Feb. 7, 1939. H. G. FISCHER 2,145,868

CONTROL APPARATUS

Filed April 16, 1936 2 Sheets-Sheet 1

Fig. 1.

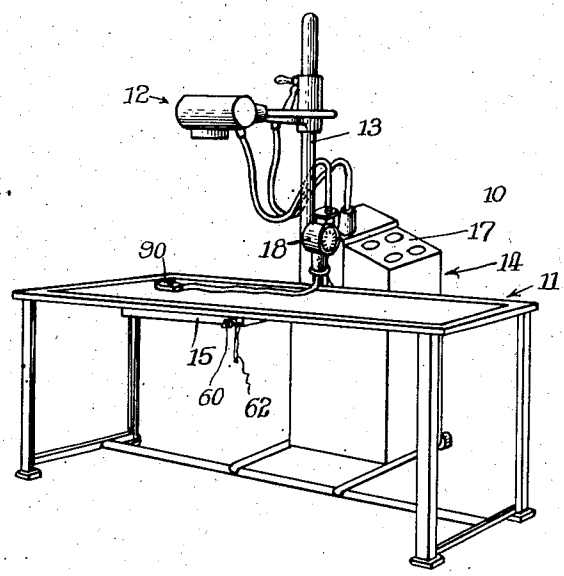


Fig. 2a.

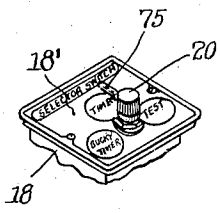


Fig. 2.

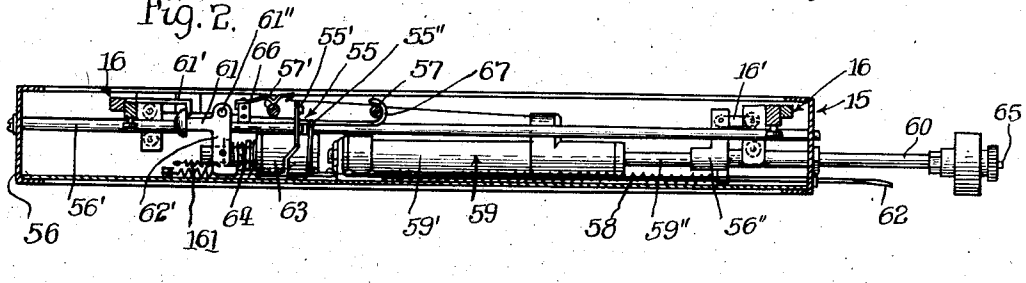
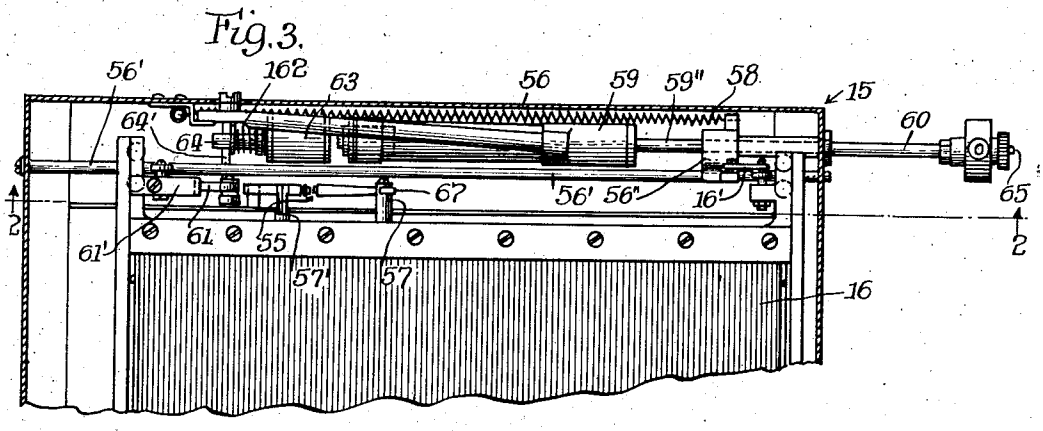


Fig. 3.



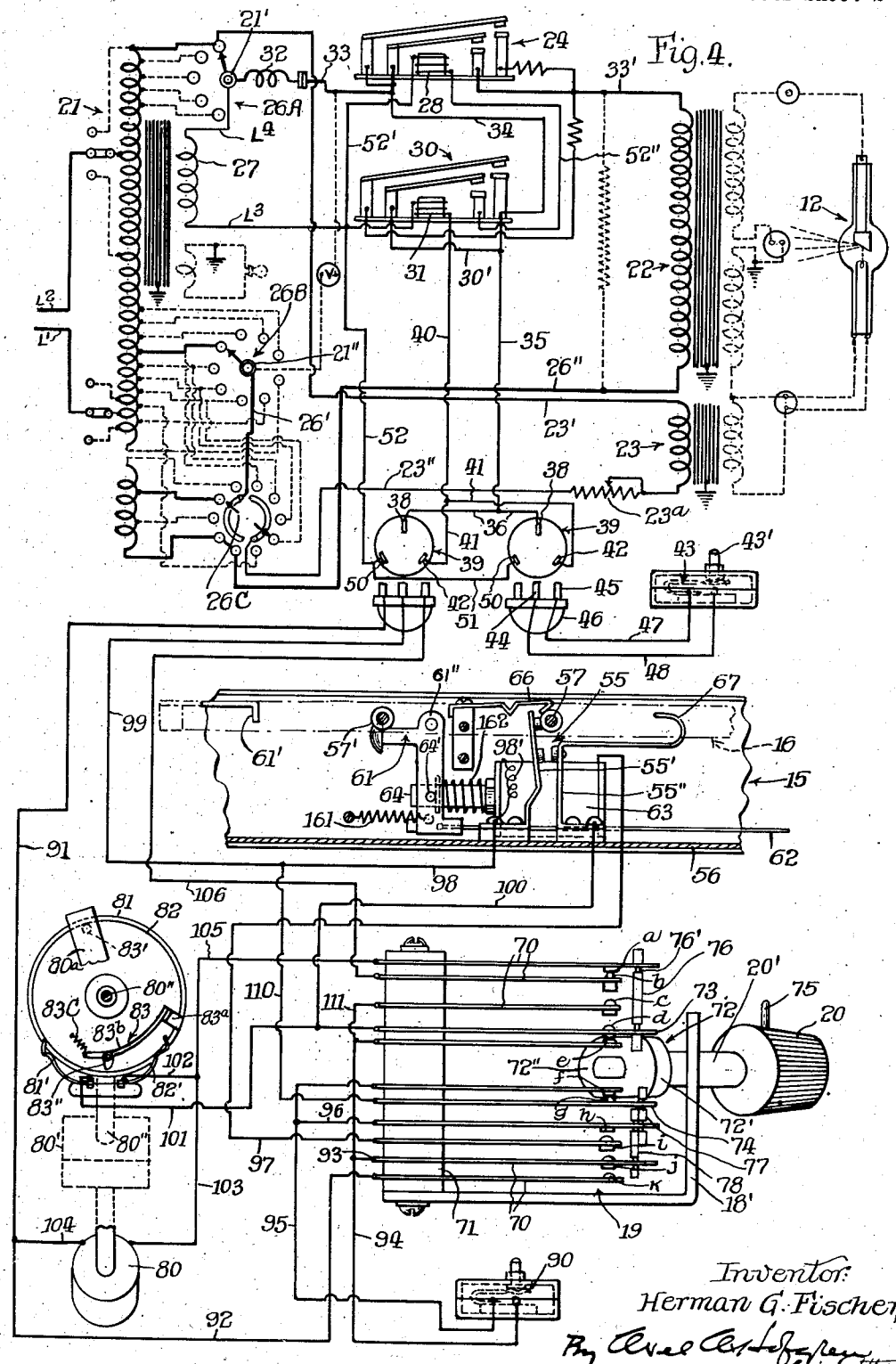
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his Atty.

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CONTROL APPARATUS

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Fig. 4.



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UNITED STATES PATENT OFFICE

2,145,868

CONTROL APPARATUS

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Application April 16, 1936, Serial No. 74,665

13 Claims. (Cl. 250—95)

The invention relates generally to automatically timed apparatus, and more particularly to such apparatus wherein the operating period which is to be accurately timed takes place during the cycle of movement of a shiftable element which constitutes one of the operative parts of the apparatus.

An illustrative example of such apparatus is found in an X-ray machine wherein the ray source is energized for a predetermined time interval during which a shiftable filter, known commercially as a "bucky" diaphram, moves transversely and preferably at a constant rate between the ray source and the photographic plate so as to insure clarity and sharpness in the resulting exposure of the plate.

An important object of the present invention is to provide an apparatus of this general character embodying, in combination, a timing mechanism wherein the accurately timed operating period of the apparatus as determined by the timing mechanism is positively and accurately interrelated to and controlled by the operative movement of such a shiftable element of the apparatus.

More particularly it is an object of the invention to provide X-ray apparatus wherein the operative period of exposure of the plate is determined by timing apparatus of unusual accuracy which is interrelated to and controlled by a shiftable bucky diaphragm so that the entire exposure period takes place while the bucky diaphragm is moving at a uniform speed.

Another object is to provide an apparatus of this character wherein, under certain predetermined arrangements of the apparatus, an accurate timing mechanism is so related to the bucky diaphragm as to insure proper operative movement of the bucky diaphragm during the entire operating period of the apparatus controlled by such mechanism.

Another object is to provide apparatus of this character having an accurate timing mechanism and a bucky diaphragm, adapted in one selective setting of the apparatus to act as an interrelated control for the exposure period, in another selected setting to control the exposure period solely by means of the timing mechanism, and in a third selected setting to control the apparatus in a manner suited for test purposes.

Other objects and advantages will become apparent from the following description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of an X-ray machine embodying the features of the invention.

Fig. 2 is a vertical sectional view taken through the bucky diaphragm substantially along the line 2—2 of Fig. 3.

Fig. 2a is a fragmental perspective view of the timer showing the indicating means for the selecting switch.

Fig. 3 is a fragmental plan view of the bucky diaphragm.

Fig. 4 is a wiring diagram of the apparatus with certain of the control elements shown diagrammatically in association therewith.

While I have shown in the drawings and will herein describe in detail the preferred embodiment of my invention, it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but aim to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

In the form chosen for disclosure herein, the invention is embodied in an X-ray machine 10 having a table 11 upon which the patient is placed. A light or X-ray source 12 is mounted for adjustment vertically on a column 13 which is carried on a control cabinet 14. Beneath the table 11 is mounted a photographic plate holder 15, this holder being adjustably secured to the table and preferably having a "bucky" diaphragm 16 (Fig. 3) associated therewith. On the top of the control cabinet 14 is a control panel 17, and detachably hung on the cabinet is a portable motor driven timer 18 of the type disclosed and claimed in the copending application of Howard H. Osborn, Serial No. 43,379, filed October 3, 1935.

In accordance with the present invention the timer 18 embodies multiple switch mechanism 19 (Fig. 4) and a control knob 20, and is associated with the bucky diaphragm 16 and with the electrical circuit of the X-ray source 12 in such a manner that the testing and operation of the machine and its control apparatus are materially simplified. Such association is shown in the circuit diagram which is illustrated in Fig. 4 of the drawings and will now be described.

Since the circuit for supplying energy to the X-ray source 12 is generally old and well known it will be unnecessary to describe it in detail. An autotransformer 21 has its primary terminals connected to suitable alternating current supply lines L1 and L2, and the secondary is provided with adjustable taps or voltage controls 26A, 26B and 26C. One secondary terminal 21' is arranged to be connected to one side of the primary of a power transformer 22 through a circuit breaker 32, a wire 33, a contactor 24 and a wire 33', where-

as the other secondary terminal 21'' is connected to the other side of the primary of transformer 22 by means of a wire 26', the main filament control 26C and a wire 26''. A filament transformer 23 has one side of its primary connected to the end tap of the winding of transformer 21 by a wire 23', and has its other side connected through an auxiliary filament control 23A and a wire 23'' to the control 26C.

The contactor 24 is normally open and, when the ray source 12 is to be energized, low voltage control current is supplied from a secondary transformer winding 27 to the actuating coil 28 of the contactor through closure of a control relay switch 30. Thus a lead wire L3 connects one side of the secondary 27 to one terminal of an actuating coil 31 of the relay 30, while a lead wire L4 from the other side of the secondary 27, in series with circuit breaker 32, wires 33, 34 and 35 and parallel branch leads 36, is connected to corresponding terminals 38 of a pair of three-terminal outlet sockets 39. A wire 40 and parallel branch leads 41 connect the other terminal of relay coil 31 to corresponding terminals 42 of the sockets 39. One terminal of actuating coil 28 is connected by lead 52' to lead L3, while the other terminal is connected by lead 52'', the relay 30 and lead 30' to wire 35 and thence through wire 34 to the other side of the secondary winding 27. Thus it will be evident that the relay 30, and hence the contactor 24 and the source 12, will be energized upon closure of a circuit across the terminals 38 and 42.

For use in preliminary testing of the light or ray source 12, a normally open foot switch 43 is preferably provided for closing the circuit across terminals 38 and 42. This switch, which may be closed by depressing a button 43', is connected across said terminals by the use of two contacts 44 and 45 of a three-contact attachment plug 46, which plug is inserted in one of the sockets 39. Wires 47 and 48 connect contacts 44 and 45 to the two sides of the foot switch 43.

For simplicity in use the third terminals 50 of the two sockets 39 are interconnected by a wire 51, and a wire 52 from one of the terminals 50 connects the same with lead wire L3 and with one end of the contactor coil 28. Thus a source of line voltage is provided between terminals 38 and 50 independently of the relay 30, and this source of line voltage is employed in operating and controlling the timer 18 and the other elements of the control apparatus, as hereinafter more fully described.

In addition to testing of the ray source 12 by means of the foot switch 43, the invention in its preferred form makes provision for timing the operation of the ray source both with and without operation of the "bucky" diaphragm. Thus when the control knob 20 of switch 19 is in the center position shown in Figs. 2[a] and 4, a pointer 75 extending radially from the knob points towards the "timer" position and the timer 18 is connected into the control circuit of the machine. When the knob 20 is rotated counterclockwise (Fig. 2[a]) so that the pointer extends in the direction of the "bucky timer" position, the timer 18 is connected to operate in conjunction with the "bucky" diaphragm. When the knob 20 is rotated clockwise to the "test" position, a manually operable "test" switch 90 (Fig. 4) is effective to control the ray source 12.

The "bucky" diaphragm 16, as illustrated most clearly in Figs. 2 and 3, is slidable on rods 56' for movement transversely of the table 11 and across the path of the X-rays from the source 12 to a photographic plate which is placed on the plate holder 15 below the "bucky" diaphragm. Prior to starting the machine the operator pulls the "bucky" diaphragm to the right hand end of its travel (Figs. 2 and 3) and during the operation of the machine the "bucky" diaphragm moves at a preselected speed towards the left, to the other end of its travel.

In one setting of the selecting or control switch 19, the present invention provides for the interrelation of the timed operating period of the machine with the shifting movement of the bucky diaphragm 16, and to this end the bucky diaphragm, in its shifting movement along guide rods 56' of frame 56, is arranged to govern the closure of a switch 55 (Figs. 2, 3 and 4) carried by the frame 56. As shown in Fig. 4, the switch 55 is actuated by a pair of lugs or pins 57 and 57' projecting from one edge of the bucky diaphragm 16 in a direction transversely of the path of movement of the bucky diaphragm. The bucky diaphram, as herein shown, is urged to the left by a spring 58 from the full line position of Figs. 2 and 3 to the dotted line position of Fig. 4, and during such movement its speed is governed by a dashpot 59. The cylinder 59' of the dashpot is fixed on the frame 56 while a movable piston rod 59'' extends therefrom and is fixed to a slide member 56'' on one of the guide rods 56'. A link 16' connects the slide member 56'' to the bucky diaphragm 16 so that the bucky diaphragm and the piston rod 59'' move together. By extending the piston rod 59'' beyond the front of the frame 56, a loading rod 60 is provided whereby the bucky diaphragm may be drawn manually to the right to its full line position of Fig. 2. In this right hand position the bucky diaphragm is releasably held by a spring biased latch 61 pivoted on the frame 56 by a pin 61'' and engageable with a hook-shaped member 61' carried by the frame of the bucky diaphragm 16. To initiate its operative return movement, the bucky diaphragm 16 may be released by a release cord 62 which is connected to an arm 62' of the latch 61 and extends outwardly through the front of the frame 56. As another release means for the latch 61, a solenoid 63 is mounted on the frame 56, and its core 64 is operatively connected to the arm 62' of the latch by a pin 64' which projects horizontally from said armature and extends loosely through a transverse hole in the arm 62'. Springs 161 and 162 serve to move the latch 61 to its hook-engaging position.

Upon release of the latch 61 the bucky diaphragm 16 starts toward the left under the influence of spring 58 until it reaches the maximum speed determined by the dashpot 59. A valve rod 65 mounted within the loading rod 60 may be employed to vary the by-pass opening of the dashpot and thereby vary the predetermined maximum speed of movement of the bucky.

As best shown in Fig. 4, the switch 55 comprises a pair of normally engaged spring contacts 55' and 55''. When the bucky diaphragm is in its left hand position of Fig. 4 the lug 57 engages contact 55' to swing it to the open position shown and this open position is maintained by a spring latch 66 as the bucky diaphragm is shifted back again to the right. During the terminal portion of such right-hand or loading movement, the lug 57 engages a hook 67 on the contact 55'' to move this contact to an open position (Fig. 2)

beyond the range of contact 55' which is then released due to actuation of the latch 66 by lug 57'. The switch 55 is then conditioned for closure as the bucky diaphragm and its lug 57 return to the left, and such closure takes place only after the bucky diaphragm has reached its constant speed as determined by the dashpot 59.

Under some circumstances the dashpot control of the bucky diaphragm may be used for timing the operation of the machine, but for the purpose of extremely accurate timing not subject to change due to viscosity changes of the fluid in the dashpot, the invention combines with the bucky diaphragm an electrically operated timer of the type disclosed and claimed in the hereinbefore mentioned Osborn application.

The action of the bucky diaphragm switch 55 in producing a coordinated control of the bucky diaphragm and the timer 18 in governing the exposure period is obtained through selective setting of the multiple switch 19 of the timer by its control knob 20. To this end the multiple switch 19, as illustrated herein in Fig. 4 comprises eleven switch contacts *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, and *k*, each mounted on an individual flexible arm 70, all of which arms are carried on an insulating bar 71 and are controlled as to position or engagement by a cam 72 carried by the shaft 20' of knob 20. The switch 19 and its actuating cam 72 are housed within the casing of the timer 18 and a shaft 20' connecting the cam with the knob 20 is journaled in and projects through the top wall 18' of the timer as shown in Fig. 2ª so as to support the knob 20 outside of and adjacent to the wall 18'. On the outer face of the wall 18' there are indicated three positions of the switch, namely, a "bucky timer" position, a "timer" position, and a "test" position. As mentioned hereinbefore, a pointer 75 on the knob 20 cooperates with these indicia to show the setting of the switch 19.

In Figs. 2ª and 4 the parts are shown in the "timer" position wherein the contact *a* normally engages the contact *b*, the contact *d* engages contact *e*, and contact *f* engages contact *g*, while the other contacts of the switch 18 are normally separated from each other. When the switch is in the setting shown in Figs. 2ª and 4, projections 73 and 74 of the arms which carry contacts *d* and *g* respectively are adjacent to opposite sides of the cam 72.

When the knob 20 is turned to the right (Fig. 2ª) to indicate "test" position, a large lobe 72' of the cam 72 presses the arm 73 upwardly so as to connect contacts *d*, *c* and *b* and, in the same movement, a pressure link 76, between arm 73 and an extension of the arm 70 of contact *a*, shifts contact *a* to an open position with relation to contact *b*. The same closed relation of contacts *f* and *g* is maintained in the "test" setting, a small lobe 72'' on the other side of cam 72 being ineffective to shift contact *g*.

When the knob 20 is turned to the left (Fig. 2ª) to indicate the "bucky timer" position, contacts *a* and *b* remain closed while the connection of contacts *d* and *e* is opened by the action of lobe 72''. Opening of contacts *d* and *e* while contacts *a* and *b* remain closed is permitted by lost motion connection 76' between the link 76 and the arm of contact *a*. In such rotation of the cam, lobe 72' shifts the arm 74 to separate contacts *f* and *g*, while links 77 and 78, between arm 74 and extensions of the arms of contacts *h* and *j*, cause contact *h* to engage contact *i*, and contact *j* to engage contact *k*.

As described in detail in the aforesaid Osborn application, the timer 18 embodies a synchronous drive motor 80 (Fig. 4) acting through reduction gearing 80' to rotate a shaft 80'' in a counterclockwise direction. A pair of collector rings 81 and 82 are mounted for rotative movement with the dial of the timer in a counterclockwise direction, the rings 81 and 82 being in insulated, non-rotative relation to each other. Connected in series with the rings is a switch 83 having a fixed contact 83*a* carried on the ring 81 and a pivoted contact 83*b* on the ring 82 and normally urged to switch closed position by a spring 83*c*. To open the switch 83, a switch actuating member or pin 83' is mounted for rotation with the shaft on an arm 80*a* fast on the shaft, and in such rotation the pin 83' is arranged to engage a lug 83'' to open the switch 83. To set the timer for a definite period, the collector rings and their switch 83 are advanced or rotated the desired amount in a counterclockwise direction with relation to the shaft 80'' and the pin 83' so as to separate the lug 83'' from the pin 83', and upon starting of the motor 80 the pin 83' is advanced until it opens the switch 83. To permit such advancing of the collector rings 81 and 82, spring contacts 81' and 82' are provided in engagement respectively with the edges of rings 81 and 82 as terminals therefor, and a ratchet means (not shown) may be employed to hold the rings 81 and 82 in their set position.

In the "bucky-timer" position of control knob 20, the normally open hand switch 90 is closed by the operator to release the bucky diaphragm 16 through the establishment of a circuit across terminals 50—38 and through the solenoid 63. This circuit includes wires 91 and 92 connecting terminal 50 with contact *k*; contact *j* and wires 93 and 94 connecting contact *j* to the hand switch 90; the hand switch 90 and wires 95 and 96 connecting the hand switch 90 to contact *h*; contact *i* and wire 97 connecting contact *i* with one side of solenoid 63; and wires 98', 98 and 99 connecting the other side of solenoid 63 with the terminal 38. This circuit energizes solenoid 63 so as to actuate the latch 61 and release the bucky diaphragm 16 for movement to the left by its spring 58.

After the bucky diaphragm has attained the speed determined by dashpot 59, the movement of lug 57 (Figs. 2 and 3) releases hook 67 and thereby permits closure of the bucky diaphragm switch 55 so as to establish a first circuit through the collector rings 81 and 82 and the timer motor 80 and start the timer 18, and simultaneously to establish a second circuit through the collector rings 81 and 82 and the control relay 30 so as to energize the light or ray source 12.

The first circuit thus established to the timer in the "bucky-timer" setting is across terminals 38—50, and includes wires 99, 98, switch 55, wires 100 and 101 connecting switch 55 to one side of switch 83 through collector ring 81, wires 102 and 103 connecting the other side of switch 83 to one terminal of the motor 80, through the motor, through wire 104 to wire 91 and thence to terminal 50.

The second circuit, which is established simultaneously to the light control relay 30 when the bucky diaphragm switch 55 is thus closed, is across terminals 38—42, and due to the fact that the coil of the relay 30 is in circuit between terminal 42 and L3 the establishment of this circuit causes the source 12 to be energized. The circuit across terminals 38—42 includes terminal 38, wires 99, 98, switch 55, wires 100 and 101,

collector ring switch 83, wire 102, wire 105 which connects wire 102 to contact *a*, the contact *b*, and wire 106 which connects contact *b* with terminal 42.

Since the collector ring switch 83 is included in the circuit which controls source 12 as well as the circuit which supplies current to the timer motor 80, it will be apparent that, when the preset period of operation of the timer 18 has elapsed, the consequent opening of the switch 83 will cause the source 12 to be deenergized and the operation of the timer motor 80 to be stopped.

In the use of the apparatus in the "bucky-timer" setting, the valve of the dashpot 59 is set so that the period of constant-speed movement of the bucky diaphragm is greater than the period set on the timer 18, and hence the bucky diaphragm continues movement after the light source has been shut off. In this continued movement the lug 57 engages contact 55' and opens the switch 55 so as to prevent use of the apparatus until the bucky diaphragm has been reloaded or moved to its right-hand position. Even then, the timer must be reset to a position away from its stopped position, and the hand switch 90 or the release cord must be actuated in order to initiate another cycle of operation.

When the exposure is to be made without the bucky diaphragm and simply under the control of the timer 18, the control knob 20 is shifted to the "timer" position with the resulting change of the relation of the contacts of the multiple switch 19 as hereinbefore described.

In this setting of the control knob 20, the operation of the X-ray is primarily under the control of hand switch 90 in that this switch is in circuit with both the timer motor 80 and the circuit to the control relay 30. The hand switch 90 must therefore be held in depressed or closed position during the entire operating period, and opening of this switch at any time during the desired period will cause the timer to stop and the source 12 to be deenergized. In a secondary sense, the operation of the apparatus in this setting of knob 20 is under the control of the timer 18, since the timer must initially be set, and after being set operates to limit and terminate the operating period despite continued closure of the hand switch 90.

The necessary circuit across terminals 42—38 to energize the X-ray source 12 is provided from terminal 42 by wire 106, contacts *b*, *a*, wires 105 and 102, collector rings 82 and 81 and switch 83 of the timer, wire 101, contacts *d*, *e*, wire 94, hand switch 90, wire 95, contacts *f*, *g*, a wire 110 connecting contact *g* to the junction of wires 98 and 99, and wire 99 to terminal 38.

The circuit across terminals 38—50 is provided from terminal 38 through wires 99 and 110, contacts *g* and *f*, wire 95, hand switch 90, wire 94, contacts *e* and *d*, wire 101, collector rings 81 and 82 and their switch 83, wires 102 and 103, the motor 80, and wires 104 and 91 to terminal 50.

In the "test" setting of control knob 20, the hand switch 90 constitutes the primary control of both the timer and ray source operation in a manner comparable to the control exercised in the "timer" setting, with the distinction, however, that the period of operation of the ray source is not and cannot be limited and terminated by the timer 18. Hence the timer 18 may in this setup be used merely as an indicator at the option of the user; but in the event that the timer is not set by the user, the ray source 12 may be energized, independently of the timer and its operation, by the closure of hand switch 90 and in a manner comparable to that effected by the foot switch 43.

In the "test" setting, the circuit through the timer motor and collector ring switch 83 and across the terminals 38—50 is provided from terminal 38 through wires 99 and 110, contacts *g* and *f*, wire 95, hand switch 90, wire 94, a wire 111 connecting wire 94 to contact *c*, through contacts *c* and *d*, wire 101, collector rings 81 and 82 and their switch 83, wires 102 and 103, the motor 80, and wires 104 and 91 to terminal 50.

The circuit for energizing the X-ray control-relay 30 is across terminals 38 and 42, and in this setting of the control knob 20 is provided from terminal 38, through wires 99 and 110, contacts *g* and *f*, wire 95, hand switch 90, wires 94 and 111, contacts *c* and *b*, and wire 106 to terminal 42.

I claim as my invention:

1. The combination, for use with an X-ray machine utilizing photographic plates, of shiftable means movable across the plate during the operation of the machine, a precision timer for the X-ray machine having a synchronous motor driving the same and a normally closed switch, means including a circuit through said switch operable by said switch to control both said motor and the X-ray machine, said circuit including a pair of normally open contacts, and control means on said first mentioned shiftable means operable to close said contacts after said first mentioned means has attained a uniform speed to complete said circuit and initiate operation of said timer and said X-ray machine, said control means maintaining said contacts closed for a period exceeding the period of operation of said timer.

2. The combination, for use with an X-ray machine utilizing photographic plates, of a screen movable across the plate during the operation of the machine, a spring urging said screen in one direction, dashpot means rendering uniform the movement imparted to said screen by said spring, locking means for holding said screen at one extreme of its movement against the action of said spring, a solenoid operable when energized to release said locking means and free said screen to the action of said spring, a circuit including said solenoid and a normally open switch hand operated to complete the circuit, a timer for the X-ray machine having a synchronous motor driving the same and a normally closed switch, said switch operating to control both said motor and said X-ray machine, a circuit including said last mentioned switch, said motor and a pair of normally open contacts, and means controlled by said screen closing said contacts after the screen has attained a uniform speed to complete said last mentioned circuit and initiate operation of said timer and said X-ray machine, said means maintaining said contacts closed for a period exceeding the period of operation of said timer.

3. Control apparatus adapted for association with the Roentgen ray source of an X-ray machine, said apparatus comprising a movable screen, a precision timer driven by a synchronous motor and having a stop switch closed during the timed period and opened at the end of said period, means for moving said screen, means for initiating operative movement of said screen independently of said timer, electrical connections including a switch operable under the control of and during the operative movement of said screen

to energize said timer motor and said ray source, said timer motor and said ray source being included in said connections so as to be under the control of said stop switch of said timer.

4. In an X-ray machine having a source of X-rays, a motor driven timer having a timing switch, and a movable bucky diaphragm, the combination of control means having a plurality of settings, electrically operated means for initiating movement of said bucky diaphragm, a control switch operated by said bucky diaphragm in its movement, and a hand switch, said control means having electrical conductors associated therewith and operatively connected in a first setting of said control means to connect said hand switch in circuit with said electrically operated means for initiating movement of said bucky diaphragm, to connect said conductors to provide a circuit through said control switch to place said bucky diaphragm in operative control of said timer and said source for starting operation of the timer and said source, and to connect said conductors to form an energizing circuit for said ray source including said timing switch whereby to place said timer in control of said source to terminate operation of said source, said control means being operable in a second setting to connect said conductors to form an energizing circuit for said ray source including said hand switch, said motor, and said timing switch, whereby to place said hand switch in control of the starting and stopping of said timer and said source and to place said timer in a dominating control of said source to stop the same regardless of the closure of said hand switch, and said control means being operable in another setting to connect said conductors to form an energizing circuit for said ray source including said hand switch and said motor whereby to place said hand switch in control of the starting and stopping of said timer and in control of the starting and stopping of said source independently of the operation of said timer.

5. In an X-ray machine having a source of X-rays, the combination of a synchronous motor-driven adjustable precision timer for stopping the machine after a preselected interval of operation and a movably mounted bucky diaphragm adapted to be moved during said interval, means for moving the bucky diaphragm at a uniform rate, and means operatively interconnecting the timer, the source of X-rays, and the bucky diaphragm operable to effect an interrelated control of the period of operation of said source of X-rays by said timer and the bucky diaphragm movement.

6. In an X-ray machine having a source of X-rays, a bucky diaphragm, means for moving the bucky diaphragm at a uniform rate, a synchronous motor-driven precision timer operable to stop the machine after a preselected time interval, a control circuit for said X-ray source including said timer, and means actuated by said bucky diaphragm and associated with said control circuit operable to initiate the operation of said timer and said source of X-rays.

7. In an X-ray machine having a source of X-rays, a timing mechanism therefor including a device operable after a predetermined time to stop said mechanism and to deenergize said ray source, a common control means for starting the operation of said mechanism and for energizing said source, and a control circuit for deenergizing said source operatively associated with the device of said timing mechanism to deenergize said source after a preselected time interval, a shiftable screen movable through an operating stroke from a rest position to a predetermined speed and thereafter in the balance of said stroke at the predetermined speed, and means governed by said shiftable screen to actuate said common control means to energize said source and start said timing mechanism after said screen has attained said predetermined speed.

8. In a ray producing apparatus, a source of rays, a shiftable element, power means operable to shift said element, governing means for maintaining a uniform rate of movement of said shiftable element after it has attained the predetermined rate, a control circuit including an adjustable precision timer operable to terminate the operating period of said ray source, means in said control circuit actuated by said shiftable element after it has attained the predetermined rate of movement to initiate operation of said timer and said ray source, and means for moving said shiftable element.

9. An apparatus comprising, in combination, a first operating element, a shiftable element, means including a spring and a hydraulic governing means for driving said shiftable element from a rest position up to a predetermined speed and thereafter continuing the movement of said element at said predetermined speed through an operating stroke of said shiftable element, a control circuit for said first operating element including an adjustable timer operable to terminate the operating period of said first operating element, a switch in said control circuit closed by said shiftable element after it has attained said predetermined speed to initiate operation of said timer and said first operating element, and means for releasing said spring to initiate operative movement of said shiftable element.

10. In an X-ray machine having an X-ray tube and photographic plates adapted to be exposed to the X-rays from the tube, a bucky diaphragm shiftable across the plate intermediate the plate and the X-ray tube, means for shifting the bucky diaphragm including a spring cocked by manual movement of the diaphragm in one direction and hydraulic fluid governing means for maintaining a predetermined rate of movement after the bucky diaphragm has been brought up to that predetermined rate, a control circuit for the X-ray tube including an adjustable timer operable to terminate the operating period of the X-ray tube after a predetermined interval, a switch in said control circuit operable by said bucky diaphragm after it has attained the predetermined rate to close the control circuit and initiate operation of said timer and the X-ray tube, and means for releasing said bucky diaphragm to the action of said cocked spring.

11. The combination, for use with an X-ray machine, of a synchronous motor driven precison timer, means operatively connecting said timer to control the termination of the period of operation of the X-ray machine, a reciprocably mounted bucky diaphragm, means for moving said bucky diaphragm in one direction during an exposure, and means operated by said bucky diaphragm during the movement thereof controlling the initiation of operation of said timer.

12. The combination, for use with an X-ray machine, of a synchronous motor driven timer controlling the termination of the period of operation of the X-ray machine, a circuit including said timer and a pair of normally open

contacts, said contacts when closed functioning to start the machine and said timer simultaneously, a movable bucky diaphragm, means for moving the bucky diaphragm, and means operable by the bucky diaphragm after a predetermined movement thereof to close said contacts and maintain the same closed longer than the period for which the timer is set.

13. In an X-ray machine, the combination of a timer operable to control the period of operation of the X-ray machine, a control switch having a plurality of settings, a movable bucky diaphragm, electrical connections effective in one setting of said control switch to form a circuit including said timer and a switch operable by the bucky diaphragm in its movement to energize and initiate operation of said timer, a hand switch, electrical means including a second circuit connected in said one setting of said control switch to include said hand switch and operable under the control of said hand switch to initiate operative movement of said bucky diaphragm, and electrical connections to said hand switch providing a third circuit connected in another setting of said control switch to include said timer and said hand switch and render said hand switch effective through said third circuit to govern directly the starting and stopping of said timer.

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