



## UNITED STATES PATENT OFFICE.

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## AUTOTRANSFORMER WITH HEATING COILS.

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*To all whom it may concern:*

Be it known that we, ARTHUR MUTSCHELLER and CHARLES FAYER, both citizens of the United States, and residents of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Auto-transformers with Heating Coils, of which the following is a full, clear, and concise description.

Our invention relates to transformers and heating coils of the type used in X-ray work, in which the source of high tension current for energizing the X-ray tube is a transformer, and in which the X-ray tube is provided with an electrically heated glower cathode, such as an incandescing filament.

More particularly stated, our invention relates to the positioning of and the connections for the small winding used in apparatus of the kind just mentioned and including a vacuum tube provided with a glower cathode, for the purpose of electrically heating the glower cathode, this winding being usually designated in this art as the heating coil.

We mount the heating coil directly upon the core of the auto-transformer used as a control for the high tension transformer, the high tension transformer being the one which supplies electricity for the main discharge through the X-ray tube.

By thus mounting the heating coil upon the core of the auto-transformer, and varying the connections accordingly, we attain a number of useful objects, among which are the following:

I. We eliminate all necessity for providing a separate transformer as a means of heating the filament, as is sometimes done, or of winding an additional secondary on the core of the high tension transformer. Such additional winding on the core of the high tension transformer is objectionable, because when the high tension currents are turned on or their voltages are varied the said additional winding is affected, and the heating currents are thereby caused to fluctuate.

II. We thoroughly stabilize the action of the heating filament, owing to the fact that in the auto-transformer as we use it the core is always saturated while the device is in action. Thus we render the filament insen-

sitive to slight variations in the line voltage, and render its action constant even when the taps controlling the auto-transformer are changed from time to time under varying working conditions, whereby the high tension transformer is subjected to different voltages.

III. We enable the incandescing filament to be energized independently of the high tension currents. This is always advantageous, because when the high tension currents for energizing the X-ray tube and the heating currents for energizing the filament are turned on at the same instant there is always a lapse of time before the filament becomes incandescent, and there is therefore a moment of delay before the discharge can pass through the tube.

IV. We enable a small auto-transformer, serving as a control for the high tension transformer and also as a means for generating currents used for heating, to be mounted independently of the high tension transformer and located conveniently among the switches and various regulating devices—the auto-transformer being a device quite compact and portable.

Reference is made to the accompanying drawing forming a part of this specification, and in which the figure shows diagrammatically a system in which our device is employed.

An X-ray tube appears at 1, and is provided with an anode 2, supported upon an electrode 3; also with an incandescing filament 4, serving as a glower cathode. The electrode 3 is connected with a wire 5, leading to a secondary winding 6 of a high tension transformer 7. A wire 8 leads from the secondary winding 6 to a wire 9, the latter leading to the incandescing filament 4.

The high tension transformer 7 is provided with a primary winding 10, and from the latter a wire 11 leads to the arm 12 of a switch 13. The switch 13 is provided with a number of contact buttons such as 14, 15, 16, the contact buttons being severally connected with wires 14<sup>a</sup>, 15<sup>a</sup>, 16<sup>a</sup>, the latter being connected with a winding 17, this being the secondary winding of an auto-transformer 18. The auto-transformer is further provided with windings 19, 20. Leads are shown at 22, 23, and are used to supply currents to the auto-transformer.

The lead 22 is connected with a slide 24 which is movable relatively to the windings 19, 20.

The lead 23 is provided with a switch 25, and this switch is connected with a wire 26, leading to the contact button 27 of another switch 28. From the switch last mentioned a wire 29 leads to the primary winding 10 of the high tension transformer 7.

The operator by moving the slide 24 relatively to the windings 19 and 20, and by shifting the arm 12 of the switch 13, can vary within wide limits the voltage and amperage of the currents used for energizing the high tension transformer 7, in the manner well understood in this art.

Mounted upon the core of the auto-transformer 18 is a winding 30, serving as a heating coil. From it a wire 31 leads to a variable resistance 32. A wire 33 leading from the variable resistance 32 is connected with a wire 34, the latter being grounded at 35. Our purpose in grounding the wire 34 is, first, to prevent the development of abnormal voltages, and particularly voltages which are extreme as compared with the potential of the earth, considered as zero; and second, to connect the filament with an inexhaustible supply of electrons. A wire 36 is joined to the two wires 33 and 34, and leads therefrom to the incandescing filament 4. A wire 37 is connected with both of the wires 8 and 9, and with the heating coil 30.

The auto-transformer is so proportioned and arranged that no matter when or to what extent it is energized, its core is thoroughly saturated with magnetic flux. Such being the case, the heating coil 30 always works to its full capacity when it is energized at all. The result of this arrangement is that whenever the auto-transformer is in action, the incandescent filament glows brightly and steadily, at its highest degree of incandescence, which is thus constant while the auto-transformer is in action.

The action of the heating coil upon the incandescing filament is independent of the action of the high tension transformer. Thus if the switch 25 be closed and the switch 28 be left open, the heating coil 30 supplies current to the incandescing filament although the high tension transformer is not being energized. It follows as a consequence that no matter what fluctuations may take place in the windings of the high tension transformer, these fluctuations can have no effect upon the incandescence of the filament.

The circuit used for heating the incandescing filament may be traced as follows: Heating coil 30, wire 37, wire 9, filament 4, wire 36, wire 33, variable resistance 32, wire 31, back to heating coil 30.

The general action of the auto-transformer, the high tension transformer and

the X-ray tube are too well understood to need any further description.

We do not limit ourselves to the precise mechanism shown, as variations may be made therein without departing from the spirit of our invention, the scope of the invention being commensurate with our claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. The combination of a vacuum tube provided with a glower cathode to be energized by electric currents, a high tension transformer connected with said vacuum tube for the purpose of sending the main discharge therethrough, a second transformer connected with said high tension transformer for controlling said high tension transformer and for energizing the same, said second transformer being so proportioned that the core thereof is magnetized to saturation whenever said second transformer is magnetized to any degree, a heating coil carried by said second transformer and energized thereby, and connections from said heating coil to said glower cathode.

2. The combination of a vacuum tube provided with a glower cathode to be energized by electric currents, an auto-transformer provided with a core and so proportioned that said core is energized to saturation whenever said auto-transformer is energized to any degree, mechanism connected with said auto-transformer and with said vacuum tube and controllable by said auto-transformer for the purpose of energizing said vacuum tube, a heating coil mounted upon the core of said auto-transformer and energized thereby, and connections from said heating coil to said glower cathode.

3. The combination of a vacuum tube provided with a filament serving as a glower cathode, a high tension transformer connected with said vacuum tube for the purpose of sending a main discharge therethrough, an auto-transformer connected with said high tension transformer for the purpose of energizing and controlling said high tension transformer, and a heating coil connected with said filament for the purpose of supplying heating currents thereto, said heating coil being mounted upon the core of said auto-transformer, said auto-transformer being so proportioned that the core thereof is magnetized to saturation whenever said auto-transformer is energized to any degree.

4. The combination of a vacuum tube provided with a glower cathode to be energized by electric currents, a high tension transformer connected with said vacuum tube for sending a main discharge therethrough, an auto-transformer connected with said high tension transformer for controlling

said main discharge through said vacuum tube, said auto-transformer being provided with a core which is always magnetically saturated whenever said auto-transformer is energized to any extent, so that the degree of magnetization of said core is independent of variations in the extent to which said auto-transformer is energized, and a heating coil mounted upon said core and energized by the magnetism thereof, said heating coil being connected with said glow-er cathode in order to supply electric currents for heating said glow-er cathode, so that said glow-er cathode is always heated to the same extent independently of the extent to which said auto-transformer and said high tension transformer are energized.

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