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AUTOMATIC ARC STARTING DEVICE

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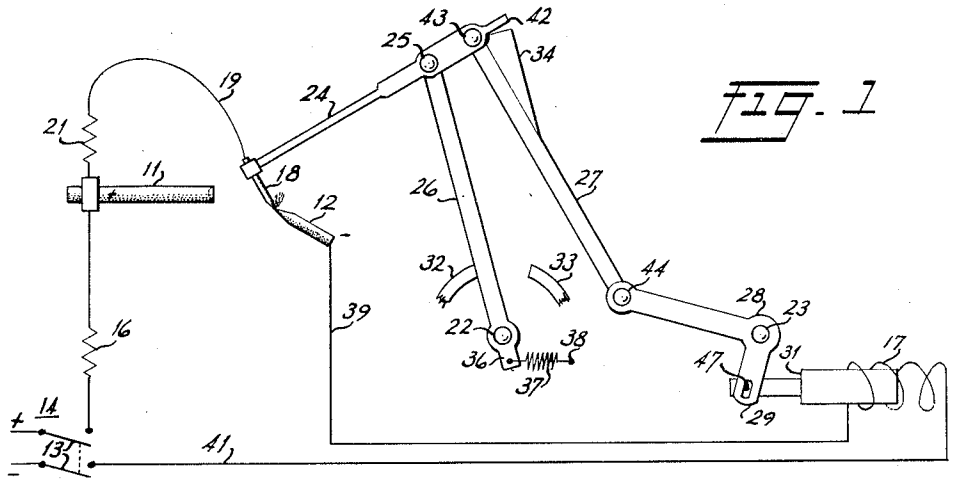


Fig. 1

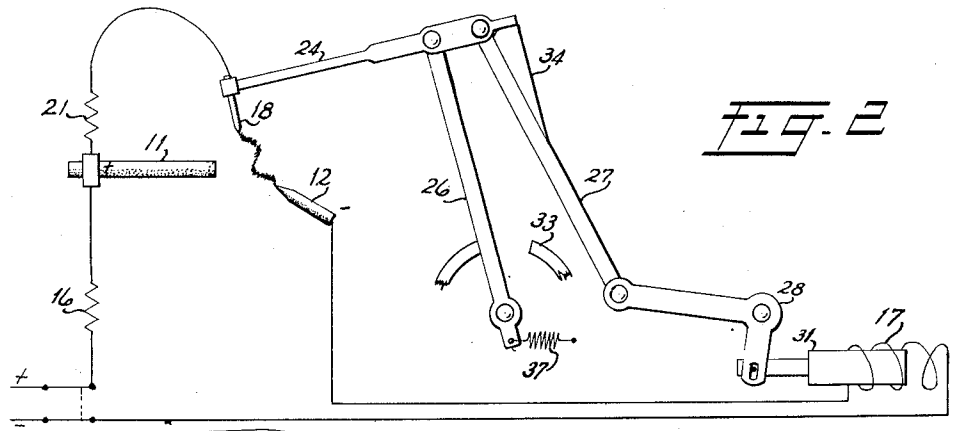


Fig. 2

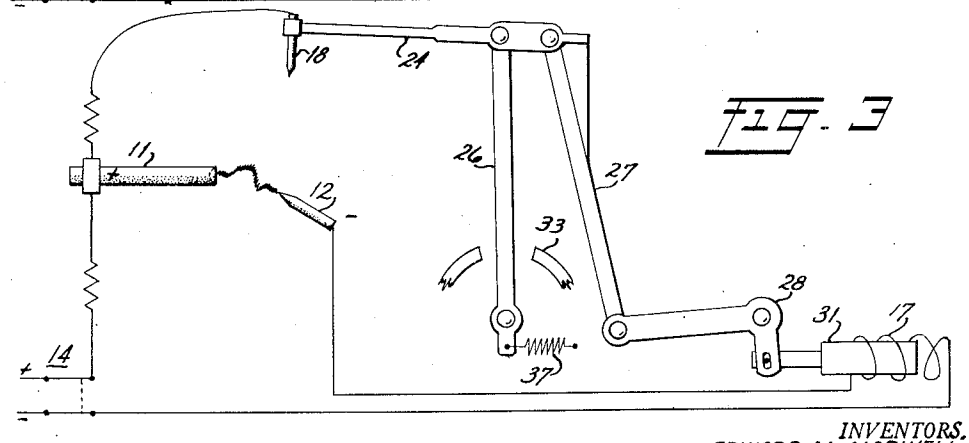


Fig. 3

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AUTOMATIC ARC STARTING DEVICE

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This invention pertains to an automatic arc starting device for employment as a lamp or furnace and more specifically to a high intensity electric arc device started by means of an auxiliary electrode.

The usual method of starting an arc by the use of a third or auxiliary electrode is to connect the auxiliary electrode electrically to one main electrode and to position it in mechanical and electrical contact with the other electrode. The position of the auxiliary electrode is controlled mechanically by a retracting solenoid. When the arc switch is closed, the arc current passes through the auxiliary electrode and the main electrode which it touches and also through the retracting solenoid. The latter instantly retracts the auxiliary electrode which draws an arc from the main electrode as it leaves it. The arc then transfers itself to the other main electrode, and is established between the main electrodes and, because the main current still flows through the retracting solenoid, the auxiliary electrode is maintained in its fully retracted position.

This mechanism is not wholly satisfactory for all purposes. For instance, if for any reason the auxiliary arc should fail to establish the main arc as the auxiliary electrode is swept back, the operation must be manually or automatically repeated, and this may occur repeatedly until the main arc is established. The basic reason why the main arc is not invariably established on initial actuation of the auxiliary electrode is that the two distinct operations of starting the arc and of moving the auxiliary electrode out of the way are merged and both are accomplished with one single uninterrupted motion of the auxiliary electrode. The described conventional type of automatically started arc is additionally not suitable for use when great heat exists in the vicinity of the main arc, the auxiliary electrode holder being close enough thereto even in its retracted position to be damaged or even destroyed.

The instant invention overcomes both of these objections. It segregates the two functions of starting the main arc and of removing the auxiliary electrode by separating its motion into two steps, the first designed to start the main arc positively, and the second delayed until the arc has been started, so that the auxilairy electrode cannot be moved to its stored position until the main arc has started. The second objection is overcome by movement of the auxiliary electrode to a position quite remote from the vicinity of the main arc. Failure of the main arc for any cause will, nevertheless, cause the auxiliary electrode automatically to restart the arc and again withdraw.

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The first objective of this invention then is to provide arc starting means of superior positiveness by maintaining an auxiliary arc until the main arc shall have been ignited thereby.

The second objective is to provide a mechanism whereby the auxiliary electrode and holder are positioned at a location distant from the main arc in order to prevent injury to the auxiliary electrode holder and its attached parts.

A further understanding of this invention may be secured from the detailed description and the accompanying drawings, in which:

Figure 1 depicts the arc-starting mechanism and its associated electrical circuit in the position when no current is flowing either in the main or auxiliary arc circuits.

Figure 2 illustrates the intermediate linkage position of the arc-starting mechanism, an arc having been established between the auxiliary electrode and the cathode but the main arc not having as yet been established.

Figure 3 is a view of the arc-starting mechanism with the auxiliary electrode in the stored position, the main arc having been ignited.

Referring now to Fig. 1, the positive electrode or anode of a high intensity carbon arc is indicated by the numeral 11 and the corresponding negative electrode or cathode by the numeral 12. Apparatus for advancing these electrodes is not shown but may be of any conventional manual or automatic type. The main arc is energized from supply conductors 13 through a switch 14, ballast resistor 16, and the winding of a plunger solenoid type of electromagnet 17. A third or auxiliary carbon electrode 18 is supported by a mechanical linkage in such manner that it may swing into physical and electrical contact with the negative electrode 12, and in Fig. 1 the auxiliary electrode is so depicted. Electrically the auxiliary electrode 18 is also connected by means of a flexible conductor 19 and through an auxiliary or striker ballast resistor 21 to the positive electrode 11.

The auxiliary electrode 18 is affixed to one end of a lever 24 pivotally connected at 25 to one end of a lever 26. The lever 26 is pivoted adjacent its other end at 22 to the frame and an arm 36 extending beyond the pivot point 22 is connected to one end of a tension spring 37, the other end of which is fastened to the frame 38. A connecting bar 27 is pivoted at one end

to the lever 24 at a pivot point 43 located adjacent to the pivot 25 but at a greater distance from the auxiliary electrode 18 so that actuation of the connecting bar 27 results in rotation of the lever 24 about the point 25 as a fulcrum.

The connecting bar 27 is provided with a stop 34 which cooperates with an extension 42 on the lever 24 limiting the amount of rotation of the lever 24 as respects the lever 26.

The other end of the connecting bar 27 is pivoted to one arm of a bell crank 28 at the point 44 and the bell crank itself is pivoted to the frame at 23. The other arm 29 of the bell crank is loosely pivoted to the armature 31 of a solenoid 17 by a slotted pivot connection 47.

The lever 26 is limited in its amount of rotational movement by stops 32 and 33 fixed to the frame.

It will be obvious from this linkage arrangement that rotation of the bell crank 28 exerting a tensile force on the connecting bar 27 will result in a limited rotation of the lever 24 about the pivot 25 without disturbing the rotational position of the lever 26 and hence such limited rotation is unrestrained by the spring 37. When, however, the extension 42 of the lever 24 abuts against the stop 34 on the connecting bar 27 any further movement of the lever 24 must be accomplished by rotation of the lever 26 about its pivot 22 which rotation is of course restrained by the spring 37.

There are thus three positions which the auxiliary electrode 18 may assume depending on the force exerted by the solenoid on the bell crank 28. The first where no force is exerted permitting the auxiliary electrode to fall into contact with the electrode 12 under the force of the spring 37. The second where an intermediate force is applied rotating the lever about the pivot 25 restained from further movement by the stops 42 and 34 and the tension of the spring 37 so that the auxiliary electrode 18 is separated from the electrode 12 by a relatively small distance. Finally in the third position where full force is applied the lever 24 is rotated together with the lever 26 as a unit about the pivot 22 against the action of the spring 37 and the auxiliary electrode 18 is thus moved to a position remote from the vicinity of the electrodes 11 and 12.

The procedure of starting the arc is initiated by closing the switch 14 manually. The arc then is automatically drawn and established between the two main electrodes in the following manner. The arc current passes from the power source through the main ballast resistor 16, auxiliary ballast resistor 21, flexible conductor 19, auxiliary electrode 18, negative electrode 12, conductor 39, solenoid 17 and conductor 41 back to the power source. The passage of the current through the solenoid 17 draws the armature 31 toward the right, rotating the bell crank lever 28 in a counterclockwise direction around its pivot pin 23, and drawing the connecting bar 27 downward. The action in turn rotates the electrode holding lever 24 about the pivot 25, raising the left end thereof and separating the carbon 18 from the carbon 12. An arc follows the moving carbon 18 and is established between these two carbon electrodes. The movement of the lever 24 and of its carbon electrode 18 continues until the right end 42 of the lever 24 comes into contact with the stop 34. This position of the linkage and of the auxiliary electrode carried thereby is termed the intermediate position. The action then stops, because the strength of the solenoid current is not sufficient to overcome the retractile force of the spring 37, the positions of the several levers then being as depicted in Fig. 2.

As the arc is drawn between electrodes 18 and 12, the latter, being the cathode, if it carries sufficient current instantly becomes incandescent and emits electrons, which are expelled outward from the tip thereof in a sheaf or cone of flame having a wide apex angle because the electrons are mutually repellant. Many of the electrons, therefore, are expelled from the cathode in the direction of the positive electrode or anode 11, and ionize the air path between electrodes 12 and 11. Moreover, the anode 11 being charged positively with respect to the charged electrons, tends to attract all that are emitted from the cathode, so that many more strike the anode than otherwise would. In addition, the anode 11 being more positively energized than the auxiliary electrode 18 because of the voltage drop existing in the auxiliary ballast 21, there is more attractive force to draw electrons to the anode than there is to draw them to the auxiliary electrode. Due to all of these reasons the path from the cathode 12 to the anode 11 becomes so highly ionized that appreciable current commences to flow between them. This reduces the amount of current that can flow to the auxiliary electrode 18, reducing the conductivity of the path thereto, thus increasing the relative conductivity of the main path, so that this transfer action quickly proceeds to completion, with all of the current passing to the anode 11 and with the arc to the auxiliary electrode 18 substantially extinguished. Because of the described emission of electrons from the cathode the precise location of the auxiliary electrode 18 is not of great importance, the described electrical and electronic conditions being paramount in importance in starting the arc between electrodes 11 and 12.

In the described action the amount of current permitted to flow through the auxiliary arc is important, for if too little current flows the arc is not of the type termed "high intensity" and electrons are not generated at the cathode and shot into the surrounding space therefrom, or are generated and discharged in insignificant quantity. Specifically, the auxiliary arc current should be not less than 40 amperes. If the auxiliary arc current is less than this amount, the main arc may not start, or may not start promptly.

The resistor 21 has a resistance several times that of the resistor 16, so that the current drawn by the main arc between electrodes 11 and 12 is at least several times that drawn by the auxiliary arc between electrodes 18 and 12. The strength of the spring 37 is so designed that the operation of the solenoid 17 is marginal in the sense that during the burning of the lower power auxiliary or starting arc the solenoid 17 carries a relatively light current and cannot overcome the tension of the spring 37, but that when the heavy current of the higher power main arc flows the solenoid 17 is strongly energized and is able to overcome the tension of the spring 37.

When, therefore, the main arc is established the following actions occur. The armature 31 is drawn further into the solenoid 17, rotating the bell crank lever 28 further in the counterclockwise direction. The connecting bar 27 is drawn down thereby and since the electrode holding lever 24 is already against its stop 34, the action causes the lever 26 to rotate clockwise until

it abuts against the stop 33. The movement of lever 26 carries the electrode-holding lever 24 with it, so that the auxiliary electrode 18 is transported to a position relatively distant from the main electrodes and completely away from their vicinity. This "stored" position is shown in Fig. 3.

Thus the three distinct positions of the arc starting mechanism are produced automatically by three current magnitudes inherently produced in operation. The transitions from the first to the second positions and current magnitudes and from the second to third are separate and distinct transitions although whether or not they are separated in time by a period of dwell in the second position is dependent upon the specific design, but does not change the theoretical basis of operation of the components. In the first position (Fig. 1), the current flow is zero, the armature 31 is fully deenergized, the retractile spring 37 is retracted and brings the auxiliary electrode 18 into contact with the cathode electrode 12. In passing to the second position (Fig. 2) and in that position, the current flow through solenoid 17 attributable to the current flow between electrode 12 and the auxiliary electrode 18 and a circuit including both resistors 16 and 21 may be of the order of 100 amperes. The solenoid is designed to overcome the weight of the electrode-holding lever 24 at, say 40 amperes current flow, and therefore, at say 100 amperes positively moves its armature 31 to the intermediate position and the lever 24 to the position shown in Fig. 2, and the retractile spring 37 remains retracted because its force cannot be overcome by the solenoid 17 at this 100 amperes current flow. In order to pass from the second to the third position the solenoid 17 must, in example here given, be energized at 250 amperes or over, for instance at 500 amperes. This occurs upon the establishment of the main arc as the mechanism attains its second position when the current through the solenoid constitutes the current though the main arc, flowing only through resistor 16. The solenoid armature 31 is thereupon drawn into its fully operated position because the current is more than its pick-up value of 250 amperes, the force of the retractile spring 37 is overcome, the lever 26 is moved to its operated stop 33 and the electrode-holding lever 24 carrying its auxiliary electrode 18 is moved to the stored position shown in Fig. 3.

When the circuit is interrupted by opening the switch 14, the electromagnet 17 is deenergized, and the retractile spring 37 and the retractile effect of the weight of the electrode-holding lever 24 both cooperate to return the electrode holding-lever 24 into contact with the cathode electrode 12.

It is obvious that the plunger type electromagnet 17 can be replaced with any other type of electromagnet appropriately connected to actuate the linkage, or with a two-winding electromagnet or with two or more separate electromagnets. For example, the plunger type electromagnet 17 can be replaced by a rotary type electromagnet disposed on the bell crank lever 28 about its fixed pivot 23.

What is claimed is:

1. In a high power arc device, anode, cathode and auxiliary electrodes, said auxiliary electrode being positioned to contact said cathode, circuit means for energizing said electrodes, means responsive to the current flow between said cathode and auxiliary electrode for moving said auxiliary electrode to a first position adjacent said cathode but out of contact therewith to establish an arc therebetween, said arc having such strength as to ignite an arc between said anode and cathode, and means responsive to the current flow between said anode and cathode when said arc is ignited to move said auxiliary electrode to a position remote from the arc between said cathode and anode.

2. In a high power arc device, anode, cathode and auxiliary electrodes, said auxiliary electrode being positioned to contact said cathode, an electric circuit including a ballast resistor connected between said anode and cathode, a circuit including a ballast resistor of higher resistance than said first mentioned ballast resistor connected between said anode and auxiliary resistor, means responsive to the current flow between said cathode and auxiliary electrode to move said auxiliary electrode out of contact with said cathode and to maintain a striking arc therebetween, said striking arc being of such an intensity as to ignite an arc between said anode and cathode, and means responsive to the current flow in said last mentioned arc to move said auxiliary electrode to position remote from said anode and cathode.

3. In a high power arc device, anode, cathode and auxiliary electrodes, said auxiliary electrode being positioned to contact said cathode, a circuit including electric motive means connected between said anode and cathode, a second circuit including current limiting means connected between said anode and auxiliary electrode whereby the power exerted by said electric motive means as a result of limited current flow between said auxiliary electrode and cathode is a fraction of the power exerted thereby as a result of current flow between said anode and cathode, first linkage means responsive to the fractional power exerted by said motive means for moving said auxiliary electrode out of contact with said cathode into a position to draw an arc therebetween, the arc so formed being of sufficient intensity to ignite an arc between said cathode and anode, and second linkage means responsive to the full power exerted by said motive means as a result of ignition of the arc between said anode and cathode for moving said auxiliary electrode to a position remote from said last mentioned arc.

4. In a high power arc device, anode, cathode and auxiliary electrodes, said auxiliary electrode being positioned to contact said cathode, a circuit including a solenoid connected between said anode and cathode, a second circuit including a ballast resistor connected between said anode and auxiliary electrode whereby the current flow through said solenoid as a result of conduction between said auxiliary electrode and cathode is less than the current flow produced therein as a result of conduction between said anode and cathode, a first linkage means operated by said solenoid moving said auxiliary electrode a limited distance from said cathode, a second linkage means operated by said solenoid only during maximum current flow therethrough for moving said auxiliary electrode to a position remote from said anode and cathode.

5. In a high power arc device, anode, cathode and auxiliary electrodes, said auxiliary electrode being positioned to contact said cathode, a circuit including a solenoid connected between said anode and cathode, a second circuit including a ballast resistor connected between said anode

and auxiliary electrode whereby current flow through said solenoid as a result of conduction between said auxiliary electrode and cathode is limited to a lesser amount than the current flow produced therein as a result of conduction between said anode and cathode, a first linkage means connected to said solenoid operative by the energy produced by said limited current flow to withdraw said auxiliary electrode to a position spaced from but adjacent said cathode, a second linkage means connected to said solenoid and operated thereby to withdraw said auxiliary electrode to a position remote from said anode and cathode, and means inhibiting operation of said second linkage means in the absence of maximum current flow through said solenoid.

6. In a high power arc device, anode, cathode and auxiliary electrodes, a holder for said auxiliary electrode, a linkage for rotating said holder and auxiliary electrode about a pivot point to move said auxiliary electrode into and out of contact with said cathode, means for limiting the amount of rotation of said holder about said pivot point, a second linkage for rotating said holder and said auxiliary electrode about a second pivot point spaced from said auxiliary electrode by a greater distance than said first pivot point, and restraining means associated with said second linkage for preventing operation thereof by a force sufficient to operate said first mentioned linkage.

7. In a high power arc device, anode, cathode and auxiliary electrodes, a holder for said auxiliary electrode, a linkage connected thereto for rotating said holder and said auxiliary electrode about a pivot point to move said auxiliary electrode into and out of contact with said cathode, means for limiting the amount of rotation of said holder about said pivot point, a second linkage connected to said holder for rotating said holder about a second pivot point spaced from said auxiliary holder by a greater distance than said first pivot point, restraining means associated with said second linkage for preventing operation thereof by a force sufficient to operate said first mentioned linkage, a circuit for energizing said cathode and anode electrodes including a solenoid, a circuit for energizing said auxiliary electrode including said first circuit and a ballast resistor connected between said anode and auxiliary electrode, and means connecting said solenoid and said first and second linkage.

8. In a high power arc device, anode, cathode and auxiliary electrodes, a holder for said auxiliary electrode, a linkage connected thereto for rotating said holder and said auxiliary electrode about a pivot point to move said auxiliary electrode into and out of contact with said cathode, means for limiting the amount of rotation of said holder about said pivot point to limit the separation of said cathode and auxiliary electrode, a second linkage connected to said holder for rotating said holder about a second pivot point placed at a greater distance from said auxiliary electrode than said first pivot point, restoring means connected to said second linkage for preventing operation thereof by a force sufficient to operate said first mentioned linkage, a circuit for energizing said cathode and anode electrodes including a solenoid and a ballast impedance connected in series, a circuit for energizing said auxiliary electrode including a second ballast impedance connected betwen said anode and auxiliary electrode said second impedance having a higher value than said first mentioned ballast resistor and said solenoid being connected to operate said first and second linkages.

9. In a high power direct-current arc device, an anode, a cathode, a first ballast impedance connected in the anode-cathode circuit, an auxiliary electrode, the auxiliary electrode being movable and so disposed that it can touch the cathode only, a second ballast impedance connected directly to said auxiliary electrode, a first electrical circuit including said auxiliary electrode and having a selected range of impedance and current strength, a first mechanical linkage electromagnetically connected to said first electrical circuit for movement thereby and mechanically connected to said auxiliary electrode for motion thereof from a position in contact with the cathode to an intermediate position, out of contact therewith, a second electrical circuit including said anode having a selected range of impedance and current strength, and a second mechanical linkage electromagnetically connected to said second electrical circuit for actuation thereby and mechanically connected to said auxiliary electrode for motion thereof from the intermediate position to a stored position.

10. In a high power direct-current arc device, an anode, a cathode, power supply terminals, a first ballast impedance connected in series with said anode said cathode and said power supply terminals, an auxiliary electrode, the auxiliary electrode being movable and so disposed that it can touch the cathode only, a second ballast impedance connected directly to said auxiliary electrode, connection means for applying power from said power supply terminals to said auxiliary electrode said second ballast impedance and said cathode in series, moving means for moving said auxiliary electrode away from said cathode in first and second distinct motions, and electromagnetic means for applying the current through said auxiliary electrode to actuate said moving means in said first distinct motion to separate the auxiliary electrode from contact with said cathode to give rise to a striking arc between the auxiliary electrode and the cathode, the striking arc having such strentgh that the negative flame emanating from the cathode reaches the anode and causes the ignition without the auxiliary electrode touching the anode, said electromagnetic means additionally after the anode cathode current has commenced to flow applying said anode-cathode current to actuate said moving means in said second distinct motion to separate the auxiliary electrode by an additional distance from said cathode to preserve said auxiliary electrode.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
743,241	Bremer	Nov. 3, 1903
1,968,011	Beck	July 31, 1934
2,186,063	Clouston	Jan. 9, 1940