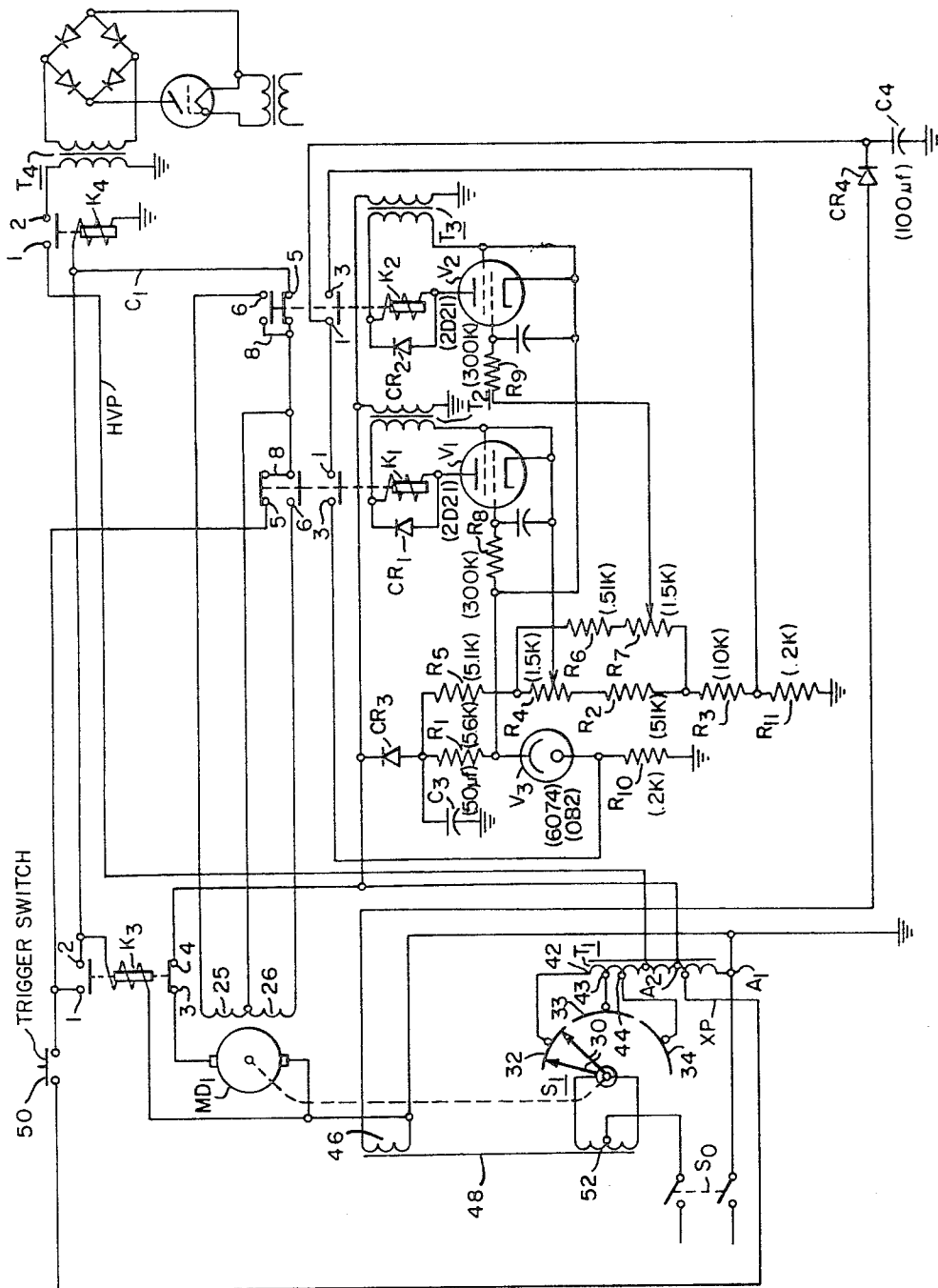


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TO REGULATE LINE VOLTAGE IN X-RAY SYSTEM
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WITNESSES

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MOTOR-OPERATED ROTARY INPUT TAP SELECTOR SWITCH TO REGULATE LINE VOLTAGE IN X-RAY SYSTEM

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ABSTRACT OF THE DISCLOSURE

A motor-operated rotary input tap selector switch selects, via contact bars, the proper input winding turns of the auto-transformer to maintain output nearly constant in spite of variation in line voltage. A reversible motor for the switch is controlled via relays by a pair of thyatron tubes according to such line voltage variation, and a choke means connected to a pair of supply line input brushes in the rotary switch generates a bias signal at the thyatron tubes which prevents the motor from stopping such brushes when as a pair they are bridging two contact bars, while at the same time preventing excessive current flow through the momentarily shorted turn of the autotransformer established by such bridging. An interlock relay controlled by the thyatron-controlled relays prevents the motor from being started during an X-ray exposure and prevents such an exposure from being initiated while the motor is operating.

Background of the invention

(1) The field of art to which the present invention pertains is X-ray electrical systems which operate from an A.C. supply line, and more particularly to such systems as include line voltage regulating apparatus therein.

(2) Line voltage regulating apparatus in X-ray electrical systems heretofore have included a manually-operated selector switch having fixed contact bars connected to different supply line input winding turns of the autotransformer from which the system is fed and a pair of contact brushes connected to one side of the supply line and movable in unison for mutual contact with a selected fixed contact bar. The two contact brushes have been so dimensioned and spaced-apart that at least one of the two is always in engagement with a fixed contact bar to prevent deenergization of the autotransformer during operation of the regulator switch. This results in bridging of two adjacent fixed contact bars from one brush to the other while being transferred to a selected new position. Such bridging tends to short circuit the transformer winding connected at opposite ends to the two bridged contact bars. A small resistor has been interposed between the brushes to reduce current flow through such winding under the bridged condition, and a mechanical detent means has been employed to urge the brushes to pass rapidly from one position to another and to hold any such position which may be selected. The resistor is adequate to take care of the usual momentary bridging conditions of the brushes while in transit between stop positions; however, it occasionally happens that the brushes get hung up in a midposition which results in burn-out of the resistor or of the respective transformer winding short-circuited by such resistor. Accordingly, it

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becomes a prime object of the present invention to provide line voltage regulator apparatus which automatically repositions the selector switch brushes according to line voltage variation while preventing such brushes from coming to rest in a bridging position across two contact bars of such switch.

Summary

In accord with general features of the present invention, the above object is obtained by provision of a reversible motor for operating the pair of contact brushes of the input tap selector switch; relay means controlling operation of said motor responsively to line voltage variation; means sensitive to voltage conditions across the brushes for preventing dropout of said relay means when the pair of brushes is bridging adjacent contact bars in the selector switch; and means for preventing operation of the switch-operating motor during the effecting of an X-ray exposure, and for preventing an X-ray exposure while such motor is being operated.

Brief description of the drawing

The single figure is a circuit diagram of an illustrative embodiment of the invention.

Description of preferred embodiment

Assuming the line switch S_0 to be closed, the autotransformer T_1 for the X-ray system has taps A_2 and A_1 nominally at 120 volts. Output from A_2 - A_1 is rectified by CR_3 and appears as nominally 170 volts D.C. on a capacitor C_3 . Discharging this capacitor are two paths, a reference path consisting of R_1 , reference tube V_3 and resistor R_{10} , an action network comprising resistors R_5 , R_4 , R_6 , R_2 , R_3 , and R_{11} .

The reference tube V_3 is a constant voltage tube so that in the reference path such tube has a constant voltage drop across it. R_{10} has a small value, and unless other currents are fed through it, as hereinafter set forth, has no significant effect. The anode of reference tube V_3 will be at a constant value of 108 volts, for example, irrespective of the usual line voltage variations.

The R_5 resistor of the action network drops C_3 voltage to 118 volts at the R_4 terminal. The arm of R_4 is connected to the cathode of a thyatron tube V_1 of a first relay means; the control grid of V_1 being connected to the reference anode of tube V_3 . The R_4 arm is adjusted so that normally the voltage at the V_1 cathode is sufficiently above that at the V_1 control grid that tube V_1 is not conductive; cathode at 111 volts and control grid at 108 volts, for example. If the line voltage falls, the 170 volts nominal at capacitor C_3 drops, say to 168 volts, for example, and the V_1 cathode voltage drops correspondingly to such as 110 volts to cause tube V_1 to fire; a transformer T_2 having its primary connected across A_2 - A_1 and its secondary connected across the tube V_1 establishes an A.C. plate voltage across tube V_1 of such as 125 volts, for example, in series with the winding of a relay K_1 .

The other part of the action network includes resistors R_6 and R_7 . The arm of R_7 is connected to the control grid of a second thyatron tube V_2 of a second relay means; the cathode of V_2 being connected to the V_3 reference. R_7 is adjusted so that at nominal line voltage V_2 does not fire, but if the C_3 voltage rises in consequence of an increase in such line voltage, V_2 grid voltage becomes more positive and V_2 is caused to fire. A trans-

former T_3 , similar to T_2 , provides plate voltage for tube V_2 , and the coil of a relay K_2 is in series with such tube.

During any period of conductance of either thyatron tube V_1 or V_2 , each fires on one-half cycle of the A.C. wave and extinguishes on the alternate half cycle. Rectifiers CR_1 and CR_2 in parallel with the coils of relays K_1 and K_2 , respectively, hold such relays picked-up for a half-cycle period following conductance of the tubes V_1 and V_2 , respectively.

From the foregoing it will be understood that V_1 fires successively to pick up relay K_1 when the line voltage as represented at A_2-A_1 is too low, and V_2 fires successively to pick up the relay K_2 when the line voltage is too high. When picked up, the relay K_1 or K_2 opens its 5, 8 contacts to disrupt an X-ray exposure control lead C_1 and deenergize relay K_4 and open its contacts 1, 2 to prevent the energizing of the primary of high voltage transformer T_4 and thus the effecting of an X-ray exposure while the line voltage regulator apparatus is in operation. At the same time, the pick-up relay K_1 or K_2 closes its contacts 8, 6 to short the appropriate shading coil 25 or 26 of the selector-switch-driving motor MD_1 for turning the brushes 30 of the rotary selector switch S_1 in the appropriate direction for switching to a contact bar 32, 33, 34, hence input tap 42, 43, 44 to the autotransformer T_1 , suited to the A.C. supply line voltage; 212 volts, 208 volts, 204 volts, etc., for example.

At the same time, 1, 3 contacts are closed by the picked-up one of the relays K_1 , K_2 to establish via CR_4 a rectified voltage, six volts for example, from an isolated detector winding 46 of a choke 48 affiliated with the brushes of switch S_1 and applies this voltage to R_{10} or R_{11} , according to which of such relays is picked up. Such voltage to R_{10} or R_{11} is of such a value and polarity that V_1 or V_2 will have an overwhelming signal to continue to conduct during every other half-cycle period. As will be apparent hereinafter, the detector winding 46 produces such holding signal exclusively while the pair of brushes of switch S_1 bridges two adjacent contact bars to assure that the switch-driving motor will not stop during such bridging.

Upon establishment of the nominal voltage at A_2-A_1 of the autotransformer T_1 , commensurate with selection of the proper input tap suited to the existing line voltage, and in the absence of a signal from the detector winding 46, the respective one of the tubes V_1 and V_2 will cease its periodic firing and its respective relay K_1 or K_2 will drop out to open its contacts 1, 3 and 6, 8 and close its contacts 5, 8 to energize relay K_4 from an XP tap on the autotransformer by way of a trigger switch 50 and the 1, 2 contacts of an interlock relay K_3 energized initially via such trigger switch, the contacts 5, 8 of relay K_2 , and the lead C_1 , and thereafter by way of such trigger switch and such contacts 1, 2 as a hold circuit independent of the K_2 relay. At the same time, the relay K_3 when picked up, opens contacts 3, 4 in the energizing circuit for the armature of the drive motor MD_1 to prevent operation of the rotary selector switch S_1 while an X-ray exposure is being effected via contacts 1, 2 of the K_4 relay.

By way of further detail of construction and operation of the illustrative embodiment, the two movable contacts, or brushes, of the rotary selector switch S_1 , are mechanically coupled for movement in unison by the armature of drive motor MD_1 and are connected as a pair across a winding 52 of the aforementioned choke 48, which winding has a center tap connected to one side of the A.C. supply line via line switch S_0 . When the pair of contacts are connected across the adjacent contact bars momentarily during actuation by the motor MD_1 , the center-tapped choke coil presents sufficient reactance to limit current through the momentarily shorted turn of the autotransformer T_1 to a safe value. When the center-tapped choke coil 52 is connected at its opposite ends to the same contact bar, it is short-circuited and its two halves cancel out each other, its impedance is near zero

and the volts per turn of the turns of such coil are near zero. When the brushes are bridging the contact bars, the volts per turn of the center-tapped choke coil 52 therebetween is high. The detector winding 46 is electromagnetically coupled to the center-tapped coil 52 of the choke 48 so that it develops a voltage correspondingly and creates the aforescribed hold signal exclusively when the switch S_1 brushes are bridging the contact bars.

In the circuit diagram shown in the drawing, the thyatron tubes V_1 and V_2 have been exemplified as types 2D21 and the values of circuit components given in the drawing are aimed at compatibility with such particular tubes. The description of the exemplified embodiment of the invention has been limited to that required for a basic understanding of the operation of such embodiment; for other minor structural details resort may be had to such circuit diagram.

We claim as our invention:

1. In an X-ray system operated from an A.C. supply line to produce X-ray exposures comprising an autotransformer from which electrical energy for operating components of the system is derived and which has multiple supply line input taps; and an input tap selector switch having spaced-apart contact bars electrically connected to respective ones of said input taps and having a pair of supply line input tap-selector brushes movable in unison for mutual engagement exclusively with a selected contact bar, which brushes are so proportioned and arranged that during transit at least one brush is in engagement with a contact bar at all times, no single one of such brushes will bridge two adjacent contact bars, but such adjacent contact bars become bridged by such brushes as a pair;

wherein the improvement comprises:

a reversible drive motor for actuating said pair of brushes,

relay means for effecting start-stop operation of said motor in opposite directions,

a control means for controlling operation of said relay means responsively to variation in supply line voltage, and

an interlock means sensitive to a voltage difference between said brushes for preventing said control means from operating said relay means to stop said motor when said pair of line input brushes is bridging two contact bars.

2. The X-ray system of claim 1, wherein: said control means comprises:

a pair of thyatron tubes,

a bias control means for said thyatron tubes for establishing bias signals proportionate to variation in line voltage relative to a stable reference voltage, and

circuit means for impressing alternating voltages from anode-to-cathode across said tubes, whereby, in the presence of the proper control bias, such tubes conduct and extinguish during each complete cycle of such alternating voltage; and said relay means includes two relay coils in series with said thyatron tubes, respectively, and rectifiers in parallel with said coils to prevent relay dropout between two consecutive periods of thyatron half-cycle conduction.

3. The X-ray system of claim 2 wherein:

said interlock means forms a part of said bias control means for the thyatron tubes and includes a detector winding electromagnetically coupled to a center-tapped choke winding connected at its opposite ends to the aforesaid brushes and at its center to one side of a supply input line to the system, whereby a tube-conduction assuring bias signal is generated in such detector winding while said pair of brushes bridges adjacent contact bars which overrides any line-voltage-variation-developed bias signal.

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4. The X-ray system of claim 2, wherein:
the line-voltage-variation bias signals are impressed
from cathode to screen on one thyatron tube and
reversely on the other thyatron tube, whereby one
tube will conduct upon an increase in supply line
voltage above a datum value and the other will con-
duct upon a decrease.
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5. The X-ray system of claim 1, further comprising a
second relay means responsive to said control means for
preventing X-ray exposure operation of such system dur-
ing actuation of the tap-selector brushes.
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