

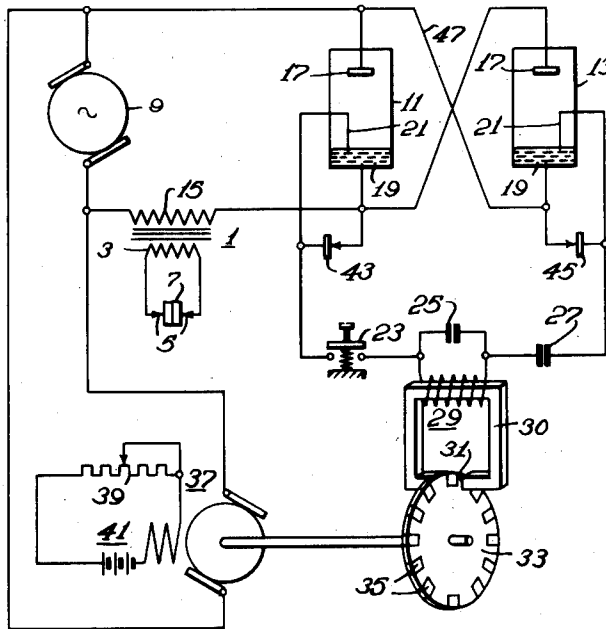
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IGNITRON WELDER CONTROL CIRCUITS

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IGNITRON WELDER CONTROL CIRCUITS

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My invention relates to electric discharge apparatus and has particular relation to electric discharge systems performing the functions of high current contactors.

With the development of electric discharge valves, such as ignitrons, capable of carrying substantial current, the practice has arisen of using the discharge valves as high current contactors. In accordance with the teachings of the prior art the supply of alternating current from a source to a load, such as a welder, for example, is controlled by connecting a pair of ignitrons in antiparallel between the load and the source and controlling the current flow through the ignitrons. In experimenting with apparatus of this type, I have encountered considerable difficulty in controlling the igniter current. To directly open and close a connection between one or a plurality of igniters and the source is not practical where the rating is of the order of several hundred to several thousand amperes because the igniter current and potential required is substantial. Where the ignitrons are to carry several hundred amperes the igniter current required is of the order of 10 to 50 amperes and the potential is of the order of one hundred volts. The opening and closing of a circuit of this type engenders arcing at the interrupting contacts and the life of the circuit opening and closing controller is not sufficiently long for practical purposes.

It is accordingly an object of my invention to provide a non-arcing arrangement for initiating and discontinuing the firing current of a discharge valve rated to pass a load current of the order of several hundred amperes.

Another object of my invention is to provide a system of simple structure for controlling the current flow through the firing electrodes of an ignitron circuit functioning as an alternating current contactor.

A more general object of my invention is to provide a readily variable impedance for controlling the current flow through a load that draws a large current of the order of 50 amperes intermittently.

More specifically stated, it is an object of my invention to provide a system of simple structure for supplying current from a source to a load that requires power in intermittent impulses.

My invention arises from the realization that the current flow through an ignitron may be reliably controlled by an impedance in series with the igniter which can be varied abruptly over a sufficiently wide range of values. To merely vary the magnitude of an ordinary impedance does not suffice for the present purpose, since a sufficient range of variation for reliable firing cannot be achieved with the necessary

speed. It often happens that the ignitrons in a contactor circuit should be rendered conductive or non-conductive within a half period of an ordinary 60-cycle alternating current source, and the corresponding variation to produce this condition should be correspondingly abrupt.

In accordance with my invention, the desired range of variation is attained by varying a reactance in circuit with igniter in such manner that it has at times the impedance of a parallel tuned circuit and at other times the impedance of a series tuned circuit. Since a parallel tuned circuit has substantial impedance the current flow through the igniter when it is interposed is small and the ignitron is non-conductive. A series tuned circuit has a small impedance and the current flow through an igniter when such a circuit is interposed may be sufficiently large to render the ignitron conductive. In accordance with my invention, the reactance in the igniter circuit is equivalent to a parallel circuit when the ignitron is to be non-conductive and a series tuned circuit when the ignitron is to be conductive. The reactance may be varied from one state to the other without mechanical contacts. Preferably the inductive reactance is provided with a coil, the reluctance of which is varied by inserting more or less magnetizable material in a gap. The same object may be achieved by varying the direct-current presaturation of the conductive reactances or by interposing more or less capacitive reactance.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which the single figure is a diagrammatic view showing an embodiment of my invention.

In the drawing, my invention is illustrated in connection with a welding load comprising a welding transformer 1 across the secondary 3 of which a pair of welding electrodes 5 engaged with the work 7, are connected. The welder is supplied from an alternating-current source 9 preferably of the usual commercial 60-cycle type. To control the current flow through the transformer 1, a pair of ignitrons 11 and 13 are interposed in anti-parallel between the source 9 and the primary 15 of the transformer. Each of the ignitrons has an anode 17, a cathode 19 and an ignition electrode 21.

In the practice of my invention, in its broader aspects, tubes of other types such as mercury pool tubes excited by the application of a high

frequency field, may be used. However, specifically, the ignitron with the immersed high resistivity ignition electrode has peculiar advantages and is to be preferred.

To control the current flow through the ignitrons 11 and 13, a reactive circuit is connected between the igniters 21 through a controller 23 which may be of the manual type such as a foot switch or a push button. The circuit comprises a plurality of capacitors 25 and 27 connected in series and an inductor 29 connected in parallel with one of the capacitors 25. The inductor is provided with a magnetizable core 30 having an air gap 31. A non-magnetic disc 33 provided with peripheral inserts 35 of magnetizable material is mounted to be rotated by a synchronous motor 37 in such manner that the inserts successively pass through the gap. The inserts 35 are readily removable so that they may be arranged in any desired manner in the periphery of the disc. Preferably the number of spaces provided for inserts 35 in the periphery of the disc is so related to the speed of the disc that one insert passes through the gap 31 during each half-period of the source 9. The phase angle in the waves of the source when the inserts move into the gap is preset by a rheostat 39 in the field circuit 41 of the motor 37.

The inductor 29 has a magnitude such that with the controller 23 closed and with magnetizable insert in the gap 31, the network 25-29 is tuned to the frequency of the source 9 and the current flow through the igniters 21 is negligible. When no magnetizable insert 35 is present in the gap, the inductance is reduced and the network 27-29 is tuned to the frequency of the source 9 and substantial current sufficient for firing, flows through the igniters. To suppress deleterious current flow in an improper sense through the igniters during firing, rectifiers 43 and 45, preferably of the dry type, are interposed between each igniter 21 and the associated cathode 19 in the proper sense.

In explaining the operation, let us assume that during a certain half-period when the controller 23 is closed, the upper terminal of the source 9 is positive and the lower terminal is negative, and at a phase angle in the half-period preset by the rheostat 39 a non-magnetizable insert enters the gap 31. In such a case, the series tuned impedance 27-29 is interposed in the igniter circuit and substantial current flows from the upper terminal of the source 9 through the conductor 47, the rectifier 45 associated with the right-hand valve 13, the series tuned network 27-29, the controller 23, the ignition electrode 21 and cathode 19 of the left-hand valve 11, the primary 15 of the welding transformer 1 to the lower terminal of the source. The current which flows through the ignition electrode and cathode of the left-hand valve 11 is sufficient for firing and since the anode-cathode potential impressed on this valve is of the proper polarity, the valve is rendered conductive and current is supplied to the load 1-7. The flow of current continues until the potential of the source 9 becomes sufficiently negative to counteract the back electromotive force of the load 1-7 and at this time, the left-hand ignitron is rendered non-conductive.

During the next half-period another non-magnetizable insert may again reduce the magnitude of inductor 29 and in this case current flow through the ignition electrode 21 and cathode 19 of the right-hand valve 13 renders the latter con-

ductive. The valves 11 and 13 thus continue to supply current to the load in a manner predetermined by the arrangement of inserts in the disc 33 and the operation of controller 23.

Although I have shown and described a certain specific embodiment of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination an electric discharge device having a control electrode and a plurality of principal electrodes, means for impressing potential between certain of said principal electrodes, a source of periodically pulsating potential, means for connecting one terminal of said source to one of said principal electrodes, reactance means for connecting said control electrode to another terminal of said source and means for varying said reactance means so that at times it constitutes a parallel circuit tuned to the frequency of said source and at other times it constitutes a series circuit tuned to the frequency of said source.

2. For use with a source of periodically pulsating potential an ignitron having a plurality of principal electrodes and an ignition electrode cooperative with one of said principal electrodes, means for impressing potential between certain of said principal electrodes, means for connecting said one principal electrode to a terminal of said source, variable reactive means for connecting said ignition electrode to another terminal of said source and means for varying said reactive means so that at times its impedance is substantially equivalent to that of a parallel tuned circuit tuned to the frequency of said source and at other times it is substantially equivalent to that of a series tuned circuit tuned to the frequency of said source.

3. For use with a source of alternating current the combination comprising an ignitron having a plurality of principal electrodes and an ignition electrode cooperative with one of said principal electrodes, means for impressing potential between certain of said principal electrodes, means for connecting said one principal electrode to a terminal of said source, capacitive means interposed between said ignition electrode and another terminal of said source, inductive means in parallel with a portion of said capacitive means and constituting therewith a parallel circuit tuned to the frequency of said source and means for at times varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source with the remainder of said capacitive means.

4. For use with a source of alternating current the combination comprising an ignitron having a plurality of principal electrodes and an ignition electrode cooperative with one of said principal electrodes, means for impressing potential between certain of said principal electrodes, means for connecting said one principal electrode to a terminal of said source, capacitive means interposed between said ignition electrode and another terminal of said source, inductive means in parallel with a portion of said capacitive means and constituting therewith a parallel circuit tuned to the frequency of said source and reactive means for at times varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source with the remainder of said capacitive means.

5. For use in varying current flow from a source of periodically pulsating current to a load the combination comprising capacitive means interposed between said source and said load, inductive means in circuit with said capacitive means and forming a parallel tuned circuit tuned to the frequency of said source with said capacitive means and means for varying said inductive means so that with said capacitive means it forms a series tuned circuit tuned to the frequency of said source.

6. The method of varying the current flow from a source of periodically pulsating current to a load with reactive means having a plurality of components interposed between said source and said load which comprises varying one of the components of said reactive means so that at times it interposes a parallel tuned circuit comprising inductive means in parallel with capacitive means tuned to the frequency of said source between said load and said source and at other times it interposes a series tuned circuit comprising said inductive means in series with capacitive means tuned to the frequency of said source between said load and said source.

7. For use in varying current flow from a source of periodically pulsating current to a load the combination comprising capacitive means interposed between said source and said load, inductive means in circuit with said capacitive means and forming a parallel tuned circuit tuned to the frequency of said source with said capacitive means and means for varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source, said varying means comprising a magnetic core having a gap and means for varying the reluctance of said gap.

8. For use in varying current flow from a source of periodically pulsating current to a load the combination comprising a plurality of capacitors interposed between said source and said load, inductive means in parallel with certain of said capacitors and forming a parallel tuned circuit tuned to the frequency of said source with said last-named capacitors and means for varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source with the remainder of said capacitors.

9. For use in controlling the supply of current from an alternating current source to a load the combination comprising a pair of electric discharge valves each having an anode, a cathode and a control electrode interposed in anti-parallel between said source and said load, capacitive means interconnecting said control electrodes, inductive means in circuit with said capacitive means and forming therewith a parallel tuned circuit tuned to the frequency of said source and means for varying said inductive means so that it forms with said capacitive means a series tuned circuit tuned to the frequency of said source.

10. For use in controlling the supply of current from an alternating current source to a load the combination comprising a pair of electric discharge valves each having an anode, a cathode and a control electrode interposed in anti-parallel between said source and said load, reactive means interconnecting said control electrodes, and having substantially the impedance of a parallel tuned circuit tuned to the frequency of said

source and means for varying said reactive means so that it has substantially the impedance of a series tuned circuit tuned to the frequency of said source.

11. For use in controlling the supply of current from an alternating current source to a load the combination comprising a pair of electric discharge valves each having an anode, a cathode and a control electrode interposed in anti-parallel between said source and said load, a plurality of capacitors interconnecting said control electrodes, inductive means in parallel with certain of said capacitors and forming therewith a parallel tuned circuit tuned to the frequency of said source and means for varying said inductive means so that it forms with the remainder of said capacitors a series tuned circuit tuned to the frequency of said source.

12. For use in varying current flow from a source of periodically pulsating current to a load, the combination comprising capacitive means interposed between said source and said load, inductive means having a magnetizable core in circuit with said capacitive means and forming a parallel tuned circuit tuned to the frequency of said source with said capacitive means and means for varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source, said varying means comprising means for varying the reluctance of said core.

13. For use in varying current flow from a source of periodically pulsating current to a load, the combination comprising capacitive means interposed between said source and said load, inductive means having a magnetizable core with an air gap therein in circuit with said capacitive means and forming a parallel tuned circuit tuned to the frequency of said source with said capacitive means and means for varying said inductive means so that it forms a series tuned circuit tuned to the frequency of said source, said varying means comprising means for inserting magnetizable material in said gap.

14. For use in controlling the supply of current from an alternating-current source to a load, the combination comprising electric discharge means including a pair of cathodes, one of which is connected directly to one terminal of said source and the other of which is connected to another terminal of said source through said load, a control electrode associated with each said cathode, reactive means interconnecting said control electrodes, and having substantially the impedance of a parallel tuned circuit tuned to the frequency of said source and means for varying said reactive means so that it has substantially the impedance of a series tuned circuit tuned to the frequency of said source.

15. The method of varying current flow from a source of periodically pulsating current to a load with capacitive means interposed between said source and said load, and inductive means in circuit with said capacitive means which comprises varying said inductive means so that at times it forms a parallel tuned circuit tuned to the frequency of said source with a portion of said capacitive means and at other times it forms a series tuned circuit tuned to the frequency of said source with another portion of said capacitive means.

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