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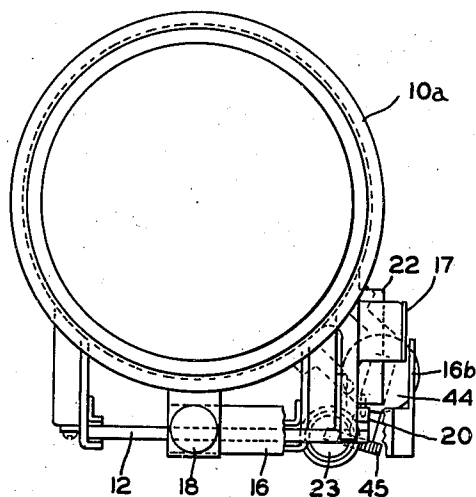
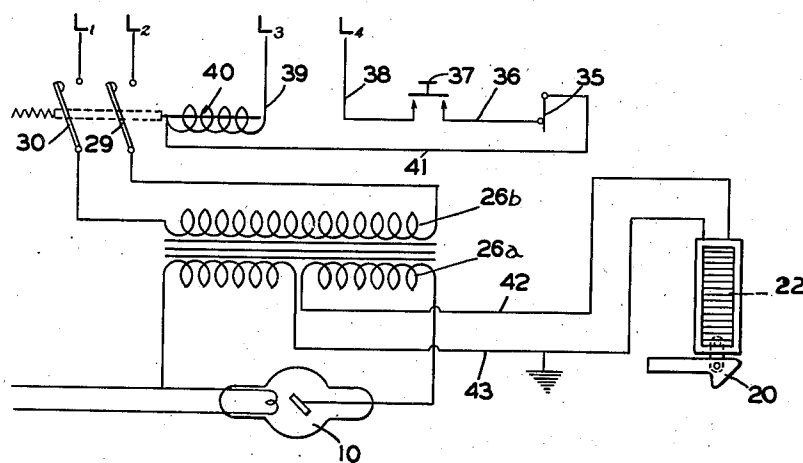
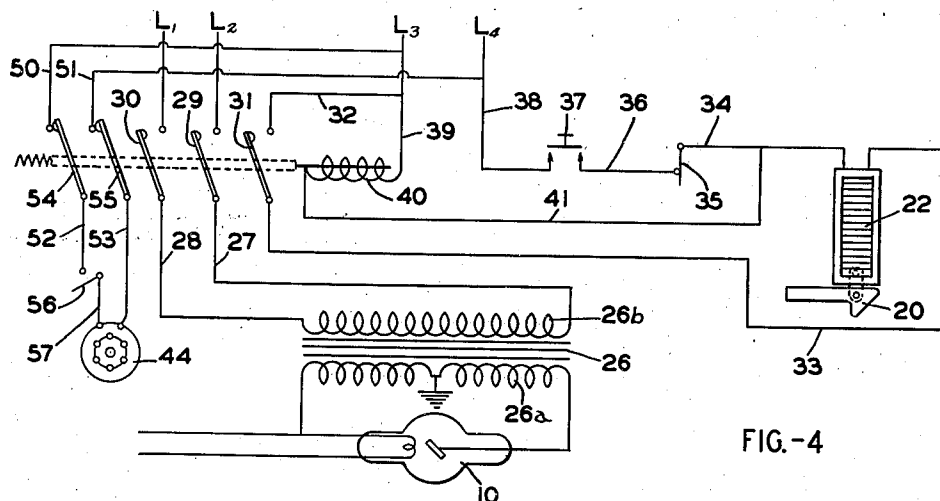
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TIMING APPARATUS FOR X-RAY EXPOSURES

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TIMING APPARATUS FOR X-RAY EXPOSURES

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8 Claims. (Cl. 250-95)

This invention relates to improvements in timing apparatus for X-ray exposures.

An object of the present invention is to provide cheap but effective means for timing X-ray exposures arranged in a novel manner.

Another object of the present invention is to provide a relatively simple exposure timing means which utilizes to the utmost the rays generated by the tube during the time it is operating but which prevents the taking of roentgenographs during the first few moments after the tube starts to operate so that pictures are not taken while current is surging in the tube and thus grid lines on the plate are avoided.

The invention also includes the structure hereinafter disclosed for carrying out the above described purposes and the essential features thereof are set forth in the claims.

In the drawings, Fig. 1 is a top plan view of an X-ray tube equipped with my improved timing apparatus; Fig. 2 is an elevational view of the same device; Fig. 3 is an end view thereof; while Figs. 4 and 5 are diagrammatic views of the operating and control circuits.

While my invention may utilize various means for controlling the X-rays during an exposure including shutters of various types such as the scissors type and others, I have illustrated as a preferred embodiment thereof the use of a shutter involving an open slit in a screen which is caused to move transversely of the tube opening. In the various views an X-ray tube of the usual type is illustrated at 10 in a housing 10a which is provided with an opening at 11 which is normally closed by a lead plate screen 12 provided with an open slit 13 which is in the position of Fig. 2 before an exposure is made. This lead plate is supported for reciprocating movement from the full line position of Fig. 2 to the dot-dash position thereof in frictionless supports which for the purpose of simplification are shown at 14 in a conventional manner. It will be understood that this detail has nothing to do with the present invention. Means is provided for urging the lead plate screen 12 from the position of Fig. 2 toward the right upon release of the controlling mechanism. The means here shown comprises a helical spring 15 supported at one end on a stud 12a of the lead screen and supported at the other end on a shoulder 16a of a bracket 16 which carries a pointer 16b which passes over readings on a scale 17 calibrated in seconds of exposure. The bracket 16 is controlled by a screw 18 threaded into a fixed bracket 19 mounted on the tube. Obviously by moving the screw 18 toward the

right as viewed in Figs. 1 and 2 the spring 15 is compressed so as to give a greater speed of movement to the lead screen 12 as it moves from left to right. The lead screen is moved against the action of spring 15 to the cocked position shown in full lines in Figs. 1 and 2. It is held in this position by a dog 20 which engages a finger 12b on the screen. The dog has a pivotal mounting at 21 and is controlled by the armature of a relay 22. The movement of screen 12 toward the right is cushioned by a dashpot 23 in which is housed a piston 24 which is connected by rod 25 with the finger 12b or some other suitable portion of the lead screen.

A suitable control circuit for the device of Figs. 1 to 3 is indicated in Fig. 4. The tube at 10 is supplied with current from the secondary 26a of the high tension transformer 26 whose primary 26b is connected by lines 27 and 28 and switches 29 and 30 with a source of power L₁, L₂. Another switch 31 connected for movement simultaneously with switches 29 and 30 serves to control the supply of current to relay 22 and also to maintain the switches 29, 30 and 31 closed after such closure has been manually initiated. The power circuit for relay 22 is from the source L₃ through line 32, switch 31, line 33, relay 22, line 34, switch 35, line 36, manually controlled switch 37 and line 38 to the source L₄. Another circuit passes from the source L₃ through line 39, solenoid 40 and line 41 to the line 34 and thence back to the source L₄.

The switch 35 as best seen in Fig. 1 comprises a pair of normally closed contacts 35a and 35b, the latter being provided with an arm 35c which extends into the path of travel of some part of the lead screen 12 such as the finger 12b which engages the arm 35c and opens switch 35 when the lead screen reaches the dot-dash position of Fig. 2.

It is thought the operation of the device will now be apparent. When the pointer 16b has been adjusted by screw 18 for the desired exposure as read upon scale 17 and with the lead screen held by the dog 20 as shown in Figs. 1 and 2, the manually controlled switch 37 is closed thus energizing solenoid 40 and closing switches 29, 30 and 31. Current is immediately supplied to the X-ray tube but the shutter does not start to move immediately because of the combined electrical and mechanical delay in the tripping of the dog 20. This combined delay is of the order of a few half cycles of the high tension current so that the surging of the current in the X-ray tube has ceased before an exposure occurs. The device here disclosed is so constructed that

the time necessary to build up sufficient pull in the relay 22 to release the dog 20 is at least three half wave lengths of the high tension current or say $\frac{3}{120}$ of a second. The relay 22 when sufficiently energized trips the dog 20 releasing the shutter or screen 12 to the action of spring 15 which moves the same toward the right as viewed in Figs. 1 and 2 causing the slit 13 to pass across the tube opening and produce an exposure of the duration desired. At the end of its travel screen 12 opens switch 35 which breaks the energizing circuit for solenoid 40 thus releasing the main switch which is opened by its spring and causes operation of the tube to cease. Obviously the manually controlled switch or button 37 could be opened at any time desired so as to cause deenergization of the solenoid 40 and the opening of the switches 29 and 30.

An alternative control circuit is illustrated in Fig. 5 where parts having similar functions to that already described are given similar reference characters. The only difference between the two control systems is that the relay 22 is placed in circuit with the high tension transformer secondary. To this end the relay is connected by lines 42 and 43 in the ground circuit of the transformer secondary 26a. This control circuit operates in the same manner as the one already described.

Power means may be provided if desired for returning the screen 12 from the dot-dash position of Fig. 2 to the full line or cocked position thereof. Means here shown for this purpose includes a motor 44 which drives a pinion 45 meshing with a rack 46 carried by an extension of the dashpot rod 25. An arm 47 carried by this rod is adapted to engage the flexible support 48a of contact 48 to move it out of engagement with contact 49 to open the control circuit when the screen reaches the cocked position where dog 20 engages the projection 12b. The control circuit for motor 44 is shown in Fig. 4 where lines 50 and 51 connected respectively with the sources L_3 , L_4 are connected with lines 52 and 53 by switches 54 and 55 upon opening of the switches 29, 30 and 31. Line 53 is connected with motor 44 and line 52 is connected through switch 56 and line 57 with motor 44. Switch 56 comprises the contacts 48 and 49 previously described. It is believed the operation of motor 44 will now be apparent. With the screen in the dot-dash position of Fig. 2, switch 56 will be closed and at the completion of an exposure when switches 29 and 30 open, the switches 54 and 55 will close thus energizing motor 44. This will drive the screen back to the full line position of Fig. 2, finally causing the opening of switch 56 and stopping the operation of motor 44. When the next exposure occurs the switches 54, 55 will be opened immediately and as the exposure takes place switch 56 will be closed later thus putting the parts in condition to return the screen to cocked position after the exposure has been completed.

It will be understood that the opening at the right-hand end of dashpot 23 as viewed in Figs. 1 and 2 is just sufficient to permit the passage of the rod which carries the rack teeth 46. This rod is then cut away for the major portion of its length as shown at 46a but again increases to the full size of the opening in the end of the dashpot as shown at 46b for a short distance ahead of the piston 24. It results from this construction that on exposure movement of the shutter it will travel for full speed across the

X-ray tube opening trapping air ahead of the piston 24 just at the end of the shutter stroke so as to cushion the movement at that point.

While the screen or shutter 12 is shown for simplicity mounted on the outside of the tube housing 10a, it will be understood by those skilled in this art that the screen or shutter might be enclosed within the housing.

What I claim is:

1. Means for controlling X-ray tube exposure time comprising an X-ray tube, an operating circuit therefor, switch means for closing said circuit, normally closed shutter means opaque to X-rays for controlling the rays from said tube, and means for causing exposure-producing movement of said shutter means in timed relation to the closing of said switch means for the purpose described.

2. Means for controlling X-ray tube exposure time comprising an X-ray tube, a high tension operating circuit therefor, switch means for causing operation of said circuit, normally closed shutter means opaque to X-rays for controlling the rays from said tube, and means for causing opening of said shutter means at an interval after the closing of said switch means of the order of a few half cycles of said operating circuit.

3. Means for controlling X-ray tube exposure time comprising an X-ray tube, a high tension operating circuit therefor, switch means for causing operation of said circuit, normally closed shutter means opaque to X-rays for controlling the rays from said tube, means for tripping said shutter to produce an exposure including an electrically operated relay, an electric circuit controlling said relay, and means for closing said relay control circuit and said switch means substantially simultaneously, said relay having a combined electrical and mechanical delay causing operation thereof at an interval after electrical energization of said relay of the order of a few half cycles of said operating circuit.

4. The combination of claim 3 including means for breaking said tube operating circuit upon completion of exposure operation of said shutter.

5. Means for controlling X-ray tube exposure time comprising an X-ray tube, a high tension operating circuit therefor, switch means for causing operation of said circuit, shutter means for controlling the rays from said tube, said shutter means comprising a reciprocating screen having a slit therethrough adapted to travel across the tube opening upon screen reciprocation, spring means urging said screen in exposure-producing direction, a dog for holding said screen against the action of said spring, an electrically operated relay for releasing said dog, an electric circuit controlling said relay, means for closing said relay control circuit and said switch means substantially simultaneously, and means operable by said shutter upon completion of its exposure-producing travel for breaking said tube operating circuit.

6. Means for controlling X-ray tube exposure time comprising an X-ray tube, an operating circuit therefor, switch means for closing said circuit, shutter means for controlling the rays from said tube, said shutter means comprising a reciprocating screen having a slit therethrough adapted to travel across the tube opening upon screen reciprocation, spring means urging said screen in exposure-producing direction, power means for moving said screen in the opposite direction to cocked position, means for holding

said screen in cocked position, and means for releasing said last named means responsive to closing of said switch means.

7. The combination of claim 6 wherein said power means is electrically operated and comprises an electrical circuit energized by completion of a shutter-controlled exposure.

8. The combination of claim 6 wherein said

power means includes an electric motor and an energizing circuit therefor, said circuit including a switch closable by opening of said first named switch means, and including a switch openable by movement of said screen to cocked position.

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