

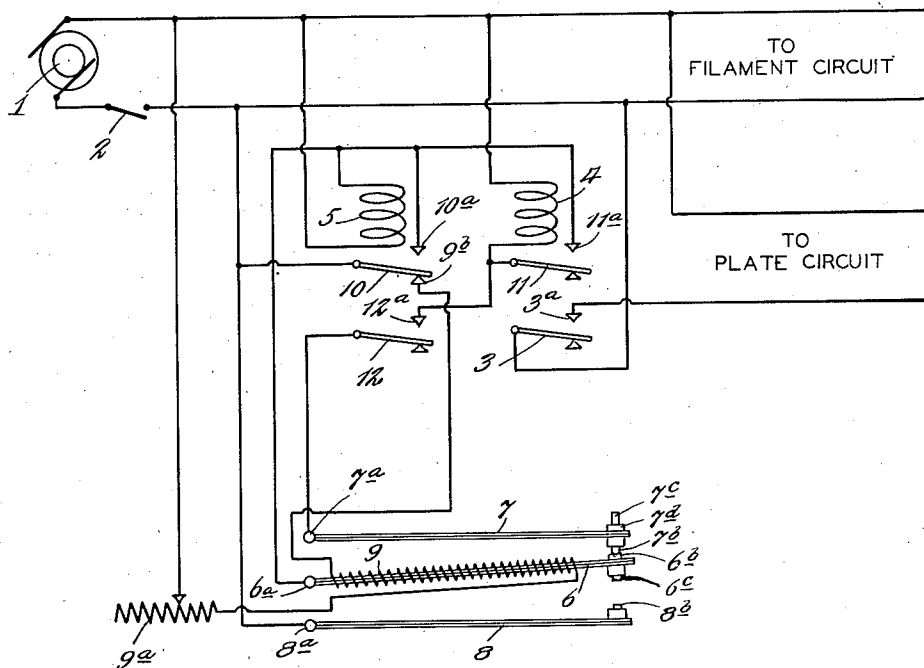
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ELECTRIC CONTROLLING APPARATUS

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ELECTRIC CONTROLLING APPARATUS

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This invention relates to controlling apparatus which is generally applicable to cases where it is desired to insure the lapse of a predetermined time interval after the control of one circuit before the control of another circuit can take place. The initial action may be the closing or opening of a circuit, or a change of any character in a circuit; and the resultant control, after a predetermined time interval, may be the closing or opening of another circuit, or movement or adjustment of any element, as may be desired.

There are a number of instances where the present invention is particularly advantageous, one of which is the control of the circuits of an electron tube. Such tubes, particularly where they are large, such as now used in broadcasting stations, will be damaged or its life unduly shortened, unless the filament circuit is closed a certain time interval before the closing of the plate circuit, so as to allow sufficient time for the filament to become heated and brought to normal operating condition before the plate circuit is energized. Another instance of application of this invention is to an oil burner where it is desired to cause the ignition circuit to be active for a certain period of time and then de-energized after the burner has attained a normal operating condition. Another application is to the control of signals for any desired purpose where after one signal or impulse is given, it is desired to cause another signal to be controlled at a predetermined time thereafter. Likewise, in the control of signs, a certain lighting circuit may be desired to be opened or closed at a predetermined interval after the closing or opening of another circuit. Also, the invention is well adapted for use in controlling the starting of electric motors where it is desired to change from starting circuit conditions to running circuit conditions after a predetermined time limit. In general, the invention is applicable to various uses for control of different circuits as desired through relay magnets, or otherwise, to give any desired results as to sequential operation of different circuits and predetermined time intervals between the control of different circuits. This invention is also adapted to be combined with other forms of controlling apparatus so as to secure the advantage of its controlling effects in conjunction with other controlling apparatus.

The main object of this invention is to provide an improved controlling apparatus which will be dependable in operation and which will definitely insure a fixed time interval after the control of one circuit before the control of another circuit. Another object is to provide an apparatus which will always maintain a predetermined time interval of control regardless of the way in which the initial control is manipulated; that is, the control of the second circuit is always a fixed time interval after the control of the first circuit, regardless of whether the first circuit has been closed or opened repeatedly, before the predetermined time interval lapses, a certain time interval always being insured after the last control of the initial circuit. Another object is to provide a simple and inexpensive form of apparatus which may be economically manufactured and readily assembled and adjusted. Another object is to avoid interference, or variations, in the controlling effects, regardless of changes in room temperature, or changes in temperature of the apparatus. Other objects and advantages will be understood from the following description and accompanying drawing, which illustrate a preferred embodiment of the invention for one of its many applications.

The drawing is a diagram showing an embodiment of my invention adapted for the control of the filament circuit of a tube and then the plate circuit at a predetermined time thereafter.

The source 1 is shown supplying current to the first circuit controlled, in this case the filament circuit, by closure of the manually operated switch 2. The second circuit which is controlled a predetermined time thereafter, in this case indicated as the plate circuit, is completed across the source by the closure of the movable contact 3 against the fixed contact 3a. The latter circuit is controlled by a relay coil 4, the excitation of

which is controlled by another relay having an actuating coil 5, which is in turn controlled by a thermostatic switch. The main thermostatic element 6 is a bi-metallic strip of two metals, such as steel and brass rolled together, or otherwise made to form an element which will change its curvature, or position, according to its temperature. This element is fixed at one end 6a and at its other end carries an upper contact 6b and a lower contact 6c. A similar thermostatic element of the bi-metallic type 7 is fixed at one end 7a and carries an adjustable contact 7b at its opposite end above the contact 6b and with which it is normally in contact. This contact 7b is made conveniently adjustable by being mounted upon the end of a screw 7c threaded in the end of the element 7 and secured in place by a check nut 7d. A third similar thermostatic strip 8 is fixed at one end 8a, while carrying at its outer end a contact 8b. This contact is at one side of or below the contact 6c and adapted to be engaged thereby. The middle thermostatic element 6 is enveloped by a winding 9 connected at one end to the upper supply line through an adjustable resistance 9a, while its other end is connected to a fixed contact 9b of the relay 5. This contact is normally engaged by the contact arm 10 of this relay when in its unattracted position, this armature being connected with the lower side of the supply line controlled by the switch 2. When the arm 10 is attracted by the coil 5, it breaks contact with the contact 9b and engages the contact 10a, which is electrically connected with one terminal of the magnet winding 5 and with the contact 11a. This front contact 11a is engaged by the contact arm 11 when the coil 4 of the second relay is energized. The two contacts 10a and 11a and one terminal of the coil 5 are electrically connected to the thermostatic element 6. The other end of the relay magnet winding 5 is connected to the upper supply line. The thermostatic element 8 and its contact is electrically connected to the lower supply line controlled by the switch 2. The remaining thermostatic element 7 and the contact carried thereby is electrically connected to another contact arm 12 of the relay controlled by the winding 5; and when the latter winding is energized, the arm 12 engages a front contact 12a which is connected to one terminal of the relay magnet winding 4, the other terminal of which is connected to the upper supply line. The contact 12a is also electrically connected to the arm 11 controlled by the relay winding 4. The other contact arm 3 is also controlled by the relay winding 4, and when the latter is energized, the armature 3 is adapted to engage the front contact 3a and thus close the plate circuit across the supply line, already referred to, or such other circuit as may be desired. In practise, heat in-

ulating barriers may be interposed between the middle thermostatic element 6 and the outer thermostatic elements in order to protect them from undue heating by radiation from the winding 9.

All parts in the drawing are shown in their non-operating positions. When the switch 2 is closed, the filament circuit is energized. Likewise, the circuit is closed through the heating winding 9 and adjustable resistance 9a by circuit which passes from the lower supply line through arm 10, contact 9b, winding 9 and resistance 9a to the other side of the line. The current in winding 9 causes the bi-metallic element 6 to be heated and gradually assume an increasing downward bend until the contact 6c engages the contact 8b carried by the element 8. The element 8 is preferably yieldable, so that when contact is made therewith, it may yield without imposing undue strain upon the element 6. The engagement of the contacts of elements 6 and 8 closes a circuit through the relay winding 5, this circuit extending from the lower supply line through element 8, thence through element 6 to one terminal of winding 5 and thence through the winding to the other side of the line. This causes actuation of the armature arms 10 and 12 to their attracted positions. The movement of contact arm 10 closes a circuit across the supply line through element 10, contact 10a and winding 5, which results in the circuit of winding 5 being maintained closed through a contact which it controls. When the element 10 leaves contact 9b, the circuit through winding 9 is opened, which permits this winding and element 6 to gradually cool from its heated condition. The movement of element 12 to its attracted position causes it to engage contact 12a, but in view of the fact that element 6 is then disengaged from element 7, no further action then results.

The gradual cooling of the element 6 causes it to change from its downwardly curved position, first breaking contact with the element 8 and then finally causing contact 6b to engage contact 7b and thereby close a circuit through the relay winding 4, this circuit passing from the upper supply line through relay winding 4, contact 12a, attracted element 12, elements 7 and 6, contact 10a and element 10 to the other side of the line. The energization of relay winding 4 causes the elements 11 and 3 to be moved to their attracted positions. When element 11 is thus caused to engage contact 11a, the circuit through the winding 4 continues from one side of the line through element 11, contact 11a, contact 10a and element 10 to the other side of the line. Thus the relay winding 4 is maintained energized through a contact which it controls in series with a contact controlled by relay winding 5. Thus the closed position of the parts con-

trolled by winding 4 is no longer dependent upon the circuit through the elements 6 and 7. When relay winding 4 is energized, the contact element 3 is caused to engage contact 3a and thereby closes the plate circuit across the supply line. It is preferable that the element 7 be yieldable so that when contact 6b engages contact 7b, no undue strain is imposed upon the thermostatic element 6.

When switch 2 is opened all the circuits are deenergized and the parts return to the positions shown in the drawing.

It is evident that a predetermined time interval must take place after the closing of the filament circuit, before the relay 4 or the plate circuit is energized, due to the requirement that a certain cycle of operation must first take place. Furthermore, the time interval is dependent upon the cooling period of the thermostatic element 6 which must require a certain time interval before it can engage the element 7. Thus the relay winding 4 and the plate circuit controlled thereby cannot be energized until the element 6 has cooled off to a predetermined amount.

The period of heating element 6 by the current through winding 9 may be made short or long by adjustment of its circuit by means of resistance 9a, but regardless of this heating period, the cooling off period must require at least a predetermined interval of time. Furthermore, regardless of the number of times the main switch 2 is closed and opened, before the plate circuit is energized, the time interval between the closing of the filament circuit and the closing of the plate circuit cannot be shortened, owing to the fact that the cooling off period of the element 6 must, in either case, require a certain time interval of undisturbed closure of switch 2 before the plate circuit can be energized. In other words, the element 6 must pass from engagement with element 8 to engagement with element 7 while switch 2 remains closed, before the plate circuit can be energized.

It is apparent that by adjusting the screw 7c, the position of the contact 7b may be caused to assume a position such that the travel of the contact 6b will be of a greater or lesser extent after breaking connection with the element 8. In this way the time interval elapsing between the closure of the filament circuit and the closure of the plate circuit may be adjusted to the desired amount.

As thus far described, it is immaterial whether the elements 7 and 8 are thermostatic elements or not; and either one or both of these elements could be merely yieldable elements, or the contacts 7b and 8b supported in any desired manner. By making each of the elements 6, 7 and 8 bi-metallic thermostatic elements with the two metals similarly related, compensation is secured for changes in temperature of the apparatus, due to weather conditions, particular location of the

apparatus, changes in temperature due to heating of the apparatus as a whole, or from any other cause. Evidently, an increase in temperature of all three elements 6, 7 and 8, although changing the positions of the contacts carried by them, would not affect their relative positions. Thus the time of sequential operation of the circuits would not be materially affected.

It will be understood that my invention is generally applicable to the sequential control of any circuits as may be desired for particular purposes; and that the number of circuits controlled, either opened or closed, may be varied by suitably relating the contacts of the relays to the movable elements thereof to give the particular controlling effects desired. In some cases the relay 4 may be omitted and replaced by the circuit intended to be ultimately controlled. It will also be understood that the particular schematic showing of the relays and the movable elements and contacts controlled thereby in the accompanying drawing is made for simplicity of understanding, and that in actual practise these parts may be arranged to assume any desired form of construction. For example, the relays may have a single pivoted armature which carries insulated contact arms variously arranged to give the desired circuit controls.

Although I have particularly described one embodiment of my invention, it will be understood that various modifications may be made therein without departing from the scope thereof.

I claim:

1. The combination of a source of current, a circuit to be controlled after a time interval, a thermostatic switch element, a contact engaged by said switch element when heated, a second contact engaged by said switch element when cooled, a device for heating said switch element, and a relay having movable and fixed contacts, said device being connected to one side of said source through a fixed contact and a movable contact of said relay to the other side of the source when said relay is deenergized, said first-named contact of the switch element being connected across said source through an exciting coil of said relay to the other side of the source when said switch element engages its first-named contact, and said second-named switch element contact being connected in the circuit to be controlled through a movable and fixed contact of said relay when said relay is energized and when said switch element engages said second-named contact thereof.

2. The combination of a source of current, a circuit to be controlled after a time interval, a thermostatic switch element, a contact engaged by said element when heated, a second contact engaged by said element when cooled, a device for heating said switch ele-

ment, a relay controlled by said switch element when the latter engages its first-named contact, a movable contact controlled by said relay and connected in the circuit of said
5 device across said source for causing the heating of said switch element when the latter is out of engagement with its contacts and before engaging its first-named contact, said circuit being opened by movement of said
10 movable contact when said switch element engages its first-named contact to control said relay, and a second movable contact controlled by said relay and connected in the circuit to be controlled and moved to closed
15 position to partially close the circuit to be controlled when said switch element engages its first-named contact to control said relay, said switch element engaging its second-named contact when cooled and thereby completing the closure of the circuit to be controlled.
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