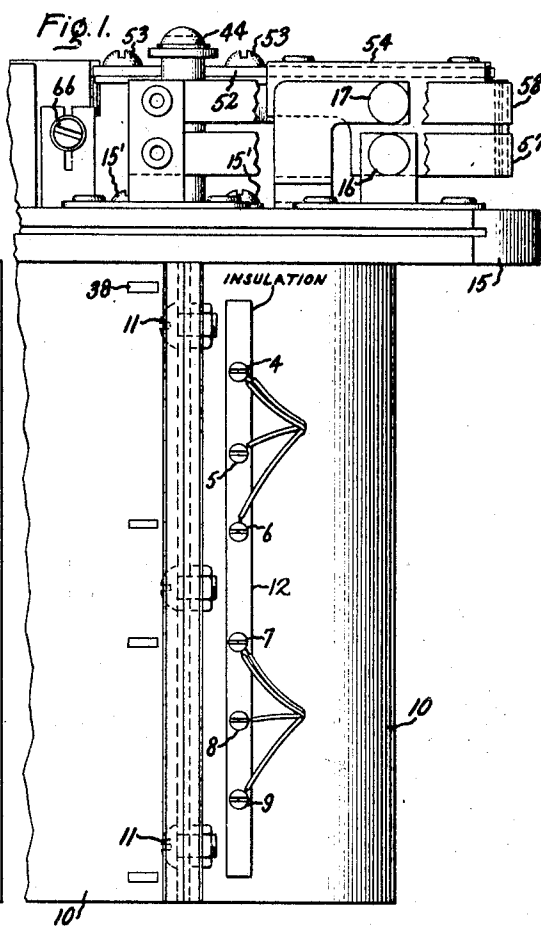
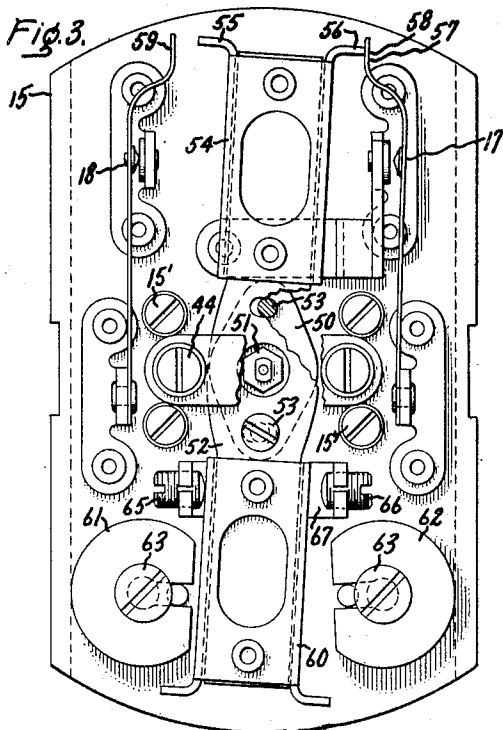
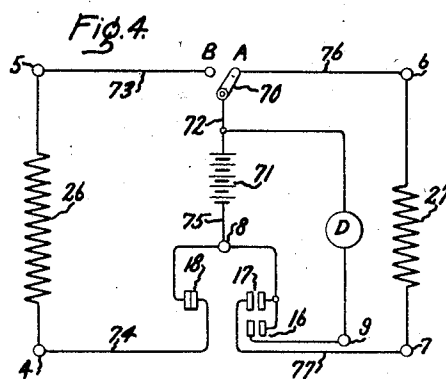


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THERMAL TIME DELAY CONTROL

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The invention relates to time delay control systems, particularly of the electrically heated thermal type adapted for operating a circuit controlling switch or other control device with a time delay dependent upon a heating interval.

The principal object is to provide an improved form of duplex thermal time delay control system and apparatus for separately obtaining two independently adjustable time delay intervals.

Another object is to enable the starting of each time delay operation of the improved duplex thermal time delay control device to be effected by means of a two-position master control switch so as to provide an independently adjustable time delay control action upon operation of the two-position master control switch to each control position.

A further object is to provide an improved thermal time delay control device having a pair of opposing thermal timing operating elements with separately energized electric heaters for operating a movable control member in opposite directions between two control positions in response to the temperature difference between the elements so as thereby to effect automatic compensation for changes in the ambient temperature and thus maintain the thermal time delay provided by each operating element more accurately.

A still further object is to minimize the electric power requirements of the improved duplex thermal time delay control device by automatically opening each heater energizing circuit as soon as the corresponding time delay operation produced thereby is completed.

Some of the more specific objects are to enclose each thermal time delay operating element and its separately energized heater within a time lag heating chamber with each chamber thermally insulated from the other and to provide separately adjustable biasing means, each for variably biasing the movable control member of the device to a corresponding one of two control positions upon each time delay operation of the member thereto, and thereby provide an improved separate adjustment of the time delay intervals obtained in operating the member in opposite directions between the two control positions.

Additional objects and advantages of the improved duplex thermal time delay control system and apparatus will become evident from the following description of the accompanying drawing illustrating a preferred embodiment of the invention, and in which Fig. 1 is a front view, partly broken away, of an improved duplex thermal time delay control device adapted for time delay cir-

cuit controlling service; Fig. 2 is a sectional view showing the detailed construction of the dual opposed thermal time delay operating elements of the improved device of Fig. 1; Fig. 3 is a top view of the device as illustrated in Figs. 1 and 2 showing more clearly the detailed construction of the movable control member that is oscillated with different adjustable time delays between two control positions, together with the improved adjustable magnetic biasing means for biasing the member to each position on operation thereto, and also revealing more clearly the detailed construction of the control switch mechanism operated by the control member; and Fig. 4 is a simplified circuit diagram showing schematically the interconnection of the two heaters of the improved device for alternate energization under the control of a two-position master switch and automatic deenergization under the control of auxiliary switch mechanism operated with a time delay by the improved time delay circuit controlling device.

As shown in Fig. 1, the improved duplex time delay device is provided with a longitudinally split cylindrical enclosing casing 10, the two halves of which are clamped together by the bolts 11, with one half carrying the terminal mounting strip 12 for the several circuit leads 4, 5, 6, 7, 8 and 9 of the device which are explained more in detail hereinafter in connection with Fig. 4. A base plate 15 of insulating material is mounted at one end of the enclosing casing 10 by means of the holding-down screws 15' and carries the elements of the main circuit controlling switch mechanism 16 and the two auxiliary normally closed circuit controlling switch mechanisms 17 and 18 that are operated with a time delay.

As more clearly shown in the sectional view of Fig. 2, the time delay operation of the control switches 16, 17 and 18 is effected by a pair of opposing thermal timing elements 22 and 23, each of which is, in the preferred embodiment illustrated, a flat bimetal spiral enclosed in one of the time lag heating chambers 24 and 25 and each has a separate electric heater 26 and 27 located within the corresponding heating chamber.

The inner end of each of the bimetal spirals 22 and 23 is secured, preferably by soldering or brazing, to a calibrating sleeve 29 that surrounds the operating shaft 30. The outer end of each of the bimetal spirals 22 and 23 is secured to its corresponding heating chamber in a similar manner. The heating chamber 24 is mounted upon a heat insulating diaphragm 32, preferably formed of moulded insulating material and provided with the projecting lugs 33 for mounting the heating

chamber 24 thereon. Both the heat insulating diaphragm 32 and the heating chamber 24 are provided with suitable central openings through which the sleeve 29 and shaft 30 extend in freely rotatable relation therewith. The heating chamber 25 is similarly mounted upon the heat insulating diaphragm 35 and both the chamber 25 and diaphragm 35 are similarly provided with central openings through which the sleeve 29 and shaft 30 extend.

The two heat insulating diaphragms 32 and 35, as well as the two end walls 36 and 37 of casing 10, preferably are provided with projecting lugs 38 which fit into suitable openings formed in the split enclosing casing 10 so as to maintain all these parts in properly spaced angular and longitudinal alignment when the two halves of the split cylindrical enclosing casing 10 are clamped together.

The operating shaft 30 is provided at the end inside casing 10 with a pivot pin 40 for rotatably supporting the shaft in a suitable bearing formed in the end wall 36 of the enclosing casing 10 and at the outside end that extends through the base plate 15 with a pin 41 for rotatably supporting the shaft in the bearing bar 42 that is removably mounted upon the two spaced apart posts 43 by the screws 44. These posts 43 are secured to the other end wall 37 of the enclosing casing 10 and extend through the base plate 15.

The calibrating sleeve 29 is adjustably clamped to the shaft 30 by means of the opposing clamping nuts 46 and 47 so that the angular position of the sleeve 29 on shaft 30 may be varied to adjust the opposing biasing forces exerted by the thermal timing operating elements 22 and 23. The operating shaft 30 carries a mounting plate 50 adjustably clamped to the outside end thereof by the clamping nut 51, and the mounting plate 50 in turn carries the balanced oscillating control member 52 adjustably clamped thereto by means of the clamping screws 53.

As shown more clearly in Fig. 3, the control member 52 carries at one end thereof a channel-shaped member 54 provided with the bent-out fingers 55 and 56 for engaging respectively the aligned spring arms 57 and 58 of the control switches 16, 17 and the spring arm 59 of switch 18 which are located in opposing spaced relation on the opposite sides of the oscillating control member 52. Each spring arm serves to bias the corresponding switch to the closed position when not engaged by the operating finger.

A balancing channel-shaped member 60 is carried at the other end of the control member 52. The member 60 is of magnetic material so as to be attracted by each of the oppositely disposed permanent biasing magnets 61 and 62 which are mounted on the base 15 by holding-down screws 63 in opposing spaced apart relation on opposite sides of the oscillating control member 52. Thus the magnetic member 60 and the magnets 61 and 62 cooperate to provide an adjustable biasing force for holding the oscillating balanced control member 52 in each of two control positions dependent upon the magnetic pull exerted on member 60 by the corresponding one of the magnets 61 and 62 which will vary as an inverse function of the air gap maintained between the magnetic member and the corresponding magnet. In order to adjust the pull of the magnets and thereby adjust the biasing force, the two adjustable stop or air gap limit screws 65 and 66 are mounted in the yoke 67 on opposite sides of the channel member 60 so that the minimum air gap in

the attracted position thereof with respect to each of the magnets 61 and 62 may be independently adjusted.

Fig. 4 shows an improved circuit control arrangement in which the main control switch 16 and the two normally closed auxiliary control switches 17 and 18 together with the two heaters 26 and 27 may be connected to effect the energization and deenergization of any electrical device D in separately adjustable time delay intervals after energization of the improved duplex thermal time delay control device under the control of a two-position master control switch 70 that may be operated either manually or automatically. The lead terminals 4, 5, 6, 7, 8 and 9 of the device as shown in Fig. 1 are correspondingly indicated in the circuit diagram of Fig. 4.

Operation

With the parts all at ambient temperature and in their respective positions shown in the drawing, the master control switch 70 may be operated to its control position B to separately energize the electric heater 26 from any suitable source such as the battery 71, the circuit extending from battery 71 through conductor 72, switch 70 in position B, conductor 73, terminal 5, heater 26, terminal 4, conductor 74, auxiliary switch 18, terminal 8 and conductor 75. The resulting heating of the thermal timing operation element 22 by heater 26 is delayed due to the heat storage mass of chamber 24, and thus provides an appreciable time delay interval after the operation of master control switch 70 to position B until the biasing force developed by the heated bimetal element 22 aided by the normal switch closing bias of spring arms 57 and 58 predominates over the opposing biasing force of magnet 61. Since the opposing biasing force of magnet 61 is varied by the adjustment of stop screw 65, the length of the time delay interval can thus be readily adjusted by adjustment of the stop screw. After the adjustable heating time delay interval has elapsed, the control member 52 is operated by element 22 with a snap action from the control position in which it is shown to its other control position. As a result, finger 55 will engage the spring arm 59 to open the switch 18 against the normal closing bias thereof and thereby deenergize the heating winding 26. At the same time, operating finger 56 will be moved out of engagement with the spring arms 57 and 58 and thereby will effect closure of the main control switch 16 and the auxiliary control switch 17 due to the normal closing bias exerted by the spring arms on the corresponding switches. Control member 52 will be held in its other control position by the biasing magnet 63 so as to hold switch 18 open against the closing bias of spring arm 59 with a force that is determined by the adjustment of stop screw 66 even though heater 26 is deenergized, and element 22 cools to the same temperature as element 23.

Assuming now that the master control switch 70 is returned to position A after the temperature of the thermal timing element 22 has returned to ambient, then heater 27 will be energized from the battery B through the auxiliary switch 17, the circuit extending from battery 71 through conductor 72, switch 70 in position A, conductor 76, terminal 6, heater 27, terminal 7, conductor 77, switch 17, terminal 8 and conductor 76. As a result, thermal timing operating element 23 will be heated with a time delay de-

pendent upon the heat storage mass of the heating chamber 25. This time delay heating of element 23 will continue for an interval that is separately adjustable by the adjustment of stop screw 66 to vary the biasing force exerted by magnet 62. Then the force exerted by element 23 aided by the switch closing bias of spring arm 59 will predominate over the variable biasing force exerted by magnet 62 and the control member 52 will be returned with a snap action to the position in which it is shown. Thereupon, the normally closed main control switch 16 will be opened and, at the same time, the normally closed auxiliary control switch 17 will be opened to deenergize the heater 27.

If desired the device D may be energized from some other source than the battery B and the main control switch 16 may be employed for any circuit controlling service in which it is desired that the main control switch 16 be closed an adjustable time interval after operation of the master control switch 70 to position B and in which the opening of the main control switch 16 is delayed for a separately adjustable time interval after the movement of the master control switch 70 to position A.

While the invention has been described in its preferred form, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention.

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

1. A duplex time delay snap action control device having, in combination, a rotatable shaft, a sleeve angularly adjustable on said shaft, a pair of opposing spiral bimetal operating elements having heat insulating means therebetween and connected with said sleeve for effecting rotation of said shaft in a direction dependent upon the temperature difference of said elements, a balanced control member carried by said shaft for oscillation between two control positions, separate switching means operated by said member in each of said positions, separately adjustable magnetic biasing means, each for biasing said control member to a corresponding one of said control positions upon operation thereto, and separate electric heating means, each energized under the control of a corresponding one of said switching means for separately heating a corresponding one of said spiral bimetal elements to effect a snap action operation of said control member from a corresponding one of said control positions to the other with a time delay dependent upon the adjustment of the corresponding magnetic biasing means.

2. A duplex time delay snap action circuit controlling device having, in combination, a magnetic member movable between two control positions, separate switch biasing means opposed by said member in each of said positions, a pair of switches, each normally closed by a corresponding one of said switch biasing means and separately opened upon movement of said member to oppose said corresponding one of said switch biasing means, and two pairs of biasing means for said magnetic member, each pair including a permanent magnetic biasing means having an adjustable air gap for variably biasing said member to hold a corresponding one of said normally closed switches open against the closing bias of the corresponding one of said switch biasing means, and an opposing thermal time delay variable biasing means having electric heating means

energized under the control of the other of said normally closed switches for varying said thermal responsive biasing means into predominance over said magnetic biasing means with a time delay dependent upon the adjustment of said air gap to effect snap action movement of said control member to the other of said positions for opening said other one of said normally closed switches and thereby deenergizing said heating means.

3. A duplex time delay snap action circuit controlling device having, in combination, a control member movable between two control positions, a pair of switch biasing means, each opposed by said member in a corresponding one of said positions, a pair of switches, each normally closed by a corresponding one of said switch biasing means and separately opened upon movement of said member to oppose said corresponding one of said switch biasing means, separately adjustable biasing means each for variably biasing said member to a corresponding one of said positions upon operation of said member thereto, opposing thermal responsive operating elements connected for oppositely moving said member, a separate electric heater for each of said operating elements, and a master switching element having two circuits separately closed thereby, each of said circuits having a corresponding one of said normally closed switches connected therein for energizing a corresponding one of said heaters and maintaining said heater energized only for the adjustable time interval after operation of said master switching element to the corresponding circuit closing position required for effecting predominance of the operating force of the corresponding operating element over the opposing adjustable biasing means to produce snap action movement of said member to open said corresponding one of said normally closed switches.

4. A time delay snap action circuit controlling device having, in combination, a magnetic member movable each way between two control positions, a pair of normally closed circuit controlling means, each separately opened upon movement of said member to a corresponding one of said positions and two pairs of biasing means for said member, each pair including a permanent magnet having an adjustable air gap for variably biasing said magnetic member to a corresponding one of said positions and an opposing temperature responsive variable biasing element having an electrical heater energized under the control of the corresponding one of said normally closed circuit controlling means opened in the other one of said positions for varying the biasing force of said magnetic means with a time delay dependent upon the adjustment of said air gap to effect snap action movement of said member to the other of said positions and thereby open said other normally closed switching means to deenergize said heater.

5. A time delay snap action control device having, in combination, a pair of separately adjustable stops, a control member movable each way between said stops, spring biasing means tending to move said member away from said stops, magnetic biasing means having air gaps separately controlled by said stops for opposing said spring biasing means to hold said member against each of said stops, and a reversible biasing means having electrically controlled means for selectively varying the biasing force thereof into predominance over the biasing

force of said magnetic biasing means with a time delay dependent upon the adjustment of each of said stops to effect snap action movement of said member into engagement with the other of said stops.

6. A duplex thermal timing device including a control member movable each way between two control positions, a separate switch biasing means operated by said member in each of said positions, two independently adjustable opposing biasing means, each for variably biasing said member to a corresponding one of said positions upon operation thereto, two opposing bimetal thermal timer elements for oppositely moving said member, each having an electric heater and operating connections for effecting snap action movement of said member from a corresponding one of said positions to the other a variable time interval after energization of said heater dependent upon the variable bias of said member to said one position, and switching means including a two circuit master control switch having a separately operable switch in each circuit thereof under control of a corresponding one of said switch biasing means for jointly controlling the energization of a corresponding one of said heaters when said member is in each of said positions and operated by said control member for separately deenergizing the corresponding heater independently of said master switch upon operation of said member to the other of said positions.

7. A duplex thermal timing device including a control member movable each way between two control positions, a separately adjustable stop for determining each of said positions, two opposing permanent biasing magnets, each for magnetically holding said member in a corresponding one of said positions upon operation thereto with a variable force dependent upon the adjustment of the corresponding stop, two opposing thermal elements for oppositely moving said member dependent upon the temperature difference of said elements, each having a separate electric heater and connections for moving said member from a corresponding one of said positions to the other in a time interval after energization of said heater dependent upon the

adjustment of said stop for determining the corresponding one of said positions.

8. A duplex time delay snap action control device having, in combination, a rotatable shaft, a pair of opposing spiral bimetal operating elements having heat insulating means therebetween and interconnected for rotating said shaft in a direction dependent upon the temperature difference of said elements and each having an electric heater, a balanced control member carried by said shaft for oscillation between two control positions, and a pair of separately adjustable magnetic biasing means each effective upon operation of said member to a corresponding one of said positions to variably bias said member thereto for providing a time delay snap action movement of said member to the other position upon energization of the heater of the corresponding operating element.

9. In a duplex time delay control, in combination, a movable control member, a pair of thermal operating elements having separate heating time lag enclosing chambers provided with heat insulating means therebetween, adjustable means for interconnecting said elements for compensating each other upon variation in the ambient temperature and for oppositely moving said member dependent upon the temperature difference of said elements, means for separately heating said chambers above the ambient temperature, and separately adjustable biasing means having connections with said member for providing separately adjustable time delays in the opposite movements thereof under control of said operating elements.

10. In a duplex time delay control, in combination, a pair of thermal operating elements having separate heating time lag enclosing chambers provided with heat insulating means therebetween, means for separately heating said chambers, and a pair of separately adjustable biasing means having connections with said elements and each rendered effective after operation of a corresponding one of said elements for providing an adjustable time delay in the operation of the other element.

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