May 23, 1939. C. STANSBURY 2,159,298

CONTROLLER FOR CIRCUIT INTERRUPTERS

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Fig. 1

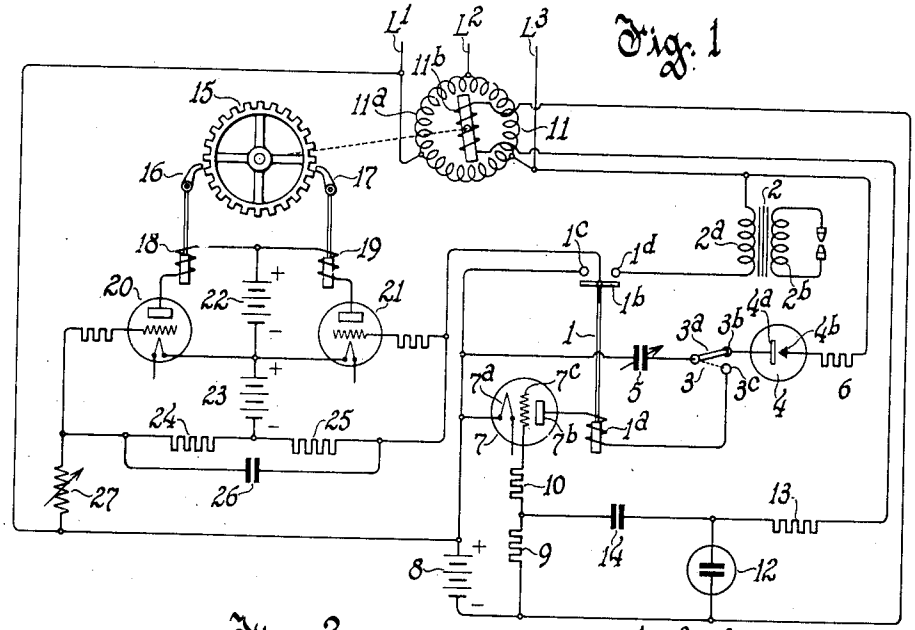
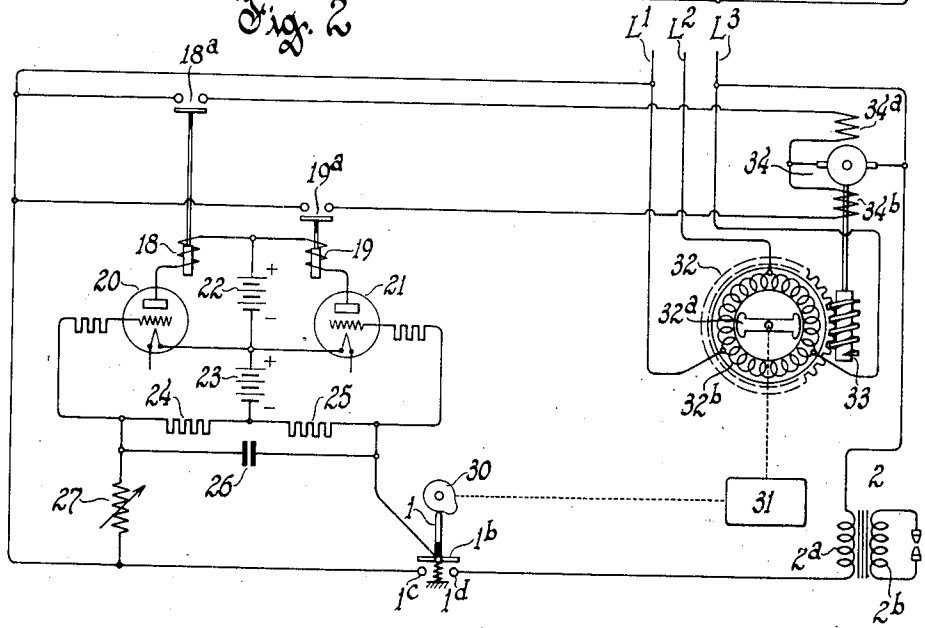


Fig. 2



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CONTROLLER FOR CIRCUIT INTERRUPTERS

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16 Claims. (Cl. 175—294)

This invention relates to a method and means for controlling an arc rupturing switch interposed in an alternating current circuit in such a manner that substantially no opening arc is produced at the switch contacts.

An object of the invention is to provide a system for repeatedly opening and closing an alternating work circuit in such a manner that arcing at the circuit opening contacts is reduced to a minimum.

Another object is to provide for the correction of the action of circuit breaking contacts resulting from wear incident upon repeated operation.

Another object is to provide sensitive means for measuring the voltage obtaining between contacts at the instant of their separation and adjust the moment of separation so as to reduce said voltage to a minimum.

Another object is to provide a system and method for causing alternating current flow to a translating device for a measured interval and time the beginning of said interval so that the voltage of the end of said interval is a minimum.

Other objects and advantages will hereinafter appear.

The accompanying drawing is illustrative of two systems embodying my invention.

In the drawing:

Figure 1 is a system in which the current to a translating device is controlled by means of an electronic tube timer, while

Fig. 2 illustrates a system wherein the current is controlled by a mechanical timer, driven by a synchronous motor.

Referring to Fig. 1, an electromagnetic switch 1, having an energizing winding 1a and a movable bridging contact 1b, which is adapted to bridge the stationary contacts 1c and 1d, controls the supply of current to the primary winding 2a of a transformer 2. Said transformer also has a secondary winding 2b which may supply the electrodes of an electric welder. Energy is supplied from the terminals L^1, L^2 and L^3 of a polyphase circuit. The system further includes a pilot switch 3, having a movable contact 3a which normally makes contact with the stationary contact 3b and which may be operated to alternatively make contact with stationary contact 3c. A rectifier 4 which may be of any known type has a cathode 4a and an anode 4b. When the switch 3 is in its normal position it connects a condenser 5 in series with rectifier 4 and a resistor 6 across the terminals L^1 and L^3. Connected between the terminal L^1 and contact 3c is the coil 1a in series with the cathode 7a and anode 7b of a gaseous electronic tube 7 which is also provided with a control grid 7c. A battery 8 connected in series with resistors 9 and 10 between the cathode 7a and grid 7c provides a normally negative bias for said grid. Connected to the lines L^1, L^2 and L^3 is the primary winding 11a of an induction regulator 11, having a rotating secondary winding 11b. By rotating said secondary winding the phase of the voltage induced therein relative to the phase of the supply voltage may be regulated. A gaseous discharge tube 12 is connected in series with a resistance 13 across the terminals of said secondary winding. Resistor 9 is also connected in series with a condenser 14 across the terminals of tube 12.

Coupled to the secondary winding 11b and revolving therewith is a ratchet wheel 15 which may be moved in opposite directions by the pawls 16 and 17, respectively. The pawls 16 and 17 may be operated by electromagnetic windings 18 and 19, respectively. Said electromagnets are connected in series with three-element electron tubes 20 and 21, respectively, across the terminals of a battery 22. Another battery 23 supplies normally a negative bias to the grids of said tubes through limiting resistors 24 and 25, respectively. A condenser 26 is connected between the grids, and one terminal thereof is also connected through an adjustable resistor 27 to line L^1, and contact 1c, while the other terminal is connected to contact 1b.

The system operates as follows: With the pilot switch 3 in the positon shown the condenser 5 stores up a given amount of electrical energy. If the pilot switch is now operated, the condenser is connected in a discharge circuit including the coil 1a and tube 7. However, the potential of grid 7c is such that no discharge current can flow, until tube 12 discharges at a given moment in the cycle of the alternating current, whereupon a positive potential is superposed upon the potential from battery 8 and the tube 7 becomes conducting, permitting the condenser to discharge through coil 1a and maintaining the magnet energized and closing circuit between contacts 1c and 1d for a time interval which depends on the design of the circuit constants. The operation of this part of the equipment is more fully explained in my co-pending application, Serial No. 100,279, filed September 11, 1936. Closure of contacts by switch 1 energizes the transformer 2 and supplies welding current.

It will be noted that the switch 1 is closed for a given interval and that the beginning of said

interval relative to the time phase of the alternating welding current is determined by the moment at which tube 7 becomes conducting. Hence the time phase of opening said circuit is also dependent on the moment of its closure. In order to prevent excessive wear of the contacts of switch 1 due to the opening arc it is desirable to open the switch when the voltage is zero, i. e., when there is no arcing. This is accomplished as follows: Assume that an arc appears on separating the contacts 1b and 1c. The polarity of said arc will be positive or negative depending on whether the circuit is opened before or after the completion of the positive half cycle of the alternating current. A unidirectional voltage is thus impressed on condenser 26, of a magnitude depending on the polarity and magnitude of the arc voltage. This voltage is superposed on the bias voltage impressed by the battery 23 upon the grids of tubes 20 and 21, making one grid more and the other less negative. If the reduction in negative bias is sufficient the respective tube becomes sufficiently conducting to energize the respective magnet 18 or 19 which in turn operates one or the other pawl 16 or 17. This rotates the ratchet wheel 15 and with it the coil 11b. As explained heretofore, rotation of said coil advances the time phase of the moment at which switch 1 is energized and therefore at which it opens its circuit. On the succeeding operation of the switch 1 the moment of opening and closing will therefore be retarded or advanced, depending on the correction made and thus the opening arc is reduced or eliminated.

If the total time during which switch 1 is energized is modified by adjusting condenser 5, the correction aforedescribed will immediately take place to produce the desired result.

In Fig. 2 the switch contacts are operated by a cam 30 which in turn is rotated through a reduction gearing 31 by a synchronous motor 32, having a rotatable armature 32a and a rotatable field 32b. The latter may be rotated in opposite directions by the worm 33 which is driven by a reversing motor 34, having reversing fields 34a and 34b, respectively.

When an arc appears between the contacts 1c and 1b, one of the magnets 18 or 19 is energized, thereby energizing the motor through the fields 34a or 34b by closure of their respective contacts 18a or 19a. Thereupon the field 32b is rotated in one or the other direction and this causes retardation or advance of the time phase of operating the contacts 1a and 1b in the manner aforedescribed.

It is to be understood that the cam 30 may be made adjustable so as to vary the relative time during which the switch is open or closed. Also any other actuating mechanism may be interposed between the driving motor and the switch.

What I claim as new and desire to secure by Letters Patent is:

1. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of means to effect cyclic closing and opening of said switch, and means to effect opening of said switch by said first mentioned means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including means operable as a function of arcing between the switch contacts.

2. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of means to effect closing and opening of said switch cyclically, and means to effect opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts.

3. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch cyclically, and means to effect opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including means operable as a function of arcing between the switch contacts.

4. In a controller for an alternating current circuit, the combination with a power-operated switch, of electromagnetic means to effect closing and opening of said switch cyclically, and means to effect opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts.

5. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch cyclically, and means to effect opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including electronic means operable as a function of arcing between the switch contacts.

6. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch cyclically, and means effecting opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including electronic tube means operable as a function of arcing between the switch contacts and electromagnetic reversing means under the control of said electronic tube means to influence said electromagnetic means.

7. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of means to effect closing and opening of said switch cyclically, and means to effect opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts, electronic tube means under the control of said energy storage means, and electromagnetic reversing means controlled by said electronic tube means and influencing said first mentioned means.

8. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch cyclically and having an energizing coil, and means effecting opening of

said switch by said electromagnetic means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including electronic tube means operable as a function of arcing between the switch contacts and electromagnetic reversing means under the control of said electronic tube means and influencing said energizing coil.

9. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch cyclically and having an energizing coil, and means effecting opening of said switch by the former means in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts, electronic tube means under control of said energy storage means and electromagnetic reversing means controlled by said electronic tube means and influencing said energizing coil.

10. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of electromagnetic means to effect closing and opening of said switch and having an energizing coil, means including a grid type electron tube connected in circuit with said coil and a source of energy to energize said coil cyclically, and means connected to the alternating current circuit and to said grid to control the conductivity of said tube for controlling said coil to effect opening of said switch in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts and electronic tube means under the control of such energy storage means and influencing said grid control means.

11. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of a synchronous motor having an armature and a relatively stationary field structure, said motor effecting closing and opening of said switch cyclically, and means to effect opening of said switch by said motor in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including means operable as a function of arcing between the switch contacts to effect rotations of said field structure.

12. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of a synchronous motor having an armature and a relatively stationary field structure, said motor effecting closing and opening of said switch cyclically, and means to effect opening of said switch by said motor in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts to effect rotation of said field structure.

13. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of a synchronous motor having an armature and a relatively stationary field structure, said motor effecting closing and opening of said switch cyclically, and means to effect opening of said switch by said motor in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts and electronic tube means under the control of said energy storage means and adapted to effect rotation of said field structure.

14. In a controller for an alternating current circuit, the combination with a power-operated switch controlling the continuity of said circuit, of a synchronous motor having an armature and a relatively stationary field structure, said motor effecting cyclic opening and closing of said switch, and means to effect opening of said switch by said motor in a substantially constant time-phase relation to the time-phase of the controlled circuit, said last mentioned means including energy storage means operable as a function of arcing between the switch contacts, electronic tube means under the control of said energy storage means and electromagnetic reversing means controlled by said electronic tube means and effecting rotation of said field structure.

15. In the method of controlling a cyclic operating force effecting the repeated operation of contacts for interrupting the flow of an alternating current with a minimum of arcing at said contacts the steps of adjusting the time phase of said cyclic operating force relative to the time-phase of the alternating current, determining the polarity and magnitude of any arc which may occur from the opening of the contacts and using the result of such determination to modify the time-phase of said cyclic operating force.

16. In a controller for an alternating current circuit, the combination with a power operated switch controlling the continuity of said circuit, of means to effect cyclic closing and opening of said switch, and means responsive to variations in the time phase of the energy flowing in said circuit relative to the time of opening of said switch to effect adjustment of the moment of opening of said switch by said first mentioned means, whereby arcing of said switch is reduced to a minimum.

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