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METHOD AND SYSTEM FOR TAKING X-RAY PHOTOGRAPHS

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Fig. 1.

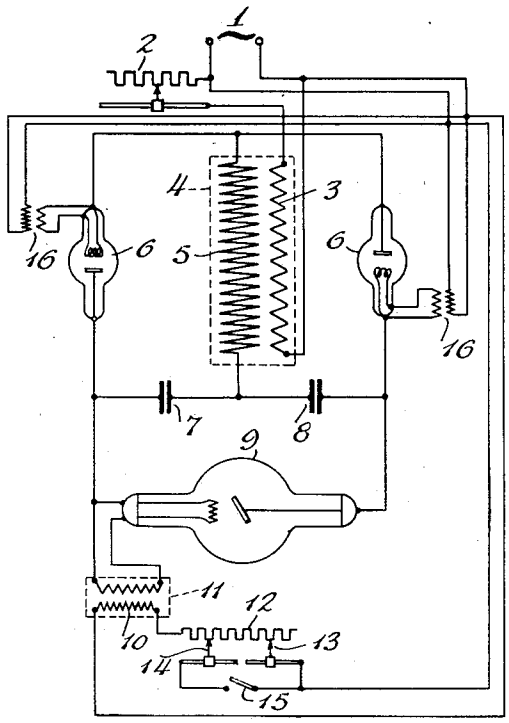
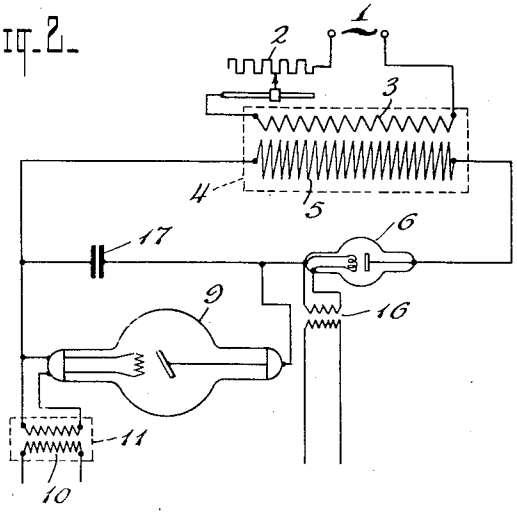


Fig. 2.



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METHOD AND SYSTEM FOR TAKING X-RAY PHOTOGRAPHS.

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My invention relates to a method or system for taking short exposure X-ray photographs or radiographs.

The apparatus employed hitherto for taking short exposure X-ray photographs or radiographs, in which the current for the X-ray tube for taking radiographs is supplied by one or more condensers, have the disadvantage, that by the simultaneous charge and discharge a very violent surge of the current occurs and thus a very considerable, although short load is placed on the line which leads to interference with other current users connected with the line.

According to my invention this disadvantage is eliminated by charging the condenser or condensers through a rectifier arrangement gradually in such a manner that the intensity of the discharge current is considerably higher than the intensity of the charging current and thus the load on the line will be small and almost uniform. The charging period is therefore very much longer than the discharge period. The condenser or condensers must be of such a capacity as to be able to deliver at a single discharge period all the energy required for the exposure.

By the new method the special advantage is obtained that all apparatus of the charging circuit may be made of smaller size than in prior systems of connection and that there is no danger to life of persons touching by chance the high tension parts of the apparatus, because the energy that can escape from these parts in such a case is much smaller than when the entire apparatus is connected with the line in the usual way.

In Figures 1 and 2 of the drawing affixed hereto two embodiments of systems or arrangements for carrying out the new method are shown diagrammatically.

Referring to Fig. 1 of the drawing, it will be seen that with the terminals 1 of the alternating current supply is connected the primary winding 3 of a high-tension transformer 4 through an adjustable rheostat 2 or other current regulating device. By the secondary winding 5 of the transformer 4, two condensers 7, 8 are charged through rectifiers such as electrical valves, preferably through high vacuum valve tubes. Each valve is connected in series with one of the condensers. In this manner two secondary circuits are formed, and it will be noted that the valves are connected in inverse directions, the same terminal of the secondary 5 being connected with unlike terminals of the two valves 6. The incandescent cathodes of the valves are heated by means of two small transformers 16 connected at their primary side to the source of alternating current 1. Between the valves and the condensers the X-ray tube 9 is connected to the rectifier arrangement, which supplies to the X-ray tube a service voltage about twice as high as the output voltage of the transformers 3, 5.

In series with the primary winding 10 of the transformer 11 likewise connected with the source of alternating current 1 and supplying current to heat the cathode of the X-ray tube 9, is connected a rheostat 12 or other suitable regulating device. This rheostat is provided with two sliding contacts 13 and 14 which are connected with a short-circuiting switch 15. The object of this switch is to effect a quick transition from the adjustment of the rheostat 12 for preliminary heating to the other for full heating. The illustration shows the switch 15 in the position for preliminary heating. By closing the switch the portion of the rheostat 12 between the contacts 13 and 14 is short-circuited and the cathode of the X-ray tube is heated fully, the X-ray tube thus attaining such a conductivity that the condensers will discharge suddenly across it with an extremely powerful current. The charging of the condensers 8, 9, however, has taken a relatively long time, since the rheostat 2 in the primary circuit of the transformer 4 permits only small currents to pass during the charging period.

The improved arrangement or system therefore has the advantage that only a light current load is placed on the line and all intermediate appliances between the line and the condensers and therefore on the entire apparatus serving for the generation of the rectified high voltage. All these parts may therefore be designed for a relatively low current intensity and thus have smaller dimensions than in systems in which a current corresponding with the momentary tube current is directly withdrawn from the line.

Instead of inserting a series resistance into the primary of the high-tension transformer, the valve tubes may equally well be so dimensioned, that they allow only the current

of the desired lower intensity to pass. It is generally preferable to work with a series resistance which enables the apparatus to be employed for diagnostic as well as therapeutic purposes. In the latter case higher current intensities may also be used as the load is continuous.

Preferably the series resistance or the conducting capacity of the valve tubes is so chosen that the secondary short-circuit of the high-tension transformer does not exceed 30 to 50 milliamperes so as to avoid any danger to the life of a person touching the high-tension carrying parts and thus causing a short-circuit.

Since for diagnostic purposes only comparatively feeble currents are used, the system may also with a fixed limitation of the current intensity be used for these purposes and the condensers may likewise be switched out, because then the increase of the voltage supplied by the secondary of the high-tension transformer brought about by these condensers is no longer required.

Instead of the arrangement illustrated in Figure 1 with two condensers connected in series in the circuit of the X-ray tube, the system with a single condenser shown in Fig. 2 may be employed. This condenser 17 is fed from the secondary winding 5 of the high-tension transformer 4 through a valve tube 6 or other suitable valve device. The X-ray tube 9 is connected in parallel to the condenser 17. The heating circuit containing the transformer 11 feeding the cathode of the X-ray tube may be the same as shown in Fig. 1.

Various changes and modifications may be made without departing from the spirit and the scope of the invention, and I desire therefore, that only such limitations shall be placed thereon as are imposed by the prior art.

What I claim as my invention and desire to secure by Letters Patent is:

1. The method of taking short-exposure X-ray photographs in which the current supplied to the X-ray tube is taken directly from a condenser device, which consists in charging such condenser device with a small rectified current from a source of alternating current during a period of time which is very long in comparison with the time of exposure, and discharging said condenser device suddenly through the X-ray tube.

2. In a system for taking short exposure X-ray photographs in combination, a high tension transformer the primary circuit of which is connected with the supply terminals, an X-ray tube, a heating circuit for the cathode of said X-ray tube, an electric valve and a condenser device connected with the secondary circuit of said transformer, the condenser device being of such capacity that it can be charged with all the energy required for feeding the X-ray tube during the exposure, a shunt circuit containing the X-ray tube and connected to said condenser device, switching means in said heating circuit for rendering the X-ray tube effective, and means in said primary circuit of such kind, that the time for charging the condenser will be very long and the loading current very small in proportion to the time and the current respectively of the discharge.

3. In a system for taking short exposure X-ray photographs in combination, an X-ray tube, a heating circuit for the cathode of said X-ray tube, a high tension transformer the primary circuit of which is connected with the supply terminals, two circuits including the secondary of said transformer and each containing a condenser and an electric valve connected in series with each other, the valves being reversely connected, the condensers being of such capacity that they can be charged with all the energy required for feeding the X-ray tube during the exposure, electrical connections from said X-ray tube to points of said condenser circuits situated between said valves and said condensers, switching means in said heating circuit for rendering the X-ray tube effective, and means in said primary circuit of such kind that the time for charging the condensers will be very long and the loading current very small in proportion to the time and the current respectively of the discharge.

4. In a system for taking short exposure X-ray photographs in combination, an X-ray tube, a heating circuit for the cathode of said X-ray tube, a high tension transformer the primary circuit of which is connected with the supply terminals, an electric valve and a condenser connected with the secondary circuit of said transformer, the condenser being of such capacity that it can be charged with all the energy required for feeding the X-ray tube during the exposure, a shunt circuit containing the X-ray tube and connected to said condenser, means in said primary circuit of such kind that the time for charging the condenser is very long and the loading current very small in proportion to the time and the current respectively of the discharge, a heating transformer for the incandescent cathode of said X-ray tube connected on the primary side to the supply terminals, an adjustable resistance in the primary circuit of said heating transformer, and a short-circuiting switch for said resistance.

5. In a system for taking short exposure X-ray photographs in combination, a high tension transformer the primary circuit of which is connected with the supply terminals, two circuits including the secondary of said transformer and each containing a condenser and an electric valve connected in series with each other, the valves being reversely connected, the condensers being of such capacity

that they can be charged with all the energy required for feeding the X-ray tube during the exposure, electrical connections from said X-ray tube to points of said condenser circuit located between said valves and said condensers, means in said primary circuit of such kind that the time for charging the condensers is very long and the loading current very small, in proportion to the time and the current respectively of the discharge, an X-ray tube, a heating transformer for the incandescent cathode of said X-ray tube connected on the primary side to the supply terminals, an adjustable resistance in the primary circuit of said heating transformer, and a short circuiting switch for said resistance.

6. A device of the character described, comprising a transformer, a current-limiting device in the primary circuit of said transformer, a current rectifier and a condenser device in series with each other and with the secondary of said transformer, an X-ray tube having its terminals connected with the secondary transformer circuits at points on opposite sides of the condenser device, and means for effecting a sudden discharge of said condenser device through said X-ray tube.

7. A device of the character described, comprising a transformer, a current-limiting device in the primary circuit of said transformer, a current rectifier and a condenser device in series with each other and with the secondary of said transformer, an X-ray tube of the incandescent cathode type in shunt with said condenser device, a current-supplying device connected with said cathode to heat it, and a switch controlling said current-supplying device and enabling a sudden discharge of the condenser device to be directed through said X-ray tube.

8. A device of the character described, comprising a transformer, a current rectifier and a condenser device in series with each other and with the secondary of said transformer, an X-ray tube of the incandescent cathode type in shunt with said condenser device, a current-supplying device connected with said cathode to heat it, and a switch controlling said current-supplying device and enabling a sudden discharge of the condenser device to be directed through said X-ray tube.

In testimony whereof I affix my signature.

CARL NIEMANN.