March 13, 1934. J. B. WANTZ 1,950,764

X-RAY APPARATUS

Filed Feb. 28, 1931 2 Sheets-Sheet 1

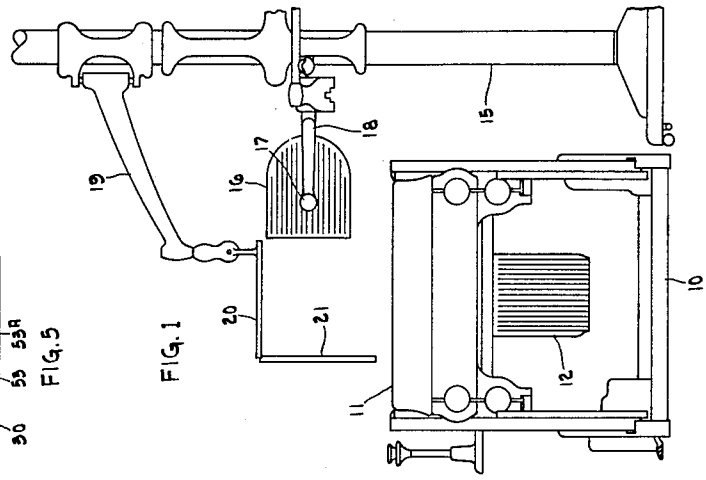


FIG. 1

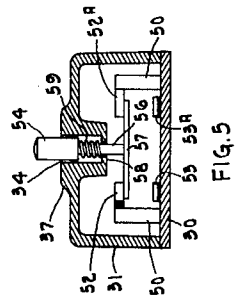


FIG. 5

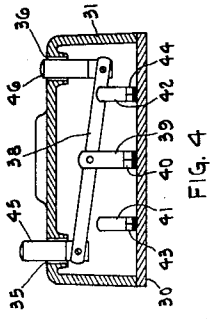


FIG. 4

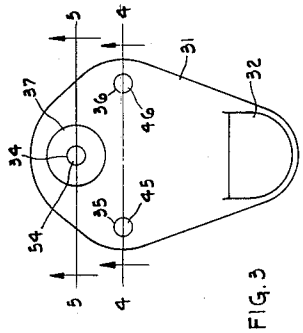


FIG. 3

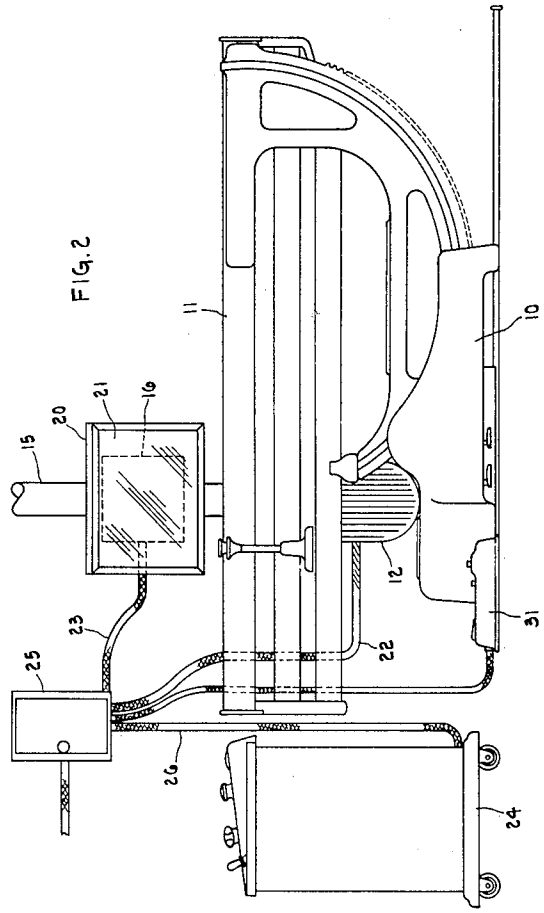


FIG. 2

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March 13, 1934. J. B. WANTZ 1,950,764

X-RAY APPARATUS

Filed Feb. 28, 1931 2 Sheets-Sheet 2

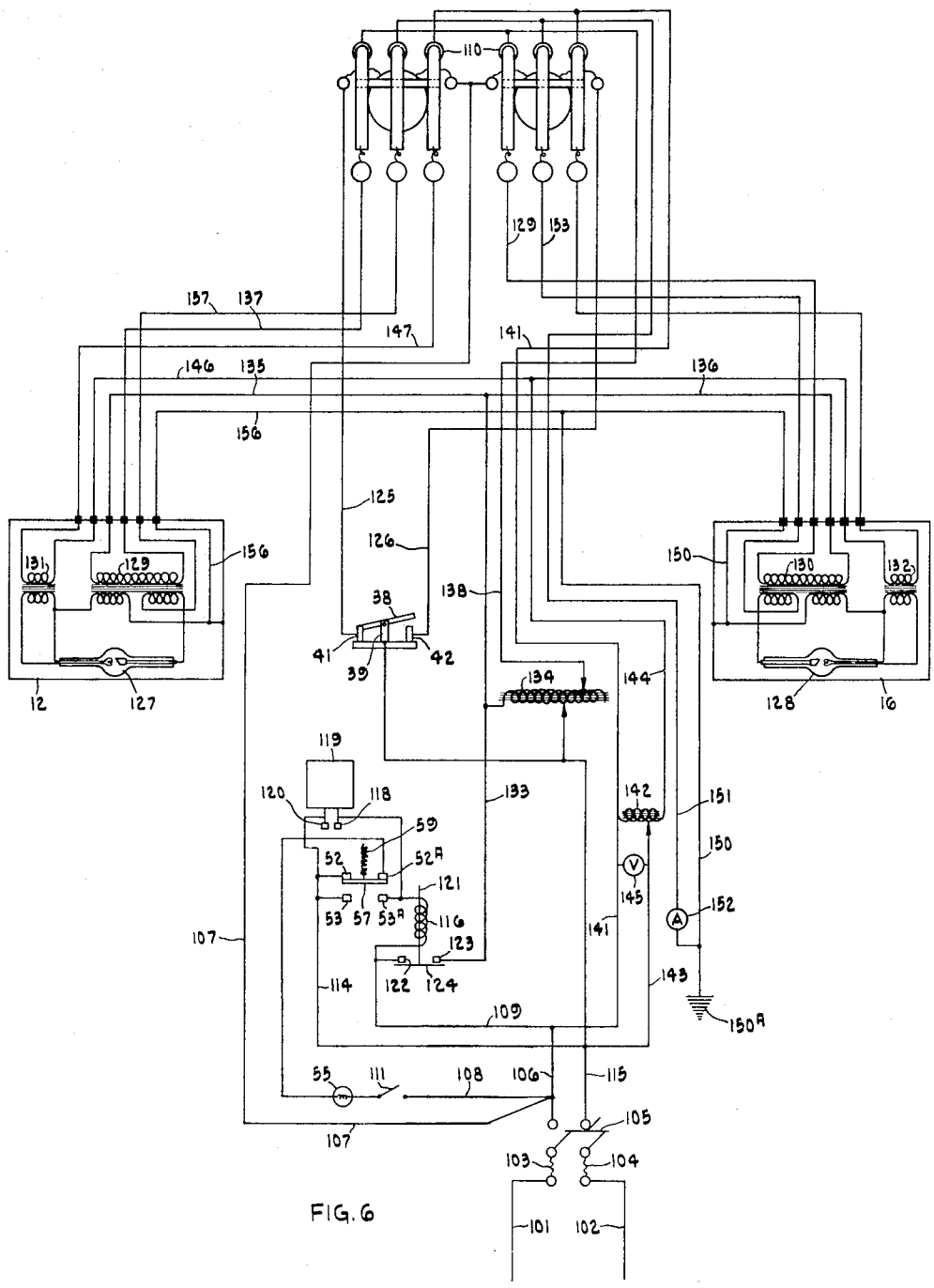


FIG. 6

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X-RAY APPARATUS

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Application February 28, 1931, Serial No. 518,986

3 Claims. (Cl. 250—34)

The present invention relates to X-ray apparatus and has particularly to do with the energization of a plurality of X-ray tubes employed in cross-fire fluoroscopy.

As here shown, the invention relates to a circuit selected for the operation of such plurality of X-ray tubes and to the arrangement of the switch or control members therefor.

At the present time, cross-fire fluoroscopy, as a result of the present invention, is becoming one of the most valuable of X-ray developments in surgery. Anterior to the invention of the present circuit and means for controlling such circuit, cross-fire fluoroscopy was not looked upon with the same favor although its possibilities were conceived.

Included in the objects of the present invention, therefore, is a means whereby tubes used for cross-fire fluoroscopy or the like may be so controlled that only one is generating X-light at any given time, the other X-ray tube being inactive.

A second object of the invention is to provide convenient means for instantly switching the electromotive force used for energizing an X-light system from one X-ray tube to another as required.

A third object of the invention is a novel switch for the control of a plurality of X-ray tubes used in cross-fire fluoroscopy or for other purposes, and particularly adapted for use at the side of an X-ray table.

A further object of the invention is the provision of a new and improved circuit for use in connection with a plurality of X-ray tubes serving a common purpose, as for example, arranged for cross-fire fluoroscopy.

These objects, and such other objects as may hereinafter appear, are obtained by the novel construction, unique arrangement, and improved combination of the several elements illustrated in the accompanying drawings, in which one form of the invention is illustrated.

In said drawings:

Figure 1 is an end elevation, generally schematic, of an X-ray table, a tube stand, fluoroscopic right-angled screens, and two heads holding oil immersed X-ray tubes, one of such X-ray tubes being at the side of the table and above the top thereof, and the other X-ray tube beneath the table; a typical installation;

Figure 2 is a side elevation of a table such as is illustrated in Figure 1, the table, control stand, tube holders, and fluoroscopic screen being more or less schematically shown;

Figure 3 is a plan view of one form which the control switch for the X-ray tube hereinafter described may take;

Figure 4 is a transverse section through said foot switch taken on the line 4—4 of Figure 3;

Figure 5 is a similar section taken on the line 5—5 of said Figure 3; and

Figure 6 is a schematic illustration of a circuit particularly adapted for use in connection with the apparatus described, illustrated in Figures 1 to 5, inclusive.

Like reference characters are used to designate similar parts in the drawings and in the description of the invention hereinafter given.

Reference should be had first to Figures 1 and 2. Upon a base 10 there is provided a tiltable table 11, the structure of which is now conventional in the X-ray art. Suitably mounted for longitudinal movement lengthwise of table 11 is a head 12 which contains an X-ray tube, not shown. There is also in head 12 tube energizing instrumentalities including high tension transformer, and suitable grounding conductors.

At the side of table 11 is a tube stand 15, and disposed thereon for vertical movement up and down said stand is a head 16 similar to or identical with head 12. Head 16 is adjustable angularly at the axis 17 where it is pivoted in the bracket 18. Disposed on stand 15 above the mounting for said head is a fluoroscopic screen holder 19 supporting two fluoroscopic screens 20 and 21, at right angles to one another as illustrated, each angularly adjustable on its own axis and otherwise movable within limitations.

The heads 12 and 16 are energized by the same electromotive force, there being cables 22 and 23 (containing the required insulated electrical conductors) each leading to one of said heads from a common control stand 24. There is conveniently disposed as near the apparatus as is practicable a wall switch in a housing 25 from whence a cable 26 (comprising a flexible covering around a plurality of cables) is connected to control stand 24.

The head 16 at the side of the table 11 is disposed for use with screen 21 and head 12 beneath the table 11 is disposed for use with screen 20. A patient resting upon the top of the table may be under the influence of X-light generated in either of said heads, 12 and 16, such X-light to penetrate the part of patient's body to be examined.

Thus, the X-light generated in the head 12 beneath the table 11 after it shall have pene-

trated the part of the patient under examination will produce a fluorescent image upon the upper and horizontal screen 20, while the X-light generated in the head 16 upon the tube stand 15 and penetrating the same part of the patient (but not conjointly with the X-light from head 12) will produce a fluorescent effect upon the vertical screen 21.

An operator at the side of table 11 may look down upon the upper fluoroscopic screen 20 for one view and by shifting his position may employ the vertical screen 21 for a different view, thus using a cross-fire of X-light for making examinations of fractured bones or the like, the change in view being made concurrently with a switching of the energizing force from one head 12 to the other 16 or vice versa.

While the operator is employing the upper screen 20, X-light, for efficiency's sake, should be generated only in the lower head 12, and while the operator is employing the vertical screen 21, he can only avail himself usefully of the X-light generated in the head 16 upon the vertical stand 15. If both heads 12 and 16 are operating, one tube is unnecessarily operating and shortening its life.

The improved apparatus herein described provides for a rapid and thorough examination of a patient and is highly practicable for setting bone fractures. An examining operator can get in rapid succession without leaving the patient right angle impressions upon the two screens. Quick comparisons of fluoroscopic images at different angles have thus been made possible, without a plurality of tubes conjointly operating. It is this opportunity for an operator to compare images at different angles which makes X-ray cross-fire examination so highly valuable.

Reference should now be had to Figures 3, 4, and 5. In these figures, there is illustrated a switch adapted to be operated by an operator's foot, and which readily may be disposed at the side of the base 10, as shown in Figure 2, of X-ray table 11 for operation without such operator having to move his eyes from the fluoroscopic screen upon which he is visualizing a patient's anatomy until at the instant he may visualize the same part upon the second screen.

The switch comprises a base 30 and a cover or housing 31 thereover and secured to base 30 in a suitable manner. At the rear end of the housing 31 is an operator's heel rest 32, the switch casing being shaped to provide rest 32, the switch casing being shaped to provide ready engagement with the heel of an operator for the purpose of permitting such operator to guide his foot movements in a correct manner without looking away from the fluoroscopic screens 20 and 21.

Through the front end of the housing 31, which end is enlarged, are three apertures, 34, 35 and 36. The central (34) of said apertures may be arranged in a boss 37. The section of the housing 31 having boss 37 as a part thereof may be higher than the remainder of the housing. At each side and to the sides of said central aperture 34 are the remaining apertures 35 and 36, which, as indicated above, are lower than the central aperture 34.

From an examination of Figures 4, and 5, and particularly of Figure 4, taken on the line 4—4 of Figure 3, it will be noted that there is a switch comprising a single blade 38 mounted on a pivot support 39, such support generally being at the center of the blade 38. The mounting 39 therefor, insulated at its base 40 from switch base 30, is a conducting element which is connected to a conductor (not shown) common to both of the contactor circuits illustrated in Figure 6 and subsequently to be herein described.

At each side of said central member 39 are split contacts 41 and 42, suitably insulated on bases 43 and 44 from switch base 30, the blade 38 of the movable contact being adapted to be forced between the split sections of contacts 41 and 42 as selected by the foot movement of the operator. The pivoting of the movable blade 38 is such that said blade cannot be in electrical connection with both side contacts 41 and 42 at any time. Said blade 38 may be moved out of contact with one contact, 41 or 42, and immediately thereafter into contact with the other, but at no time can the movable blade 38 establish conjoint connection with both contacts 41 and 42.

One of said split contacts, 41 or 42, in association with the central blade 38, is arranged for the purpose of establishing a circuit to X-ray head 12 and the other is adapted to establish in combination with said central blade 38 a circuit to the other of said X-ray heads 16.

At each end of said movable blade 38 is pivoted an insulating member, 45 and 46, hereinafter called a switch pedal and which is adapted to extend upwardly through the housing 31, one of these, 45, at one side and extending through aperture 35, and the other, 46, at the other side through aperture 36.

The arrangement of the insulating foot pedals 45 and 46, just described, is such that when the switch is fully closed to establish either circuit, the pedal 45 or 46 is pushed down until its top is substantially level with the top of housing 31, while the opposite pedal projects outwardly of the apparatus a relatively great distance, and sufficient to provide a guide to prevent the operator's foot from slipping therepast when moved across the top of the switch housing. The projecting switch provides a means to indicate to an operator through touch or sight which X-ray tube circuit is closed.

By referring to Figure 5, which is a section taken on line 5—5 of Figure 3, it will be noted that there is disposed upon the base 30 two posts 50. The tops of posts 50 comprise inwardly directed legs terminating in button contacts 52 and 52*a*, one of said posts 50 being suitably insulated from button 52. Immediately beneath said contact members 52 and 52*a* are two additional contacts 53 and 53*a*, suitably insulated from the base 30 of the device.

Contacts 53 and 53*a* form a connectable break in the circuit from a source of power to a switch now being described, the circuit being closed as an incident to establishing a contact across contact buttons 53 and 53*a*. The contacts 52 and 52*a* are in a circuit with a lamp 55 of low intensity common to rooms in which fluoroscopic examinations are being conducted and are engaged only when X-light is not being generated (see Figure 6).

In the aperture 34 in boss 37 there is a foot pedal 54, generally circular in form. Secured thereto is a stem 56. Said foot pedal 54 and/or said stem 56 may both be of insulating material. At the bottom of stem 56 is a strip of contacting material 57. At the base of said boss 37 is a sleeve 58. Intermediate sleeve 58 and the head of foot pedal 54 is a coil spring 59 which is

wrapped around the stem 56 so that strip 57, just described, is normally urged into a position to close the circuit to light 55 and to open the X-light circuit switch, the tendency of spring 59 being to force the foot pedal 54 and the switch member 57 controlled thereby upwardly out of engagement with the contacts 53 and 53*a*.

By pressing upon foot pedal 54, an operator may force said pedal 54 downwardly until the strip connector 57 bridges contacts 53 and 53*a*, thereby establishing a circuit intermediate said contacts 53 and 53*a* and permitting of the flow of current in a selected circuit controlled by the foot pedals 45 and 46, to permit of and cause energization of the X-light circuits in head 12 or head 16.

By the arrangement just described, in combination with the circuit illustrated in Figure 6, an operator resting his foot upon the housing 31 first determines whether he wishes to energize the upper or the lower X-ray tube head 16 or 12. Having determined which of these he desires to employ, the operator presses the proper foot pedal 45 or 46 at the right or the left side of the switch housing 31, if the selected circuit is not already established, and he thereafter energizes the selected tube circuit by pressing upon the central switch member 54.

In order to change the energization from one head to the other, the operator releases the spring foot pedal 54, thereby deenergizing the previously operating circuit entirely, and presses the raised foot pedal in housing 31, thereby changing the closable X-ray circuit from one head to the other head. The operator thereafter presses the central foot pedal 54 to close the circuit and to energize the selected head. As the head energizing switch is adapted to move to an open position the instant that pressure is released therefrom, neither tube in the circuit is energized except when the operator so arranges therefor by manual operation, and under no conditions is more than one tube energized at any one time.

Reference will now be had to Figure 6, a schematic representation of the improved circuit for the heads 12 and 16. Such circuit comprises leads 101 and 102 from a source of alternating current energy of suitable voltage to fuses 103 and 104. At the end of the fuses is a double pole switch 105 and the contacts therefor. A left hand conductor 106 leading therefrom has several forks 107, 108 and 109 leading therefrom as follows.

Through the conductors 106 and 107, one line runs to a central binding post of two three-pole contactors 110. By way of conductors 106 and 108, through a switch 111, a circuit to the indicating light 55 is formed, the circuit being fixed contact 52*a*, movable strip contact 57 actuated by a spring 59, fixed contact 52, the contacts 52*a*, 57 and 52 normally being in contact, and conductors 114 and 115. When strip contact 57 is in upper position, the ends of the strip 57 engage contacts 52 and 52*a* to close the circuit to light 55. Separation of contacts 52 and 52*a* when contact 57 is depressed prevents the flow of current to light 55.

From conductor 109 in connection with one end of a coil 116, a circuit extends through said coil 116, the conductor at the other terminal of said coil being bifurcated, one leg terminating in contact 53*a* and the other leg running to a contact 118 of a time switch 119. In the time switch 119, there is a second contact 120 which is connected to conductor 114 which runs to conductor 115 in the other side of the alternating current lines. When contacts 118 and 120 are brought together by time switch 119, the coil 116 is energized to move the armature 121 by drawing strip contact 124 into contact with contacts 122 and 123, said strip 124 being moved with armature 121 of which it is a part.

The foot switch enclosed in housing 31 is arranged to have its contacts 53 and 53*a* connect the conductors 114 and 109 by the use of strip 57 through the coil 116 when the time switch 119 is not employed and such floor switch, forming a part of the subject matter of this application for Letters Patent, is in use. When the circuit thus established therethrough is closed, the circuit is from one side of the alternating current line to the coil 116, through the switch contacts 53*a*, 57 and 53, and to the other side of the alternating current line. Said foot switch is spring actuated for the purpose of keeping the subdued light circuit closed and to prevent the X-ray tube circuit from being closed except by manual operation as an incident to placing pressure upon foot pedal 54.

Whenever the coil 116 is energized, contactor 124 is brought into physical connection with the two separated buttons 122 and 123. Thereupon, either the system of X-light generation at one side of the drawings (Figure 6) or the other system of X-light generation at the other side of the drawings is energized. The system which is energized is determined by the position of switch 38 which is so arranged so that it can establish a circuit to one head of the apparatus at a time, the other X-ray head or other side of the circuit not being energized.

The operation of the foot switch, which is adapted to be controlled by the toe of the operator's foot or in any other suitable way, governs the circuits now to be described. A conductor runs to the centre contact 39 in the foot switch. At either side of said center contact 39 is a part of blade 38. As shown blade 38 is in connection with contact 41. From contact 41, conductor 125 runs to one side of the operating coil of one of the three-pole contactors 110 (Figure 6). The circuit extends through the operating coil therein, to a central binding post for said three-pole contactors, from where a conductor 107 goes directly to the opposite side of the alternating current source.

If the foot switch is changed so that contact 38 engages post 42, then the circuit is from conductor 115 at one side of the alternating current source to the center contact 39, through the switch member 38 to the contact 42, by a conductor 126 to one side of the operating coil of the other of the three-pole contactors 110 through the operating coil therein to the center binding post for said contactors, and through conductor 107 to the other side of the alternating current source.

At this point, it is well to remark that the switch hereinabove described as operated by pedals 45 and 46 controls circuits which are in no way dependent upon a switch actuated by time switch 119 or by foot pedal 54 heretofore described. The selection of an X-light circuit to be employed is arranged preliminary to the energization of an X-ray circuit and by an independent electrical circuit and by circuits which are selectively energized whenever the hand switch 105 is closed.

By the system of wires and the circuit herein

shown, while only one X-ray head may be energized at any time, many of the conductors or wires are common, thus saving much in the way of material and labor in the carrying out of the scheme of X-ray tube operation and of course making the manufacture of the device a relatively simple matter.

In each of the heads 12 and 16, the former at the left-hand side and the latter at the right-hand side of Figure 6, is an X-ray tube (127 and 128), a high tension transformer (129 and 130) having a split secondary, and a filament current transformer (131 and 132).

The circuit to the high tension transformers is as follows: conductor 106, through the two contacts 122 and 123 by conductor 133 to one terminal in an auto transformer 134 and from thence to a bifurcation in the line from which two conductors branch, one (135) going to the left-hand terminal of high tension transformer 129 in the left-hand head 12, and the other (136) to the right-hand terminal of the high tension transformer 130 in the right-hand head 16.

From the right terminal of the left-hand high tension transformer 129, a conductor 137 runs to the left-hand contact of the left-hand three-pole contactor 110 and therethrough by way of conductor 138 to said auto-transformer 134. The left-hand terminal of the right-hand high tension transformer 130 connects with conductor 129 to the left-hand contact of the right-hand three-pole contactor 110 and then through the conductor 138 to auto-transformer 134. The circuit to auto-transformer 134 is by way of conductor 115 to one terminal thereof and to the other side of the alternating current source of power by conductor 133 connected to the other terminal thereof.

For the purpose of energizing the filament current transformers, there is a circuit by way of conductor 106 and 141 from one side of the line to one terminal of an auto-transformer being connected to conductor 143 in electrical connection with conductor 115. The secondary current from said auto-transformer 142 includes circuit 141 to the right-hand contact of the right-hand three-pole contactor 110 through which the current may flow to one terminal of one terminal of the filament transformer 132 in the right-hand head 16. From the other terminal of the primary of said filament transformer 132, the circuit is to the other terminal of the auto-transformer 142 by way of conductor 144.

Across the conductors 141 and 143 of the filament current transformer circuit there is a volt meter 145 to indicate the voltage impressed upon the auto-transformer 142.

The conductor 141 extends to the left-hand three-pole contactor 110, and to the filament current transformer 131 in the left-hand X-ray head 12, and from said filament current transformer 131 by way of conductor 146 and conductor 144 to auto-transformer 142.

The primary circuits to the heads 12 and 16 having been described, the secondary circuit in said heads now will be traced. As previously stated, the secondaries of the high tension transformers 129 and 130 are split. One section thereof has a terminal connected to a conductor leading to the anode of the X-ray tube in the head. The other terminal is connected to the cathode of said tube. The centers of said sections of the secondary are grounded upon the casing forming the head, one being electrically connected to a conductor 150 which is grounded at 150*a* externally of the apparatus.

The conductor 150 so grounded is in electrical connection with a second conductor 151 in which a milliammeter 152 is disposed, said conductor 151 extending to the intermediate contactor of the right-hand three-pole contactor 110 and therethrough by way of conductor 153 to the other section of said secondary coil.

A similar circuit is provided in the left-hand X-ray head 12. The circuit is from the centers of the secondary coil of high tension transformer 129 to the head where said secondary is grounded, there being in association with said ground circuit, a conductor 156 connected to conductor 150, and conductor 151 extending, as previously described, to the intermediate contact of the left-hand three-pole contactor 110, therethrough by way of conductor 157 to the left-hand central terminal of the right-hand section of the secondary of the high tension transformer 129.

The filament transformer within each head is connected to a filament within the cathode of each tube, one leg of the circuit thereto being independent of the high tension circuit, and the other leg of such filament circuit being common to the high tension conductor to the cathode.

From the foregoing, it will be seen that when the switch 38 is in the position shown in the schematic diagram of the circuit (Figure 6), only the left-hand X-ray head 12 is in circuit; and that when the left-hand X-ray head is in circuit, the right-hand head 16 is inactive. When the position of the switch 38 is changed, then the right-hand head 16 is in circuit and the left-hand head 12 is inactive.

Thus, there is provided a relatively simple electrically actuated circuit which may be controlled from any convenient point by a low tension means adapted to shift the contacts in the circuit for establishing a selective energization in respect to two wholly independent X-light heads, and in which only one of the heads may be energized at a time. Such energization is rapidly obtained and readily controlled from a foot switch adjacent to an X-ray table in a convenient position, or from a hand switch placed at any convenient point on the table to replace such foot switch, such hand switch to have levers readily operable by the hand to take the place of the pedal members employed in a foot switch.

I claim:

1. X-ray apparatus comprising two independently operable X-ray tubes having a single source of energy, a single means for controlling such energy, a selector switch, and a single main switch, in combination with a container for each X-ray tube having oil insulation and a tube energizing instrumentality therein, a primary circuit for each tube including the primary of the tube energizing instrumentality associated therewith, said source of energy, said means for controlling said source of energy, and said main switch, and a secondary circuit from said high tension energizing instrumentality and including the tube associated therewith, said primary circuits and said secondary circuits having connectors therein for the opening and closing of such circuits, the connectors in the circuits relating to each tube being grouped together, means for the conjoint operation of the connectors in each group, and circuits to said operating means, one circuit including the operating means for one group of connectors, said

source of energy, and said selector switch, and the other circuit including the operating means for the other group of connectors, said source of energy and said selector switch.

2. X-ray apparatus comprising two independently operable X-ray tubes having a single source of energy, a single auto transformer for controlling such energy, a single filament current regulator, a selector switch, and a single main switch, in combination with a container for each X-ray tube having oil insulation and tube energizing instrumentalities therein, the latter comprising a high tension transformer and a filament current transformer, a primary circuit for each tube including the primary of the high tension transformer associated therewith, said source of energy, said auto transformer, and said main switch, a secondary circuit from each high tension transformer and including the tube associated with said high tension transformer, and the secondary of said high tension transformer, a primary filament current circuit for each filament current transformer including said source of energy, said filament current regulator, and the primary of the filament current transformer, and a secondary filament current circuit for each tube including the filament in the tube, and the secondary of the filament current transformer in the container therewith, said primary circuits, said secondary circuits, and said filament current primary circuits having connectors therein for the opening and closing of such circuits, the connectors in the circuits energizing each tube being grouped together, means for the conjoint operation of the connectors in each group, and circuits to said operating means, one circuit including the operating means for one group of connectors, said source of energy, and said selector switch, and the other circuit including the operating means for the other group of connectors, said source of energy and said selector switch.

3. X-ray apparatus comprising two independently operable X-ray tubes having a single source of energy, a single auto transformer for controlling such energy, one current measuring device for indicating the energy impressed upon each of said tubes when energized, a single filament current regulator, a selector switch, and a single main switch, in combination with a container for each X-ray tube having oil insulation and tube energizing instrumentalities therein, the latter comprising a high tension transformer, a primary circuit for each tube including the primary of the high tension transformer associated therewith, said source of energy, said auto transformer, and said main switch, a secondary circuit from each high tension transformer including said current measuring device, the tube associated with said high tension transformer, and the secondary of said high tension transformer, a primary filament current circuit for each filament current transformer including said source of energy, said filament current regulator, and the primary of the filament current transformer, and a secondary filament current circuit for each tube including the filament in the tube, and the secondary of the filament current transformer in the container therewith, said primary circuits, said secondary circuits, and said filament current primary circuits having connectors therein for the opening and closing of such circuits, the connectors in the circuits energizing each tube being grouped together, means for the conjoint operation of the connectors in each group, and circuits to said operating means, one circuit including the operating means for one group of connectors, said source of energy, and said selector switch, and the other circuit including the operating means for the other group of connectors, said source of energy and said selector switch.

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