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LOW VOLTAGE PERCUSSION WELDER WITH
AUXILIARY ARC STRIKING CIRCUIT
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FIG. 1

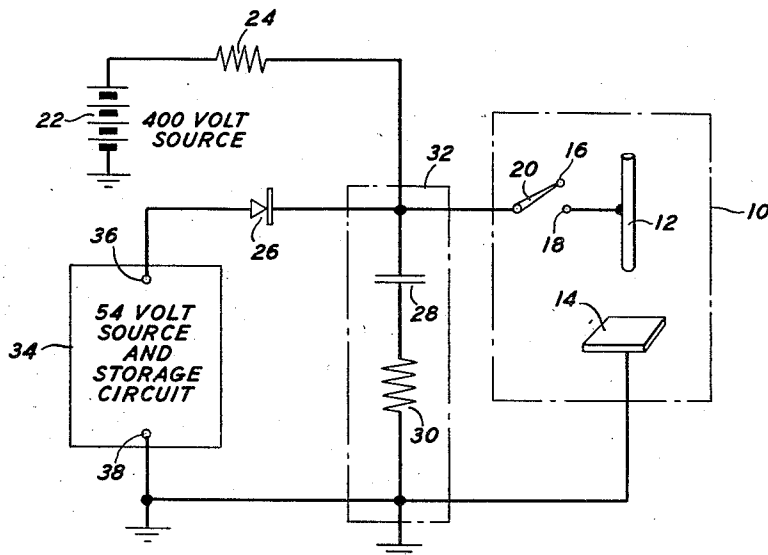
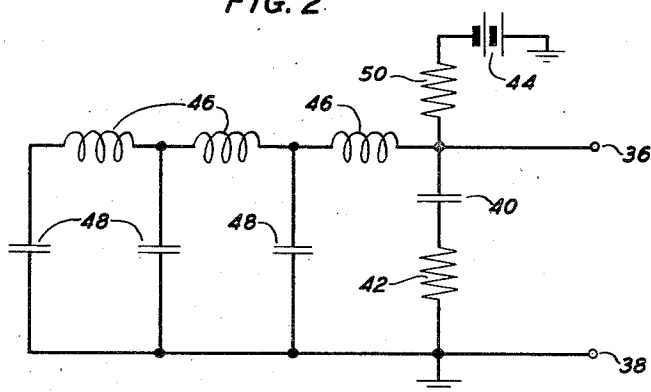


FIG. 2



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LOW VOLTAGE PERCUSSION WELDER WITH AUXILIARY ARC STRIKING CIRCUIT

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Application June 19, 1956, Serial No. 592,386

6 Claims. (Cl. 219-95)

This invention relates to a method and arrangement for use in percussion arc welding systems of the general type described in detail in my copending joint application with W. S. Boyle, Serial No. 592,366, being filed concurrently with this application. More particularly, it relates to the addition of an auxiliary high voltage, low current, storage circuit and charging source therefor, to a low voltage (circa 50 volts), high current, percussion arc welding system, whereby the welding arc can be initiated at a much greater electrode separation. A substantially increased time is then available in which to establish the high current amplitude through the arc required to produce satisfactory welds. The inclusion of a large resistor, in the order of 10 megohms, for example, in series with the auxiliary high voltage supply, substantially eliminates the hazard of serious electrical shock to the person using the welder. The auxiliary capacity likewise is of such low capacity that no substantial hazard of shock is present.

As explained in detail in the above-mentioned copending application, if a voltage in the order of only 50 volts is used an arc will not be initiated until the electrodes have closed to a separation of probably less than 5×10^5 inches. In view of the fact that the usual welding gun used in the type of system under consideration brings the electrodes, or pieces to be welded, together at a velocity in the order of 50 inches per second, the normal time interval between the initiation of the arc and its extinction by closure of the electrodes will (at 50 volts) be normally only a fraction of a microsecond. In said copending application, it was therefore suggested that one electrode be "feathered" or brought to a point so that when the arc was initiated the "feather" or pointed end would be burned back and a considerably greater additional time (circa 275 microseconds) thus gained before the arc was extinguished by firm closure of the contacts.

Even with the best available types of noninductive leads, one of which is illustrated and described in detail in my above-mentioned, joint, copending application, there will still be sufficient inductance in the leads and inherent inductance in the remaining components of the circuit in which the arc is established to delay the rise of current in the arc to the necessary amplitude by several microseconds. Usually a current in the order of 400 amperes or more must be established to insure that a satisfactory weld will be obtained. This current must be maintained for at least a few microseconds to form films of molten metal on each of the surfaces which are to be welded together and to maintain the temperature in the immediate vicinity of the weld until firm closure of the electrodes has been effected. Cooling thereafter completes the weld.

In accordance with the present invention, if an auxiliary storage circuit, of higher voltage but limited capacity, charged from a higher voltage but limited current source be associated with the 50 volt, high capacity, storage circuit and a diode rectifier be inserted between the two to isolate the lower voltage storage circuit from that of

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higher voltage, as will be described in detail hereinafter, an arc may be established at a much greater electrode separation. Assuming, for example, the higher voltage to be 400 volts, an arc will be initiated between the electrodes by energy from the 400 volt storage source at a separation in the order of at least 70×10^{-5} inches. Once initiated, the arc can be sustained by a relatively small voltage. For example, between clean copper electrodes the back electromotive force generated in the arc will be in the order of 14 volts. The above-mentioned diode switch then operates to permit the high capacity 50 volt storage circuit to maintain the arc. Assuming one electrode to be a copper wire 20 mils in diameter, the high current from the 50 volt storage circuit will "burn back" this electrode several mils before the arc is extinguished by firm closure of the electrodes, so that a total arc duration in the order of 100 to 200 microseconds or more will be available in which to effect a strong, neat weld. The general process is substantially as described in detail in my above-mentioned copending joint application, except that since a relatively long feather need not be burned off a somewhat shorter arc duration will suffice.

For welding larger conductors to apparatus terminals, somewhat longer arc duration intervals may be more suitable and can be obtained by increasing the auxiliary voltage to 500 or even 600 volts so that the arc will be initiated at a still greater electrode separation. The last-mentioned voltage represents about the upper limit at which presently available diode rectifiers can be expected to operate satisfactorily. In addition, even a limited current source of higher voltage than 600 volts may involve some hazard of electrical shock to personnel using the welding gun and thus defeat the principal objective in using a main low voltage, energy storage circuit for arc welding in accordance with the present application and applicant's above-mentioned copending joint application.

A principal object of the invention is to eliminate the necessity of carefully feathering an electrode in the process of percussion arc welding of electrodes together where a main energy storage circuit charged to a low voltage (circa 50 volts) is to be employed.

Other and further objects, features, and advantages of the invention will become apparent during the course of the following description and from the appended claims.

An illustrative embodiment of the present invention is shown in diagrammatic schematic form in Fig. 1 of the accompanying drawing; and a modified low voltage, energy storage circuit for use in the circuit of Fig. 1 is shown in Fig. 2.

In more detail in Fig. 1 of the accompanying drawing, the electrodes 12 and 14 represent, by way of example, a small conductor and a portion of an apparatus terminal, respectively, which are to be arc welded to form a good electrical and strong, neat, mechanical connection therebetween.

Electrodes 12 and 14 are held in a percussion welding gun, not shown in detail but represented diagrammatically by the dash-line block 10. Gun 10 can be, for example, a trigger operated mechanism of the type illustrated and described in detail in the copending application of A. L. Quinlan, Serial No. 581,074, filed April 27, 1956. Alternatively, it can be substantially as described in United States Patent 2,184,627, granted December 26, 1939, to G. W. Watson. The functions of the gun are to throw the switch 20 from its off position 16 to its on position 18 and simultaneously to bring the electrodes 12 and 14 together at an appreciable velocity such, for example, as a velocity of from 10 to 50 inches per second.

With switch 20 in its off or charging position, high voltage source 22 charges capacitor 28 to its own voltage through the circuit including resistors 24 and 30 and

ground. Resistor 24 functions to limit the current which can be drawn from voltage source 22 to a value such that the hazard of serious electrical shock to a person using the welder is substantially eliminated. Resistor 30 functions to critically damp the circuit including capacitor 28 so that oscillations cannot be set up.

Diode rectifier 26, which can, for example, be a high power, silicon rectifier, of the type disclosed and claimed in the copending application of M. B. Prince, Serial No. 503,299, filed April 22, 1955, serves to isolate the 54 volt source and energy storage circuit 34 from the high voltage source 22 and its associated storage circuit.

The 54 volt source and energy storage circuit 34, having terminals 36 and 38, can be substantially identical with those disclosed, described in detail, and claimed in my above-mentioned copending joint application, except that since, as described hereinabove, a somewhat shorter over-all arc duration interval is contemplated in connection with the arrangements of the present invention, the transmission line or ladder network portion of the storage circuit of my copending joint application can, for the purposes of the present invention, comprise fewer sections. More specifically, as shown in Fig. 2, only three series inductors 46 and three shunt capacitors 48 (instead of five each, as per the copending joint application) need be employed for use in arrangements of the present invention. As for the copending joint application, source 44 may have a voltage of 54 volts, resistor 50 may have a resistance of 1000 ohms, capacitor 40 may have a capacity of 750 microfarads, resistor 42 may have a resistance of .04 ohm, each of capacitors 48 may have a capacity of 200 microfarads, and each of inductors 46 may have an inductance of 8 microhenries.

Correspondingly in Fig. 1, described above, where source 22 has a voltage of 400 volts, resistor 24 may have a resistance in the order of 10 megohms, resistor 30 may have a resistance of approximately 20 ohms, and capacitor 28 may have a capacity of 10,000 micro-microfarads.

When an arc is initiated between electrodes 12 and 14 by discharge of capacitor 28, the back electromotive force generated in such a short arc, between, for example, clean copper electrodes, will be in the order of 14 volts. Energy from the storage circuit 34, flowing through diode rectifier 26, can then sustain the arc and complete the welding process. The general considerations involved after the initiation of the arc are substantially the same as for arrangements of my above-mentioned copending application, except that since a relatively long feather need not be burned off one of the electrodes the actual arcing interval may be somewhat less and the sustained surge of power from the ladder-type storage network can therefore have a somewhat shorter duration so as to terminate within 100 microseconds or so after firm closure of the electrodes and the consequent extinction of the arc has occurred.

Numerous and varied arrangements within the spirit and scope of the principles of the present invention will readily occur to those skilled in the art. No attempt to exhaustively cover all such arrangements has here been made.

What is claimed is:

1. A percussion arc welding system which includes, in combination a pair of electrodes to be welded together, an energy storage circuit which includes a high voltage, low capacity portion, a low voltage, high capacity portion and a diode rectifier interposed between said portions to isolate the low voltage from the high voltage portion and to switch from one to the other as the high voltage portion is discharged, low inductance means interconnecting both said portions to said electrodes and means for bringing said electrodes together at an appreciable velocity whereby an arc will be initiated at a substantial electrode separation, determined by the high voltage portion of the energy storage circuit, and sustained by the low voltage portion of said storage circuit until the arc is extinguished by firm closure of said electrodes.

2. An energy storage circuit for a percussion welding system, said circuit including a high voltage, limited capacity portion and a low voltage, high capacity portion, the two being connected in parallel, a diode rectifier included between said high voltage and low voltage portions to isolate the latter from the former portion and low inductance leads for connecting said storage circuits to a pair of electrodes to be welded together during the welding interval.

3. An energy storage circuit for a percussion arc welding system of the type which includes, as the main source of welding power, a high capacity storage circuit and means to charge said circuit to a voltage substantially less than 100 volts, an auxiliary source of welding power comprising a low capacity storage circuit, means for charging said low capacity storage circuit to a voltage of several hundred volts, said means including in series therewith a resistor of several megohms, and means connecting said main and said auxiliary sources in parallel, said last-mentioned means including a high power rectifier connected to isolate said main source from said auxiliary source.

4. A circuit as defined in claim 3 and a resistor connected in series with said low capacity storage circuit to inhibit oscillations in said circuit.

5. A circuit as defined in claim 4 and low inductance means to connect said storage circuits to electrodes to be welded together.

6. An energy storage circuit comprising a high capacity portion, means for charging said portion to a voltage of less than 100 volts, a low capacity portion, means for charging said low capacity portion to a voltage of several hundred volts, said last-mentioned means including in series a resistor of several megohms, a rectifier interconnecting said two portions and inhibiting the transfer of energy from said low capacity to said high capacity portion while permitting energy transfer in the reverse direction and resistive means in series with said low capacity portion to inhibit oscillation in said portion.

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