the upper end of a link 28, by means of cross-bars 29. At their lower ends links 28 are pivotally attached to the base 30 of the cabinet 10. The platen 26 is mounted to slide vertically in guides 31 and 32

attached to the table on opposite sides of said platen, see Fig. 4. Any mechanical or other means may be employed to adjust the platen 26 vertically in its guides so as to closely compress that portion of the film beneath the sections 18 and 71 between the two intensifying members 24 and 25 with a substantially uniform pressure over the entire area of the film section to be exposed during the period of radiographic exposure. As illustrated the cross-bars 29 are attached by pull-rods 34 and 35 to the armature 36 of an electromagnet 39, which when energized tends to pull the bars 29 into alignment or nearly into alignment with the centers 37 and 38 by means of which the links 27 and 28 are pivotally attached to the platen 26 and to the table base 30. Adjustable stop members 40 and 41 carried by the cabinet serve to limit the movement of the links 28 under the pull of the magnet 39 to prevent the rods 29 being pulled over or across the line between the centers 37 and 38. The adjustable stops 40 and 41 also provide for variously limiting the movement of the respective links 28 so as to independently adjust the pressure of the platen at its four corners, so as to insure a uniform pressure of the platen against the film over its entire area, thereby forcing all portions of the intensifying sheets 24 and 25 into substantially uniform degrees of intimacy of contact with the interposed film 21. In order to further insure such uniform intimacy of contact between the intensifier sheets and the film, I preferably insert a sheet of wool felt or other resilient material 42 between the intensifier sheet 24 and the cabinet section 71, and a sheet of wool-felt or similar resilient material 43 between the intensifier sheet 25 and the platen 26. In order to distribute the strain in a substantially uniform manner from the armature 36 to the respective bars 29 a tensioning spring 44 and yoke 45 are interposed between the armature and one of the bars 29, and means provided to adjust the tension of said spring 44 so that one pair of the links 28 seat against their stops 40, and the spring 44 then yields to allow the other pair of links 28 to seat against their stops 41. A movable Bucky diaphragm 67 is designed to be employed and interposed between the section 18 and the section 71 to absorb any laterally directed or greatly diverging X-rays.

In order to feed the film along step by step, off from the roll 19 to a position beneath the sections 18 and 71, and thence after being exposed onto the roll 20, I preferably provide a rock-shaft 46 journaled to the cabinet and provided with an actuating hand lever 47 projecting at one side of the table, and with a wheel or wheel segment 48 to the periphery of which is attached a cord or flexible cable 49 see Fig. 5. To the opposite end of said cable is attached one end of a tensioning spring 50. The opposite end of the spring 50 is attached rigidly to the cabinet. An automatically actuated clutch 51 is attached to the cable 49 and moves therewith to or from the shaft 46 as the shaft 46 is rocked between prescribed limits by the hand lever 47. The spring 50 is alternately extended and retracted endwise thereof as the shaft 46 is rocked, and thereby holds the cable 49 continuously under tension. The clutch 51 is shown applied to one edge only of the film, but may if desired be duplicated and applied, using a single rock shaft 46, to opposite edges of the film. The clutch 51 has two rigid jaws 52 and 53 with an intermediate recess 54 into which the edge of the film enters. The jaw 52 is provided with a pocket or recess 55 having an inclined wall 56 and a substantially vertical wall 57. A cylindrical roller 58 is held loosely in said pocket 55 in contact by gravity with one face of the film. When the clutch 51 is moved in one direction the roller 58 rolls within the pocket into a position to wedge said roller 58 firmly into position between the inclined face of the pocket and the face of the film, pressing the film against the face of the jaw 53, and thereby clutching the film and the clutch 51 together to cause the film to be fed from roll 19 toward roll 20 as the shaft 46 is rocked in one direction.

A reverse movement of the shaft 46 causes the roller 58 to release its grip upon the film and to roll within the pocket 55 into contact with the substantially vertical wall of the pocket where it remains disengaged from the film until the direction of movement of the shaft 46 is again reversed.

The hand lever 47 is preferably detachably mounted upon the end of the shaft 46 by frictionally or otherwise engaging a tubular section 59 of said hand lever over the end of shaft 46. This enables the handle to be removed, and prevents unauthorized operation of the shaft 46. A tensioning weight or spring 230 applied to the shaft 22 of the roll 20 exerts a mild tension upon the film tending to roll the film upon the roll 20, and take up any slack in the film between the rolls 19 and 20, but not sufficient to feed the film from roll 19 to roll 20 independently of the hand feed. A ratchet wheel 60 and pawl 61 are preferably employed to prevent the shaft of roll 20 from rotating in a reverse direction.

The manually actuated shaft 46 for feeding the film forward may be employed to repeatedly make radiographic exposures at short time intervals, or at longer intervals and to ordinarily and generally serve the requirements of a radiographic operator. If desired, however, a more rapid forward and intermittent feed of the film may be attained by motor, or by electrically actuated mechanism in order that moving picture effects may be attained by securing a series of radiographic exposures of moving internal organs up to the frequency or speed limit permissible by reason of the sensitiveness of the films to radiographic action. It is designed to normally actuate the platen 26 at each forward feed of the film in order to secure intimate contact between the film and the intensifying members, but such action of the platen may be omitted under certain conditions of operation if desired. I also contemplate including in an electric circuit 64, with the magnet 39, electrically actuated means to rock the shaft 46, and also preferably electrically actuated means to energize an X-ray tube, and feed a Bucky diaphragm, said several members being arranged to operate through a cycle of movement.

In Figure 3 I have illustrated diagrammatically the above mentioned electrically actuated apparatus in which 67 represents a Bucky diaphragm mounted to move transversely between the X-ray tube 68 and the film 21, said diaphragm being mounted between two cabinet sections 18 and 71, spaced apart for that purpose, and pervious to X-rays and impervious to light rays, said members 18 and 71 corresponding to members 18 and 71 of Figs. 1 and 4. The diaphragm 67 is attached to a belt or tape 72 which is energized by a weight or spring 73 attached to shaft 74 to feed the diaphragm 67 toward the right hand. The opposite end of the belt 72 is attached to a segment 75 on shaft 76, which shaft carries a

series of commutators 77, 78 and 79 by means of which the electrical circuit 64 or branches thereof may be opened and closed at suitable time intervals to carry out the cycle of movements required to make the successive exposures upon successive sections of the film 21, corresponding to the film 21 of Fig. 4. A continuously rotating driving member or motor 82 is adjustable by a setting lever 88 to be driven at relatively different predetermined rates of speed, and is provided with a crank wheel 83 carrying a crank pin 84. The motor shaft 85 also continuously rotates a commutator 86 which serves to open the circuit 64 covering substantially one half of each rotation of the motor shaft 85.

The crank pin 84 engages the outer or free end only of a crank arm 87 rigidly mounted upon the shaft 76 during a fraction of each revolution of the motor shaft 85 to rock the shaft 76 a portion of a revolution clockwise against the tendency of the weight 73 to rotate the shaft 76 in a counter-clockwise direction. The clockwise rotation of shaft 76 restores the Bucky diaphragm to its initial position and shaft 46 is rocked to feed the film 21 one step forward. If desired the shaft 46 of Fig. 3 may be periodically rocked independently of the shaft 76 by means of an electromagent 107 similar to the magnet 39, included in a branch of the circuit 64, periodically closed at the commutator 77, to periodically feed the film 21 forward.

The commutator 86 serves to open or break all branches of the circuit 64 covering the period that shaft 76 is being rocked clockwise, and to close the circuit at said commutator 86 covering the period that the shaft 76 is being rocked by the weight 73 in a counter-clockwise direction, as shown in Fig. 3. The commutators 78, 79, and 77 operate in the order named to successively close branches of circuit 64 covering only the counter-clockwise movement of shaft 76.

The commutator 78 acts first to close a branch through the magnet 39 to actuate the links 27 and 28 and apply pressure to the sheet 25 to clamp the film 21 between the sheets 24 and 25 covering the period of exposure of the film to X-rays. The commutator 79 is timed to next act and close a branch to actuate an electrically energized electrical switch 92 to thereby first close and later open the primary circuit 93 of a high tension transformer, thereby exposing the film to X-rays from tube 68 energized by high tension secondary circuit 94. Commutator 77 closes a branch through magnet 107 to actuate the shaft 46 at the end of the counter-clockwise movement of shaft 76, to thereby feed the film 21 forward one step, after the circuit branch through the commutator 78 and magnet 39 has been opened, and after the circuit branch through the commutator 79 and switch member 92 has been opened, thereby de-energizing circuits 93 and 94. A dash-pot cylinder 95 is stationarily mounted relative to the shaft 76 and contains a body of liquid, oil for instance, in which is a stationary gate 96, and a movable gate 97, mounted upon the shaft 76 to rock to and fro in said cylinder and to thereby cause the liquid to surge first in one direction and then in the opposite direction through valved ports 101 and 102 in the stationary gate. An adjustable valve stem 98 carrying a pointer 103 moving over a dial 104 enables one of said ports to be variably regulated to thereby variably regulate the counter-clockwise rotation of the shaft 76, and thereby the speed or rate of movement of the diaphragm 67, and the length of exposure of the successive film sections to X-rays from the tube 68. A manually operable trip or latch 105 may be employed at will to initiate operation of the shaft 76 and taking of a series of radiographs.

The apparatus herein illustrated and described is capable of considerable modification within the scope of the claims without departing from the spirit of my invention.

What I claim is:

1. In a radiographic apparatus the combination with an X-ray generator and a support for a subject to be radiographed, of an elongated X-ray sensitive member having a section thereof at all times in position for exposure to the rays of said X-ray generator, a diaphragm at all times interposed between said generator and said sensitive member, an intensifier member, means whereby the intensifier is moved into and from intimate contact with the X-ray sensitive member, means for effecting limited movement of the diaphragm in opposite directions, means for moving the sensitive member intermittently between said intensifier and said diaphragm, an electric motor and cooperating means operated and conditioned thereby for cyclically energizing the X-ray generator for a suitable exposure period, for actuating the means whereby the intensifier is moved into intimate contact with the sensitive member and for moving the diaphragm at uniform speed in one direction across said sensitive member during a radiographic exposure period of the sensitive member and then releasing the intensifier, and permitting the return movement of the diaphragm in the opposite direction.

2. In a radiographic device of the class described the combination with an X-ray film and a support for a subject to be radiographed, of a pair of spaced film carrying spools rotatable on fixed axes on opposite sides of the field of exposure, means normally tending to rotate one of said spools for winding the film on said spool, a shaft and cable carrying pulley, a spring resisting movement of said pulley in one direction, a film clamp carried by the cable and gripping the film to advance the film across the exposure field when the cable is moved against the resistance of the spring and releasing the film when the cable, pulley, and shaft are moved under the influence of the spring, a diaphragm interposed between the generator and the film, a strap member for moving said diaphragm in opposite directions, means automatically moving said strap member in one direction, a motor driven rock shaft connected to the strap to move the strap in the opposite direction, commutators on the rock shaft, electrical means to actuate the pulley shaft for advancing the film, electric means controlling energization of the X-ray generator to expose the film and an electric supply circuit including said commutators and said electrical means effecting, in conjunction with the motor driven rock shaft, a synchronized automatic cycle of operations comprising shifting of the film, then simultaneously energizing the X-ray generator and moving the diaphragm, then releasing the film and returning the film clamp while returning the diaphragm to its initial position.

3. In a radiographic apparatus the combination of means to produce stepwise advancement of an X-ray sensitive member, intensifier means, a platen having mechanism for pressing the intensifier means into intimate contact with the

X-ray sensitive member, a diaphragm movable in opposite directions across an area corresponding with the area of the intensifier, counter-weight mechanism for effecting movement of said diaphragm in one direction, a pair of non-aligned parallel shafts, motor means to continuously drive one of the said pair of shafts, engaging pin mechanism on said pair of shafts whereby the continuously driven shaft of said pair may move the other shaft of said pair in the same direction with it during part of each revolution of the continuously driven motor shaft, the diaphragm moving member being connected to the said other of said pair of shafts to produce rocking movement thereof through the joint action of the motor driven shaft and said diaphragm moving means, an X-ray generator and electromagnetic means for actuating the advancing means for the sensitive member, and commutator means on the rocking shaft included in an electric circuit for cyclically effecting clamping of the intensifier to the X-ray sensitive member, energizing the X-ray generator, releasing the clamp of the intensifier and then actuating the shaft of the advancing member for the X-ray sensitive member.

4. In a radiographic apparatus the combination of a support for a subject to be radiographed, an elongated X-ray sensitive film, means to produce stepwise advancement of the film, intensifier means, means to clamp the intensifier means intimately against the film, a diaphragm movable in opposite directions across an area coinciding with the area of the intensifier, a strap connected to the diaphragm to effect movement thereof, counter-weight mechanism effecting movement of the strap in one direction, a rock shaft effecting movement of the strap in the opposite direction, motor driven means cooperating with the counter-weight mechanism to produce rocking movement of the shaft, electromagnetic means controlling stepwise advancement of the film, electromagnetic means effecting clamping of the intensifier clamping means and electric circuit means including commutators on the rock shaft and said electromagnetic means to effect successively the advancement of the film, the clamping of the film, and release of the film with co-ordinate shifting of the diaphragm by said rock shaft and counter-weight mechanism.

JOHN ROBERT KELLEY.