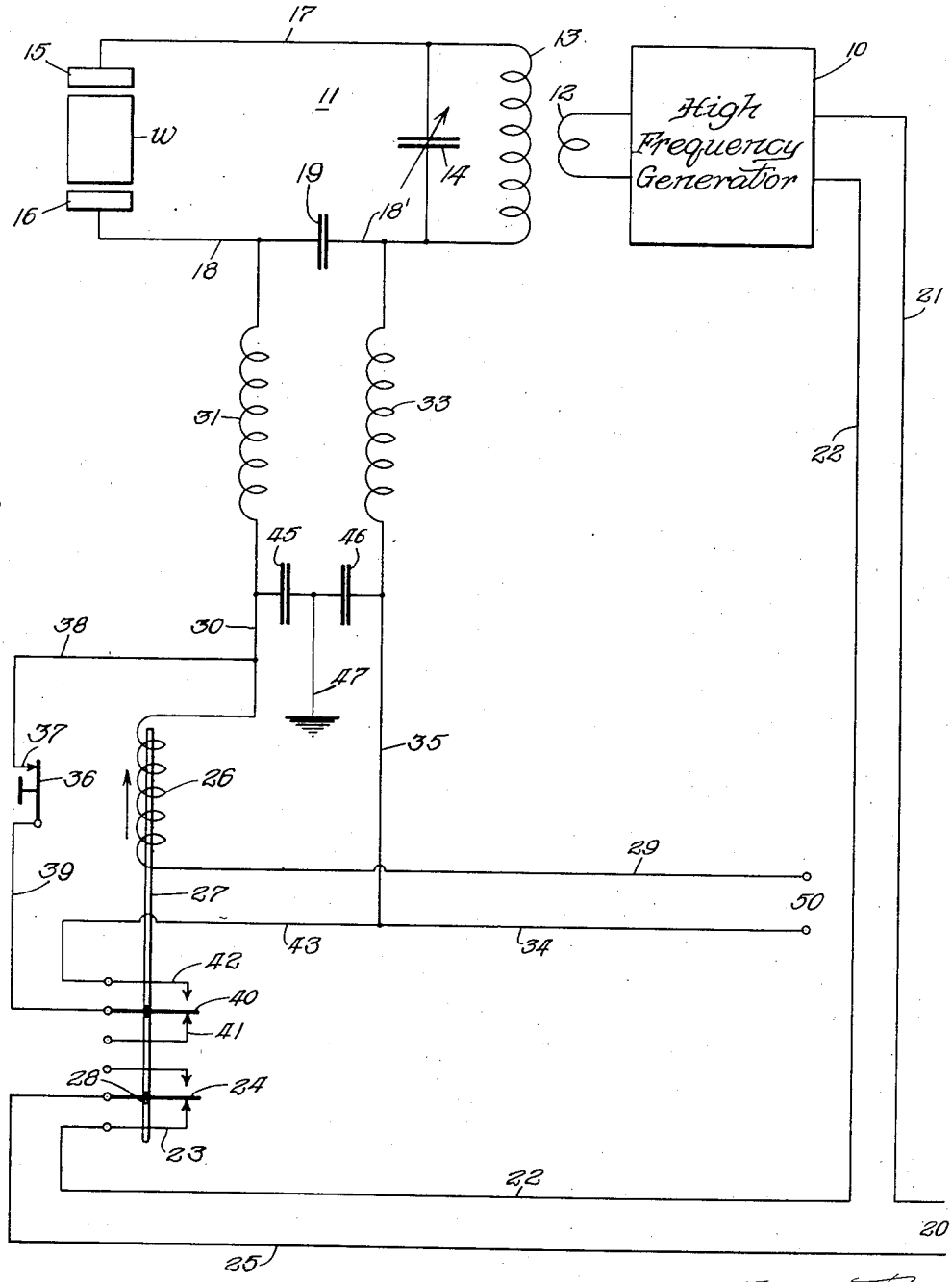
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PROTECTIVE CIRCUITS FOR ELECTRONIC EQUIPMENT

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PROTECTIVE CIRCUITS FOR ELECTRONIC EQUIPMENT

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More particularly, this invention relates to means for protecting high frequency oscillators of the type used to heat plastic and other materials for molding, glue setting, etc., it being the general object of the invention to provide a new and improved means for protecting such oscillators and the electrodes thereof.

Many applications have been made of high or radio frequency currents in dielectric heating devices for heating plastic or other materials. Usually to heat the material it is placed between two electrodes which carry a high frequency current and form a portion of a high frequency oscillator output circuit. Since a high voltage exists between the electrodes, ionization of the air and formation of an arc therebetween for frequent occurrences.

If the air gap between the electrodes is broken down so that an arc forms, damage as a rule results to the electrodes, the work in process, the oscillator and other parts of the equipment. Frequently, the electrodes are in the form of relatively expensive dies so that burning or pitting on the surface thereof spoils the dies for precision work. The usual protective devices, such as circuit breakers and fuses, fail to give adequate protection in circuits of this nature principally because of the time consumed for them to operate.

It is another object of this invention to provide a protective means for high frequency power circuits which will disconnect the high frequency power from the circuit in a fraction of a second after or substantially simultaneously with the formation of an arc, and thereby prevent damage to the equipment.

It is another object of the invention to provide a protective means for a high frequency oscillator which utilizes a low frequency or direct current carried by the arc for actuating a circuit breaking relay.

A more particular object is to provide a disconnecting relay in the primary circuit of a high frequency oscillator and an operating coil for the relay connected in series with a low frequency A. C. (or a D. C.) source and the electrodes so that upon the formation of an arc between the electrodes by the high frequency current the arc provides a path for carrying the low frequency current to energize the relay coil.

Other objects will become readily apparent from the following detailed description taken in connection with the accompanying drawing wherein,

The figure is a diagrammatic representation of a preferred form of the invention.

While the invention is herein disclosed as embodied in a protective means for a high frequency oscillator, it is not intended to limit the invention

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to the specific form and arrangement shown, it being contemplated that various changes may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

As illustrated in the drawing, an oscillator is shown comprising a high frequency generator 10, coupled to a high frequency oscillating circuit 11 by means of a coupling link 12. The tank circuit of the high frequency oscillator includes an inductance 13 and a capacity 14. An electrode 15 is connected by means of a lead 17 to one side of the tank circuit, and an electrode 16 is connected to the other side by means of leads 18 and 18' and a blocking condenser 19 therebetween. This condenser presents negligible impedance to the flow of high frequency current, but blocks the flow of low frequency A. C. or D. C. current. The electrodes are suitably arranged in spaced relation so that the work piece or material W may be positioned therebetween.

The primary of the high frequency generator may receive its energy supply from a 60 cycle A. C. source 20, one side 21 from the primary leading directly to the energy supply source and the other side 22 leading to one contact 23 of a relay, the other contact 24 of which is connected by a lead 25 to the other side of the energy supply source 20. A relay coil 26 has an armature 27 associated therewith, which armature is connected to the movable contact 24 at 28 so that when the relay coil 26 is energized, the armature 27 is raised and the contacts 23, 24 are disengaged to break the primary circuit to the high frequency generator.

One end of the coil 26 is connected by a lead 29 to one side of a low frequency A. C. or D. C. power source 50 of control current. The other end of the coil 26 is connected by a lead 30 and a choke coil 31 to the electrode lead 18 on one side of the blocking condenser 19 which is inserted between the leads 18 and 18'. A similar choke coil 33 is connected between the lead 18' (on the other side of the blocking condenser 19) and a lead 34 (which connects with the other side of source 50) by a lead 35 so that the power source for supplying control current has high impedance to oscillator currents. By-pass condensers 45 and 46 are connected in series between leads 30 and 35 and to ground by a lead 47, and cooperate with the choke coils 31 and 33 to confine flow of the high frequency current to the oscillator circuit and to prevent flow thereof in the relay and supply circuits. Thus, a circuit can be traced from the control current source 50 through leads 34 and 35, and choke coil 33 to the lead 18' on the right hand side of the blocking condenser and thence through the induction 13 and lead 17 to the upper electrode 15. From the lower electrode 16 the circuit continues through lead 18

on the left hand side of the blocking condenser, choke 31 and lead 30 to the coil 26 and thence through lead 29 to source 50. During normal operation of the high frequency oscillator no control current can flow in this circuit due to the gap between the electrodes 15 and 16 since the power source for supplying control current provides a difference of potential too low to initiate breakdown between the spaced electrodes 15 and 16, with the result that the relay contacts 23 and 24 remain closed by gravity action on armature 27, and the equipment remains in operation. If, however, an arc forms between the electrodes 15 and 16, the arc completes a low impedance path for the control current between the electrodes, and flow of current from the power source 50 energizes the relay coil 26 and causes it to raise the armature 27, opening the contacts 23, 24, and shutting down or disabling the equipment by cutting off the energy supply 20. The control current flows substantially instantaneously upon formation of an arc with the result that the low frequency power supply to the oscillator is shut off before any damage can occur.

Preferably, a manual switch 36 is provided in a holding circuit for the relay coil so that after the relay has been operated to shut off the high frequency current to the electrodes, it is necessary to open the switch 36 before the equipment can again be placed in operation. The switch has a stationary contact 37 connected by a lead 38 to lead 30 at one end of the relay coil. The movable contact of the switch is connected by a lead 39 to a movable contact 40 carried on the relay armature 27. Normally the contact 40 engages a stop member 41, but when the relay is energized, it engages a stationary contact 42 which is connected by a lead 43 to the junction of leads 34 and 35. Thus, when the relay coil is energized and the armature 27 is raised a holding circuit for the relay coil is completed through the contacts 40, 42, and in order to place the equipment in operation again it is necessary to disengage the manual switch 36.

It is contemplated that the relay coil 26 may be selected for operation from a low frequency source of A. C. similar to the source 20 or that it may alternatively be selected for operation on direct current. Whichever the variety of control current provided by the source 50 it is intended that it be of such type as will not flow across the gap between the electrodes 15 and 16 except when carried by an arc or other objectionable discharge therebetween of the high frequency current.

I claim:

1. In combination, a high frequency oscillator including a primary circuit, a tank circuit and output electrodes deriving energy from said tank circuit, means for controlling the operation of said oscillator comprising a relay having a pair of contacts in said primary circuit, an operating coil for said relay which when energized disengages said contacts and shuts down the oscillator, a blocking condenser inserted in series with one electrode and the tank circuit presenting negligible impedance to the flow of high frequency current but blocking the flow of low frequency alternating current, a circuit for energizing said relay coil comprising a source of low frequency alternating control current, a connection between said source and said oscillator at one side of said blocking condenser, a connection from the other side of said source to one end of said coil and a connection from the other end of said coil to said oscillator on the other side of said blocking condenser, radio frequency chokes in said connections to the opposite sides of said blocking condenser, by-pass condensers connected between the ends of said radio frequency chokes remote from the oscillator, the circuit through the relay operating coil being completed upon an arc discharge between the electrodes of the high frequency circuit which arc discharge provides a conducting path between the electrodes for the low frequency current and causes energization of the relay and shuts down the oscillator.

2. A combination as defined in claim 1 including means operated by said coil to form a holding circuit therefor when energized, and means operable to break said holding circuit to recondition the high frequency oscillator for operation.

3. In combination, a high frequency oscillator including a primary circuit, a tank circuit and output electrodes deriving energy from said tank circuit, means for controlling the operation of said oscillator comprising a relay for said primary circuit, said relay having an operating coil which when energized shuts down the oscillator, a blocking condenser inserted in series with the electrodes and tank presenting negligible impedance to the flow of high frequency current but blocking the flow of control current, a circuit for energizing said relay coil comprising a source of control current, a connection between said source and said oscillator at one side of said blocking condenser, a connection from the other side of said source to one end of said coil and a connection from the other end of said coil to said oscillator on the other side of said blocking condenser, means for preventing high frequency current from passing through said operating coil, the circuit through the relay operating coil being completed upon an arc discharge between the electrodes of the high frequency circuit which arc discharge provides a conducting path between the electrodes for the control current and causes energization of the relay and shuts down the oscillator.

4. A combination as defined in claim 3 including means operated by said coil to form a holding circuit therefor when energized, and means operable to break said holding circuit to recondition the high frequency oscillator for operation.

5. In combination, a high frequency oscillator including a primary circuit, a tank circuit and output electrodes deriving energy from said tank circuit, means for controlling the operation of said oscillator comprising a relay for said primary circuit, said relay having an operating coil which when energized shuts down the oscillator, a blocking condenser inserted in series with the electrodes and tank presenting negligible impedance to the flow of high frequency current but blocking the flow of direct current, a circuit for energizing said relay coil comprising a direct current source, a connection between said source and said oscillator at one side of said blocking condenser, a connection from the other side of said source to one end of said coil, a connection from the other end of said coil to said oscillator on the other side of said blocking condenser, radio frequency chokes in said connections to the opposite sides of said blocking condenser, by-pass condensers connected between the ends of said radio frequency chokes remote from the oscillator, the circuit through the relay operating coil being completed upon an arc discharge between the electrodes of the high frequency circuit which arc discharge provides a conducting path be-

tween the electrodes for the direct current and causes energization of the relay and shuts down the oscillator.

6. In combination with a high frequency oscillator having an energy supply circuit, an output circuit, and output electrodes deriving energy from said output circuit, means for controlling the operation of the oscillator comprising an electrically operated switch device in the energy supply circuit of the oscillator including an operating coil which when energized shuts down the oscillator, a source of control current, and means connecting said coil in series with said electrodes and across said control current source so that an arc discharge between the electrodes forms a conducting path for the control current completing the circuit for energizing the operating coil of the switch device.

7. In combination with a high frequency oscillator having an energy supply circuit, an output circuit, and output electrodes deriving energy from said output circuit, means for controlling the operation of the oscillator comprising an electrically operated switch device in the energy supply circuit of the oscillator including an operating coil which when energized shuts down the oscillator, a source of low frequency control current, means connecting said coil in series with said electrodes and across said control current source so that an arc discharges between the electrodes forms a conducting path for the control current completing the circuit for energizing the operating coil of the switch device, and means for preventing high frequency current from passing through said operating coil.

8. In combination, a high frequency oscillator including a primary circuit, a tank circuit and output electrodes deriving energy from said tank circuit, means for controlling the operation of said oscillator comprising a relay for said primary circuit, said relay having an operating coil which when energized shuts down the oscillator, a blocking condenser inserted in series with the electrodes and tank presenting negligible resistance to the flow of high frequency current but blocking the flow of a control current, a circuit for energizing said relay coil comprising a control current source, a connection between said source and said oscillator on one side of said blocking condenser, a connection from the other side of said source to one end of said coil and a connection from the other end of said coil to said oscillator on the other side of said blocking condenser.

9. In combination with a high frequency oscillator having an energy supply circuit and having output electrodes deriving energy from the oscillator, means for controlling the operation of the oscillator comprising an electrically operated switch device in the energy supply circuit of the oscillator including an operating coil which when energized shuts down the oscillator, a source of control current, and means connecting said coil in series with said electrodes and across said control current source.

10. In combination, a high frequency oscillating circuit including a blocking condenser and two spaced electrodes in series, said spaced electrodes forming part of a load, a power source for supplying control current, said source having high impedance to oscillator currents and being connected to said circuit at points having low impedance connections to said spaced electrodes, said power source providing a difference of potential too low to initiate breakdown between said spaced electrodes and said spaced electrodes normally providing an open circuit for said power circuit while an arc between said electrodes provides a low impedance between said spaced electrodes to close said power circuit, means responsive to flow of current from said power source incident to arcing for disabling said oscillating circuit, and means independent of arcing conditions for restoring said oscillating circuit to operation.

11. Apparatus of the character claimed in claim 10, wherein a low frequency energy supply source is connected to the oscillating circuit for supplying the energy thereto, and wherein said disabling means comprises means for cutting off said oscillating circuit from said low frequency energy supply.

12. Apparatus of the character claimed in claim 10, wherein a source of low frequency energy is provided for said oscillating circuit for energizing said circuit, and wherein said disabling means includes means energized by said control power source for maintaining said disabling means in a locked condition after disabling said oscillating circuit.

13. Apparatus of the character claimed in claim 10, wherein a low frequency energy supply source is provided for the oscillating circuit for energizing said circuit, and wherein said control current power source is energized by low frequency, and wherein the disabling means includes means energized by one of said low frequency sources for maintaining and disabling means locked after disabling said oscillating circuit.

14. In combination, a high frequency oscillating circuit including a blocking condenser and two spaced electrodes in series, said spaced electrodes forming part of a load, a power source for supplying control current, said source having high impedance to oscillator currents and being connected to said circuit at points having low impedance connections to said spaced electrodes, said power source providing a difference of potential too low to initiate breakdown between said spaced electrodes and said spaced electrodes normally providing an open circuit for said power source while an arc between said electrodes provides a low impedance between said spaced electrodes to close said power source, means responsive to flow of current from said power source incident to arcing for disabling said oscillating circuit, and manually operable switch means independent of arcing conditions for restoring said oscillating circuit to operation.

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Certificate of Correction

Patent No. 2,454,618. November 23, 1948.

JOHN McWILLIAMS STONE

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 16, for the word "for" read *are*; column 2, line 58, for "induction" read *inductance*; column 5, line 30, claim 7, for "discharges" read *discharge*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of April, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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