

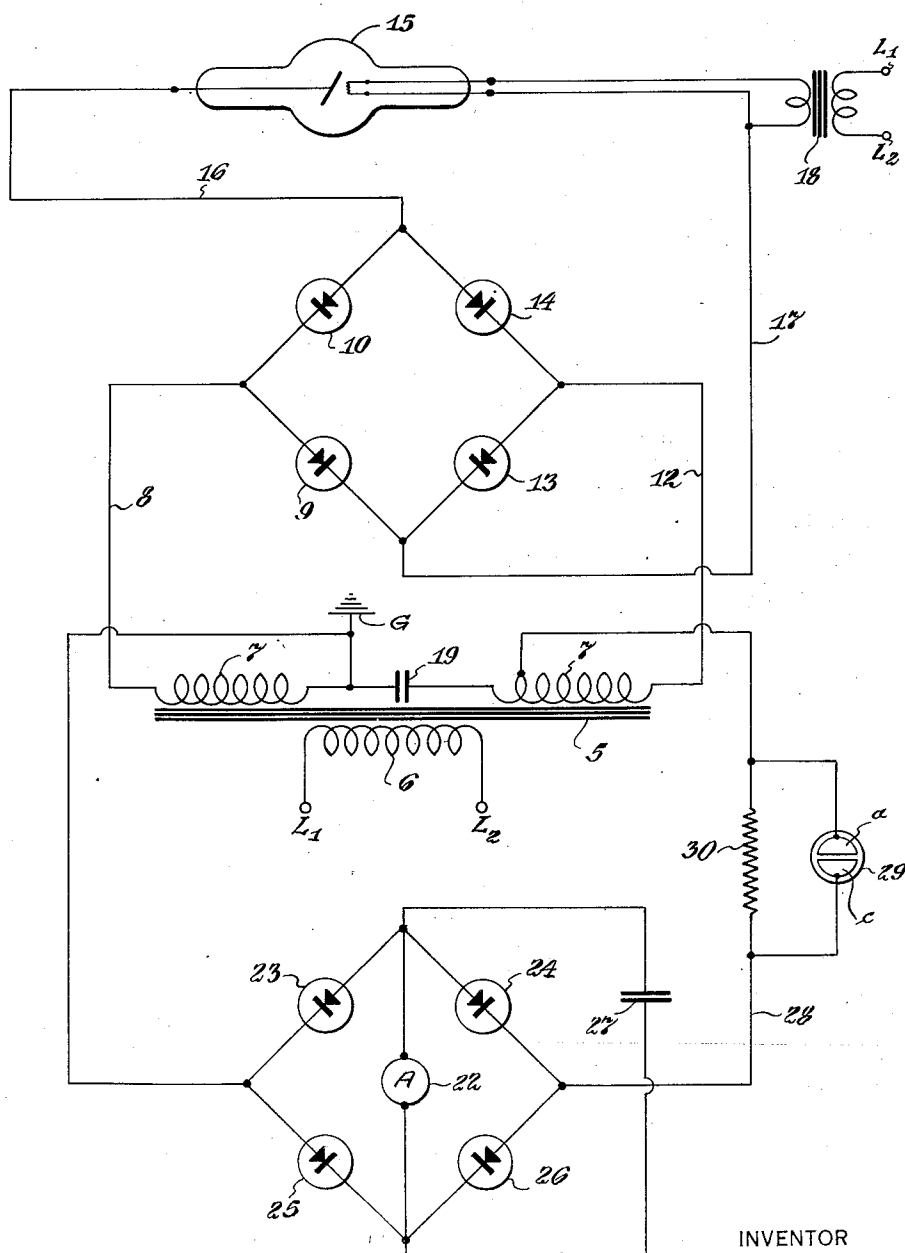
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X-RAY SYSTEM

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## X-RAY SYSTEM

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**1** The present invention relates to X-ray apparatus and more particularly to an energizing system for an X-ray tube wherein an indicator is employed to signal the operator during operation of the system that various parts thereof are properly functioning.

In high tension X-ray systems it is now quite customary to employ a full-wave bridge circuit rectifier arrangement so that the X-ray tube is energized by high potential unidirectional electrical energy. However, should one of the rectifying valve tubes fail for any reason there has been no way in which this fact is ascertainable resulting in perhaps many faulty radiographs before discovery, with attendant wastage of film in addition to the remaking of the exposure.

It is accordingly the primary object of the present invention to eliminate the above noted disadvantages by the provision of an indicator to signal or indicate to the operator whether or not the rectifying valves are properly functioning.

Another object of the present invention is the provision of an indicator included in the low voltage metering circuit which will give an accurate indication to an operator whether or not the high voltage rectifying valve tubes are functioning properly.

Further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein the single figure is a schematic illustration of an X-ray system constructed in accordance with the present invention.

Referring now to the drawing in detail, the circuit arrangement in general is very similar to that shown and described in Patent No. 2,322,404, issued to Louis L. Weisglass on June 22, 1943, and assigned to the same assignee as the present invention. The apparatus comprises a high tension transformer 5 having its primary winding 6 connected to a source of A. C. current of the usual commercial potential L1, L2. The secondary winding 7 of this high tension transformer is connected by a conductor 8 to the cathode and anode of a pair of high voltage rectifying valve tubes 9 and 10, respectively, while the remaining end of this secondary winding 7 is similarly connected by a conductor 12 to the cathode and anode of a further pair of high voltage rectifying valve tubes 13 and 14, respectively. These rectifying valve tubes are of the thermionic type and have their cathodes heated from the customary low voltage transformer which has not been shown for simplicity.

**2** An X-ray tube 15 has its anode connected by a conductor 16 to the cathode of the respective valve tubes 10 and 14 while its thermionic cathode is similarly connected by a conductor 17 to the anode of the respective high voltage rectifying valve tubes 9 and 13, thus completing a full wave rectifying bridge circuit of the usual type. The thermionic cathode of the X-ray tube 15 receives heating energy from a low voltage transformer 18 the primary winding of which may be connected to the same commercial source of supply L1, L2 as the primary winding 6 of the high voltage transformer 5. The secondary winding 7 is connected to ground G at its midpoint and a condenser 19 is connected in series with the secondary winding 7 to compensate for the capacity effect in the latter winding.

In order to measure the true useful current supplied to the X-ray tube 15 a direct current meter 22 of the D'Arsonval type is connected to a bridge rectifying circuit similar to the X-ray tube so that unidirectional current is supplied to the meter 22. For this purpose one side of the meter 22 is connected to the cathode of a pair of low voltage rectifiers 23 and 24, which may be the copper oxide type known as "Rectox" but preferably are mercury filled rectifiers as mentioned in the above noted Patent No. 2,322,404, while the other side of the meter 22 is connected to the anodes of a similar pair of rectifiers 25 and 26, and a condenser 27 is shunted across the meter 22 as a protective capacitor for the meter.

The anode and cathode of the respective rectifiers 23 and 25 are grounded as at G while the anode and cathode of the respective rectifiers 24 and 26 are connected by a conductor 28 to a compensating winding of the high voltage secondary winding 7. The system thus far described differs very little from that shown and claimed in the above mentioned patent and hence functions in the identical manner to record the true useful current flowing through the X-ray tube.

In accordance with the present invention, however, a discharge device such as a neon lamp 29 provided with electrodes a and c and shunted by a resistance 30 for limiting the current passing through the lamp, is interposed in the conductor 28 and thus in series with the rectifying bridge arrangement for the meter 22. During each half wave of the alternating current cycle when current flows through the secondary winding 7, it also flows simultaneously through the lamp 29, with its inherent A. C. sine wave, although flowing unidirectionally through the meter 22 due to the rectifying arrangement.

Accordingly, when current is flowing through the high voltage energizing circuit for the X-ray tube and simultaneously through the neon lamp 29 both electrodes *a* and *c* of the latter will glow. This will be better appreciated if it be assumed that at a given instant the end of the secondary winding 7 connected to the cathode of high voltage rectifying valve 9 is negative then such valve tube, as well as the valve tube 14, will be conductive and high voltage electrical energy will flow through the X-ray tube and back (through rectifier 14) to the other end of the secondary winding 7. At this same instant that rectifying valves 9 and 14 are conductive, current is flowing through the meter circuit in one direction and electrode *a* of the neon lamp will glow since the latter is so connected that electrode *a* is momentarily positive when valves 9 and 14 are conductive.

During the next half wave of the alternating current cycle the polarity reverses so that high voltage rectifiers 10 and 13 become conductive with reversal in the direction of current flow through secondary winding 7 as well as through the meter circuit so that electrode *c* of the neon lamp 29 now glows. Consequently if one electrode of the neon lamp glows during one half cycle when current is flowing through high voltage rectifying valves 9 and 14 and the other electrode glows when current is flowing through rectifying valves 10 and 13, then the visual or indicating effect of the neon lamp to the operator is that all rectifying valves are properly functioning because both electrodes of the neon lamp would be glowing.

If, however, in the case assumed either of valves 9 or 14 becomes defective, then the electrode *a* ceases to glow indicating one or both have failed; and in a similar manner, should the electrode *c* of the neon lamp 29 cease to glow, this indicates that one or both of the rectifying valves 10 or 13 have become defective.

It will thus become obvious to those skilled in the art that an X-ray system is herein provided in which an indicator in the form of a neon glow lamp is utilized to give an indication to the operator whether or not the high voltage rectifying valves are properly functioning. Should one fail the apparatus is immediately de-energized by the operator thus avoiding the possibility of making faulty radiographs with wastage of film.

Although one embodiment of the present invention has been shown and described, it is to be understood that still further modifications thereof may be made without departing from the spirit and scope of the appended claims.

I claim:

1. An X-ray system comprising an X-ray tube, a high potential source of alternating current electrical energy, rectifying means connected to said source and to said X-ray tube for converting the energy supplied to said X-ray tube into unidirectional current, and means connected to said high potential source and in series with said X-ray tube but subject to a slightly less current flow than said X-ray tube and operable during each half wave of the alternating current cycle to indicate to an operator the particular sine of the alternating current cycle normally passed by said rectifying means and to identify the particular rectifying means upon failure thereof to pass current of a given sine wave.

2. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential

secondary winding, rectifying valve tubes connected to the high potential secondary winding of said transformer and to said X-ray tube for converting the energy supplied by the secondary winding to said X-ray tube into unidirectional current during the entire alternating current cycle, and indicating means connected to a portion of said high potential secondary winding and in series with said X-ray tube and subject to a current flow of lesser magnitude than that supplied to said X-ray tube and operable during the entire alternating current cycle to indicate to an operator the particular sine of the alternating current cycle normally passed by said rectifying valve tubes and to identify the particular rectifying valve tubes upon failure thereof to pass current of a given sine wave.

3. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential secondary winding, rectifying valve tubes connected to the high potential secondary winding of said transformer and to said X-ray tube for converting the energy supplied by the secondary winding to said X-ray tube into unidirectional current during the entire alternating current cycle, and a glow lamp having electrodes therein connected in series with said high potential secondary winding of said transformer and said X-ray tube and operable during the entire alternating current cycle to indicate to an operator the particular sine of the alternating current cycle normally passed by said rectifying valve tubes and to identify the particular rectifying valve tubes upon failure thereof to pass current of a given sine wave.

4. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential secondary winding, rectifying valve tubes connected to the high potential secondary winding of said transformer and to said X-ray tube for converting the energy supplied by the secondary winding to said X-ray tube into unidirectional current during the entire alternating current cycle, and a glow lamp having electrodes therein connected in series with said high potential secondary winding and said X-ray tube and operable during the entire alternating current cycle to support a glow discharge at one or both of its electrodes to indicate to an operator the particular sine of the alternating current cycle normally passed by said rectifying valve tubes and to identify the particular rectifying valve tubes upon failure thereof to pass current of a given sine wave.

5. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential secondary winding, rectifying means connected to said secondary winding and to said X-ray tube for converting the energy supplied by said secondary winding to said X-ray tube into unidirectional current, a metering circuit including said X-ray tube and said high potential secondary winding which carries a capacity current due to the capacity of the high potential circuit and including a meter for measuring the current supplied to said X-ray tube, and means connected in series with said meter for indicating to an operator during the entire alternating current cycle the particular sine of the alternating current cycle normally passed by said rectifying means and to identify the particular rectifying means upon failure thereof to pass current of a given sine wave.

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6. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential secondary winding, rectifying means connected to said secondary winding and to said X-ray tube for converting the energy supplied by said secondary winding to said X-ray tube into unidirectional current, a metering circuit including said X-ray tube and said high potential secondary winding which carries a capacity current due to the capacity of the high potential circuit and including a meter for measuring the current supplied to said X-ray tube, and a glow lamp provided with electrodes connected in series with said meter and operable by the occurrence of a glow discharge at one or both of its electrodes to indicate to an operator during the entire alternating current cycle the particular sine of the alternating current cycle normally passed by said rectifying means and to identify the particular rectifying means upon failure thereof to pass current of a given sine wave.

7. An X-ray system comprising an X-ray tube, a source of alternating current electrical energy including a transformer having a high potential secondary winding, rectifying means connected to said secondary winding and to said X-ray tube for converting the energy supplied by said secondary winding to said X-ray tube into unidirectional current, a metering circuit including said X-ray tube and said high potential secondary

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winding which carries a capacity current due to the capacity of the high potential circuit and including a series connected meter for measuring the current supplied to said X-ray tube, a glow lamp provided with electrodes connected in series with said meter and operable by the occurrence of a glow discharge at one or both of its electrodes to indicate to an operator during the entire alternating current cycle the particular sine of the alternating current cycle normally passed by said rectifying means and to identify the particular rectifying means upon failure thereof to pass current of a given sine wave, and an impedance connected in shunt to said glow lamp for limiting current flow in the latter.

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