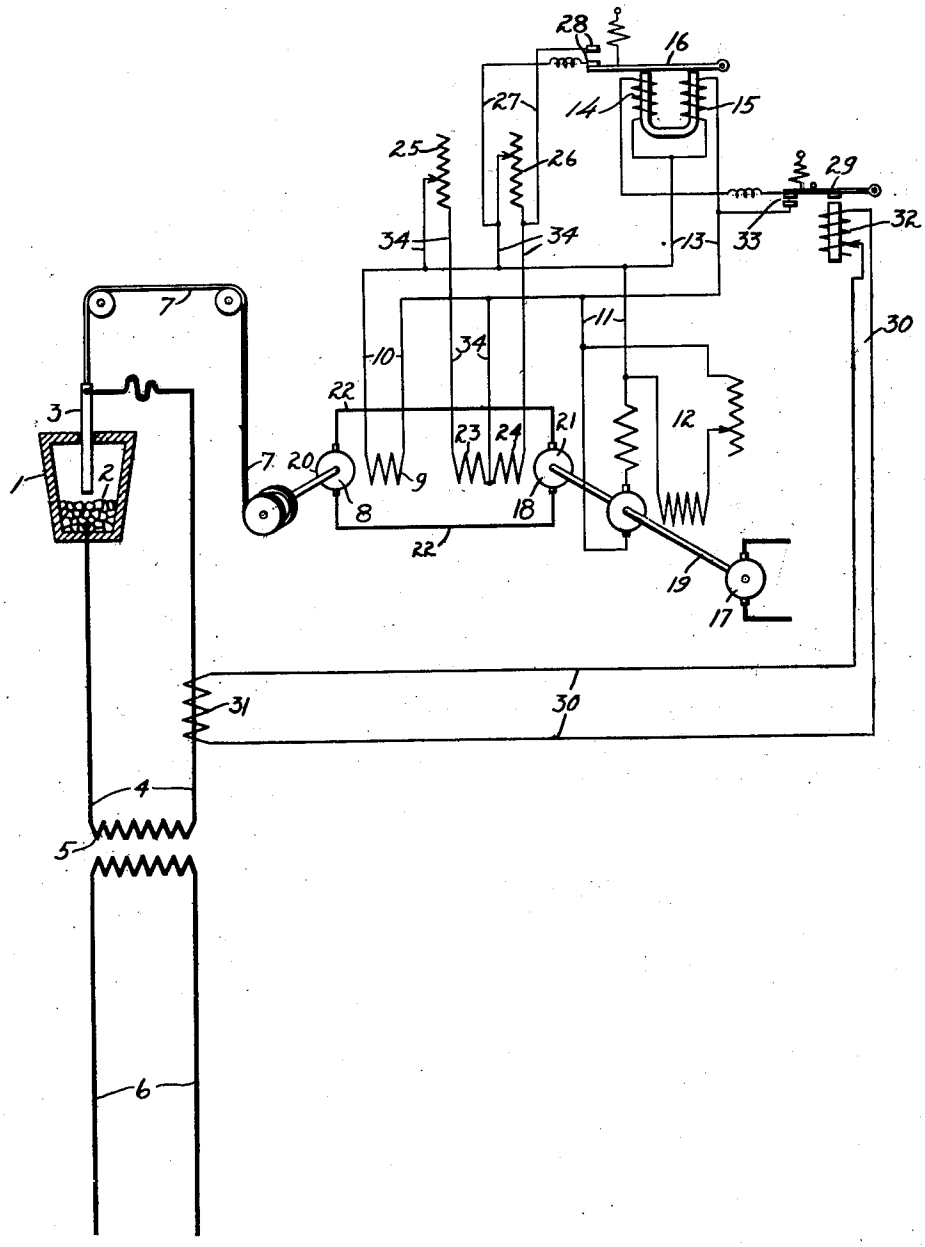
H. HOLLIS.

ARC REGULATING SYSTEM.

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1,298,715.

Patented Apr. 1, 1919.



WITNESSES:

T. R. Krear.

Fred. A. Miller

INVENTOR

Harry Hollis

BY

Wesley G. Carr

ATTORNEY

UNITED STATES PATENT OFFICE.

HARRY HOLLIS, OF LEBANON, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ARC-REGULATING SYSTEM.

1,298,715. Specification of Letters Patent. Patented Apr. 1, 1919.

Application filed September 10, 1917. Serial No. 190,506.

To all whom it may concern:

Be it known that I, HARRY HOLLIS, a citizen of the United States, and a resident of Lebanon, in the county of Lebanon and State of Pennsylvania, have invented a new and useful Improvement in Arc-Regulating Systems, of which the following is a specification.

My invention relates to electric furnaces of the arc type and particularly to means for regulating the arcs thereof.

One object of my invention is to provide a regulating means for a furnace of the above indicated character that shall employ the relative bucking effects of differentially acting generator field-magnet windings to control the arc through the power source of an electrode-actuating motor.

Another object of my invention is to provide means for controlling the arc in an electric furnace that shall be accurate in its degree of response to current fluctuations and that shall not require interruption of the circuit of the actuating motor.

A further object of my invention is to provide a single means for controlling the movement of an electrode to and from its arc-striking position and for maintaining a predetermined arc.

In practising my invention, I employ a separately-excited direct-current motor for operating the electrode. The armature of this motor is connected in closed-circuit relation to the terminals of a differentially-wound separately-excited generator. The magnitude and direction of the exciting flux of the generator may be controlled by adjusting the field-winding rheostats that are connected in circuit with the opposing field-magnet coils of the generator. Thus, the amount of movement and the direction of rotation of the motor, and, consequently, the regulation of the electrode may be controlled.

This control is made responsive to fluctuations in the arc through a series transformer that is connected in the furnace supply circuit and a current-responsive relay the winding of which is connected in series with the secondary of the transformer. The current-responsive relay controls a differential relay that operates in accordance with arc variations, to intermittently short circuit one of the generator field rheostats and to thereby permit dominance of the one or the other of the field magnets of the generator.

Short or inconsequential fluctuations of the arc current will not change the position of the electrode because prevented by the inertia of the motor armature and the intermittent surges of oppositely directed flux in the field of the generator. Only a considerable change of arc current will effect the operation of the electrode-actuating motor.

The single figure of the accompanying drawing is a diagrammatic view of an electric furnace provided with a control system embodying my invention.

A furnace 1, containing a charge of material 2, is provided with a movable electrode 3 and is adapted to be supplied with current from the secondary circuit 4, of a transformer 5, the primary winding of which is connected to a main supply circuit 6.

The electrode 3 is operatively connected, by a drum-and-cable mechanism 7, or other suitable means, to a direct-current motor 8.

The field-magnet winding 9 of the motor 8 is supplied, through conductors 10 and 11, with current from a compound-wound generator 12 that also supplies current, through conductors 11 and 13, to coils 14 and 15 of a differential relay 16 and through rheostats 25 and 26 and conductors 34 to the field-magnet windings 23 and 24 of a generator 18.

The rotatable members of compound-wound generator 12, an alternating-current driving motor 17 and the differentially-wound generator 18, are mounted on a shaft 19 and are adapted to operate at a constant speed.

The armature 20 of the motor 8 and the armature 21 of the generator 18 are connected in series relation in a closed circuit by means of conductors 22. The fluxes produced by the currents traversing the oppositely-connected field-magnet windings 23 and 24 of the generator 18 may be regulated by their respective rheostats 25 and 26 to control the polarity of the said generator. The contact members 28 of the differential relay 16 are adapted to intermittently short-circuit the rheostat 26 through conductors 27.

A current-responsive relay 29 receives current, through a circuit 30, from a series transformer 31 that is connected to the arc-

supplying secondary circuit 4 of the transformer 5. Current for the relay 29 may be adjusted to any desired value by a suitable rheostat or by varying the number of turns of the winding 32 thereof. The contact members 33 of the relay 29 are adapted to alternately connect and disconnect the coil 14 of the differential relay 16 from the circuit 13.

With current flowing in the circuit 6 and the rheostats 25 and 26 properly adjusted, the operation of my device is as follows.

The motor 17 is energized to drive the generators 12 and 18, the former of which supplies current to the field-magnet winding 9 of the motor 8, to the field-magnet windings 23 and 24 of generator 18, and to the differential relay coils 14 and 15. The generator 18 supplies current, in the proper direction, to the armature 20 of the motor 8 to cause the latter to lower the electrode 3 into engagement with the material 2. Upon engagement of the electrode 3 and the material 2, current of greater value than the normal operating current of the arc will flow in the circuit 4, thereby causing sufficient current to flow in the circuit 30 to actuate the relay 29 to effect engagement of the contact members 33. Current will then flow in the winding 14 of the differential relay 16 which will thus be actuated to effect engagement of the contact members 28. This short-circuits the rheostat 26 to cause a relatively greater current to flow in the field-magnet winding 24 than in the winding 23 and reverses the polarity of the generator 18. The reversed current in the circuit 22 operates to reverse the direction of rotation of the armature 20 and thereby raises the electrode 3. When the electrode is raised to a point just beyond the point at which the arc current reaches its normal value, the contact members 33 are disengaged by reason of the reduced current in the circuit 30, thereby reversing the polarity of the generator 18 and tending to lower the electrode 3.

When the electrode, in response to the above action, is lowered to a point just below the point at which the arc current has its normal value, the contact members 33 become engaged by reason of the increased current in the circuit 30, and the polarity of the generator 18 is again reversed. This action of changing polarity of the generator 18 will continue very rapidly when normal arc current flows, very small changes in position of the electrode causing a bucking action in the generator windings, and, by reason of the inertia of the armature 20 of the motor 8, keeping the arc of substantially constant value. The inertia of the armature 20 prevents its response to inconsequential fluctuations, but a considerable change in the arc current will permit the generator 18 to remain of the proper polarity long enough to restore that current to normal value.

The electrode 3 may be normally in or out of engagement with the material 2 under inoperative conditions, in accordance with the polarity of the generator 18, and automatically assumes normal operating conditions when the driving motor 17 is started.

The furnace operation may be discontinued by adjusting one or both of the rheostats 25 and 26 to such values that the opposing fluxes of the windings 23 and 24 are neutralized, and the electrode may be raised or lowered by adjusting the rheostats until the flux of one of the windings 23 and 24 is greater than the other.

The above described arrangement of my invention may be readily adapted, in a similar manner, to each electrode of a three-phase system.

While I have shown and described a particular arrangement of my invention, it is to be understood that many changes may be effected therein without departing from the spirit and scope thereof, as set forth in the appended claims.

I claim as my invention:

1. In an electric arc furnace, an electrode, means normally active for actuating the electrode, and independent means responsive to variations in the length of the arc for controlling the normally active means.

2. In an electric arc furnace, an electrode, means for actuating the electrode, power means normally connected to said actuating means, and means responsive to the current traversing the electrode for controlling said power means.

3. In an electric furnace, the combination with a movable electrode and a motor for actuating the electrode, of a differentially-wound generator for supplying power to the actuating motor, and means responsive to the current traversing the electrode for effecting electrical balance in the generator to maintain a predetermined arc.

4. In an electric furnace, the combination with a movable electrode and a motor for actuating the electrode, of a differentially-wound generator for supplying power to the actuating motor, and means controlling the effectiveness of the windings of the generator.

5. In an electric furnace, the combination with a movable electrode and a motor for actuating the electrode, of a differentially-wound generator for supplying power to the actuating motor, and means responsive to the current traversing the electrode for controlling the effectiveness of the windings of the generator.

6. In an electric furnace, the combination with a movable electrode and a motor for actuating the electrode, of a differentially-

wound generator for supplying power to the actuating motor, and means responsive to the current traversing the electrode for varying the ampere turns of one of the windings of the generator.

7. In an electric furnace, the combination with a movable electrode and a motor for actuating the electrode, of a differentially-wound generator for supplying power to the actuating motor, a differential relay for varying the ampere turns of one of the windings of the generator, and means responsive to the current traversing the electrode for controlling the differential relay.

8. In a regulating device, the combination with an actuating device, of means for actuating said device, a differentially-wound generator for supplying power to the actuating device, and means responsive to the movement of the actuating device for controlling the differential windings of the generator.

9. In an electric furnace, the combination with an electrode and means for actuating the electrode, of independent means responsive to the current traversing the electrode for governing said actuating means to effect movement of the electrode to its arc-striking position and normally active to maintain a predetermined arc.

10. The combination with a movable electrode and a motor for actuating the electrode, of a generator having two windings so connected that, when no current traverses the electrode, the motor is actuated by the generator to move the electrode to its arc-striking position, and means for so neutralizing one of the windings that the electrode is maintained in a predetermined position when current traverses the same.

11. In an electric apparatus, the combination with an adjustable member and electrical means for actuating said member, of independent governing means for said actuating means normally electrically connected thereto, and means for rendering said governing means active under predetermined conditions.

12. In an electric apparatus, a conducting member, electrical means for moving the conducting member, and independent governing means normally connected to the electrical means for governing the operation of the electrical means in accordance with the current flowing through the conducting member.

13. In an electric apparatus, the combination with a movable member and means for actuating said member and normally in operative relation thereto, of dynamo-electric means for rendering said actuating means active in accordance with predetermined electrical conditions of said apparatus.

14. In an electric apparatus, the combination with a movable member and means for actuating said member and normally in operative relation thereto, of governing dynamo-electric means for rendering said actuating means active in accordance with predetermined electrical conditions of said apparatus, said governing means embodying normally balanced controlling means.

15. In an electric apparatus, the combination with a movable member and normally energized electrical means for actuating said member, of normally balanced means for governing said electrical means in accordance with predetermined electrical conditions of said apparatus.

16. In an electric apparatus, the combination with a movable member and means for actuating said member and normally in operative relation thereto, of a differentially wound and operating generator for governing said actuating means, and means responsive to a predetermined electrical condition of said apparatus for controlling the effectiveness of said generator.

17. In an electric apparatus, the combination with a movable member and means for actuating said member and normally in operative relation thereto, of electrical governing means for said actuating means, and a differential relay for varying the effectiveness of said governing means in accordance with predetermined electrical conditions of said apparatus.

18. In an electric furnace, an electrode, a motor for moving the electrode, a generator for supplying power to the motor, and means for varying the excitation of the generator in accordance with the current flowing through the electrode.

In testimony whereof, I have hereunto subscribed my name this thirty-first day of August, 1917.

HARRY HOLLIS.