

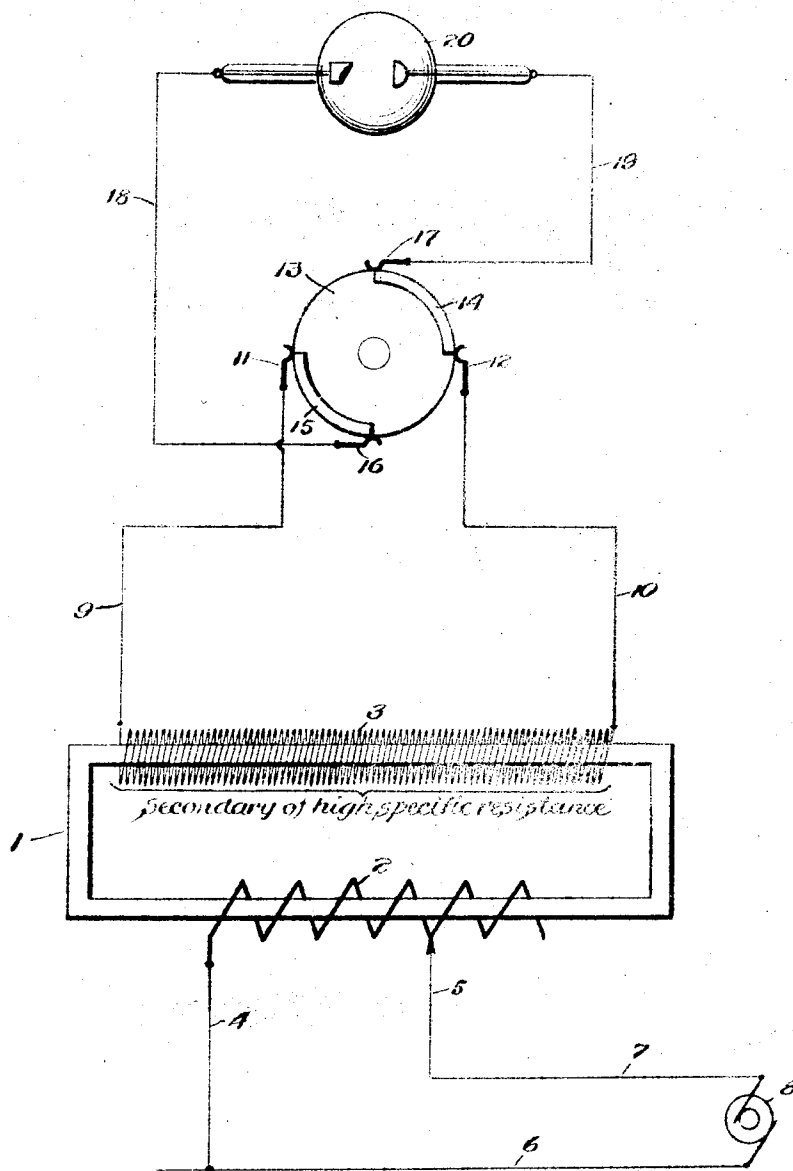
Nov. 16, 1926.

1,607,141

R. H. WAPPLER

HIGH RESISTANCE SECONDARY WINDING

Filed March 23, 1922



INVENTOR
Reinhold H. Wappler
BY Walton Harrison
ATTORNEY

UNITED STATES PATENT OFFICE.

REINHOLD H. WAPPLER, OF NEW YORK, N. Y., ASSIGNOR TO WAPPLER ELECTRIC COMPANY, INC., OF LONG ISLAND CITY, NEW YORK, A CORPORATION OF NEW YORK.

HIGH-RESISTANCE SECONDARY WINDING.

Application filed March 23, 1922. Serial No. 546,141.

My invention relates to means for preventing the development of undue amperages in certain kinds of circuits in which high tension currents are supplied by the secondary winding of a transformer.

More particularly stated I seek to use, in the secondary winding, a high ohmic resistance of such character and so distributed as to remain constant even when subjected to very high potentials.

For the purpose here contemplated I make the secondary winding of a material the specific resistance of which is much greater than the specific resistance of copper, or I make the secondary winding partly of copper and partly of a material having a specific resistance higher than that of copper. Thus in either case I confer upon the secondary winding as a whole a specific resistance higher than that of copper wire. German silver or any of the alloys used for resistance wire may be employed as the material of the secondary winding.

In a secondary circuit used for X-ray work, it is necessary to limit the current employed, while developing very high potentials. Much depends, however, upon the manner in which the current is thus limited. If there be inserted in the circuit one or more resistance units in which the ohmic resistance is very high, the resistance offered by the unit or units does not remain constant, especially at high potentials. As a matter of fact, practically any sort of resistance unit in the relation here contemplated, is utterly unreliable at high potentials. I find, however, that the ohmic resistance of the unit or units may be rendered both constant and reliable if it be made in the manner here contemplated, namely, by increasing the internal resistance of the secondary winding, by making the winding of wire having a high specific resistance.

In the use of high potential transformers, and especially those used in X-ray work, there is great difficulty in holding back an excess of current. If for instance it is desired to produce X-rays of a certain dosage, it becomes necessary to prevent the increased flow of current which otherwise happens inevitably, owing to the changes taking place in the X-ray tube itself, when subjected to high potentials. Therefore it is obvious that by limiting the flow of cur-

rent throughout the entire length of the secondary circuit, or at least throughout a predominating portion thereof, we develop better conditions for maintaining constancy in the density and power of the radiation. No matter how any number of separate resistances may be arranged in the primary circuit, these resistances do not have as good an effect, for the purposes here contemplated, as an internal resistance embodied in the secondary winding and distributed throughout all or the greater portion of the length thereof.

I find, moreover, that by arranging the resistance as above suggested the secondary winding may be caused to generate currents similar in character to those of a static machine in which the internal resistance is enormously high. Such being the case, by producing currents of the kind here contemplated, rectifying such currents, and causing them to produce a discharge, the apparatus can be substituted for a static machine.

The principle of my invention may perhaps be more easily understood by bearing in mind in X-ray work the potentials may easily run up to several hundred thousand volts; and at an instant while the voltage is very high (perhaps at or near its highest peak), the internal resistance of the X-ray tube may suddenly drop, and by so doing invite a rush of current through the tube and thus through the secondary winding; whereas by the use of my invention the current which can develop is necessarily kept very small, even if the ohmic resistance of the X-ray tube suffers an enormous drop.

Again, by the use of my invention in a high potential transformer, the current value of the high potential currents generated by the transformer may be limited within reasonable bounds by the inherent characteristic of the secondary winding, so no matter how high may be the voltages employed there can never under any circumstances be an excess of current; and this desirable result is attained without the addition of any resistance unit or analogous member extrinsic to the secondary winding.

Reference is made to the accompanying drawing forming a part of this specification, the figure being a diagram showing a simple X-ray system including a represen-

tative form of my high resistance secondary winding.

A high tension transformer 1, in this instance suitable for X-ray work, is provided with a primary winding 2 and a secondary winding 3.

The primary winding 2 may be of the usual or any preferred construction, and is connected by a wire 4 and a sliding connection 5 with a pair of leads 6 and 7, the latter being connected with an alternating current generator 8, by aid whereof the primary winding 2 is energized.

By means of the sliding connection 5 the number of turns in the primary winding, effective for energizing the transformer, may be varied at the will of the operator, and the transformation ratio may be changed accordingly.

The transformer may be oil-insulated, if desired, the form of the insulation being no part of my invention.

The secondary winding 3 is by means of wires 9 and 10 connected with brushes 11 and 12. These brushes are mounted upon a rectifying switch 13, provided with sectors 14 and 15 of conducting material. The rectifying switch 13 may be of the usual or any preferred construction, and is synchronously driven. The rectifying switch 13 is provided with two brushes 16 and 17, and from these brushes two wires 18 and 19 lead to an X-ray tube 20.

While the particular X-ray tube here shown is an ordinary gas tube, it will be understood that any other tube, such for instance as a tube of the Lilienfeld type or of the Coolidge type may be employed instead.

The secondary winding 3 consists of an insulated wire made of conducting material the specific resistance of which is higher than that of copper; as, for example, German silver or any suitable resistance alloy. Preferably the wire of the secondary winding is of uniform diameter throughout the entire length of the winding, so that the ohmic resistance of the winding is rendered uniform from one end of the winding to the other.

In some instances I make the secondary winding partly of wire of the kind just described and partly of copper wire, but in any event the mean specific resistance of the secondary winding as a whole is higher than if the entire winding wire made of copper wire of the same gauge.

By means of the secondary winding made as above described, very high potentials may be developed and yet the current values may be maintained relatively low.

When an X-ray tube is energized by means of this apparatus, the discharge through the tube is of the type known in this art as a "fine spray" discharge.

I have made the discovery that if X-rays are employed for therapeutical purposes, and are made by aid of the apparatus above described, the magnitude of the ohmic resistance of the secondary winding may become quite an important factor in the efficacy of the treatment. For instance, ordinarily in treating an infected tonsil the ohmic resistance of the secondary winding should be different from that required for treating a deep seated organ afflicted with cancer.

In working with X-ray tubes and some other kinds of vacuum tubes, it is often desirable to prevent the development of oscillations. This point is of great importance in connection with the operation of X-ray tubes. Where oscillations are developed the heating of the tube and the danger of a breakdown are greatly increased. Moreover, the oscillations tend to render the action of the tube freakish, and also to interfere with uniformity in the penetration of the X-rays produced.

As is well known in this art, the development of oscillations in a given circuit is dependent, mainly at least, upon the relations of the inductance, capacity, and ohmic resistance, usually designated as the constants, of the circuit. It is therefore practicable to prevent oscillations from taking place in a high tension circuit for energizing an X-ray tube, by suitably apportioning the inductance, capacity, and ohmic resistance. I find, however that by far the best way to prevent the development of oscillations in this connection is to use a sufficiently high ohmic resistance of the kind above described.

A great advantage possessed by a high potential transformer made in accordance with my invention is, that the transformer contains inherently within itself the means for preventing the development of an excess of current, even when very high potentials are employed. This dispenses with all necessity for inserting a resistance unit of any kind in series with the secondary winding, and consequently does away with all necessity for changing such resistance unit from time to time and under varying conditions, in order to avoid excess of current.

I do not limit myself to the precise mechanism shown and described, as variations may be made therein without departing from my invention the scope of which commensurate with my claims.

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

1. In a device of the character described the combination, with a vacuum tube and a rectifying switch for rectifying high tension currents used for making discharges through said tube, of a transformer provided with a high tension secondary winding connected with said rectifying switch, said high ten-

sion secondary winding having its internal resistance high enough to prevent the development of oscillations in the secondary circuit.

5 2. In a device of the character described the combination, with a vacuum tube and means for rectifying high tension currents for making discharges through said vacuum tube, of a transformer provided with a high
10 tension secondary winding, said secondary winding being connected with said rectifying switch and having an internal resistance high enough to prevent the development of oscillations in the secondary circuit, said
15 transformer being further provided with a primary winding, and means controllable by the operator for varying the number of

turns of the primary winding effective for energizing the transformer.

3. In a device of the character described 20 the combination, with a vacuum tube and means for rectifying high tension currents used for making discharges through said vacuum tube, of a transformer provided with a high tension secondary winding for 25 energizing said vacuum tube, said high tension secondary winding having its internal resistance high enough to prevent the development of oscillations in said vacuum tube, said transformer being further provided 30 with a primary winding whereby said transformer is energized.

REINHOLD H. WAPPLER.