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RESISTANCE WELDING APPARATUS

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Fig. 1.

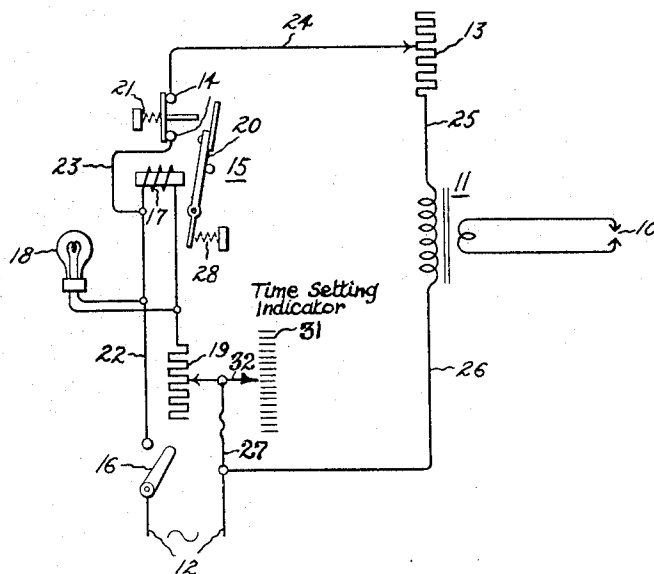
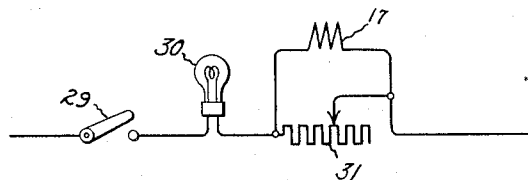


Fig. 2.



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UNITED STATES PATENT OFFICE

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RESISTANCE WELDING APPARATUS

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9 Claims. (Cl. 175—320)

My invention relates to an electric timer and to control systems embodying said timer.

It is an object of my invention to provide an electric timer that is inexpensive, easily adjusted, simple to install with existing equipment and accurate for the usual timing operations required in industry.

It is a further object of my invention to provide a timer that functions in response to the variation in the voltage distribution in a circuit the resistance value of a portion of which rapidly changes due to current heating.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawing, Fig. 1 of which diagrammatically represents one embodiment of my invention as applied to the control of a resistance spot welder, and Fig. 2 of which is a diagrammatic representation of a modification of the timing circuit forming a part of the system of Fig. 1.

In the system shown in Fig. 1 the electrodes 10 of a resistance spot welding machine are connected to the secondary of a transformer 11, the primary of which is connected to a source of supply 12 through a rheostat 13, the contacts 14 of a relay 15 and a switch 16. The operating winding 17 of relay 15 is connected to a timing circuit in which a thermally variable resistance element 18 is connected in series with a rheostat 19, or similar element, the resistance of which does not vary materially with changes in temperature due to current heating. This timing circuit is connected to the source of supply 12 through switch 16 which also connects the transformer circuit to the same source of supply.

The thermally variable resistance element 18 may be a standard Mazda lamp the resistance of which rapidly increases with the increase in temperature of its filament due to current heating. Because of the variation in resistance of the lamp 18 the voltage distribution in the timing circuit varies, the voltage across the operating winding 17 of relay 15 at any instant being the line voltage minus the IR drop across the rheostat 19. When the switch 16 is closed the source of supply is connected to the timing circuit and at the same time through contacts 14 of relay 15 to the welding transformer 11. At the first instant the cold resistance of lamp 18 is low and consequently most of the voltage drop appears across the rheostat 19. As the lamp heats up, however, its resistance rapidly increases and the current flow in the timing circuit decreases until the voltage applied to the operating winding 17 of the relay 15

is sufficient to initiate the movement of its armature 20 which eventually opens the relay contacts 14 by its impactive engagement therewith. These contacts are normally biased into engagement with one another by a spring 21 and their opening deenergizes the welding transformer a predetermined time after its energization resulting from the closure of switch 16.

Satisfactory timing operations have been obtained when the control lamp was of such a nature that about one-half of the welding time was required to bring the voltage applied to the operating winding of the relay to a value which initiated the movement of its armature and then allowed a still further rise in voltage which was sufficient to actuate the armature and separate the relay contacts. During the first interval the essential variables of the relay are balanced out so that no appreciable changes in the timing can be caused thereby.

The switch 16 may be connected with the mechanism employed for moving the electrodes into and out of engagement with the work to be welded so that it is not closed until after the electrodes have been brought into engagement with the work. Such a connection is well known in the art and consequently has not been illustrated in the drawing. After the electrodes have been brought into engagement with the work and the switch 16 closed, the system above described operates as follows:

The closure of switch 16 simultaneously completes the transformer circuit and the timing circuit. The transformer circuit is completed as follows: From one terminal of the source of supply 12 through switch 16, conductors 22 and 23, contacts 14 of relay 15, conductor 24, rheostat 13, conductor 25, the primary of welding transformer 11 and conductor 26 to the other terminal of the source of supply 12. The timing circuit is completed as follows: From one terminal of the source of supply 12 through switch 16, conductor 22, lamp 18, rheostat 19 and conductor 27 to the other terminal of the source of supply 12. As has been pointed out above, the variation in voltage distribution in this timing circuit with the variation in current flow therethrough resulting from the variation of the resistance of lamp 18 eventually applies a voltage to the operating winding 17 of relay 15 which causes this relay to operate, opening its contacts 14 and terminating the welding operation which was initiated by the closure of the switch 16.

When the switch 16 is open the timing circuit is deenergized, deenergizing the operating wind-

ing 17 of relay 15 and its armature is returned to the position illustrated in the drawing through the agency of a biasing spring 28, thus permitting the contacts 14 of the relay 15 to again close due to the bias imparted thereto by spring 21. The filament of the lamp 18 rapidly cools when the timing circuit in which it is located is deenergized and, consequently, the control of which it forms a part may be operated with great frequency without disturbing the calibration determined by the adjustment of rheostat 19.

It is, of course, apparent that instead of using a standard Mazda lamp as part of the timing circuit any thermally variable resistance may be used. This thermally variable resistance may be made of molybdenum, tantalum, etc. having a positive temperature coefficient of resistance similar to that of the tungsten filament of the standard Mazda lamp, or it may have a negative temperature coefficient of resistance such as possessed by the filament of a carbon lamp. In either case suitable circuits must be provided in order to cause the thermally variable resistance to function properly.

In Fig. 2 I have diagrammatically represented a timing circuit employing a thermally variable resistance having a negative temperature coefficient such as the carbon filament lamp referred to. In Fig. 2 the timing circuit is completed through switch 29, carbon filament lamp 30 and rheostat 31. The operating coil 17 of the relay 15 is connected across the rheostat and is responsive to the rise in voltage across the rheostat which occurs as the resistance across the lamp 30 decreases as the lamp heats up.

It is, of course, apparent that any circuit in which the voltage distribution varies with the variation in the resistance value of a portion thereof due to current heating may be employed for operating an electro-responsive device which is connected to be responsive to a voltage variation in said circuit. Thus the particular circuits above illustrated and described are merely illustrative of electric timing circuits embodying my invention.

The standard Mazda lamp 18 above referred to may be of the vacuum type or of a type having a gas filling. When a gas filled lamp is employed the system can be operated at about ten times the frequency that is possible when employing a vacuum lamp and still maintain the desired accuracy of timing. This is due to the fact that the filament of a gas filled lamp cools much more rapidly and is enabled to maintain its cold to hot resistance ratio in shorter periods of time than is possible when using a vacuum lamp.

The system described in Fig. 1 has been repeatedly operated at approximately one second intervals when adjusted for a three cycle timing operation and it has been found that the variation in timing has never been much more than $\frac{1}{10}$ of a cycle when using a 60 cycle source of supply. With a 10 cycle timing operation, the greatest variation was about $\frac{1}{3}$ of a cycle. Variations in the voltage of the source of supply will affect the timing obtained and it may be that the variations above noted were the direct result of variations in line voltage and not due to the frequency of operation. By proper selection of the thermally variable resistance element and the relay, it is possible to make the variation in time inversely proportional to the square, cube or even directly proportional to the line voltage within a predetermined operating range.

The electric timer above described is easily

adjusted by adjusting the rheostat 19 which may be provided with a time setting indicator having a scale 31 and a pointer 32 giving the time settings obtained at definite line voltages with lamps of various wattage for various adjustments of the rheostat. Thus a scale may be provided for lamps of 40, 60 and 75 watt capacity. The timing becomes more critical with the higher wattage lamps when using the same adjusting rheostat.

Since the timer embodies only a rheostat, a lamp socket, a lamp, a relay and the necessary connections above described, it is apparent that it is not only simple but quite inexpensive. Furthermore, from what has been noted above it is apparent that extremely short periods of time are obtainable by making simple adjustments. The timer is easily installed with existing equipment and when used for welding machines as described above, may be enclosed with the primary rheostat 13 of the welding transformer 11, thus forming a compact unit embodying all the controls for the welder.

My electric timer is particularly suited for timing resistance welding operations in that the timing depends on the line voltage, increasing when the voltage drops and decreasing when the voltage rises, to give a substantially constant watt input to the weld. It is, however, apparent that this electric timer may be used for controlling the operation of any translating device and that it will function on a direct current or alternating current source of supply. It may be used for flashing lamps to obtain a very intense light for photographic or signaling purposes as disclosed in application Serial No. 102,569, George W. Inman, for "Method and apparatus for flashing electric discharge devices", filed concurrently herewith and assigned to the same assignee.

Various modifications and applications of my invention will occur to those skilled in the art in view of the particular embodiments above illustrated and described. It is to be understood therefore that I intend to cover all such modifications as fall within the true spirit and scope of my invention, as pointed out in the claims annexed hereto.

What I claim is new and desire to secure by Letters Patent of the United States is:

1. An electric timer comprising a circuit in which a thermally variable resistance element is connected in series with an adjustable resistance element the resistance of which does not vary materially with changes in temperature due to current heating, a voltage responsive device connected across one of said elements, means actuated by said voltage responsive device, a time setting indicator, means for adjusting said adjustable resistance element in accordance with the setting of said indicator, and means for connecting said series connected resistance elements to a source of voltage.

2. An electric timer comprising a circuit in which a lamp having a filament with a positive temperature coefficient of resistance is connected in series with an adjustable resistor the resistance of which does not vary materially with changes in temperature due to current heating, a relay having an operating winding connected in said circuit in parallel with said lamp, means actuated by said relay, a time setting indicator, means for adjusting said adjustable resistor in accordance with the setting of said indicator, and means for connecting said series connected lamp and resistor to a source of voltage.

3. An electric timer comprising a circuit in

which a gas filled lamp having a filament with a positive temperature coefficient of resistance is connected in series with an adjustable resistor the resistance of which does not vary materially with changes in temperature due to current heating, a relay having an operating winding connected in said circuit in parallel with said lamp, means actuated by said relay, a time setting indicator, means for adjusting said adjustable resistor in accordance with the setting of said indicator, and means for connecting said series connected lamp and resistor to a source of voltage.

4. An electric timer comprising a circuit in which a tungsten filament lamp is connected in series with an adjustable resistor the resistance of which does not vary materially with changes in temperature due to current heating, a relay having an operating winding connected in said circuit in parallel with said lamp, means actuated by said relay, a time setting indicator, means for adjusting said adjustable resistor in accordance with the setting of said indicator, and means for connecting said series connected lamp and resistor to a source of voltage.

5. An electric timer control comprising a translating device, a relay having an operating winding and contacts which are normally biased into engagement with one another and which are opened upon a predetermined energization of said operating winding, a circuit in which said relay contacts and said translating device are connected, a circuit in which a thermally variable resistance element is connected in series with an adjustable resistance element the resistance of which is substantially unaffected by temperature variations due to current heating and in which said relay operating winding is connected in parallel with one of said elements, a source of supply, and means for simultaneously connecting said translating circuit and said relay operating winding circuit to said source of supply.

6. An electric timer comprising a voltage responsive relay having an operating winding and a control element actuated thereby, means including a rheostat for connecting said operating winding to a source of supply, a time setting indicator, means for adjusting said rheostat in accordance with the setting of said indicator, and a thermally variable resistor connected in parallel circuit with said operating winding of said relay, said thermally variable resistor having a low resistance when cold and heating up very rapidly with the passage of current there-through from said source of supply so that about half the timing period determined by said electric timer is consumed in building up a voltage across said thermally variable resistor sufficient to initiate the operation of said relay and balance out the essential variables thereof, the fur-

ther rise in voltage across said thermally variable resistor being sufficient to actuate the control element of said relay.

7. An electric timer control comprising a translating device, a relay having an operating winding, an armature and contacts which are normally biased into engagement with one another and which are opened by the impact of said armature the movement of which is initiated upon a predetermined energization of said operating winding, a circuit in which said relay contacts and said translating device are connected, a circuit in which a tungsten filament lamp is connected in series with an adjustable resistance element the resistance of which does not vary materially with changes in temperature due to current heating and in which said relay operating winding is connected in parallel with said tungsten filament lamp, a source of supply, means for simultaneously connecting said translating circuit and said relay operating winding circuit to said source of supply, a time setting indicator, and means for adjusting said adjustable resistance element in accordance with the setting of said indicator.

8. An electric timer comprising a voltage responsive relay having an operating winding and a control element actuated thereby, a thermally variable resistance element whose resistance changes rapidly with changes in temperature due to current heating connected in series circuit with an adjustable resistance element whose resistance does not vary materially with changes in temperature due to current heating, and means for connecting said series circuit including said resistance elements to a source of voltage, the operating winding of said relay being connected across one of said resistance elements and the rate of change of voltage across said thermally variable resistance element upon being connected with said source being such that about half the timing period determined by said electric timer is consumed in building up a voltage across the operating winding of said relay which is sufficient to initiate its operation.

9. An electric timer control comprising a translating device, a relay having an operating winding and contacts controlled thereby, a circuit in which said relay contacts and said translating device are connected, a circuit in which a thermally variable resistance element is connected in series with an adjustable resistance element the resistance of which is substantially unaffected by temperature variations due to current heating and in which said relay operating winding is connected in parallel with one of said elements, a source of supply, and means for simultaneously connecting said translating circuit and said relay operating winding circuit to said source of supply.

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