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HIGH-FREQUENCY OSCILLATOR CIRCUIT
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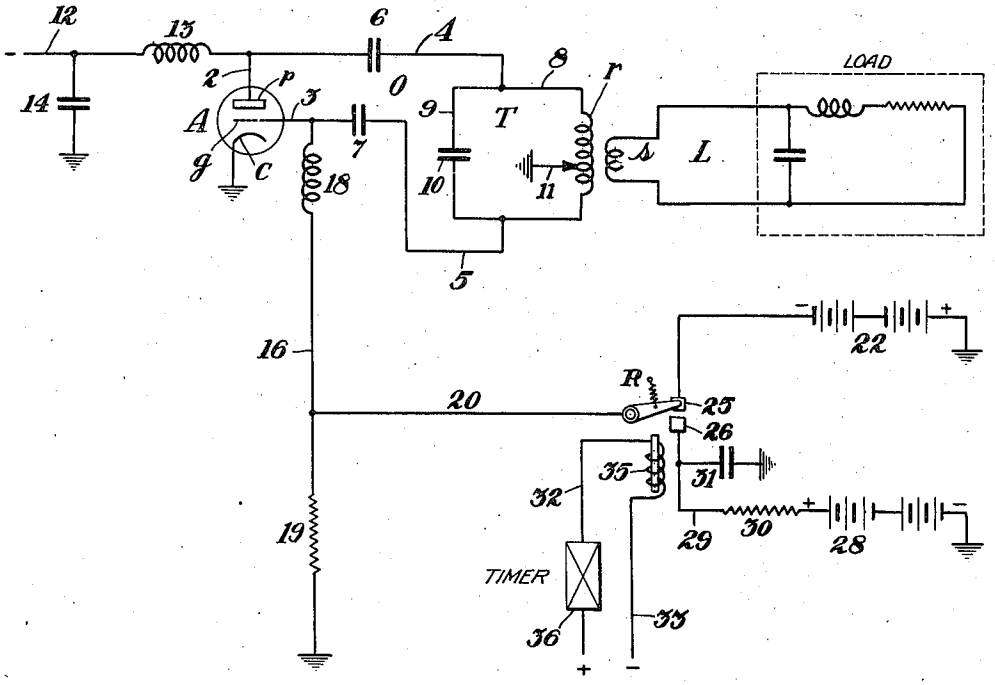


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## HIGH-FREQUENCY OSCILLATOR CIRCUIT FOR INDUCTION HEATING APPARATUS

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This invention relates to high frequency oscillator circuits particularly adapted for the energizing of induction heating apparatus such as is employed for example in the induction heating or hardening of steel or in like use wherein substantially the maximum load is employed as the normal operating condition. In induction heating of this type the work piece to be hardened or otherwise treated is placed within the heating coil prior to starting of the oscillator which, coupled with the fact that a peak load is presented by the work during the initial period in the heating operation, establishes a load condition which makes it difficult to initiate high frequency oscillation in the oscillator circuit. In the desired economical operation under maximum load the condition may exist that an oscillator capable of sustaining oscillation with the applied load is normally unable to initiate oscillation under the same load level. The object of the present invention is to provide an improved circuit arrangement which will produce a starting impulse or shock in a grid circuit so as to start oscillation in a heavily loaded tank circuit. The improved circuit is accordingly designed to establish oscillation under the aforesaid conditions of maximum load by the momentary application of a high value positive voltage pulse to the grid.

For the described purpose there is provided a supplemental energizing or shocking circuit including a positive voltage grid bias supply or source which is controlled by a relay to be effective with the initial energizing of the heating circuit and which operates to apply a positive potential to the grid of the oscillation tube as a supplemental positive impulse to effect an abrupt change of plate current to be instrumental in establishing or initiating the oscillation.

The improved circuit arrangement of the present invention will be more readily understood by reference to the accompanying drawings wherein there is diagrammatically shown a conventional oscillator circuit arrangement with which is incorporated the relay controlled supplemental and positive voltage grid bias supply circuit for applying the momentary shocking voltage to initiate the oscillation.

The conventional induction heating circuit arrangement as shown, of the Hartley oscillator circuit type, includes the oscillator tube A having the plate *p* and grid *g* connected to the oscillator circuit O including connections 2 and 3 connected to the plate and grid respectively, leads 4 and 5 provided with condensers 6 and 7 and connected to parallel leads 8 and 9 of tank circuit T having

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included therein a primary energizing coil *r* and condenser 10 respectively. The coil *r* has the adjustable ground connection 11 to establish regeneration in the known manner. The condensers 6 and 7 provide a low impedance path for the radio frequency current while forcing the direct current to flow through the tube. The usual cathode *c* of the oscillator tube is connected to ground as shown. The input for the oscillator circuit is by the lead 12 from a high tension source having the usual radio frequency choke 13 to prevent radio frequency current flowing into the high tension supply and a protective condenser 14 in a shunting connection is grounded as shown. The load circuit is shown at L including the usual secondary or coupling coil *s*. The normal negative grid bias voltage is developed across resistor 19, and is applied thru connection 16 and thence thru radio frequency choke coil 18 to the grid *g*. Connection 20 to the lead 16 functions normally to provide a fixed negative grid bias voltage sufficient to stop oscillation. This connects to the negative grid potential source 22 by means of a relay switch R normally engaging the contact 25.

In accordance with the present invention there is further provided a supplemental circuit arrangement operative momentarily to impress a positive grid bias upon the oscillator tube resulting in an abrupt change of plate current in a manner and of a magnitude to be effective to start oscillation. For this purpose the relay R is of double throw type adapted on opening of contact 25 to close a second contact 26 of a positive grid potential source 28 including batteries connected to lead 29 through resistance 30 and provided with a shunted and grounded condenser 31. The relay switch R is operated by the closing of circuit connections 32—33 having in series therewith the relay coil 35 and a suitable timer indicated at 36; this circuit being closed or initiated by a push button or manual switch at a convenient location.

The improved circuit is accordingly adapted to establish oscillation under the condition of substantially maximum load by the momentary application of an increased positive grid bias occurring upon the discharge of condenser 31. The positive grid bias established by the discharge of condenser 31 produces an abrupt rate of change of the plate current and since this rate of change controls the magnitude of voltage across the tank circuit it is the means for inducing a sufficiently high voltage at the grid of the tube to initiate and sustain oscillation. This shock voltage will be impressed on the grid circuit immediately upon the closing of the relay on contact 26 and there-

after, the duration of the sustained oscillation will be determined by the timer **36** in accordance with the desired time of induction heat treatment of the work piece or load as will be readily understood.

The provision of condenser **31** insures that there is an instantaneous potential of sufficient magnitude to produce a shock and start oscillations in the circuit. However, the condenser is immediately partially discharged and thus the potential of grid *g* is reduced to a normal value sufficient to sustain oscillations. These oscillations continue until relay switch R is operated to connect the negative potential of contact **25** to the grid, at which time the oscillations are suppressed.

What is claimed is:

1. In combination: an oscillator tube having anode, cathode and control grid electrodes; a feedback oscillation circuit connected to said electrodes; a source of voltage normally connected to said grid, the potential of said source having a value which prevents oscillation being developed in said oscillation circuit; a supplemental source of voltage comprising a capacitor, a resistance, and a capacitor charging means connected in series relation, the potential of said supplemental source having a value sufficient to initiate oscillations in said circuit; and means for connecting said supplemental voltage source to said grid for a predetermined period of time.

2. In combination: an oscillator tube having anode, cathode and control grid electrodes; a feedback oscillation circuit connected to said electrodes; a source of voltage normally connected to said grid, the potential of said source having a value which prevents oscillation being developed in said oscillation circuit; a normally disconnected supplemental source of voltage comprising a capacitor, and a capacitor charging means connected to charge the capacitor, the potential of said supplemental source having a value sufficient to initiate oscillations in said circuit; and means for connecting said supplemental voltage source to said grid to start oscillations in said circuit and means for disconnecting said supplemental voltage source to stop oscillations in said circuit.

3. A circuit for starting oscillations in a self-excited oscillator circuit including an electronic tube having an anode, cathode and control grid, comprising, in combination: a source of potential of such value as to prevent oscillation in said oscillator when said source is connected between said cathode and said control grid; a second source of potential of such value as to initiate oscillations in said oscillator circuit when connected between said cathode and said control grid; switching means for disconnecting said first source of potential from said control grid and connecting said second source thereto; a resistor connected between said second source of potential and said switching means; and a capacitor connected from the end of said resistor adjacent said switching means to said cathode, whereby the operation of said switching means from said first to said second position applies a high potential to said control grid to initiate oscillation and thereafter said voltage reduces to a lower value sufficient to sustain oscillation.

4. In combination: an oscillator tube having anode, cathode and control grid electrodes; a feedback oscillation circuit connected to said electrodes; a voltage source including a direct current source and a condenser charged thereby, the potential of said voltage source having a value sufficient to initiate oscillations in said circuit; means for connecting said direct current voltage and condenser in parallel to said grid to start oscillations in said circuit; said connecting means being such as thereby to discharge said condenser and to reduce the potential of said source to a potential less than its initial value but sufficient to permit sustained oscillations in said circuit.

5. A circuit for starting oscillations in a self-excited oscillator circuit including an electronic tube having an anode, cathode and control grid, comprising, in combination: a source of potential of such value as to prevent oscillation in said oscillator when said source is connected between said cathode and said control grid; a second source of potential of such value as to initiate oscillations in said oscillator circuit when connected between said cathode and said control grid; switching means for disconnecting said first source from said control grid and connecting said second source thereto; and circuit means connected to said second source of potential operative upon commencement of oscillations in said oscillator circuit to reduce the potential of said second source to a potential less than its initial value but sufficient to sustain oscillations in said oscillator circuit, whereby operation of said switching means from said first to said second position applies a high potential to said control grid to initiate oscillation and then reduces said voltage to a lower value during the desired period of oscillation.

6. A circuit for starting oscillations in a self-excited oscillator circuit including an electronic tube having an anode, cathode and control grid, comprising in combination: a source of potential of such value as to initiate oscillations in said oscillator circuit when connected between said cathode and said control grid; switching means for connecting said source of potential to said control grid; a resistor connected between said source of potential and said switching means; and a capacitor connected from the end of said resistor adjacent said switching means to said cathode, whereby operation of said switching means applies a high potential to said control grid to initiate oscillation and thereafter said voltage is reduced to a lower value sufficient to sustain oscillation.

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