Jan. 12, 1943. E. H. VEDDER 2,308,255

DISCHARGE APPARATUS

Original Filed Aug. 17, 1938

Fig. 1.

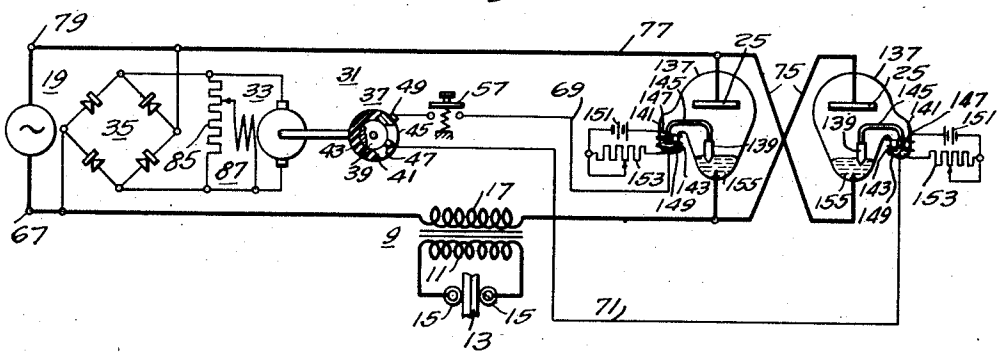
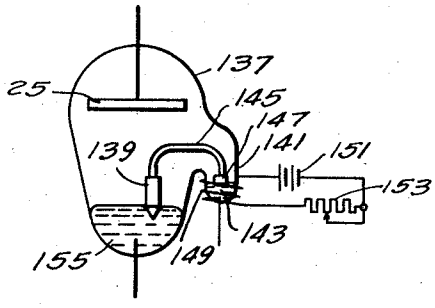


Fig. 2.



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Patented Jan. 12, 1943 2,308,255

UNITED STATES PATENT OFFICE

2,308,255

DISCHARGE APPARATUS

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Original application August 17, 1938, Serial No. 225,368, now Patent No. 2,290,657, dated July 21, 1942. Divided and this application August 5, 1941, Serial No. 405,474

7 Claims. (Cl. 250—27)

My invention relates to electric discharge apparatus and has particular relation to discharge apparatus for controlling the supply of current to a load requiring power in intermittent pulses such as a resistance spot and seam welding load, for example.

This application is a division of application, Serial No. 225,368, filed August 17, 1938.

The present invention also relates to an application Serial No. 214,160, filed June 16, 1938, by me and Russell W. Staggs, and assigned to the Westinghouse Electric & Manufacturing Company, and is an extension of the invention disclosed therein.

In the last-mentioned application, apparatus is disclosed that incorporates electric discharge valves of the immersed-ignition-electrode type through which current is generally supplied from an alternating current source to a load requiring power in intermittent pulses. By the proper selection of the ignition electrodes of the discharge valves, and by the proper adjustment of the circuit in which they are connected, the load current variations are maintained within limits as regards both the current-time product and the magnitude of the individual sub-impulses which form a main impulse.

As is explained in the aforesaid application, the load supplied in the practice of the invention disclosed often has a poor power factor and the supply of the pulses is initiated at random. The magnitude of the variations produced is dependent on the relationship between the angle in the half-cycles of the source at which the valves are rendered conductive and the angle at which current zero occurs. The former I shall designate herein as the ignition angle; the latter as the power factor angle.

In accordance with the invention disclosed in the aforesaid application, variations in the current-time product and the magnitudes of the sub-impulses are limited by so selecting the ignition electrodes and their circuits that the ignition angle is of the same order of magnitude as the power factor angle. However, no simple means is made available in accordance with the said invention for adjusting the ignition angle with any degree of precision at a definite value and no simple contrivance for varying the current flow through the load over a wide range is provided.

It is accordingly an object of the present invention to provide an arrangement of simple structure in accordance with the aforesaid application, in which the ignition angle shall be adjustable at will.

A more general object of my invention is to provide a control system incorporating an electric discharge valve of the immersed ignition electrode type, in which the instant at which the valve is rendered conductive shall be adjustable at will by the proper adjustment of the ignition circuit.

Another general object of my invention is to provide an arrangement of simple structure for supplying a load from an alternating source wherein the supply of power shall be initiated at instants in the half periods of the source which may be selected at will.

Still another general object of my invention is to provide apparatus for supplying a load from an alternating current source through electric discharge valve means of the immersed ignition electrode type, in which the impedance of the ignition circuit shall be varied at will to vary at will the instants in the half periods of the source at which the valve means is rendered conductive.

A more specific object of my invention is to provide a resistance spot and seam welding system of simple structure incorporating the feature of heat control.

Another specific object of my invention is to provide an electric discharge valve of the immersed ignition electrode type, the ignition angle of which is variable to vary the magnitude of the current flow therethrough.

A still further object of my invention is to provide an electric discharge valve of the immersed ignition electrode type that shall be particularly adaptable for use in apparatus in which the ignition electrode is to be supplied continuously or for relatively long intervals of time with current when the valve is in operation.

More concisely stated, it is an object of my invention to provide simple and tractable apparatus for supplying current to a load requiring power in intermittent pulses, by the operation of which the magnitude of the pulses supplied shall be variable over a wide range.

According to my invention, the ignition potential for the electric discharge valves is derived from the same source as the anode-cathode potential. The ignition angle is varied by varying the impedance through the ignition electrode and the cathode in which it is immersed.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention it-

self, 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 specific embodiments when read in connection with the accompanying drawing, in which:

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

Fig. 2 is a diagrammatic view showing a valve in which the ignition electrode has variable conductivity.

The apparatus shown in Fig. 1 is a resistance seam welding system comprising a welding transformer 9 from the secondary 11 of which current impulses are supplied to a material 13 to be welded through a pair of welding electrodes 15. The primary 17 of the welding transformer is connected to a suitable source 19 of alternating current, which may be an ordinary commercial 60-cycle source, through a pair of electric discharge valves 137 of the immersed ignition electrode type. Each of the valves has an anode 25 composed of nickel, carbon or other suitable material, a cathode 155 consisting of a pool of mercury or like material, and an ignition electrode 139 composed preferably of boron carbide but in certain cases also of silicon carbide or other materials. The valves 137 are connected between the source 19 and the load 9—13 in anti-parallel.

In seam welding apparatus, the current is supplied in the form of discrete impulses; each impulse consists of a train of sub-impulses, one sub-impulse flowing during each half period of the source. To measure out the welding current impulses, a timing system 31 comprising a direct current motor 33 which is supplied from the source 19 through a rectifier 35 and which drives a commutator 37 is provided. The commutator 37 is provided with an inner completely conducting ring 39 and an outer ring 41 in metallic engagement with the inner ring. The outer ring 41 has an insulating segment 43 extending over a portion of its periphery and a conducting segment 45 extending over the remainder. Brushes 47 and 49 engage the inner and outer rings 43 and 45, respectively, and are, in turn, connected in a circuit including a suitable circuit closing element 57 which may be a foot switch, a push button, or the like.

When power is supplied to the system and the switch 57 is closed, a circuit through the ignition electrodes 139 of the valves 137 is closed and opened with a periodicity dependent on the speed of rotation of the commutator 37 and for intervals, depending on the relative lengths of the conducting and insulating segments. As shown in Figs. 1 and 2, each discharge valve 137 is provided with a side arm 141 in which a small pool 143 of mercury is disposed. A rigid wire 145 is secured to the ignition electrode 139 and extends into the side arm 141. At its free end, the wire carries a block 147 of magnetic material which dips into the mercury 143. The connection to the ignition electrode may take place through the mercury 145 in the side arm 141, the block 147 of magnetic material and the stiff wire 145. The circuit then extends from the lower terminal 67 of the source 19 through the primary 17 of the welding transformer 9, the cathode 155 and ignition electrode 139 of one valve, a conductor 69, the switch 57, the conducting segment 45 of the commutator 37, a conductor 71, the ignition electrode 139 and cathode 155 of the other valve, a conductor 75, a conductor 77, to the upper terminal 79 of the supply source.

With the ignition electrodes 139 connected as shown, the potential of the source is impressed across the series circuit including the ignition electrode and cathode of each valve. For a predetermined polarity of the source potential, one or the other of the ignition electrodes 139 is supplied with a positive half wave of potential at the same time that positive anode-cathode potential is impressed on its valve 137, the two potentials being in phase. When during any positive half-cycle the potential across one ignition electrode 139 rises to a sufficiently high value, the corresponding valve is rendered conductive. After the valve becomes conductive, the sum of the ignition electrode-cathode potentials of the two valves is reduced to the arc drop value, which is of the order of 10 to 20 volts and, therefore, the flow of substantial current through the ignition electrodes is interrupted. As the source potential varies in polarity, the valves are alternately rendered conductive and alternating current pulses are supplied to the material to be welded in rhythm with the half-cycles of the source.

Impulses made up of trains of half-cycle sub-impulses are thus supplied for intervals of time determined by the length and the speed of rotation of conducting segment 45 of the commutator 37. The number of sub-impulses which make up an impulse and therefore the time of supply of each welding impulse or the number of welds per unit time, may be varied or regulated by controlling the speed of the motor 33. The latter object is accomplished in a simple manner by varying the resistance 85 in the field circuit 87 of the motor. The time between impulses is, of course, dependent on the length and speed of the insulating segment 43. The ratio of the welding time to the pause may be varied by varying the relative lengths of the conducting and insulating segments 45 and 43. The measuring out of a predetermined number of sub-impulses to make up a welding impulse is known in the art as the timing of the supply of welding current. In addition to the timing, another desideratum in welding is heat control, i. e., the control of the heating of the material to be welded during the welding operation.

The heat supplied by the welding current is dependent on the magnitude of the welding current which flows and therefore on the magnitude of the sub-impulses. In the present case, the magnitude of the sub-impulses is dependent on the angle in the half-cycles of the source at which the sub-impulses current flow is initiated and this angle, in turn, is simply the ignition angle. To control the heat supplied during welding, therefore, the ignition angle is controlled.

In Figs. 1 and 2, a valve 137 of the immersed ignition electrode type, with which continuous variation of the ignition angle is possible, is disclosed. In this structure, the impedance through the ignition electrode 139 and the cathode 155 is varied continuously by varying the volume of the portion of the electrode immersed in the cathode. As previously mentioned, the block 147 connected to the ignition electrode 139 by stiff wire 145, is of magnetic material. A suitable solenoid 149 is disposed around the side arm 141 in which block 147 is located.

The solenoid is connected in circuit with a source 151 and a rheostat 153 and its magnetic field is set by adjusting the rheostat. As the intensity of the field varies, the extent to which the ignition electrode 139 dips into the mercury

cathode 155 is varied and the impedance through the ignition electrode 139 and cathode 155 is correspondingly varied. Since the magnitude of ignition potential varies with the impedance through the ignition electrode and cathode, the instants in the half periods of the source at which each valve 137 is rendered conductive may be set by the proper adjustment of the corresponding rheostat 153.

It is to be noted that while my invention has been disclosed herein as applied in a seam welding system, it has general applicability and may be used wherever the supply or power to a load is to be controlled. In particular, it may be used with advantage in a spot welding system such, for example, as is shown in the above-mentioned application to me and Staggs.

Although I have shown and described certain specific embodiments 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. An electric discharge device of the immersed-ignition electrode type having a plurality of principal electrodes and an ignition electrode partially immersed in one of said principal electrodes that requires a potential of a definite magnitude to be impressed across said ignition electrode and one principal electrode to render said device conductive and means for varying at will the impedance said ignition electrode and one principal electrode to vary the magnitude of the potential required.

2. In combination, an electric discharge device of the immerser-ignition-electrode type having a plurality of principal electrodes and an ignition electrode partially immersed in one of said principal electrodes, a source of periodically pulsating potential, means for impressing a potential from said source between said principal electrodes, means for impressing a potential from said source across said ignition electrode and said one principal electrode, and means for varying the impedance said ignition electrode and one principal electrode at will to predetermine the instants in the periods of said source when said device is rendered conductive.

3. In combination, an electric discharge device of the immersed-ignition-electrode type having a plurality of principal electrodes and an ignition electrode partially immersed in one of said principal electrodes, a source of periodically pulsating potential, means for impressing a potential from said source between said principal electrodes, means for energizing said ignition electrode from said source, and means operable at will for varying the extent of immersion of said ignition electrode to predetermine at will the instants in the periods of said source when said device is rendered conductive.

4. In combination, an electric discharge device of the immersed-ignition-electrode type having a plurality of principal electrodes and an ignition electrode partially immersed in one of said principal electrodes, a source of periodically pulsating potential, means for impressing a potential from said source between said principal electrodes, means for energizing said ignition electrode from said source, means for mounting said ignition electrode to permit vertical movement thereof, and means operable at will for varying the vertical position of said ignition electrode to vary the extent of immersion thereof and thereby predetermine at will the instants in the periods of said source when said device is rendered conductive.

5. In combination, an electric discharge device of the immersed-ignition-electrode type having a plurality of principal electrodes and an ignition electrode partially immersed in one of said principal electrodes, a source of periodically pulsating potential, means for impressing a potential from said source between said principal electrodes, means for energizing said ignition electrode from said source, means for mounting said ignition electrode to permit free vertical movement thereof, means including a solenoid for controlling the vertical position of said ignition electrode and thereby the extent of immersion thereof, and means operable at will for varying the intensity of the magnetic field of said solenoid to vary the extent of immersion of said ignition electrode whereby to predetermine at will the instants in the periods of said source when said device is rendered conductive.

6. In an electric discharge device of the immersed-ignition-electrode type, a plurality of principal electrodes, an ignition electrode partially immersed in one of said principal electrodes, means including a solenoid for controlling the extent of immersion of said ignition electrode, and means operable at will for varying the intensity of the magnetic field of said solenoid to vary the extent of immersion of said ignition electrode and thereby the impedance through said ignition electrode and one principal electrode.

7. In an electric discharge device of the immersed-ignition-electrode type, a plurality of principal electrodes, an ignition electrode partially immersed in one of said principal electrodes, means for mounting said ignition electrode to permit substantially vertical movement thereof, means including a solenoid for determining the vertical position of said ignition electrode, and means for varying the intensity of the magnetic field of said solenoid at will to vary the vertical position of said ignition electrode and thereby the extent of immersion thereof.

EDWIN H. VEDDER.