Nov. 30, 1943. Y. E. EFRAIMOVITCH 2,335,399

AUTOMATIC INDUCTION REGULATOR FOR ARC AND ORE FURNACES AND SIMILAR AUTOMATIC PURPOSES

Filed March 18, 1941 2 Sheets-Sheet 1

Fig. 1.

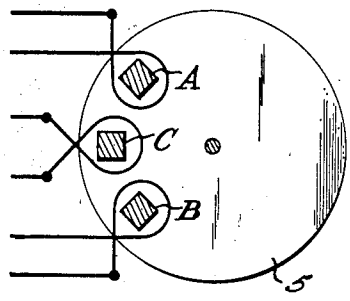


Fig. 2.

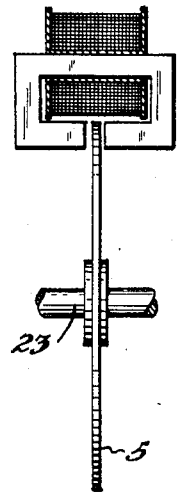
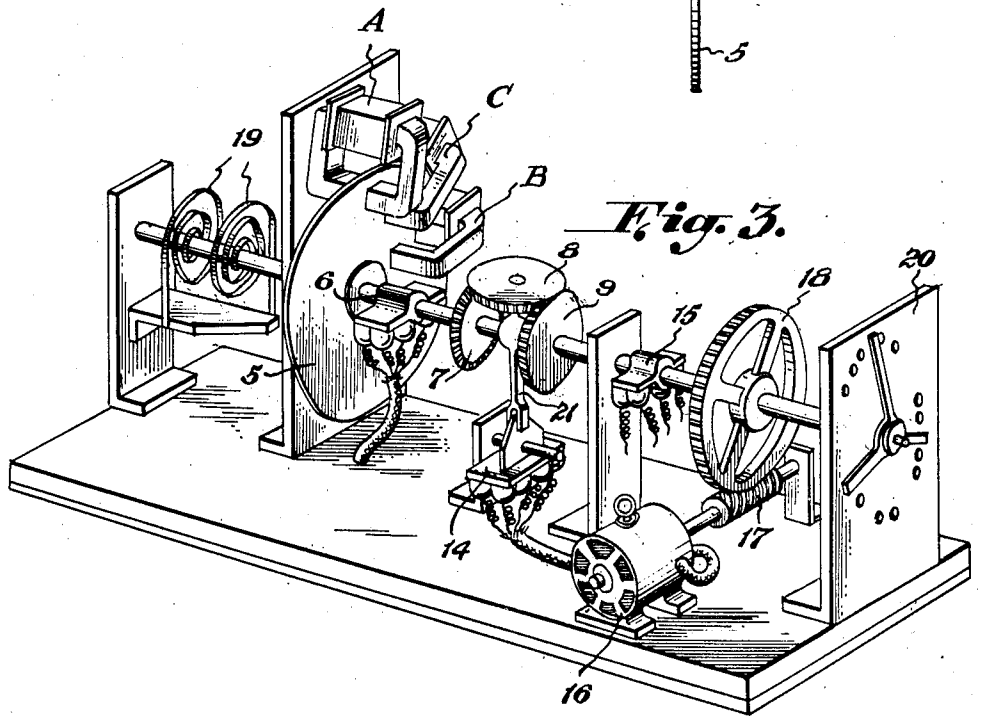


Fig. 3.



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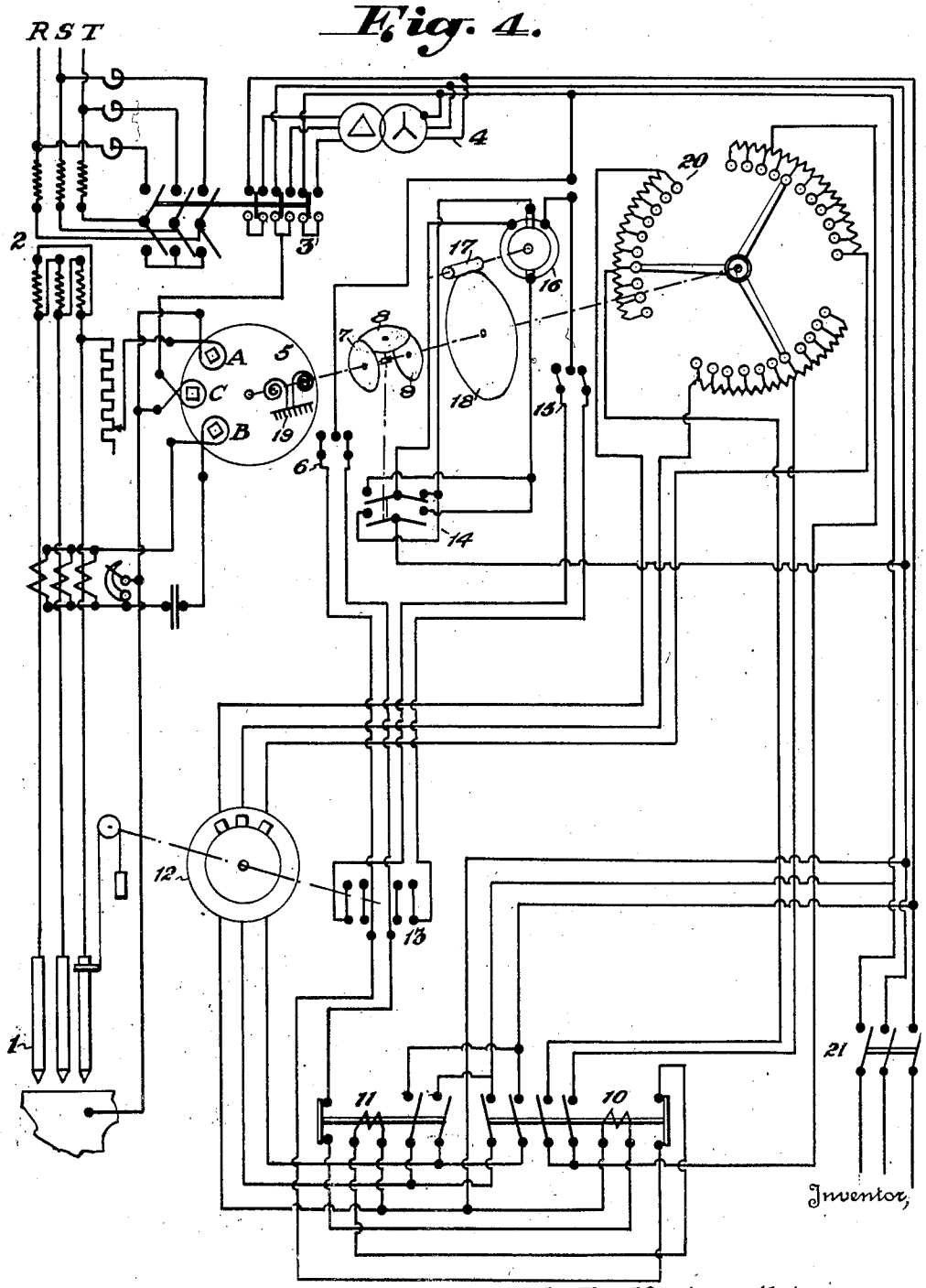
Attorneys.

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Fig. 4.



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UNITED STATES PATENT OFFICE

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AUTOMATIC INDUCTION REGULATOR FOR ARC AND ORE FURNACES AND SIMILAR AUTOMATIC PURPOSES

Yuri Efimovitch Efraimovitch, Moscow, Union of Soviet Socialist Republics

Application March 18, 1941, Serial No. 384,018. In the Union of Soviet Socialist Republics April 13, 1938

4 Claims. (Cl. 13—13)

This invention is a continuation in part of application Serial No. 267,494 filed April 12, 1939.

Existing systems of automatic regulators for the regulation of arc furnaces possess low sensitiveness and insufficiently smooth change of speed when shifting the electrodes; there is also present lack of dependence between this speed and the magnitude of irregularity in the furnace operation. More perfect regulators use very complicated and expensive apparatus and a great number of motors (in some occasions attaining 8 motors with three phase furnaces).

In the present invention the number of revolutions of the motor which is to shift the electrode shows direct dependence on the magnitude of irregularity in the furnace operation. A particular construction of the control member, which is to perceive the irregularities of the furnace operation achieves high sensibility of the entire device.

In the adjoined drawings

Fig. 1 shows a theoretical diagram of the control member

Fig. 2 shows an elevational view of the control member

Fig. 3 is a perspective view of the regulator in its essential two parts—the control member and the tailing system.

Fig. 4 illustrates an exemplary scheme of electrical connections adapted to the regulation of one phase of the electric furnace.

The control member consists of an aluminium disc 5 penetrated by the fluxes of three magnetic circuits A, B and C (Fig. 1).

On the shaft of the control member (see Fig. 3) is fastened the reversing switch 6 connected to the contactors of the motor which performs the lifting and lowering of the electrode (neither the contactors nor the motor are shown on Fig. 3). Two spiral springs 19, the tension of which can be regulated, tend to hold the control member in its initial position and to react against the moment of rotation created by the coils A, B and C.

The resistor 20 is intended to increase or decrease the resistances in the rotor circuit of the motor serving to shift the electrode. In order to follow exactly the movements of the control member the shaft 22 of the resistor 20 is linked to the shaft 23 of the control member by means of a tailing system. This latter consists of three bevel gears 7, 8 and 9, the first of which is fastened on the shaft of the control member. Bevel gear 9 is fixed on the shaft of the resistor 20; the position of the third bevel gear 8 which is freely revoluble on the extension of the shaft 22 is determined by the position of bevel gears 7 and 9; this third bevel gear is terminated by the pin 21, which grips the fork of the reversing switch 14. The shaft 23 is located with one of its ends in the shaft 22 as in a bearing and can freely rotate in it.

The sliders of the resistor 20 represent three brushes having mutual electrical interconnections.

The reversing switch 14 starts the motor 16 in either direction, whereby a rotation of the shaft of the resistor 20 and a corresponding movement of contacts of the resistor results, this shaft being driven by the worm gear 17—18, fixed on the shaft of the motor 16.

On Fig. 4 is shown an exemplary electrical scheme of the regulator, set for one phase of the furnace, as in the arc furnace 1 with three electrodes the motor 12 regulates only one electrode. The furnace transformer 2 is fitted with a reversing switch 3 which performs the overswitching of the high-tension winding from delta to star; blocking contacts are fixed on the shaft of this reversing switch 3 and serve to start the control member accordingly to the disturbances in the normal operation of the furnace. The windings on the coils of the control member are correspondingly energized: coil A from the arc tension, coil B from a current transformer of the same phase, coil C from an outside source of energy. The resistances in circuit of the coils A and B and capacities in circuit of the coil B, shown in Fig. 4 are chosen so as to make the currents in coils A and B equal and coinciding in phase. By means of the low powered transformer 4 and the blocking contacts of the switch 3 there is created an artificial phase-displacement of 90° between the fluxes of winding C and the windings of A and B.

The motor 16 is started in either direction by means of the tailing system 7, 8, and 9 and the reversing switch 14, its rotation being transmitted to the resistor 20 through the worm-gear 17—18, whereby the magnitude of resistances, inserted in the chain of the rotor of the motor 12, is correspondingly modified.

The contactors 10 and 11 are provided to secure the starting of the motor 12 or correspondingly to brake it after the regulating process has reached its end.

Both outer contacts on the right side of 10 (on Fig. 4) serve to switch out a part of the resistances in resistor 20 when the motor 12 is starting to lift the electrode.

Both reversing switches 13 fixed on the shaft of the motor 12 shown only in Fig. 4 and 15 on the shaft of the resistor 20 are connected in a well known scheme to the purpose of switching the motor 12 over to braking by counter current and to control of this braking after the regulating process has come to an end.

The system is connected to an outer net by means of the switch 21.

By adding correspondingly simple devices the proposed system of automatic regulation could easily perform the electrode shifting by hand operation.

The action of the device is as follows:

To the first part of the described device (control member) 5 with spring 19 and reversing switch 6 movement is imparted when a disturbance in the normal working conditions of a phase of the furnace induces corresponding alterations of the current in the coil windings A and B of the control member; the interaction of the fluxes of these coils with the currents induced in the disc by the coil winding c creates a moment on the axis of disc 5, which forces the disc to turn by an angle which is proportional to the magnitude of the occurred disturbances, the magnitude of the angle of revolution being regulated by the tension of spring 19. (It is understood that during normal operating conditions the moment on the axis of the control member equals zero.) The turning of the control member 5 closes the corresponding contacts of the reversing switch 6. This is accompanied by the on switching of contactor 10 or 11, which in turn start the motor 12 in the corresponding direction, whereby the electrode is lifted or lowered.

The second part of the proposed device is intended to regulate the speed of the shifting of the electrode according to the magnitude of the occurred disturbance in normal operating conditions and works as follows:

The bevel gear 7 coupled to the shaft of the control member 5 is turned simultaneously with the rotation of this latter, and carries along bevel gear 8, which by means of its pin closes the corresponding contacts of the reversing switch 14. Until this moment the bevel gear 9, rigidly fixed on the shaft of the resistor 20 and this shaft are motionless. The reversing switch 14 starts the motor 16 in the corresponding direction and the shaft of the resistor with the bevel gear 9 is driven into motion by means of the worm gear 17—18; bevel gear 9 rotates in a direction opposite to that of the bevel gear 7 and thereby brings gear 8 and reversing switch 14 to their initial position. The entire process as described is based upon the scheme of connection of the motor 16 and the reversing switch 14; this is worked in such a manner that when gear 7 is started in one direction, it so closes the reversing switches 14 that the third gear 9 will be rotated by the motor 16 in an opposite direction, which will result in an off-switching of 14, bringing forth a stoppage of motor 16.

The following movements of the control member 5, characteristic as to the gradual restoration of normal conditions in the regulated phase, will cause a gradual restoring of the shaft of resistor 20 in its initial position, during which this shaft will exactly repeat the shifting of the shaft of control member 5 according to the already described performance. It is to be noted that the invention may be best understood on reference to Figures 3 and 4, wherein the electrode shifting motor 12 is started by rotation of the disc 5 through actuation of the contactors 10 and 11. The contactors 10 and 11 are energized selectively by means of the switch 6. The important feature of the invention relates to the differential gear mechanism formed by the gears 7, 8 and 9 and in which the planet gear 8 is moved when the gear 9 remains sttaionary and when the gear 7 is rotated to start the motor 16 which thereafter rotates the gear 9 to open the circuit to the motor 12 through the switch 15 and to restore the planet gear 8 to its original position and to vary the resistor 20 to adjust the speed of the motor.

The present automatic regulator as described possesses high sensibility owing to the ingenious construction of the control member and is responsive to the requirements of a smooth dependence between the speed of electrode shifting and the magnitude of disturbances in the normal working condiitons of the furnace, this feature being achieved by the action of the described tailing system, which exactly transmits the movements of the control member to the speed regulating device of the electrode shifting motor.

Having thus described the invention and the mode of its performance what I claim is:

1. In apparatus for automatically shifting an electrode of an arc furnace, a motor for shifting said electrode, a rotatable shaft, yieldable means tending to maintain said shaft in a neutral position, means responsive to a disturbance of the normal electrical characteristics of the arc furnace for rotating said shaft from the neutral position, means including a reversing switch actuated upon rotation of said shaft for starting said motor, a gear driven by said shaft, a second shaft normally fixed against rotation, a second gear connected to the second shaft, a planet gear wheel meshing with said gears so as to swing upon rotation of the first shaft, a second motor for rotating the second shaft, means including a reversing switch for starting the second motor upon swinging of the planet gear, and movable means actuated by rotation of the second shaft for adjusting the speed of the first motor.

2. An automatic regulator for electric arc furnaces comprising control means including a rotatable control part and coils of three electromagnetic circuits for rotating said rotatable part, the windings of said coils being energized from the current of one phase of the arc furnace, from voltage of the same phase and from an outside source, spring means normally tending to hold the rotatable part of said control means in a neutral position, an electrode regulating motor, a reversing switch on the rotatable part of said control means and operable to start the electrode regulating motor in either direction, movable means for adjusting the speed of said motor, and means operated in dependence upon rotation of said rotatable control part for moving said adjusting means in degree proportional to the extent of rotary movement of said rotatable part.

3. An automatic regulator for electric arc furnaces comprising control means including a rotatable disc and coils of three electromagnetic circuits for rotating said disc, the windings of said coils being energized from the current of one phase of the arc furnace, from voltage of the same phase and from an outside source, oppositely acting springs normally tending to hold the rotatable disc of said control means in a neutral position, an electrode regulating motor, a reversing switch operable by said discs to start the electrode regulating motor in either direc-

tion, movable means for adjusting the speed of said motor, and means operated in dependence upon rotation of said rotatable disc for moving said adjusting means in degree proportional to the extent of rotary movement of said disc.

4. An automatic regulator for electric arc furnaces comprising control means including a rotatable control part and coils of three electromagnetic circuits for rotating said rotatable part, the windings of said coils being energized from the current of one phase of the arc furnace, from voltage of the same phase and from an outside source, spring means normally tending to hold the rotatable part of said control means in a neutral position, an electrode regulating motor, a reversing switch on the rotatable part of said control means and operable to start the electrode regulating motor in either direction, and a device for adjusting the speed of the motor, said device including a resistor connected with the regulating motor, a gear wheel driven by the rotatable control part, a second gear wheel connected with said resistor, a third gear wheel meshing with each of the two first mentioned gear wheels, an auxiliary motor, a reversing switch controlling said auxiliary motor and operable by said third gear wheel, and a driving connection between said auxiliary motor and said resistor for moving said resistor in degree proportional to the extent of rotary movement of said rotatable part.

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