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SWITCHING DEVICE FOR X-RAY WORK

Filed June 25, 1938

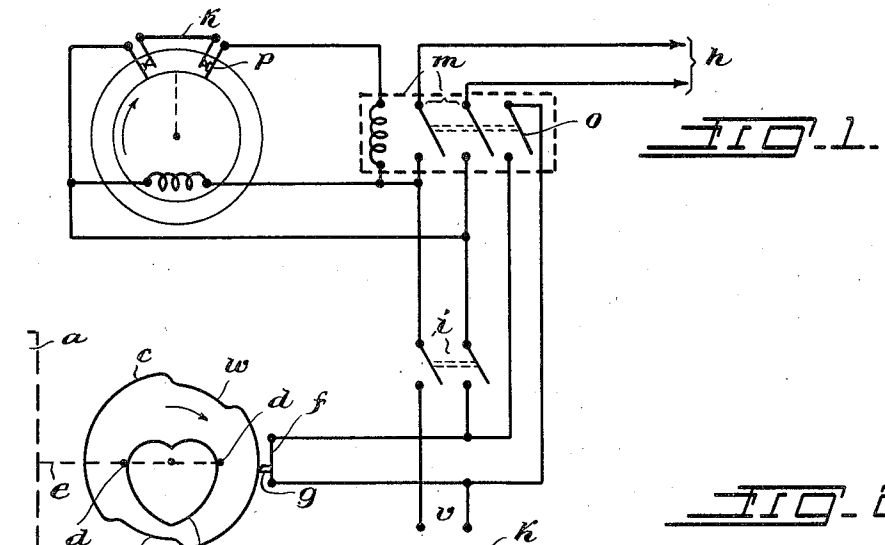


FIG. 1.

FIG. 2.

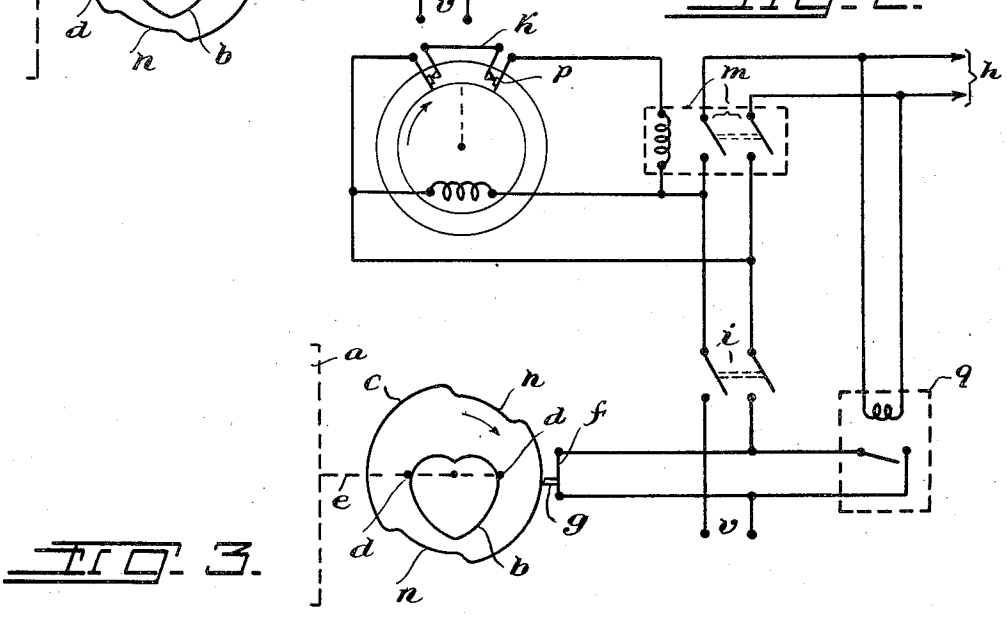
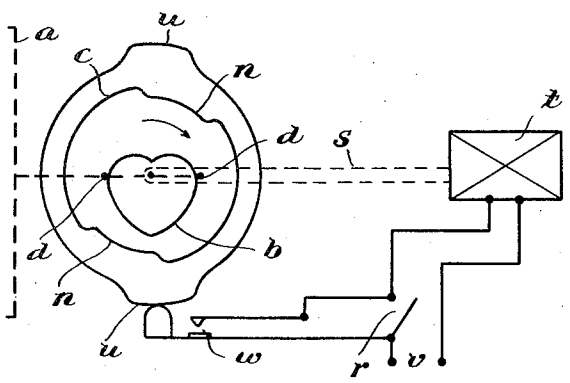


FIG. 3.



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SWITCHING DEVICE FOR X-RAY WORK

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7 Claims. (Cl. 250—62)

This invention relates to X-ray work and refers more particularly to an X-ray tube switching device used in connection with a diaphragm for secondary X-rays.

In the co-pending patent application of Konrad Gund relating to a Diaphragm for secondary X-rays, Serial Number 186,330, filed January 22, 1938, a diaphragm is described which is reciprocated in the path of X-rays and which is used for intercepting the secondary X-rays which would otherwise blur the X-ray image.

However, if the X-ray device is switched off every time the diaphragm for intercepting secondary X-rays approaches the end of its path, the durability of the device and particularly of the X-ray tube, is considerably reduced and the patient may be inconvenienced. Furthermore, this procedure may increase the period of time necessary for exposure to an undesirable extent, namely, by the entire time necessary for the reversal of the diaphragm's movement, thereby diminishing the clearness of the X-ray photograph.

An object of the present invention is the provision of a device which is used in X-ray work in combination with a reciprocating diaphragm, and through the use of which the necessity of constantly switching the X-ray tube on and off is avoided, although the outlines of the screen do not appear upon the image.

Other objects will be apparent in the course of the following specification.

The present invention involves the consideration that the continuous switching on and off of the X-ray tube is unnecessary if the total time of the exposure is many times that which is necessary for the reversal of the diaphragm's movement. Consequently, the objects of the present invention may be realized through the provision of an automatically operable device which prevents the closing of the main electrical circuit if the X-ray device is switched on while the movable diaphragm is changing the direction of its movement, although the main electrical circuit is not interrupted during any subsequent changes in the direction of the diaphragm's movement, which may take place during exposure.

In accordance with some of the practical embodiments of the inventive idea, the reciprocable diaphragm is coupled with a cam which actuates an auxiliary switch included in the main circuit, said auxiliary switch being rendered ineffective once the main switch has been switched on by means of a relay or a third switch.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawing showing by way of example, some of the aforesaid practical embodiments.

Figure 1 is a diagram illustrating one of these embodiments;

Figure 2 is a diagram showing another embodiment;

Figure 3 shows a further embodiment.

The device illustrated in the drawing comprises a reciprocable diaphragm *a*, which is used in the art for the purpose of intercepting secondary X-rays. This diaphragm consists usually of layers of material, such as lead, which is impermeable to X-rays, arranged between layers of a substance which transmits the X-rays. The diaphragm *a* is situated in the path of the X-rays between the X-ray tube and the X-ray image.

In certain instances it may be advisable to use a diaphragm having X-ray-absorbing strips centered in relation to the focal point of the X-ray tube.

The diaphragm *a* is reciprocated by a device which is known per se and which comprises a motor driving a disc *b* having the shape of a cardioid. The disc *b* is provided with outer side surfaces which engage the members *d* guided along these surfaces and firmly connected with a rod *e*, the opposite end of which is attached to the diaphragm *a*.

Due to this arrangement, the diaphragm *a* is reciprocated in a direction perpendicular to that of the X-rays when the cardioid-shaped disc *b* is rotated.

The disc *b* is operatively and firmly connected with a switching disc *c* which is rotated along with the disc *b*. The disc *c* is provided with cut-out portions *n*, the position and length of which has a certain relationship to the positions of the reciprocating diaphragm *a*, as will appear more clearly hereinafter.

The main electrical circuit of the device constitutes the primary circuit of a high voltage transformer, the position of which is indicated diagrammatically by the letter *h* in the drawing. The secondary winding of the transformer is connected to the X-ray tube.

The main circuit includes a main switch *i* which is manually operated to close the circuit. A relay *m* may be also included in the circuit.

Furthermore, the main circuit includes an auxiliary switch *f* comprising a contact lever which is swingable to close or open the main circuit. The contact lever of the switch *f* carries a projection *g* which rides upon the outer side surfaces

of the switching disc *c*. It is apparent that when the disc *c* is in the position illustrated in the drawing, the auxiliary switch *f* is closed. However, as soon as a cut-out portion *n* is moved beneath the projection *g*, this projection following the outlines of the disc *c* will move to the bottom of the cut-out portion *n* moving with it the lever of the switch *f*, with the result that the auxiliary switch *f* will remain open so long as the projection *g* is situated within the cut-out portion *n*.

The relay *m* comprises a switch which is automatically closed as soon as the magnetic coil of the relay is energized.

A time relay *k* is connected in parallel to the main switch *i* and to the switch of the relay *m*, the magnetic coil of the relay *m* being included in the circuit of the time switch *k*. The time switch *k* is of standard construction and comprises pairs of contacts *p* which are separated one from the other after the expiration of a predetermined time interval.

The switch of the relay *m* is operatively connected to another auxiliary switch *o*, (Figure 1) which is closed automatically at the same time when the switch of the relay *m* is closed. The contacts of the auxiliary switch *o* are connected in parallel to the auxiliary switch *f*, so that the switch *f* is short-circuited when the auxiliary switch *o* is closed.

The operation of the device is as follows:

Assume that the main switch *i* is closed by hand at the time when the switching disc *c* is in the position shown in the drawing, so that the auxiliary switch *f* is closed at the time of the closing of the main switch *i*. The magnetic coil of the relay *m* and the circuit of the time relay *k* will be energized, with the result that the magnetic coil will attract the switch of the relay *m* and will cause this switch to close. Then the entire main circuit will be closed and the X-ray tube will be energized, so that the exposure may commence.

Since the auxiliary switch *o* is operatively connected with the switch of the relay *m*, the switch *o* will close at the time when the switch of the relay *m* is closed, thus short-circuiting the auxiliary switch *f*. When, therefore, in the course of the rotation of the switching disc *c* the cut-out portion *n* is moved underneath the projection *g*, thereby causing the auxiliary switch *f* to open, the main circuit of the device will still remain closed, due to the fact that the auxiliary switch *f* has been short-circuited by the switch *o*. Thus the cut-out portions *n* will not influence the operation of the X-ray tube, and the main circuit of the device will be interrupted only by the operation of the time relay *k* after the predetermined period of time necessary for exposure has expired.

If, however, the cut-out portion *n* is situated underneath the projection *g* at the time the main switch *i* is closed, the closing of the switch *i* will not close the main circuit, since the auxiliary switch *f* will remain open. The main circuit will be closed only when the auxiliary switch *f* will be closed, namely, after the cut-out portion *n* has moved beyond the projection *g*.

It is apparent that the switching disc *c* should be so constructed that the position of its cut-out portions *n* bears a certain predetermined relationship to the positions of the diaphragm *a*, which is reciprocated by the cardioid shaped disc *b*. Namely, the positions of the cut-out portions *n* should be such that the auxiliary switch *f* remains open shortly before the diaphragm *a* reaches the end of its path, at the moment when the diaphragm *a* is at at standstill and for a short period thereafter, while it begins its return movement in the opposite direction.

Furthermore, the size of the cut-out portions *n* should be such that when the period of exposure is very short, the time during which the X-ray tube is operated does not coincide at all with those periods of time, during which the diaphragm *a* reverses the direction of its movement.

Due to the described arrangement, the exposure of the diaphragm *a* will take place at times when the diaphragm *a* reverses the direction of its movement only when the total time of exposure, namely, the total amount of time during which the main circuit is closed, is a multiple of the period of time required by the reciprocating diaphragm *a* for reversing its direction of movement.

According to a modified construction shown in Figure 2, the auxiliary switch *o* may be eliminated and may be substituted by an auxiliary relay *q*, which comprises a magnetic coil connected in parallel with the main circuit. This coil may attract a switch which is connected in parallel with the auxiliary switch *f*. In all other respects, the construction is the same as the one just described. When the main switch *i* is switched on, an electrical circuit is established, provided that the auxiliary switch *f* is situated in the position shown in the drawing. The relay *m* is energized, thereby causing a flow of electrical current which will energize the magnetic coil of the relay *q*, with the result that the switch of the relay *q* will be closed. Thus, the auxiliary switch *f* will be short-circuited, so that any subsequent opening of the switch *f* will not affect the main electrical circuit.

As already mentioned, the diaphragm *a* may have the form of a flat body carrying absorbing strips which are centered in relation to the focal point of the X-ray tube, and it may be desirable in some instances to carry out the X-ray work when the diaphragm is at a standstill. In that case, the diaphragm should be situated substantially in the middle of its path, since otherwise the X-ray image may be distorted. Therefore, in accordance with the present invention, a device shown in Figure 3 is provided through the use of which the diaphragm *a* for the secondary X-rays is stopped only at a time when it is situated substantially in the middle of its path. A device of this type may be conveniently combined with the described constructions.

This device comprises a motor *t* which is used for driving the discs *b* and *c* by the shaft *s* and a switch *r* used for the purpose of switching the motor on and off. A contacting device *w* is connected in parallel to the switch *r* and is actuated by cams or similar members *u* which are arranged upon the disc *c* and which are used to interrupt the electrical current operating this motor only when the diaphragm *a* is situated in the middle of its path.

It is apparent that the specific illustrations shown above have been given by way of illustration and not by way of limitation, and that the structures above described are subject to wide variation and modification without departing from the scope or intent of the invention, all of which variations and modifications are to be included within the scope of the present invention.

What is claimed is:

1. The combination of a reciprocable diaphragm for intercepting secondary X-rays and

a main electrical X-ray tube circuit having a main switch; with means connected with said diaphragm for reciprocating the same, said main circuit including an auxiliary switch connected in series with said main switch; means connected with the first-mentioned means and said auxiliary switch to maintain said auxiliary switch open during the reversal of the direction of movement of said reciprocable diaphragm, and means connected with said main circuit for short-circuiting said auxiliary switch when said main circuit is switched on.

2. The combination of a reciprocable diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with means connected with said diaphragm for reciprocating the same, said main circuit including an auxiliary switch connected in series with said main switch; means connected with the first-mentioned means and said auxiliary switch to maintain said auxiliary switch open during the reversal of the direction of movement of said reciprocable diaphragm, another auxiliary switch, and means connecting said auxiliary switch with said main circuit to short-circuit the first-mentioned auxiliary switch when the second-mentioned auxiliary switch is closed.

3. The combination of a reciprocable diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with means connected with said diaphragm for reciprocating the same, said main circuit including an auxiliary switch connected in series with said main switch; means connected with the first-mentioned means and said auxiliary switch to maintain said auxiliary switch open during the reversal of the direction of movement of said reciprocable diaphragm, a relay having a magnetic coil operatively connected with said main circuit, whereby said magnetic coil is energized after the main circuit is closed, and a switch operated by said magnetic coil and connected in parallel with said auxiliary switch, whereby said auxiliary switch is short-circuited when the switch operated by the magnetic coil is closed by the energization of that coil.

4. The combination of a reciprocable diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with means connected with said diaphragm for reciprocating the same, said main circuit including an auxiliary switch connected in series with said main switch; means connected with the first-mentioned means and said auxiliary switch to maintain said auxiliary switch open during the reversal of the direction of movement of said reciprocable diaphragm, and means connected with the first-mentioned means for stopping said diaphragm substantially in the middle of its path of movement.

5. The combination of a diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with a rotary member, means connecting said rotary member with said diaphragm for reciprocating the latter, a member operatively connected with the first-mentioned member; said main circuit including an auxiliary switch engaging the second-mentioned member and connected in series with said main switch, the second-mentioned member actuating said auxiliary switch to cause it to remain open during the reversal of the direction of movement of said diaphragm, a motor connected with at least one of said members for actuating the same, a switch connected with said motor, and a contact device connected with said switch and at least one of said members to interrupt the operation of said motor only when said diaphragm is substantially in the middle of its path of movement.

6. The combination of a reciprocable diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with means connected with said diaphragm for reciprocating the same, said main circuit including an auxiliary switch connected in series with said main switch; means connected with the first mentioned means and said auxiliary switch to maintain said auxiliary switch open during the reversal of the direction of movement of said reciprocable diaphragm and prior to said reversal for a period of time which is a multiple of the time period necessary for said reversal, and means connected with said main circuit for short circuiting said auxiliary switch when said main switch is switched on.

7. The combination of a diaphragm for intercepting secondary X-rays and a main electrical X-ray tube circuit having a main switch; with a rotary member, means connecting said rotary member with said diaphragm for reciprocating the latter, a member operatively connected with the first-mentioned member; said main circuit including an auxiliary switch engaging the second-mentioned member and connected in series with said main switch, the second-mentioned member having cut-out portions formed therein and actuating said auxiliary switch to cause it to remain open during the reversal of the direction of movement of said diaphragm and prior to said reversal for a period of time which is a multiple of the time period necessary for said reversal, a motor connected with at least one of said members for actuating the same, a switch connected with said motor, and a contact device connected with said switch and at least one of said members to interrupt the operation of said motor only when said diaphragm is substantially in the middle of its path of movement.

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