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X-RAY SYSTEM

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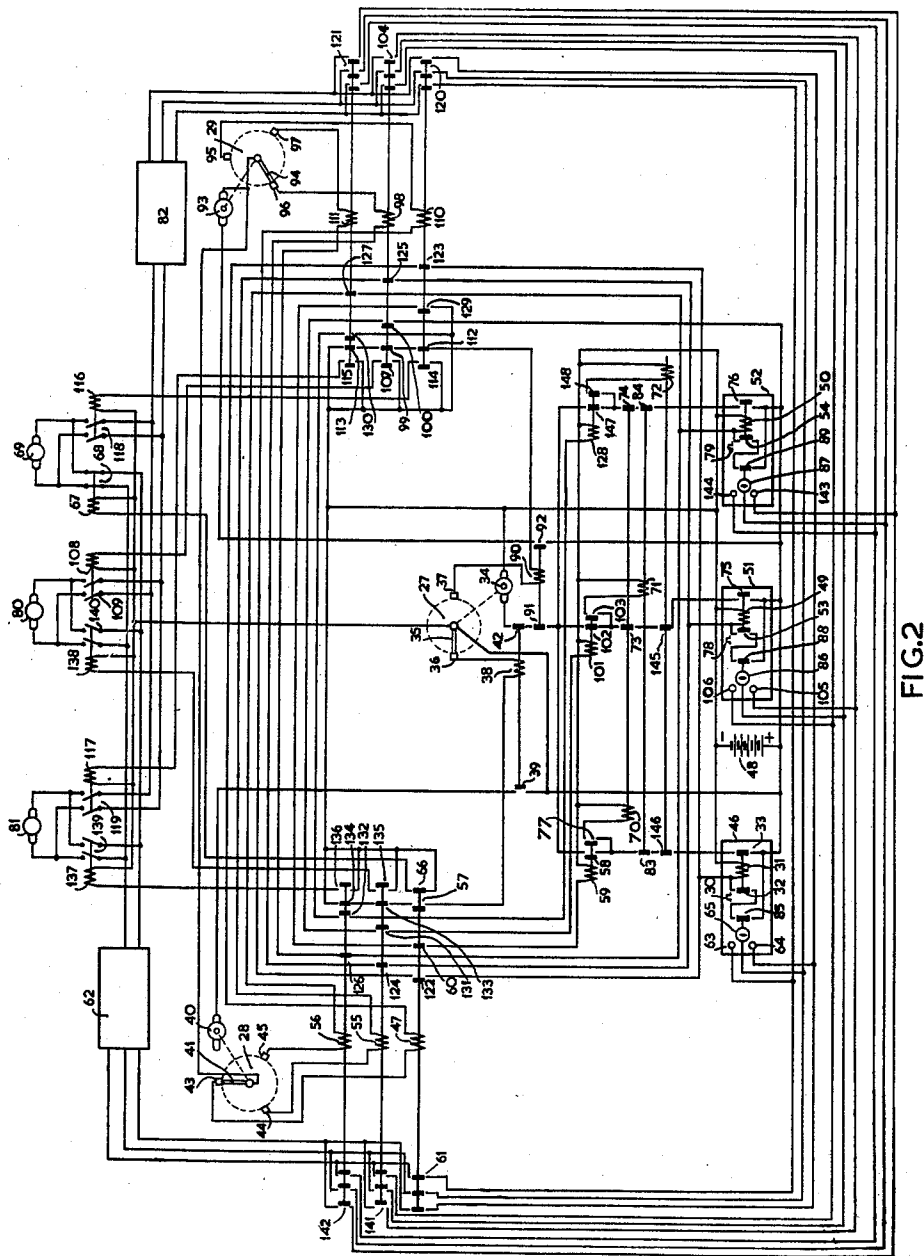


FIG. 2

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## X-RAY SYSTEM

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8 Claims. (Cl. 250—94)

The present invention relates to a system for examining symptoms of disease by means of X-rays. Usually such a system comprises a number of apparatus of various kinds and sizes and it must be adapted not only to routine examinations and the making of radiographs of common biological disorders but also to perform less frequent specialistic examinations.

In systems of sufficient extent to satisfy all requirements all the apparatus will hardly ever be used simultaneously. In addition, the periods during which the various apparatus is used are widely different. Some apparatus will be used frequently while other apparatus is used comparatively or even absolutely seldom. Hence the effective usefulness of the separate apparatus is widely different.

X-ray apparatus is known comprising a high-voltage generator and a control-desk which contains the regulating members for adjusting the tube loads, while high-voltage switches are used by means of which at least two X-ray tubes can be separately and not simultaneously connected to the high-voltage generator. Thus the patients can be distributed over a number of treatment rooms. While at one point the making of a radiograph is being prepared, the generator can be connected to another tube to make a radiograph. Thus, the supply part of the apparatus is used to better advantage. This method has a limitation, however, in that in the case of fluoroscopy the generator is monopolized by one of the tubes for a long period of time, so that radiography by means of the other tubes is delayed.

If in a system comprising a common generator and a control desk for at least two X-ray tubes each tube is arranged in a separate room, the doctor treating the patients cannot himself operate the regulators on the control desk for adjusting the tube current, the anode voltage and the loading periods, so that instructions must be passed on to an assistant stationed at the desk.

Another method of adjusting the regulators consists in a use of remote control by means of servo-motors which are operated from the point at which the X-ray tube is disposed.

In a system comprising a common generator and control devices for supplying a number of X-ray tubes it is known to perform remote control by means derived from automatic telephony. Each X-ray tube is associated with a contact plug of a connecting lead. To each contact plug there can be connected a telephone dial by which, through the connecting lead, signals are supplied to members which are disposed close to the regulating devices and operate them for the adjustment of the current and the voltage by which, and of the time during which, the X-ray tube is loaded.

At any time, only a single X-ray tube must be connected to a high-voltage generator and the associated regulating device. Large systems require a number of high-voltage generators.

The present invention relates to a system comprising at least two high-voltage generators and a larger number

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of X-ray tubes, in which each X-ray tube can be connected to each generator by means of a switching arrangement which prevents a generator from being connected simultaneously to two or more X-ray tubes and an X-ray tube from being connected simultaneously to two or more generators. For this purpose, use is made in a known switching arrangement of a panel on which are mounted for each tube a group of jacks and of relays equal to the number of generators, the energizing windings of these relays being connected to the jacks. By means of a contact plug the jacks of a group are connected to the supply lead so that the relays concerned are energized and cause an X-ray tube to be connected to one of the generators. The jacks of the remaining relays, which control the connection of another X-ray tube to the same generator, are cut-off in this event.

This known system has a limitation in that the selection of a combination of an X-ray tube and generator must be effected on a panel which is arranged centrally of the system and consequently remote from at least part of the X-ray tubes. This limitation is avoided by the invention. According to the invention, each X-ray tube is associated with at least one operating device provided with a control member, the switching arrangement containing a selecting arrangement of the kind used in automatic telephony which is operated by the control member so as to establish a connection between the operating device and a generator which is not yet occupied by an X-ray tube with the result that the X-ray tube is connected to this generator.

This operating device may include the generator regulating device also. Such a device is bulky and consequently not readily transportable. A lighter construction is obtained by combining the regulating devices with the high-voltage generators and providing the operating devices with at least one member for remote control of the regulating device, this member or these members being connected by the selecting arrangement to the regulating device of the generator to which the associated X-ray tube is connected.

The operating device may be provided with a telephone dial which provides the electric pulse trains by means of which the required adjustments of the regulating device are obtained. A dial has the disadvantage that the adjustments effected do not remain visible. For this reason push buttons or sliding buttons are preferred. These buttons may operate servo-motors which adjust the regulators to the required positions.

In order to connect the generators to the X-ray tubes, each X-ray tube can be associated with a number of high-voltage switches, one for each generator, the X-ray tubes being connected to one of the inputs of each associated switch while the generators are connected to the other inputs. The switches can be operated through a connection established by the selecting arrangement.

In order that the invention may readily be carried into effect, three embodiments thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a schematic block diagram of an embodiment of the system of the present invention comprising three generators and five X-ray tubes;

Figure 2 is a schematic diagram of another embodiment of the system of the present invention; and

Figure 3 is a schematic block diagram of still another embodiment of the system of the present invention.

In Figure 1, reference numerals 1, 2 and 3 designate generators and reference numerals 4, 5, 6, 7 and 8 denote X-ray tubes. It is assumed that the generators are combined with regulating devices for adjusting the tube currents, the anode-voltage and the loading periods. The X-ray tubes are connected to the generators through high-

voltage switches. The crossing points of connecting leads 9, 10 and 11 from the generators and of leads 12, 13, 14, 15 and 16 to the X-ray tubes indicate the points at which high-voltage switches are provided.

Each X-ray tube is associated with an operating device 17, 18, 19, 20 and 21 provided with a controller, for example, a push button. The operating devices are connected to a selector 23 by leads 22. The selector is connected to the generators 1, 2 and 3 by leads 24 for operating the regulating devices and, by leads 25, to high-voltage switches 26 which are electrically operated by the selector.

Fig. 2 shows an embodiment of a system comprising two generators and three X-ray tubes, the selecting arrangement of the system comprising a main rotary selector 27 and two auxiliary rotary selectors 28 and 29. Each auxiliary selector operates a generator so that, if more generators are used, the number of auxiliary selectors must be increased accordingly. The main selector 27 has a number of pre-determined positions, one for each auxiliary selector.

The main selector 27 is operated by means of controllers. The number of controllers is equal to that of the X-ray tubes. It is assumed that the controllers are incorporated in operating devices adjacent the X-ray tubes. When a push button 30 is pushed in, a taking-over relay 31 is energized. The push-button 30 can be released without the relay being released. A contact 32 bridges the push-button switch 32. The taking-over relay 31 closes another contact 33 which is connected in the circuit of a motor 34 which drives a rotary arm 35 of the main selector 27. The rotary arm 35 has two positions in which contact can be made with fixed contact members 36 and 37. The contact 36 serves to operate the auxiliary selector 28 and the other contact 37 operates the auxiliary selector 29. If a larger number of generators and consequently of auxiliary selectors are used, the number of fixed contact points must be increased accordingly. When the rotary arm 35 is moved, it is enabled first to come into contact with the contact piece 36 and to complete the circuit of a relay 38. This relay operates a contact 39 in the current supply lead to a motor 40 of the auxiliary selector 28. When the relay 38 is energized, the motor 40 drives a switch arm 41. The relay 38 also operates a contact 42 in the circuit of the motor 34 of the main selector 27 and, when the relay 38 is energized, this contact breaks the circuit. The relay may not be energized, in which event the arm 35 rotates on to the contact piece 37. The reason why the relay 38 should not be energized will be discussed hereinafter.

The motor 40 rotates the arm 41 of the auxiliary selector 28 past three contact pieces 43, 44 and 45. Each of these contact pieces corresponds to an operating device and the associated X-ray tube. The contact piece 43 co-operates with an operating device 46 through a relay winding 47 one end of which is connected to the contact piece while the other end is connected, through a current supply lead, to the taking-over contact 32 of the relay 31 in the operating device 46. When this taking-over device is closed, the winding 47 is connected to the positive terminal of a voltage supply 48.

Similarly, relays 49 and 50 of operating devices 51 and 52 are connected to the other contact pieces 44 and 45 of the auxiliary selector 28 and to taking-over contacts 53 and 54 of these operating devices.

When during its rotary movement the arm 41 of the auxiliary selector 28 comes into contact with the contact piece 43, the winding 47 is energized because current is supplied through the closed taking-over contact 32 of the relay 31. When the arm passes the other contact pieces 44 and 45 nothing happens, since the taking-over contacts 53 and 54 in the circuits of the corresponding relays 49 and 50 are not closed or one of these circuits is broken when one of the remaining operating devices has operated the associated X-ray tube through the other auxiliary selector 29.

When the push-button switch 30 is pushed-in, the winding of the taking-over relay 31 is energized and the contact 32 is closed. This contact is connected in parallel with the push-button switch 30 which is again released.

The relay 31 also closes the contact 33, the motor 34 is started and has moved the rotary arm 35 of the main selector 27 to the position shown. It is assumed that this arm has not previously made contact with the contact piece 37, for in this event, if none of the X-ray tubes is operative, the arm remains on this contact piece. Due to the fact that the relay 38 is energized, the contact 39 completes the circuit of the motor 40 of the auxiliary selector 28 and the contact 42 breaks the circuit of the motor 34 of the main selector 27. The rotary arm 41 of the auxiliary selector 28 is rotated by the motor 40 past the contact pieces of this auxiliary selector, further switching manipulations being effected only by the arm contacting the contact piece 43. In this position the circuit including the winding of the relay 47 is closed. When this winding is energized, the relay is moved to the operative position, as is shown in Fig. 2. The relay switch operates a contact 57 in the circuit of the relay 38 so that this relay returns to the initial position. The contact 39 is opened, so that the circuit of the motor 40 is broken and the arm 41 remains in the position shown. In order to prevent the motor 34 of the main selector 27 from being operated again by the closure of the contact 42 of the relay 38, there is connected in the circuit of the contact 33 of the taking-over relay 31 a contact 58 of a relay 59 the energizing winding of which is fed through a contact 60 of the relay switch 47. In the operative position, this contact is closed and the relay 59 is brought in the operative position so that the contact 58 breaks the circuit of the motor 34. Thus, the release of the relay 38 does not switch the motor 34 into circuit again, however, it can be switched in if the contact 58 of the relay 59 is bridged due to the fact that the push-button switch of one of the remaining operating devices is pushed in.

Furthermore, the relay switch 47 operates a three-pole switch 61 for completing three circuits between a generator 62 and the operating device 46. Through these circuits the regulating devices of the generator 62 for adjusting the load of the X-ray tube can be remotely controlled by means of the operating device. The current and voltage can be selected through two leads by means of adjusting buttons 63 and 64 on the operating device with the aid of known arrangements for remote control which are not shown in the drawing. Reference numeral 65 denotes a time adjusting device which controls the starting of the generator.

The relay switch 47 also operates a switching contact 66 which can complete the circuit in which the energizing winding 67 of a high-voltage switch 68 is connected. By means of the high-voltage switch 68 and X-ray tube 69 is connected to the generator 62.

Some safety steps must be taken to prevent two X-ray tubes from being connected to the same generator or two generators from being connected to the same X-ray tube. When an operating device is actuated by one of the push-button switches, the connections of the two remaining operating devices to the motor 34 of the main selector 27 must be interrupted temporarily. This is effected by relays 70, 71 and 72. The relay 70 is energized immediately when the taking-over relay 31 is operated by means of the push-button switch 30. The relay 70 operates contacts 73 and 74 which are included in the circuits of the motor 34 which are connected to the taking-over relays 49 and 50 through contacts 75 and 76. When the switch 30 is pushed in, these circuits are immediately broken by the contacts 73 and 74. In order to enable the other operating devices 51 and 52 to be operated after the generator 62 has been connected to the X-ray tube 69, which is selected by the push-button 30, the contact 60 of the relay switch 47 interrupts the current through the winding 59 so that not only the

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contact 58 but also the contact 77, which is operated by this relay, are opened in the circuits of the relay 70. Hence, the relay 70 is released and the contacts 73 and 74 are closed. Now, one of the two remaining X-ray tubes 80 and 81 can be connected to a second generator 82 by pushing-in one of the push-buttons 78 and 79 of the operating devices 51 and 52.

The further operation is similar to that described hereinbefore. If, for example, the push-button 78 is pushed in, the taking-over relay 49 closes the contacts 53 and 75. Consequently, the push-button can be released immediately. Thus, the relay 71 is energized and contacts 83 and 84 in the current-supply leads from the two remaining operating devices 46 and 52 to the motor 34 are opened. The circuit in which the contact 75 of the taking-over relay 49 is operative, however, is closed and the motor 34 starts to move the arm 35 so that this arm leaves the contact piece 36 and is rotated until it reaches the contact piece 37.

It is true that by pushing-in the third push button 79 the corresponding taking-over relay 50 is energized, however, this has no further effects in this control circuit. The contact 76 of the taking-over relay 50 is closed but the motor 34 of the main selector 27 starts only after one of the other circuits has been rendered inoperative, that is to say, when the making of a radiograph by one of the two tubes which were already switched into circuit is completed and the control circuit concerned has been rendered inoperative. When the tube is no longer loaded, the current in the energizing winding of the taking-over relay concerned is interrupted temporarily. This interruption is effected by a contact 85 connected in the circuit of the relay 31 of the operating device 46, which contact is coupled to the timing switch 65 so that at the end of the load period the contact is opened for a short period of time. In the remaining operating devices, time switches 86 and 87 are coupled to contacts 88 and 89 respectively.

When the arm 35 of the main selector 27 has reached the contact piece 37, the winding of a relay 90 is energized and a contact 91 switches the motor 34 out of circuit. A contact 92 completes the circuit for a motor 93 of the auxiliary selector 29 and this motor rotates an arm 94 past contact pieces 95, 96 and 97, the winding of a relay switch 98 being energized by the arm contacting the contact piece 96. Then, a switching contact 99 interrupts the current flowing through the relay 71 so that the motor 93 stops and the arm 94 remains on the contact piece 96. A contact 100 on the armature of the relay switch 98 establishes a connection to a relay 101. This relay operates a contact 102 in the current supply lead to the motor 34, which is thus switched out, and a contact 103 in the circuit of the relay 71. By interrupting the energizing current in this relay, the contacts 83 and 84 in the leads connecting the operating devices 46 and 53 to the motor 34 of the main selector are closed. Consequently, this motor can be started again by means of a push-button switch on one of these devices.

The relay 98 switches a three-pole switch 104 into circuit. This switch makes the connections between the operating device 52 and the generator 82. On the device 52 there are mounted knobs 105 and 106 for adjusting the voltage and current when loading the X-ray tube 80.

The relay 98 also operates a contact 107 by means of which it switches on the energizing current of a relay 108 which operates a high-voltage switch 109. Through this switch the X-ray tube 80 is connected to the generator 82.

Thus, in the present case, the X-ray tube 69 and subsequently the X-ray tube 80 are connected to a generator. If meanwhile the third push-button 79 has been pushed-in also, the taking-over relay 50 associated therewith takes over the connection and keeps the device prepared for connection of the tube 81 to one of the generators

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62 and 82 as soon as one of the tubes 69 and 80 is switched off. To the fixed contact pieces 95 and 97 of the auxiliary selector 29 are connected relays 110 and 111 associated with operating devices 46 and 52. The relays 110 and 111 operate contacts 112 and 113, respectively, which have the same function as the contact 99 of the relay 98. The relays further operate contacts 114 and 115 in the circuits of the relays 116 and 117 of high-voltage switches 118 and 119. These high-voltage switches are connected to the generator 82. This generator can be connected to operating devices 46 and 52 by means of three-pole switches 120 and 121 which can be operated by the relays 110 and 111.

When the contact arm 94 passes over a fixed contact piece to which a relay is connected which switches on an X-ray tube which is already connected to a generator by the other auxiliary selector, it must be certain that this relay is not energized. For this purpose, the armature of the relay is provided with another contact which is connected in the circuit of the corresponding relay connected to the other auxiliary selector. The relay 47 of the auxiliary selector 28 is associated with the same operating device 46 as the relay 110 of the auxiliary selector 29. When the relay 47 is in the operative position, the circuit of the relay 110 is broken by means of contact 122. Conversely, when relay 110 is in the operative position, the circuit of relay 47 is broken by a contact 123 of relay 110. This prevents the two generators from being both connected to the X-ray tube 69. The X-ray tube 80 is protected in the same manner in that the relay 55 includes a contact 124 in the circuit of the relay 98 and the latter relay has a contact 125 in the circuit of the relay 55. Furthermore, the relay 56 has a contact 126 in the circuit of the relay 111 and the latter relay a contact 127 in the circuit of the relay 56.

The relays 110 and 111 and the relays 55 and 56 also operate contacts 129, 130, 131 and 132 in the circuits of the relays 59, 101 and 128 similarly to the operation of contacts 60 and 100 of relays 47 and 98 in the circuits of relays 59 and 101 respectively.

The relays 55 and 56 are also provided with contacts 133 and 134 which similarly to the contact 57 of the relay 47 are operative in the circuit of the relay 38. In addition, relay 55 and 56 have further contacts 135 and 136 respectively. These contacts are connected in the circuits of relays 137 and 138 which operate high-voltage switches 139 and 140. Furthermore, relays 55 and 56 are provided with three-pole switches 141 and 142 for connecting operating devices 51 and 52, respectively, to the generator 62. The load is adjusted by adjusting knobs 143 and 144 on the operating device 52.

The X-ray tube 81 is rendered operative by means of the operating device 52 when one of the generators becomes available and the push-button 19 has switched in the taking-over relay 50. By the subsequent energization of the relay 72 the connections of operating devices 46 and 51 to the motor 34 of the main selector are broken at 145 and 146. The motor 34 is started and rotates the arm 35 over the contact pieces 36 and 37 of the main selector 27. If both generators are operating, the relays 38 and 90 are not energized since in this event the current supply leads to these relays are interrupted. However, when one of the generators 62 or 82 becomes available, the arm remains on one of the contact pieces the circuit of which is completed at that instant through the relay 38 or the relay 90. Then one of the auxiliary selectors is rotated until either in the auxiliary selector 28 a connection is established to the relay 56 or in the auxiliary selector 29 a connection is established to the relay 97. When these relays have been made operative by contacts 132 or 130, the circuit of the relay 128 is completed so that by means of contacts 147 and 148, which are operated by this relay, the circuit of the motor 34 is interrupted, while the circuits by which this motor is connected to the other operating devices are again com-

pleted due to the fact that the relay 72 is rendered inoperative.

In the system described the number of X-ray tubes exceeds the number of generators by one, so that the X-ray tubes cannot be used all together. Therefore, preferably a signalling device is added to each operating device, for example, by providing another contact on each of the relays 47, 55, 56, 98, 110 and 111 so that, if one of the relays is in the operative position, a signalling device is actuated. The number of possible switching positions can be further increased if the regulating devices are not fixed to the generators but are exchangeable with respect to these generators while the selecting arrangement selects not only a free regulating device but also a free generator, the closure of the high-voltage switch of a certain tube being associated with the establishment of the connection between the generator selected and the regulating device selected. In this case, the selecting arrangement must comprise a second set of auxiliary selectors which serve to provide separate connections between the generators and the regulating devices.

Such a system is shown by the block-schematic diagram of Fig. 3. The generators are designated by 150, 151 and 152, the X-ray tubes by 153, 154, 155 and 157 and the regulating devices by 158, 159, 160 and 161. The generators are connected to the X-ray tubes through high-voltage switches which are indicated at the crossing points of the connections between the generators and the X-ray tubes. The generators can be connected to the regulating devices by means of relay switches provided at the crossing points of the connecting leads.

Each X-ray tube is associated with an operating device 162, 163, 164, 165 and 166 provided with a controller. The operating devices are connected to a selecting arrangement 168 by leads 167. The selecting arrangement 168 is connected by leads 164 to regulating devices 158, 159, 160 and 161. In addition, the selecting arrangement 168 is connected to electromagnetically operated high-voltage switches 170 by leads 171 for supplying the energizing current. Finally, the selecting arrangement 168 is connected by leads 172 to relay switches 173 by which the regulating devices 158, 159, 160 and 161 can be connected to the generators 150, 151 and 152. The relay switches 173 are electrically operated by the selecting arrangement 168.

In order to enable an X-ray tube to become operative, the selecting arrangement must be actuated by means of the controller associated with the tube concerned. The selecting arrangement establishes a connection between one of the regulating devices through leads 169 so that the adjustments required for loading the X-ray tube can be performed by means of the operating device. Subsequently, the load current of the X-ray tube selected can be switched into circuit. Since the number of regulating devices exceeds the number of generators, generally a regulating device is available. Even if the generators are already operating, the adjustment of the load quantities can be effected. As soon as a generator becomes available, the selecting arrangement ensures that the regulating device selected is connected to this generator and that the high-voltage switch concerned is closed which connects the X-ray tube to the generator. The radiograph is then made. Finally, the generator can be used for loading another tube.

Such a system can be adapted to specific requirements by slight modifications. If, for example, many screening operations have to be performed, generators of low power can be used in addition to a few large-power generators which are used for making radiographs. Thus, groups of generators are provided and therefore the selecting arrangement must include a group selector preceding the main selectors. This extension can readily be effected by methods which are known in automatic telephony for discriminating between various groups of connections.

The use of a number of generators reduces the like-

lihood of considerable delays due to operational faults. If one of the generators fails, operations can be continued with the same variety by means of the remaining generators.

In addition, when the number of points at which patients are treated is increased, this is less expensive when the available number of generators is sufficient. In this event the only apparatus to be bought is that required to provide the new point of treatment by means of X-rays.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means.

2. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means each having at least two inputs, a number of said switching means equal to the number of said generators being coupled to each of said switching means, each of said switching means having one input connected to its associated tube and another input connected to an associated generator, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means.

3. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes, means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means, and means associated with each of said tubes for indicating the energized condition of its associated tube.

4. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of regulating means for adjusting the load of each of said tubes and for controlling the starting of each of said generators, the number of said regulating

means being at least equal to the number of said generators, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes and for an associated one of said regulating means, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes and coupling each of said regulating means control means to an associated one of said regulating means, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said tube control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means and responsive to said regulating means control means for connecting one of said regulating means control means to the regulating means associated with said available generator.

5. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of regulating means for adjusting the load of each of said tubes and for controlling the starting of each of said generators, the number of said regulating means being equal to the number of said generators, each of said regulating means being fixedly connected with an associated one of said generators, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes and for an associated one of said regulating means, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes and coupling each of said regulating means control means to an associated one of said regulating means, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said tube control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means and responsive to said regulating means control means for connecting one of said regulating means control means to the regulating means associated with said available generator.

6. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of regulating means for adjusting the load of each of said tubes and for controlling the starting of each of said generators, a plurality of switching means coupling each of said regulating means to each of said generators, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes and for an associated one of said regulating means, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes and coupling each of said regulating means control means to the switching means coupled to a corresponding one of said regulating means, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said tube control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means and responsive to said regulating means control means for connecting one of said regulating means control means to the regulating means associated with said available generator and for connecting the said associated regulating means to the said available generator.

7. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of regulating means for adjusting the load of each of said tubes and for controlling the starting of each of said generators, the number of said regulating means being at least equal to the number of said generators, a plurality of switching means each having at least two inputs, a number of said switching means equal to the number of said generators being coupled to each of said switching means and a number of said switching means equal to the number of said generators being coupled to each of said regulating means, each of said first-mentioned number of switching means having one input connected to its associated tube and another input connected to an associated generator and each of said last-mentioned number of switching means having one input connected to its associated regulating means and another input connected to an associated generator, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes and for an associated one of said regulating means, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes and coupling each of said regulating means control means to the switching means coupled to a corresponding one of said regulating means, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said tube control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means and responsive to said regulating means control means for connecting one of said regulating means control means to the regulating means associated with said available generator and for connecting the said associated regulating means to the said available generator.

8. An X-ray system comprising a plurality of X-ray tubes, more than one high voltage generator for supplying power to said tubes, the number of said tubes exceeding the number of said generators, a plurality of switching means coupling each of said generators to each of said tubes, a plurality of regulating means for adjusting the load of each of said tubes and for controlling the starting of each of said generators, the number of said regulating means being at least equal to the number of said generators, a plurality of servo-motors for controlling said regulating means, a plurality of operating means equal to the number of said tubes, each of said operating means including control means for an associated one of said tubes and for an associated one of said regulating means, and means coupling each of said operating means to the switching means coupled to a corresponding one of said tubes and coupling each of said regulating means control means to an associated one of said regulating means, said coupling means comprising an automatic telephone system type selecting arrangement responsive to said tube control means for connecting a selected one of said tubes to an available one of said generators under the control of said operating means and responsive to said regulating means control means for controlling the regulating means associated with said available generator through the servo-motor associated with the said associated regulating means and for connecting one of said regulating means control means to the said associated regulating means.

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