

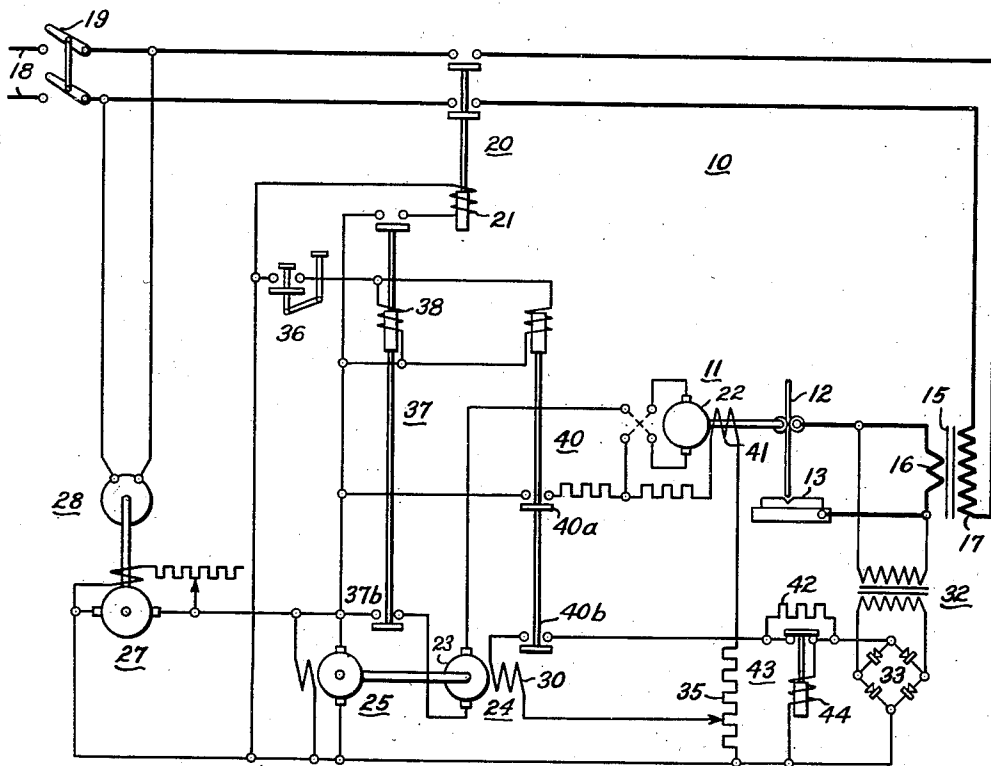
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H. C. JENKS

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CONTROL SYSTEM

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WITNESSES:

Deleau Gumm
F. V. Gielma

INVENTOR

Harold C. Jenks.

BY *G. M. Crawford*
ATTORNEY

UNITED STATES PATENT OFFICE

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CONTROL SYSTEM

Harold C. Jenks, Cincinnati, Ohio, assignor to
Westinghouse Electric Corporation, East Pitts-
burgh, Pa., a corporation of Pennsylvania

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My invention relates, generally, to control systems and has reference in particular to automatic arc-welding control systems.

Generally stated, it is an object of my invention to provide a simple and improved automatic arc-welding control system which is inexpensive to manufacture and is easy to operate.

More specifically, it is an object of my invention to provide for preventing freezing of the welding electrode when it is fed toward the work which is to be welded, preparatory to striking an arc, and to increase the responsiveness of the electrode feed motor during welding operations.

It is also an object of my invention to provide for increasing the normal operating value of the arc-responsive control voltage which controls the electrode feed motor without unduly increasing the value of the control voltage under open circuit conditions.

Another object of my invention is to provide for reducing the rate of feed of the welding electrode toward the work while attempting to strike an arc without affecting the rate of feed during welding.

Yet another object of my invention is to provide for improving the arc-striking characteristics of an alternating-current automatic arc-welding control system.

Still another object of my invention is to provide for effectively increasing the arc-responsive control voltage in an alternating-current automatic arc-welding system under operating conditions without increasing the value of the control voltage under open circuit conditions of the arc welding circuit above a predetermined safe operating value for the control circuit rectifier.

A further object of my invention is to provide for increasing the operating voltage applied to the control generator field of an automatic arc-welding control system in order to obtain smoother operation of the feed motor during welding.

Other objects will in part be obvious, and will in part appear hereinafter.

In practicing one embodiment of my invention, a reduced rate of feed of the electrode toward the work on which an arc-welding operation is to be performed in order to strike an arc, is obtained by reducing the effective value of the control voltage which is derived from the arc-welding circuit and applied to the control generator field. A voltage-responsive relay controls the connection of a resistor in the control circuit so as to reduce the effective value of the control voltage under open circuit conditions of the electrode circuit. A saturable transformer normally in-

creases the effective value of the control voltage from the normal operating value, and saturates below the open circuit value of the electrode circuit voltage so as to prevent a like increase in the control voltage under open circuit conditions of the electrode circuit.

For a more complete understanding of the nature and objects of my invention, reference may be made to the following detailed description which may be read in connection with the accompanying drawing, in which the single figure is a diagrammatic view of an automatic arc-welding system embodying the invention in one of its forms.

Referring to the single figure of the drawing, the reference numeral 10 may denote, generally, an automatic arc-welding control system wherein a reversible direct-current feed motor 11 is operatively connected to an arc-welding electrode 12 for moving it relative to a workpiece 13 upon which a welding operation is to be performed. Electrical energy may be supplied to the arc-welding electrode by means of a transformer 15 having a secondary winding 16 connected to the electrode and the work to provide an arc-welding circuit. The primary winding 17 of the transformer may be connected to a suitable source of alternating current represented by the conductors 18 by means of a knife switch 19 and a line switch 20 having an operating winding 21.

Operation of the feed motor 11 may be effected by connecting the armature 22 thereof to the armature 23 of a control generator 24 which may be driven by a suitable motor 25. The motor 25 may be energized from a constant potential source such as the generator 27, which may be driven by an alternating-current motor 28 connected to the alternating-current source through the knife switch 19. Control of the feed motor 11 may be effected by controlling the energization of the field winding 30 of the control generator 24.

In order to control the operation of the feed motor 11 to maintain predetermined arc characteristics between the electrode 12 and the work 13, the field winding 30 may be energized by connecting it to a source of substantially constant control voltage and a source of control voltage variable in accordance with voltage conditions in the arc-welding circuit. For example, a control transformer 32 may be provided for deriving an arc-responsive control voltage from the arc-welding circuit, which may be rectified by means of a rectifier bridge circuit 33. The field winding 30 of the control generator may be connected across the rectifier circuit 33 and the constant potential

generator 27 connected in opposed relation by means of a potentiometer 35.

In order to provide for controlling the operation of the automatic arc-welding control system, a push button switch 36 may be utilized for controlling the operation of a control switch 37 by connecting the operating winding 38 thereof to the substantially constant potential source 27 which may be of a relatively low voltage. Operation of the control switch 37 provides an operating circuit for the line switch 29 which controls the connection of the welding transformer 15 to the alternating-current source 13, which may be of a relatively high voltage. A relay 40 may be used for controlling the energization of the field winding 30 of the control generator 24 and the field winding 41 of the feed motor 11.

In order to provide for feeding the electrode 12 toward the work 13 at a relatively slow rate preparatory to striking an arc, a control resistor 42 may be utilized for reducing the control voltage applied to the field winding 30 under these conditions. A voltage-responsive relay 43, having an operating winding 44 connected across the rectifier bridge circuit 33, may be provided for rendering the control resistor 42 ineffective as soon as the electrode 12 engages the work 13. The relay 43 may be so designed that while it is readily operable under open circuit conditions of the arc-welding circuit, the voltage of the arc-welding circuit during welding is insufficient to operate the relay.

With a view to providing smoother operation of the feed motor 11 during welding operations, the control transformer 32 may be designed to normally increase the voltage applied to the rectifier circuit 33 over the normal value of the arc voltage in the arc-welding circuit in a predetermined ratio. In order to prevent the voltage applied to the rectifier circuit 33 under open circuit conditions of the arc-welding circuit from likewise being increased in the same ratio, the control transformer 32 may be designed to saturate at a value of arc-welding circuit voltage intermediate the normal arcing value of from 25 to 35 volts and the open circuit value which may range from 60 to 90 volts.

Accordingly, the control transformer 32 will be less effective under open circuit conditions of the arc-welding circuit and will not increase the control voltage under open circuit conditions to a value which might prove harmful to the rectifier devices in the rectifier circuit 33. In practice I have found it advantageous to increase the normal operating value of the control voltage in the ratio of approximately two to one, and by using a saturable control transformer 32 have been able to keep the control voltage within safe limits in respect to the rectifier devices in the bridge circuit 33 under open circuit conditions of the arc-welding circuit.

When it is desired to perform an arc-welding operation, the knife switch 19 may be closed so as to energize the motor 23 in order to make the constant potential control voltage from the generator 27 available. This energizes the motor 25, which drives the control generator 24, and provides voltage for operating the control switches and relays.

Upon closure of the push button switch 36, operating circuits are provided for the control switch 37 and the control relay 40. Accordingly, the line switch 29 is energized and operates to connect the welding transformer 15 to the alternating-current source 13, energizing the arc-

welding circuit. At the same time, the armature 23 of the control generator is connected to the armature 22 of the feed motor 11 through contact members 37b of the control switch 37 and contact members 40a of the control relay 40, while the field winding 30 of the control generator is connected across the constant potential generator 27 and the rectifier bridge circuit 33 in opposed relation through contact members 40b of the control relay by means of the potentiometer 35.

As soon as the welding transformer 15 is energized, the voltage-responsive relay 43 is operated and effectively inserts the control resistor 42 in series circuit relation with the rectifier bridge circuit 33 and the field winding 30 so as to reduce the energization thereof and provide for feeding the electrode 12 toward the work 13 at a relatively slow rate. Because of the saturating characteristic of the control transformer 32, the effective ratio thereof under open circuit conditions of the arc-welding circuit will be substantially less than its normal operating ratio so that the alternating-current voltage applied to the rectifier bridge circuit 33 will not be sufficient to harm the rectifier devices.

As soon as the electrode 12 engages the work 13, the voltage across the secondary winding 16 of the welding transformer is reduced to a relatively low value. Accordingly, the saturating effect of the control transformer 32 is removed so that the control transformer regains its normal operating ratio and applies an increased control voltage to the rectifier bridge circuit 33. At the same time, the voltage-responsive relay 43 returns to the deenergized position because of the reduced arc-welding circuit voltage and shunts the control resistor 42, effectively removing it from the energizing circuit of the control generator field winding 30. The control generator 24 may therefore operate at a maximum efficiency to retract the welding electrode 12 in order to strike an arc, and thereafter maintain predetermined arc-welding conditions under the control of the arc-responsive voltage derived from the arc-welding circuit through the control transformer 32.

From the above description and accompanying drawing it will be apparent that I have provided in a simple and effective manner for improving the operating characteristics of automatic arc-welding control systems. Freezing of the electrode to the work when attempting to strike an arc because of overrunning of the feed motor, is substantially prevented by providing a reduced rate of feed preparatory to striking an arc, without effecting the rate of electrode feed toward the work during welding. Smoother operation of the feed motor under welding conditions is also obtained by reason of using a step-up control transformer to amplify the arc-responsive control voltage while welding. Adequate protection is provided for the rectifier circuit by reason of the saturating characteristic of the control transformer which prevents the open circuit value of the arc-welding circuit voltage from being amplified to the same extent.

Since certain changes may be made in the above-described construction, and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all the matter contained in the above description and shown in the accompanying drawing shall be considered as illustrative and not in a limiting sense.

I claim as my invention:

1. An automatic arc-welding system for feeding an electrode to maintain an alternating-current arc with a workpiece in an electrode circuit comprising, a direct-current electrode feed motor, control means including a control generator operable to apply a variable direct-current control voltage to the feed motor, means including a transformer saturable in response to open circuit conditions in the electrode circuit and rectifier means for applying a control voltage to the control means responsive in different degrees to different condition of the electrode circuit, and means responsive to a condition of the arc circuit for reducing the voltage produced by the control means under predetermined electrode circuit conditions.

2. A control system for an alternating-current arc electrode circuit comprising, a direct-current feed motor operatively connected to feed an electrode to strike and maintain an arc with a workpiece, a control generator for applying a variable voltage to the feed motor, means including a rectifier device of the oxide type and a transformer saturable under open circuit voltage conditions of the arc electrode circuit for connecting the rectifier device to the arc electrode circuit for deriving a control voltage from the arc electrode circuit for controlling the voltage of the generator, a control resistor for reducing the effective value of the control voltage, and relay means responsive to the arc circuit voltage operable to render the control resistor ineffective under arcing conditions.

3. In a control system for an electrode in an alternating-current arc-welding circuit, a direct-current feed motor operatively connected to the electrode, a control generator for applying a variable voltage to the feed motor, means for controlling the voltage of the generator including rectifier means and a saturable transformer con-

nected between the rectifier means and the arc-welding circuit for producing an arc-responsive voltage greater in proportion to the voltage of the arc-welding circuit under arcing conditions than under open circuit voltage conditions, and means responsive to open circuit conditions for reducing the effective value of the arc-responsive voltage.

4. In a control system for an electrode feed motor operatively connected to an electrode for moving the electrode relative to a workpiece for striking and maintaining an arc in an alternating-current arc circuit, means for controlling the operation of the feed motor including rectifier means of the oxide type and a control transformer saturable below the open circuit value of arc voltage for connecting the rectifier means between the electrode and workpiece for producing a control voltage under open circuit conditions having a closer relation to the open circuit arc circuit voltage than the operating value of the control voltage does to the operating value of the electrode circuit voltage.

5. An alternating-current arc-welding system comprising, a direct-current feed motor disposed to be operatively connected to an electrode for feeding it to strike and maintain an arc with a workpiece, a control generator for applying a variable direct-current voltage to the feed motor, circuit means for applying a substantially constant control voltage to the control generator, additional circuit means including a rectifier device and a transformer disposed to be connected to the arc-welding system and saturable below the open circuit voltage thereof for applying a variable control voltage to the control generator for improving the response of the feed motor under arc-welding conditions.

HAROLD C. JENKS.