

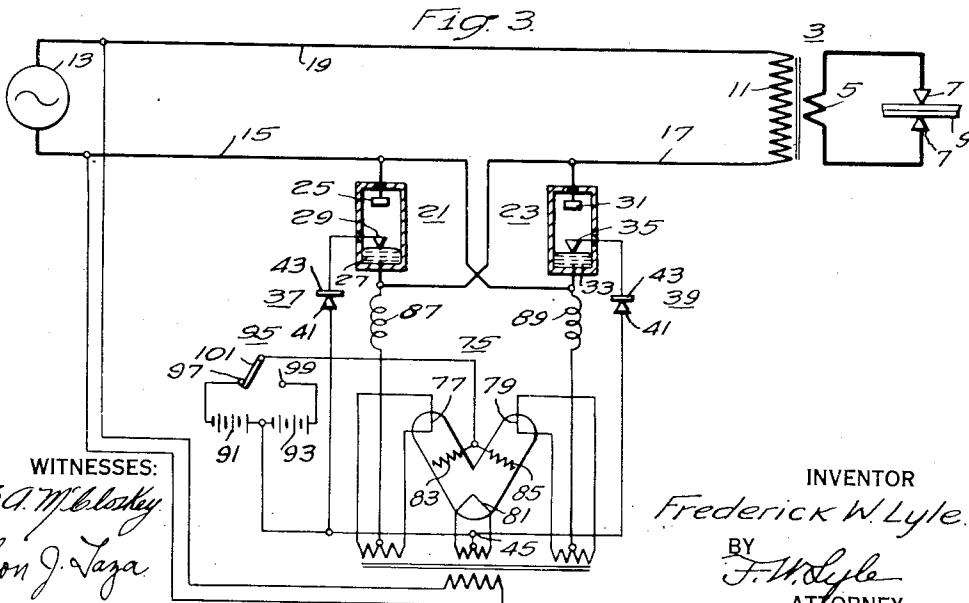
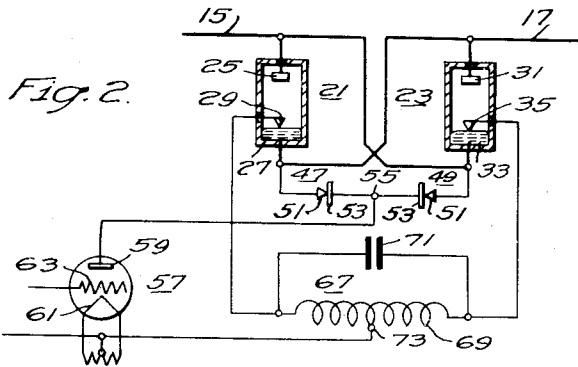
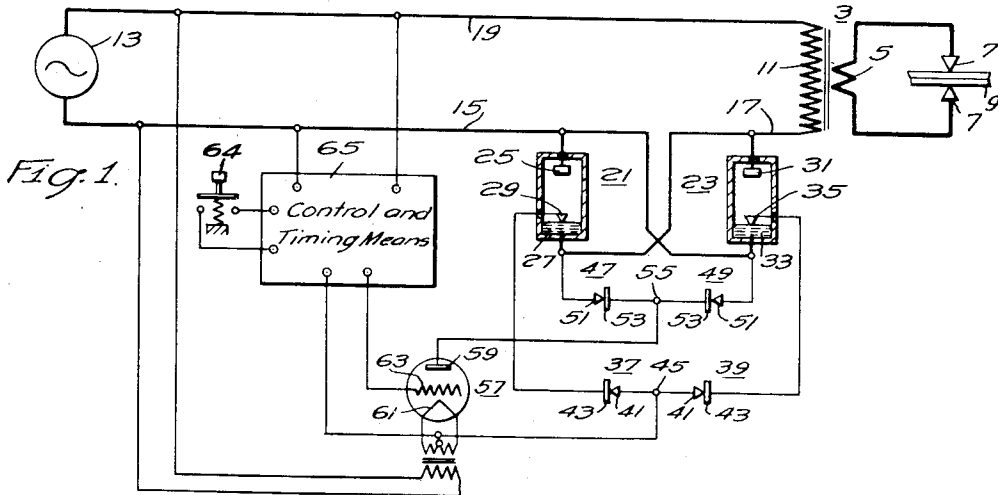
May 20, 1941.

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2,242,894

CONTROL SYSTEM

Filed June 30, 1939



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2,242,894

CONTROL SYSTEM

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Application June 30, 1939, Serial No. 282,174

15 Claims. (Cl. 250—27)

My invention relates to control systems and it has particular relation to control systems utilizing electric discharge apparatus for controlling the flow of power from a source to a work circuit.

An object of my invention is to provide a system of simple structure incorporating a minimum of auxiliary discharge devices for controlling the current flow through a pair of main electric discharge devices.

Another object of my invention is to provide a system of simple structure incorporating a minimum of auxiliary discharge devices for controlling current flow through a pair of main electric discharge devices of the immersed-ignition-electrode type connected in anti-parallel.

A more general object of my invention is to provide a novel circuit for controlling an electric discharge device of the immersed-ignition-electrode type.

A further object of my invention is to provide a simple, efficient, and inexpensive system for controlling the current flow from a source to a load.

An ancillary object of my invention is to provide a resistance, spot and seam welding system of simple construction that shall operate reliably and efficiently.

In accordance with my invention, power is supplied to the material to be welded, or to any other suitable load, from an alternating-current source through electric discharge devices of the arc-like type. The main discharge devices are controlled by an auxiliary discharge device of the arc-like type. When the latter is rendered conductive, current flows through the main discharge devices and the load, and when the auxiliary discharge device is non-conductive, the current flow through the main discharge devices is interrupted. The auxiliary discharge device is rendered conductive and maintained conductive for a predetermined time interval by control and timing means.

The control system for a pair of electric discharge devices of the immersed-ignition-electrode type connected in anti-parallel is simplified, in accordance with my invention, by interconnecting the ignition electrodes of the discharge devices through a high impedance network made up of relatively low impedance elements, and supplying ignition current to the discharge devices through the low impedance elements. In particular, the ignition electrodes are interconnected by a network comprising a plurality of rectifiers. To supply ignition current, the impedance of the net-

work is controlled by means of the auxiliary discharge device referred to hereinabove.

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:

Figure 1 is a diagrammatic view of an embodiment of my invention;

Fig. 2 is a partial diagrammatic view showing a modification of my invention; and

Fig. 3 is a diagrammatic view showing another modification of my invention.

The apparatus shown in Figure 1 comprises a welding transformer 3, to the terminals of the secondary 5 of which a pair of welding electrodes 7 are connected. The electrodes engage the material 9 to be welded and when current is transmitted through a primary 11 of the transformer, welding current flows through the material.

The primary 11 of the transformer is supplied from an alternating-current source 13, which may be of the usual 60-cycle commercial type, through conductors 15, 17 and 19, and a pair of electric discharge devices 21 and 23 connected in anti-parallel. The discharge devices are of the immersed-ignition-electrode type. The discharge device 21 has an anode 25, a mercury pool cathode 27, and an ignition electrode 29. Similarly, the discharge device 23 has an anode 31, a mercury pool cathode 33 and an ignition electrode 35.

The discharge devices 21 and 23 may be replaced by grid-controlled discharge devices provided a proper resistor, and if desired, a source of biasing potential, are shunted between the control electrode and one of the principal electrodes of each such substituted grid-controlled discharge device.

The ignition electrodes 29 and 35 of the discharge devices are interconnected by a pair of back-to-back rectifiers 37 and 39, each rectifier having an anode 41 and a cathode 43. The anodes 41 are connected to a common junction 45 and the cathodes 43 of rectifiers 37 and 39 are connected to starting electrodes 29 and 35, respectively. A second pair of rectifiers 47 and 49, each having an anode 51 and a cathode 53, are connected back-to-back between the cathodes 27 and 33 of the main discharge devices 21 and 23, so that the cathodes 53 are connected to a com-

mon junction 55. While the rectifiers 37, 39, 47 and 49 are preferably of the dry type, it will be understood that rectifiers of the electronic type may be utilized.

To control the flow of ignition current through the starting electrodes 29 and 35, an auxiliary discharge device 57 is provided. The latter is preferably of the arc-like type and comprises an anode 59, a hot cathode 61, and a control electrode 63 and a gaseous medium at a suitable pressure. The cathode 61 of the auxiliary discharge device 57 is connected to the junction 45 of rectifiers 37 and 39. The anode 59 of the auxiliary discharge device is connected to the junction 55 of rectifiers 47 and 49.

To control the energization of the auxiliary discharge device 57, control potential is impressed between the control electrode 63 and the cathode 61 by control and timing means 65. It will be understood that conventional starters or timers, many of which are well known in the art, may be utilized for controlling the auxiliary discharge device 57.

To initiate a welding operation, a circuit controller 64 which is preferably manually operated and may be a foot switch of a push-button, is closed to thus initiate the operation of the control and timing means 65 and because of the potential thereby impressed on control electrode 63, the auxiliary discharge device 57 is rendered conductive.

Assume that at the instant under consideration, the polarity of the source 13 is such that the anode 25 of the left-hand discharge device 21 and the cathode 33 of the right discharge device 23 are positive relative to the cathode 27 of the left-hand discharge device and the anode 31 of the right-hand discharge device. Ignition current will then flow through a circuit which extends from the energized conductor 15 through rectifier 49, anode 59 and cathode 61 of auxiliary discharge device 57, rectifier 37, ignition electrode 29, cathode 27 to the energized conductor 17. This ignition current causes discharge device 21 to be rendered conductive and current to flow from source 13 through the left-hand discharge device 21 and primary 11 of the welding transformer 3. Current does not flow through the right-hand discharge device because at this time its anode 31 is negative relative to its cathode 33, and starting electrode 35 is deenergized.

When the potential of the source 13 reverses, the ignition current flows from energized conductor 17 through rectifier 47, auxiliary discharge device 57, rectifier 39, control electrode 35, cathode 33 to energized conductor 15. However, at this time, the anode potential of the right-hand discharge device 23 is positive and the latter is rendered conductive, while the left-hand discharge device 21 is not conductive. It is to be noted that as soon as one or the other of the main discharge devices 21 or 23 is rendered conductive and this occurs immediately after the initiation of current flow through the associated electrodes, the rectifiers 49 and 37 or rectifiers 47 and 39, respectively, and auxiliary discharge device 57 are short-circuited by the main discharge device and the current flow through the ignition electrodes 29 and 35 is discontinued for the remainder of the half cycle. In this manner, power loss and the other disadvantages arising from the continuous current flow through the ignition electrodes, is avoided.

After a time interval predetermined by the

operation of the control and timing means 65, the auxiliary discharge device 57 is rendered non-conductive. Thus ignition current no longer flows through ignition electrodes 29 and 35 and the rectifiers 37, 39, 47 and 49. The main discharge devices 21 and 23 become non-conductive and remain non-conductive and the current flow through the welding transformer 3 is discontinued. The auxiliary discharge device 57 remains non-conductive until the next cycle of operation is initiated by the closing of switch 64 or automatically reinitiated after a predetermined time by the control and timing means 65.

The rectifiers 37 and 39 connected between the starting electrodes 29 and 35 may be replaced by a network 67 comprising an inductor 69 shunted by a capacitor 71, as shown in Fig. 2. The cathode 61 of auxiliary discharge device 57 is connected to an intermediate tap 73 on the inductor 69. The inductor 69 and the capacitor 71 are preferably tuned to the alternating-current supply frequency to constitute an anti-resonant circuit, but this is merely an ancillary feature as capacitor 71 may be omitted, or a resistor substituted for inductor 69. The operation of the system modified as shown in Fig. 2 is substantially the same as the operation hereinabove described with reference to Fig. 1.

The modification shown in Fig. 3 is the same as that shown in Fig. 1 except that the rectifiers 47 and 49 and the auxiliary discharge device 57 have been omitted. An auxiliary electric discharge device 75 having a plurality of filamentary electrodes or hot filaments 77, 79 and 81 and control electrodes 83 and 85, is connected between the cathodes 27 and 33 of the main discharge devices 21 and 23, so that electrode 77 is connected through an impedance 87 to cathode 27 and electrode 79 is connected through an impedance 89 to cathode 33. The electrode 81 is connected to the junction 45 of rectifiers 37 and 39. Batteries 91 and 93 each having a terminal voltage greater than half the peak alternating potential of the source 13, or any other suitable source of control potential, are connected between the control electrodes 83 and 85 and the electrode 81. To control the operation of the system a control device 95 having stationary contact members 97 and 99 and moving contact members 101 is utilized. When the control circuit is closed through contact members 97 and 101, the auxiliary device 75 is maintained in the deenergized condition. When the control circuit is closed through contact members 99 and 101, the auxiliary device 75 becomes energized and alternating-current from source 13 passes through the discharge device 75 through a circuit which extends from the energized conductor 15, impedance 89, electrode 79, electrode 77, impedance 87, to energized conductor 12. When the polarity of the source is such that anode 25 is positive relative to cathode 27, ignition current will flow through a circuit which extends from the energized conductor 15, through impedance 89, electrode 79, electrode 81, rectifier 37, ignition electrode 29 to the energized conductor 17. Discharge device 21 is then rendered conductive while discharge device 23 remains non-conductive as hereinabove described with respect to Fig. 1. Similarly, when the polarity of the source 13 is reversed, discharge device 23 is rendered conductive while discharge device 21 is non-conductive.

It will be recognized that the control device 95 of Fig. 3 or the control and timing means 65

of Fig. 1 may be replaced by a conventional timing device, many of which are well known in the art. Timing means of the type described in a copending application Serial No. 34,003 of John W. Dawson, filed July 31, 1935, and assigned to the Westinghouse Electric & Manufacturing Company may be utilized. The addition of the timing means to systems constructed according to my invention will be apparent to persons skilled in this art. For example, in applying the timer shown in Fig. 1 of Dawson in place of control device 95, the operating coil of relay 58 and switch 57 are connected in series across the source 13. The primary winding of transformer 43 is also connected across the source 13. The negative terminal of battery 34 is connected to the control electrodes 83 and 85 and the conductor 39 is connected to junction 45.

It is to be noted that while the discharge devices 15 and 16 are illustrated as separate valves, they may, under certain circumstances, be replaced by a single double-polarity discharge device comprising a pair of mercury pool electrodes in each of which an ignition electrode is immersed.

I do not wish to be restricted to the specific structural details, arrangement of parts or circuit connections herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of my invention. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. In combination, a pair of electric discharge devices connected in anti-parallel, each discharge device having a plurality of principal electrodes and an ignition electrode in contact with one of the principal electrodes, means for impressing an alternating potential between said principal electrodes, a pair of rectifiers having like terminals connected together, said first pair of rectifiers being connected in parallel with said discharge devices, a second pair of rectifiers having like terminals connected together, said second pair of rectifiers being connected between the said ignition electrodes, and a common circuit, including an auxiliary discharge device, connected between the said pairs of rectifiers for controlling the ignition current through said ignition electrodes.

2. In combination, a pair of electric discharge devices connected in anti-parallel for controlling the supply of power from a source to a work circuit, each discharge device having an anode, a mercury pool cathode and an ignition electrode in contact with said cathode, a network comprising a first pair of rectifiers having like poles connected together, said first pair of rectifiers being connected between the said control electrodes, a second pair of rectifiers having like poles connected together, said second pair of rectifiers being connected between the said anodes of the said pair of discharge devices and an auxiliary electric discharge device connected between the common junction of the first pair of rectifiers and the common junction of the said second pair of rectifiers, and control means associated with the said auxiliary discharge device for controlling the energization of the said pair of discharge devices.

3. In combination, a pair of electric discharge devices connected in anti-parallel for controlling the supply of power from a source to a work circuit, each discharge device having an anode, a

cathode, and an ignition electrode immersed in said cathode, a parallel-tuned network consisting of a plurality of impedances and tuned to the frequency of said source, connected between the ignition electrodes of said valves, one of said impedances having an intermediate tap, a pair of back-to-back rectifiers connected between the anodes of said pair of discharge devices, an asymmetrically conductive auxiliary discharge device having a plurality of principal electrodes, means for connecting one of the principal electrodes of said auxiliary discharge device to the intermediate tap of said one impedance, means for connecting the other principal electrode to the common junction of said rectifiers, and means associated with the said auxiliary discharge device for controlling the energization of the said pair of discharge devices.

4. In combination, a pair of electric discharge devices connected in anti-parallel for controlling the supply of power from a source to a work circuit, each discharge device having a plurality of principal electrodes and a control electrode, a network having one portion comprising a first pair of rectifiers and an auxiliary electric discharge device connected between the said control electrode and one of the principal electrodes of one of the said pairs of discharge devices, and having another portion comprising a second pair of rectifiers and the said auxiliary discharge device connected between the said control electrode and one of the principal electrodes of the other of the said pair of discharge devices and control means associated with the said auxiliary discharge device for controlling the energization of the said pair of discharge devices.

5. For use in supplying an alternating current load from a source of alternating current, the combination comprising a pair of electric discharge devices of the immersed ignition electrode type connected in anti-parallel between said source and said load, each of said discharge devices having an anode, a cathode, and an ignition electrode immersed in said cathode, a first pair of rectifiers connected between the anode and the ignition electrode of one of said discharge devices, a second pair of rectifiers connected between the anode and the ignition electrode of the other of said discharge devices, and a common circuit interconnecting the said first pair of rectifiers and the said second pair of rectifiers, the said common circuit including means for controlling the flow of current through said rectifiers and said ignition electrodes to render the said discharge devices conductive.

6. For use in controlling the supply of power from a source of periodically pulsating potential to a load, the combination comprising a pair of electric discharge devices each having a plurality of principal electrodes and a control electrode, a first pair of rectifiers connected between the control electrode and one of the principal electrodes of one of the said discharge devices, and a second pair of rectifiers connected between the control electrode and one of the principal electrodes of the other of said discharge devices, the said rectifiers being interconnected by a common circuit including means for controlling the flow of current through the said rectifiers to control the energization of the said discharge devices.

7. For use in supplying an alternating current load from a source of alternating current, the combination comprising a pair of electric discharge devices of the immersed-ignition electrode type connected in anti-parallel between said

source and said load, each of said discharge devices having an anode, a cathode, and an ignition electrode immersed in said cathode, a first pair of rectifiers having like poles connected together, said first pair of rectifiers being connected between the said ignition electrodes, a second pair of rectifiers having like poles connected together, said second pair of rectifiers being connected in parallel with said discharge devices, and means for transmitting current through the said rectifiers and said ignition electrodes to render said discharge devices conductive.

8. In combination, an alternating current supply having two line conductors, two electric discharge devices each having an anode, a cathode and a control electrode, said discharge devices being connected to deliver current to opposite conductors of said supply, two unilaterally-conductive current paths having a first set of like terminals connected together and a second set of like terminals connected respectively to the opposite conductors of said supply, a network having a neutral point, said network being connected in series with the control electrodes of said two discharge devices across said two conductors, and means including a control electrode to control current flow between said neutral point and said first set of like terminals.

9. In combination, an alternating current supply having two line conductors, a pair of electric discharge devices of the immersed ignition electrode type connected in antiparallel to deliver current to opposite conductors of said supply, each discharge device having an anode, a cathode and an ignition electrode immersed in said cathode, two unilaterally-conductive current paths having a first set of like terminals connected together and a second set of like terminals connected respectively to the opposite conductors of said supply, a network having an intermediate terminal, said network being connected in series with the ignition electrodes and cathodes of said two discharge devices across said two conductors, and means including a control electrode to control current flow between said intermediate terminal and said first set of terminals.

10. In combination, an alternating current supply having two line conductors, two electric discharge devices each having an anode, a cathode and a control electrode, said discharge devices being connected to deliver current to opposite conductors of said supply, two unilaterally-conductive current paths having a common junction and a pair of terminals, said terminals being connected respectively to opposite conductors of said supply, a network comprising a pair of unilaterally conductive current paths having a set of like terminals connected together, said network being connected in series with the control electrodes of said two discharge devices across said two conductors, and control means comprising a single current path for controlling the current flow between said junction and said set of like terminals.

11. In combination, an alternating current supply having two line conductors, two main electric discharge devices each having an anode, a cathode and a control electrode, said main devices being connected to deliver current to opposite conductors of said supply, an auxiliary electric discharge device having three principal electrodes arranged to constitute two unidirectional discharge paths, one of said principal electrodes being common to both discharge paths, means for connecting the other two electrodes respec-

tively to said two conductors, a network comprising two unilaterally conducting paths having a set of like terminals connected together to said one principal electrode of said auxiliary device, said network being connected in series with the control electrodes of said two main devices across said two conductors, and control electrode means for said auxiliary discharge device.

12. In combination, a first and a second main electric discharge device of the immersed-ignition-electrode type connected in antiparallel for controlling the supply of power from a source to a work circuit, each main discharge device having an anode, a cathode, and an ignition electrode immersed in said cathode, a first control circuit for said first main discharge device, said first control circuit comprising a first and a second rectifier, an auxiliary discharge device and the ignition electrode and the cathode of said first main discharge device connected in series circuit relation to be energized from said source, a second control circuit for said second main discharge device, said second control circuit comprising a third and a fourth rectifier, the said auxiliary discharge device and the ignition electrode and the cathode of said second main device connected in series circuit relation to be energized from said source, and control means for said auxiliary discharge device.

13. For use in supplying an alternating current load from a source of alternating current, the combination comprising a pair of main electric discharge devices of the immersed-ignition-electrode type connected in anti-parallel between said source and said load, each of said main discharge devices having an anode, a cathode, and an ignition electrode immersed in said cathode, a pair of back-to-back rectifiers connected between the ignition electrodes, the said rectifiers having a common junction, an auxiliary discharge device having a pair of anodes, a cathode, and a control electrode, means connecting the anodes of said auxiliary discharge device to the cathodes of said main discharge devices, means for connecting the cathode of said auxiliary discharge device to the junction of said rectifiers and means connected between the control electrode and the cathode of said auxiliary discharge device for rendering said auxiliary discharge device conductive.

14. In combination, a pair of electric discharge devices of the immersed-ignition-electrode type connected in anti-parallel for controlling the supply of power from a source to a work circuit, each discharge device having a pair of principal electrodes and a starting electrode immersed in said cathode, two unilaterally conductive current paths having a common junction and a set of like terminals connected respectively to opposite principal electrodes of said discharge devices, a network having an intermediate terminal, said network being connected between the starting electrodes of said discharge devices and means including a control electrode to control current flow between said set of like terminals and said intermediate terminal through said common junction.

15. In a system for controlling the supply of power from a source to a work circuit, in combination, a pair of main electric discharge devices connected between said source and said work circuit, each of said main discharge devices having a pair of principal electrodes and a starting electrode, a pair of rectifiers having a first set of like terminals connected together

and having one terminal of a second set of like terminals connected to a principal electrode of one of said main discharge devices and another terminal of said second set of like terminals connected to a principal electrode of the other of said main discharge devices, a network having an intermediate terminal, said network being connected between the starting electrodes of said discharge devices and means including an aux-

iliary electric discharge device having a plurality of principal electrodes and a control electrode connected between the junction of said first set of like terminals of said rectifiers and the said intermediate terminal of said network for controlling the ignition of said main discharge devices.

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