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C. D. GEER

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CONTROL SYSTEM

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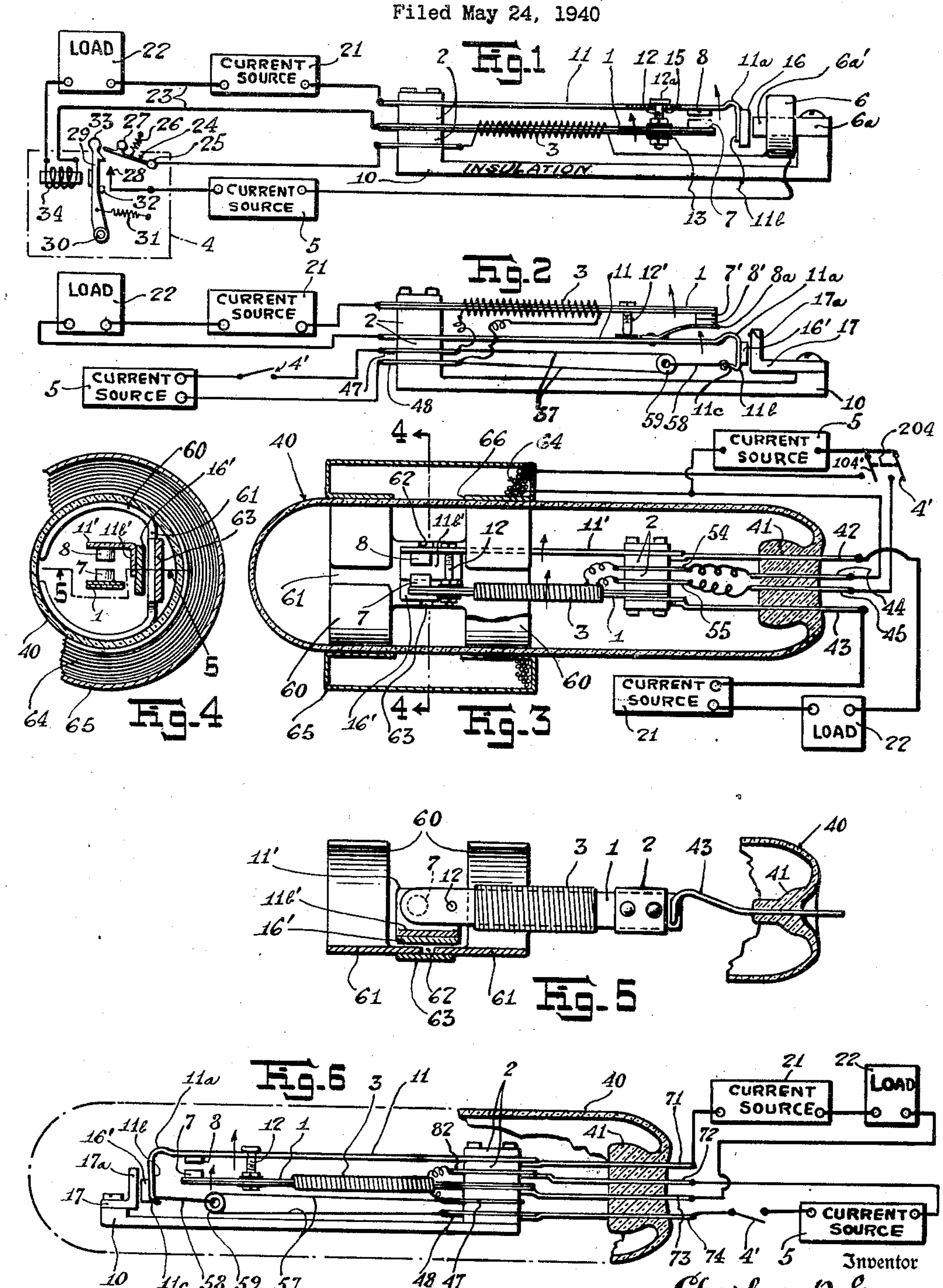

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CONTROL SYSTEM

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19 Claims. (Cl. 200—122)

This invention relates to control systems, and especially, though not in all aspects limitatively, to systems for electrical control.

An important aspect of the invention relates to control systems, of relay nature for example, which produce their control action at the expiration of a time interval or delay following an initial manipulation or action; and it is a general object to provide an improved system, and improvements for a system, of that type. Typically, though not necessarily limitatively, such a system may involve the accumulation of energy, for example of heat, in an energy-storing device which in turn forms an operating element in the system.

It is another object to provide an improved control or relay system of the delayed-action type just mentioned, characterized by substantial uniformity of the delay intervals in all normal, though rapid, use.

It is another object to provide an improved system of the type described, which may be operated a number of times, or re-cycled, in quick succession without substantial change of its delay interval.

It is another object to provide an improved system of the type described, which may be operated immediately following a prior incompleted operation, with its normal delay interval.

It is another object to provide an improved system of the type described, operatively including an energy storing device, with which quickly repeated but substantially uniform re-cycling may be effected.

It is another object to provide an improved control system of the type described, operatively including an energy-storing device, which may be operated with uniform action substantially independent of the level of energy contained in that device.

Other objects are the provision of improvements for a control system of the type described whereby it is caused to fulfill the above-stated objects in novel and advantageous manners.

In the co-pending application of Charles T. Jacobs, Serial No. 336,873, filed May 23, 1940, as a continuation in part of a prior application, Serial No. 128,219, filed February 27, 1937, and assigned to the assignee of this application, there was disclosed and broadly claimed a control system adapted to accomplish objectives above indicated. It is an object of this invention to provide improvements in, and improved variations of, the control system disclosed and claimed in that application.

Other and allied objects will more fully appear from the following description and the appended claims.

In the description reference is had to the accompanying drawing, of which:

Figure 1 is an elevational view of the principal portion of a control system according to my invention, further portions of the system appearing therein schematically;

Figure 2 is an analogous view of a control system embodying my invention in a modified form;

Figure 3 is an essentially central cross-sectional view taken through a "vacuum-type" relay embodying my invention in a somewhat further modified form, remaining portions of the control system in which the relay is employed appearing in the figure schematically;

Figure 4 is a cross-sectional view taken substantially along the line **4**—**4** of Figure 3;

Figure 5 is a cross-sectional view taken substantially along the line **5**—**5** of Figure 4; and

Figure 6 is a view generally analogous to Figure 3, but illustrating a "vacuum-type" relay embodying my invention in a still further modified form.

Attention may first be directed to the embodiment of my invention illustrated in Figure 1. Herein **1** represents a bimetallic strip, composed in the usual way of two metals of dissimilar thermal coefficients of expansion, clamped at one extremity in an insulating stack **2** at one end of an insulating base **10**; it will be understood that this strip will bend generally arcuately, for example upwardly at its free extremity (as indicated by the arrow therethrough) as its temperature is raised. Broadly, this strip represents an energy-storing device, positionally responsive to its own energy (heat) content; and in association therewith there is provided means operable at will to vary that energy content—e. g., for supplying energy or heat thereto. This means is illustrated as the heating winding or resistance **3** wound about the strip **1** over a considerable portion of the length of the strip; this winding may be connected, for example through the manually operable switching system **4** hereinafter more fully described, to the battery or other electric current source **5**.

In this embodiment the control device to be operated is an electric switch comprising as its two members the contacts **7** and **8**; these are normally maintained in predetermined mutual relationship (for example, spaced apart by a predetermined distance) and are operated (for example, moved toward each other) only during periods of energy supply to the bimetallic strip **1**. My invention permits one of the control members—e. g., contact **7**—to occupy the simple relationship to the bimetallic strip **1** of immediate connection thereto; accordingly it has been shown carried by that strip at the top of its free extremity.

The other control member, or contact **8**, has been shown disposed above contact **7** and carried on the bottom of a leaf spring **11**; this spring is disposed spacedly above the strip **1**, its extremity being clamped in the stack **2** at a distance above the strip 1. To maintain a predetermined relationship between the contacts 7 and 8 the spring 11 is subjected to a self-generated upward bias (as indicated by the arrow therethrough), and response to this bias is limited by a screw 12 extending between the spring 11 and the strip 1. The screw 12 may for example be insulatedly secured through the strip 1 by the insulating bushings 13, and may pass freely through a hole 15 in the spring 11, the spring bearing upwardly against the bottom of the head 12a of the screw.

As in the invention disclosed and claimed in the copending application abovementioned, simultaneously with the supply of energy to the strip 1 there is rendered inoperative the means which normally maintain the control members in predetermined relationship; further as in that case, this may be done by then suitably clutching or engaging one of the control members. According to my invention, however, it is possible to couple or engage an appropriate one of the control members with a stationary object, rather than with one of the movable elements of the system, thus materially simplifying the construction and opening the way to many specific variations otherwise difficult or impossible of employment.

In the embodiment of Figure 1 I couple or engage, with a stationary object, the contact 8; this is conveniently done by operating on the spring 11 which carries that contact, preferably at a point near to the contact. Accordingly I have shown the spring, just beyond the contact, folded first upwardly and then reversely downwardly, to form first a loop 11a and then a downhanging portion 11b; and to the outer side of the portion 11b I have shown secured an armature 16. Secured to the outer end of the base 10 there has been shown an electromagnet 6 with horizontal pole 6a, from whose inner end 6a' the armature 16 is normally very slightly spaced to permit normal vertical movement of the armature and spring 11 and contact 8 unimpeded by any touching of the pole end 6a'. Upon energization of the electromagnet 6, however, the electromagnet will attract the armature 16 into contact with the pole end 6a' (the spring 11 flexing slightly at the loop 11a), thus frictionally engaging the arm and spring 11 and contact 8.

The electromagnet 6 may be electrically connected for energization simultaneous or concomitant with the energization of the strip-heating winding 3; the simplest connection for such purpose may be a connection in common with that winding, and a common connection of series nature has been illustrated by way of example. The switching system 4 therefore jointly controls the energizations of the electromagnet 6 and of the electro-thermal device represented by the bimetallic strip 1 with its winding 3.

Normally (e. g., during periods when current is not being supplied to the winding 3 and the electromagnet 6) any up or down movement of the strip 1, occasioned by ambient or any other condition, will be accompanied, in view of the maintenance of a predetermined relationship between the control members as above described, by a corresponding movement of spring 11; in other words, the control members normally move jointly with each other. Upon closure of the switching system 4 (e. g., of 24 against 28, as hereinafter further discussed), however, the winding 3 and the electromagnet 6 will be simultaneously energized, and armature 16 will be attracted into intimate contact with the pole end 6a'; its frictional engagement therewith will prevent that upward movement of spring 11 and contact 8 which would otherwise accompany the heat-produced rise of strip 1. Accordingly that rise, at the rate predetermined by the characteristics of the electro-thermal device 1—3, will carry the contact 7 toward and into contact with the contact 8.

It is not important just what elevation the strip 1 and spring 11 may have at the time of closure of the switching system 4, the armature 16 preferably having a vertical dimension large enough so that some portion of it will always be in horizontal juxtaposition to the pole end 6a'. And so long as the temperature of the strip 1 at the time of switching system closure is any temperature, within a considerable range, which causes a given small strip movement to require substantially the same interval of current flow through the winding 3, closure of the contacts 7 and 8 will result at the end of an interval after switching system closure which is substantially independent of the initial strip temperature.

The operation of the control device—i. e., the closure of the control members or contacts 7 and 8 against each other—may of course be utilized for any desired purpose. Schematically I have illustrated them (7 through the strip 1, and 8 through the spring 11) connected in a series circuit with a current source 21 and load 22 by the conductors 23, so that they serve to control the flow of current from that source through that load.

No particular limitation is intended as to the nature of the switching system 4, or as to that of the load 22, or as to the presence or absence of means interrelating them in addition to the time-delay relay which the described structure constitutes. The switching system 4 may, as illustrated in later figures, be a simple single-pole single-throw switch, which may if desired be manually opened at an appropriate time after the control device (7—8) has been operated to supply current to the load 22. Automatic opening means for the switching system may, however, be incorporated therein, particularly for use in cases where the load 22 is to be supplied with only a momentary pulse of current from the source 21, and such automatic means have been included in the showing of Figure 1. Thus the switching system may comprise the pole 24 pivoted at 25 and upwardly biased as by spring 26, but movable downwardly as by knob 27 to close against contact 28. When so closed it may be held in that position by being then engaged by a latch 29, pivoted as at 30 and biased as by spring 31 into such engagement (or, when the pole 24 is raised, against stop 32). For manually opening the switching system at any desired time there may be provided on the latch a knob 33, by which it may be disengaged from the pole 24. There is associated with the latch, however, an additional latch-disengaging means automatically responsive to the closure of the contacts 7—8. This means may consist simply in an electromagnet 34 positioned to disengagingly attract the latch, and connected in series with the load circuit—e. g., serially in one of the conductors 23. The use of such automatic means is not only conservative of energy from the source 5, but also helps to obviate excessive heating of the strip or energy-storing device 1—e. g., helps to maintain a more nearly average level of energy therein.

It will be appreciated, however, that even in the event of the use of such automatic switch-opening means, the temperature of the device 1 will not always be the same at all the different times of closing of the switching system 4; that temperature will for example be higher than usual in the case of closing (re-closing) so soon after a prior operation of the system that gradual energy losses (e. g., conduction, convection and radiation cooling) have not had an opportunity to return the strip 1 to ambient temperature, or in the case of re-closing immediately or soon after a prior closure interrupted deliberately before operation of the contacts 7—8. In most known control systems such an early re-closing of the switch, or "re-cycling" manipulation of the system, causes the control device (e. g., contacts 7—8) to operate at the end of a time interval which is substantially altered or shortened—in some cases practically to zero—from that interval of operation which normally characterizes the system. By my invention there is provided in a simplified structure the ability, characteristic of the system disclosed and claimed in the co-pending application above-mentioned, to use the system a second or succeeding time—i. e., to recycle it—just as soon as desired after a prior use or incompleted use, without substantial departure from the normal interval of intended delay. For immediately upon the opening of the switch 4 (e. g., 24 from 28)—whether that interruption occurs before, with, or after the closing of contacts 7 and 8—the armature 16 and spring 11 will be released by the electromagnet 6, restoring the normal spaced relationship of the contacts. However soon the switch 4 may be re-closed, the armature 16 will simply be attracted to the pole end 6a' in a fresh position, and the operation of the system will be repeated with the normal time interval. Of course there may be an ultimate limit to the number of recycling operations which can be performed in immediate succession, but such a limitation is of very infrequent significance in the usual case.

It will of course be understood that I employ the phrase "control device" or "control members" in a very broad sense, intending thereby no unnecessary limitation to cooperating contacts. Cooperating contacts, however, probably constitute the most frequently encountered type of control device to be operated with the predetermined delay which my invention contemplates; and to illustrate an alternative arrangement of such contacts, I show them in Figure 2 in normally closed relationship, to be opened after a predetermined delay interval.

Figure 2 also illustrates an engaging or coupling means, alternative to the electromagnetic type, whose use broadly in a system of the instant type is an element of my invention. In general, this engaging or coupling means may be termed an electro-thermal one, and more specifically it may be termed a hot-wire means. While it has heretofore been employed as a contact-moving means in certain relay systems, it has not insofar as I am aware been employed in the clutching, coupling or engaging capacity contemplated by my invention—in which capacity I have found it to have marked advantages in respect of simplicity, small size, ease of incorporation in relays of the vacuum type, and the like.

Most readily to arrange the system of Figure 2 for the normally closed condition of the contacts, I have shown the bimetallic strip 1 positioned above the spring 11. Again the strip 1 moves upwardly with temperature rise, and again the spring 11 is biased upwardly—which in this instance is toward the strip 1. One of the control members or contacts appears as 7', carried on the bottom of the strip 1 at its free extremity. The other control member or contact appears as 8', carried on the top of a light spring 8a which extends upwardly and outwardly from an intermediate point on the top of spring 11. The bias of spring 11 toward strip 1 is limited, in its influence on the spring, by a screw 12' threaded through the strip 1 and extending downwardly to be impinged against by the spring 11, or preferably by a small pad of insulating material secured on the top of that spring. By means of the screw 12' the contacts 7' and 8' are maintained normally in a condition of predetermined pressure—arising from a constraint of spring 8a—against each other. The spring 11 may again be provided with the loop 11a and with the downhanging portion 11b.

On the outer side of the portion 11b there may be secured a small block 16', typically though not necessarily metallic. To the top of the outer extremity of the base 10 there may be secured an L-shaped or other suitably formed member having an inner vertical face 17a against which the block 16' may come into frictional contact. The portion 11b of spring 11 is biased so that this contact will tend to be established. The portion 11b, however, is curved inwardly at its bottom to form a lug 11c; to this is secured one end of a link 58 whose other end terminates in an insulating spool 59; and passing around this spool, and extending to have its ends secured to respective lugs 47 and 48 in the stack 2, is provided a fine resistance wire 57. The length of 57—59—58 is chosen so that normally the spring portion 11b is flexed sufficiently to maintain the block 16' dependably free of contact with the member face 17a. The wire 57, however, is connected to be traversed by current, or energized, simultaneously with the energization of the electro-thermal device 1—3; by way of example, the winding 3 has been shown terminally connected to the lugs 47 and 48 in which the wire 57 terminates, so that these elements are electrically in parallel. Upon their joint energization, as from source 5 through switch 4', the expansion of wire 57 resulting from its heating permits the bias of spring portion 11b to become effective to cause the frictional engagement of block 16' with the member face 17a. Obviously this engagement acts on spring 11 in an analogous manner to the electromagnetically produced engagement of 16 with 6a' in Figure 1—subject to the qualification that any delay in the effecting of the engagement, due to thermal inertia of the wire 57, becomes added to the normal delay interval of the bimetallic strip 1, though this effect is usually inconsequential.

In respect of the contact action, it will be understood that when the spring 11 is engaged or rendered stationary, the heat-produced rise of the bimetallic strip 1 will move contact 7' away from the spring 11. But for a time, predetermined by the normally predetermined pressure of contact 8' against contact 7', the contact 8' will be moved upwardly by spring 8a in continued contact with 7'—at the end of which predetermined time, when the spring 8a has yielded up its constraint, contact between 7' and 8' will be broken. While this continued movement of contact 8' may be inconsistent with a theory that it is engaged or clutched or rendered stationary by 16' 17a, there is still carried out the basic operation of engaging or clutching or rendering stationary one of two control members—since the spring 11 itself may entirely warrantably be considered as one of those members, either the bimetallic strip 1 or the contact 7' being the other.

Subject to the distinctions already made apparent, the action of the system of Figure 2 may be considered analogous to that of the system of Figure 1 as already detailedly described. Upon any opening of switch 4' the original or predetermined relationship of the control members is of course substantially instantly restored (the only delay being the minute one required for cooling of the wire 57), so that the system is substantially immediately rendered available for prompt re-cycling with substantially the normal delay interval. And it is to be understood that in presenting at once in Figure 2 several features of modification from the system of Figure 1, no limitation at all is intended as to the combinations of the several features, which are obviously not interdependent.

In Figures 3, 4 and 5 I show an embodiment of my invention in a vacuum-type relay—i. e., a relay whose contacts and associated parts are enclosed within a sealed receptacle evacuated of air, in which however an atmosphere of inert gas may if desired be introduced for one or another special purpose known in the art. In this embodiment I have illustrated electromagnetic engaging means, broadly in analogy to those of Figure 1; in adapting them to the peculiar requirements of a vacuum-type relay, however, I have employed an external coil and an internal magnetic structure magnetically energized thereby, such as is disclosed and claimed in the copending application of Herbert O. Wilson, Serial No. 108,420, filed October 30th, 1936, and assigned to the assignee of this application.

Reference being had to Figure 3, and to Figures 4 and 5 in aid thereof, there will be seen an evacuated glass receptacle 40 having the inwardly extending seal 41 at its righthand extremity. Passing inwardly through the seal and extending for an appreciable distance within the receptacle are the top and bottom lead-in wires 42 and 43, while between the latter there pass through the seal and extend for a shorter distance within the receptacle the lead-in wires 44 and 45. A spring 11' and a bimetallic strip 1 are assembled in an insulating stack 2, in analogy to the Figure 1 construction, and the assembly appears within the receptacle 40. The assembly is supported on the lead-in wires 42 and 43; the extremity of the spring 11' extending beyond the stack may be welded to the lead-in wire 42, while the extremity of the bimetallic strip 1 in the stack may be connected to the lead-in wire 43. A heater winding 3 is provided about the strip 1, and its extremities may be connected to the lead-in wires 44 and 45, if desired through the medium of lugs 54 and 55 assembled in the stack 2.

Contacts 7 and 8 may be carried respectively by the bimetallic strip 1 and spring 11' near their free extremities, and the strip-spring spacing arrangement comprising screw 12 etc. may be employed, all in analogy to the Figure 1 construction. An alternative armature arrangement is employed, however. This may comprise a lug 11b' folded downwardly from one side of the free end portion of the spring 11' (in Figure 3, the rear side, so that the lug appears behind the contact 8), and the armature 16' may be secured to the outer (in Figure 3, the rear) side of the lug 11b'.

Longitudinally straddling the armature there may be provided within the envelope or receptacle 40 an internal magnetic circuit adapted to be magnetically energized by means hereinafter described. This structure may comprise two "collector" rings 60 of magnetic material, each in the form of an almost closed letter C, excepting that it may be flattened over a minor circumferential portion 61 diametrically opposite to its point of discontinuity. These rings may be resilient and biased to expand so as to cling to the interior wall of the envelope 40. The flattened portions 61 of the two rings may be extended toward but not fully into contact with each other (in Figure 3, behind the armature 16'), a gap 62 being formed therebetween. The ends of the portions 61 immediately to each side of this gap are disposed parallel and close to the outer surface of the armature 16'. To render the collector-ring structure an integral one, the portions 61 may be bridged by a small plate 63 of non-magnetic material secured to the outer surface of each.

To energize the magnetic circuit there may be employed a coil 64 surrounding and co-axial with the envelope 40, and preferably extending longitudinally thereof for at least the length of and in juxtaposition to the internal collector-ring structure just described. Preferably this coil will be clad with a casing 65 of magnetic material, over its outer and end surfaces, and over its inner surface excepting for a central gap 66 approximately coinciding longitudinally with the spacing between the main portions of the collector rings 60; the inside surface of this casing will preferably fit as snugly as possible over the envelope 40. It will be understood that the function of the casing is to concentrate the field of the coil across the gap 66, while the function of the internal collector-ring structure is to collect the so-concentrated field and further concentrate it across the internal gap 62. It will further be understood that when the coil 64 is electrically energized, the resulting magnetic excitation of the gap 62 will serve to attract the armature 16' into contact with the adjacent inner surfaces of the flattened ring portions 61, to frictionally engage the latter. This armature movement is permitted by flexing of the lead-in wires 42 and 43, the whole structure of stack 2 and strip 1 and spring 11' indulging integrally in the movement, which of course is at right angles to the contact-influencing movements of strip and spring (e. g., is rearward in Figure 3); those lead-in wires are made of resilient material, and are biased to normally maintain the structure just mentioned in such position that armature 16' is normally just dependably free of contact with the portions 61 to which it is attracted upon the energization abovementioned.

The coil 64 may be energized concomitantly with the energization of the electro-thermal device 1—3. By way of example, one of the coil terminals and the lead-in wire 44 (for winding 3) have been shown connected to a first terminal of the current source 5, while the other coil terminal and the lead-in wire 45 have been shown connected thru respective switches 104' and 4' to the second terminal of the current source 5; if the switches be unicontrolled (as indicated by the tie 204), coil 64 and winding 3 will be energized in parallel. Subject to such distinctions as are obviously implicit in the special description presented for this embodiment, its operation is of course identical with that of the Figure 1 system, and special consideration of its operation seems therefore unnecessary. There may be noted, however, the extreme simplicity and compactness of the relay for one which includes electromagnetic action for the engaging or clutching function, and its enclosed nature—all made practicable by the employment of the principles of my invention more broadly disclosed in connection with the first embodiment.

Finally, in Figure 6, I have illustrated what I believe to be the preferred form of my invention when a vacuum-type construction is to be employed. This uses the hot-wire arrangement illustrated in Figure 2, thereby obviating the necessity for recourse to magnetic structures partially within and partially without the sealed envelope. By way of example, I have shown the hot-wire arrangement embodied with the normally open contact arrangement of Figure 1. Four lead-in wires **71**, **72**, **73** and **74** have been shown passing inwardly through the seal **41**. As shown, the top element assembled in the stack **2** is the spring **11**, to which the wire **71** may be welded; the next element assembled in the stack is a lug **82** forming a first terminal for the heater winding **3**, and to which the wire **72** is welded; the next element is the bimetallic strip **1**, to which wire **73** is welded; the next element is the lug **47**, forming the top anchorage for the wire **57** and, if a series arrangement of winding and wire is desired, the second terminal for the heater winding **3**; and the last element is the lug **48**, forming the bottom anchorage for the wire **57**, and to which the lead-in wire **74** is welded.

The internal structure is otherwise believed sufficiently described as the spring, strip, heater, contact and relation-maintaining-means assembly of Figure 1, with the engaging or coupling structure of Figure 2. Externally the terminals **72** and **74** may be connected in a series circuit with the source **5** and switch **4'** for joint energization of the heater winding and wire **57**; and the terminals **71** and **73** may be connected in a series circuit with the source **21** and load **22**, for current supply to the load at the end of the predetermined time interval after any closure of switch **4'**—as in other cases, substantially independent of the past history of the use of the system.

There have been made apparent many broad features which are generic to the several disclosed embodiments of my invention and to other variations thereof which will suggest themselves. Among such features it may be noted that in each of the disclosed embodiments the bimetallic arm **1** and the spring **11** or **11'**, with their respective contacts, may be taken as constituting a control device, in which the arm and spring jointly form means which operate that device in response to joint or concomitant energization of the electro-thermal and coupling devices.

While in disclosing the various embodiments of my invention I have shown and described simultaneous energizations of the energy-storing (or electro-thermal) and coupling devices, certain aspects of my invention are not necessarily limited to this feature. Thus the energization of the coupling device during energization of the storing device is a particular case of coupling-device operation during change of energy content or temperature of the storing or electro-thermal device, and various aspects of my invention embrace the latter. For certain purposes the energizations of the two devices may be separately controlled. The incorporation of the separate-control feature in any of the embodiments of my invention has been schematically illustrated by way of example in Figure 3, by the separate switches **4'** and **104'** which may obviously be independently operated without the tie **204** therebetween. In such a case broadly, the final control means (e. g., **7—8**) will be operated when, during any period of coupling-device energization, the energy supplied to the storing (e. g., electro-thermal) device less any losses therefrom (whether the latter energy supply be continuous or intermittent) has reached a predetermined value. The switches **104'** and **4'** will of course respectively control the coupling device and the energy supply to the storing means appropriately to the ultimate control function to be performed by the system.

While I have disclosed my invention in terms of particular embodiments thereof, I do not intend any unnecessary limitations of its broader aspects by virtue of the details of those embodiments, which may obviously be varied within wide limits without departure from the spirit of the invention, or from its scope as expressed in the appended claims.

I claim:

1. A control system comprising, in combination, an energy-storing device positionally responsive to its own energy content; control means comprising coacting movable control members normally maintained in predetermined mutual relationship, said energy-storing device being associated with one of said control members to move the same; means operable to clutch the other of said members without interfering with the operating movement of the first member; and means for simultaneously varying the energy content of said energy-storing device and operating said clutching means.

2. A control system comprising, in combination, an electro-thermal device; control means comprising coacting movable control members normally maintained in predetermined mutual relationship, said electro-thermal device being associated with one of said control members to move the same; means operable to clutch the other of said members without interfering with the operating movement of the first member; and means for simultaneously supplying current to said electro-thermal device and operating said clutching means.

3. A control system comprising, in combination, an energy-storing device positionally responsive to its own energy content; control means comprising coacting movable control members, a first of said members being moved by said energy-storing device and the second of said members being normally maintained in predetermined relationship thereto; clutch means actuable to maintain stationary said second member without interfering with the movement of the first member; and means for simultaneously varying the energy content of said energy-storing device and actuating said clutch means.

4. A control system comprising, in combination, a bimetallic switch member; a cooperating switch member arranged for movement normally in predetermined relationship to said bimetallic switch member; means operable to clutch said cooperating switch member without interfering with the operating movement of said bi-

metallic switch member; and means for simultaneously heating said bimetallic switch member and operating said clutching means.

5. A control system comprising, in combination, coacting control members; a device positionally responsive to its own energy content for moving a first of said members; means normally maintaining a predetermined mutual relationship of said members independent of the level of said energy content; and means operable during change of the energy content of said device, and associated with and influencing the second of said members, for rendering said maintaining means inoperative.

6. A control system comprising, in combination, coacting control members; a thermal device adapted to move a first of said members in accordance with change of the temperature of said device; means normally maintaining a predetermined mutual relationship of said members independent of the temperature of said device; and means operable during change of the temperature of said device, and associated with and influencing the second of said members, for rendering said maintaining means inoperative.

7. A control system comprising, in combination, a control device including two coacting control members normally having a predetermined mutual relationship, whereby said control device has a predetermined normal condition from which it is operable by departure of said members from said predetermined mutual relationship; means energizable to operate said control device, including an electro-thermal device associated with and influencing one of said members; and means, associated with and influencing the other of said members and rendered effective by the deenergization of said operating means, for substantially instantaneously restoring said control device to said predetermined normal condition.

8. In a control system, including coacting control members normally jointly moved, and operable by relative movement of said members: the combination of an electrically energizable thermal device for moving a first of said members, and electrically energizable clutch means for retaining the second of said members from joint movement with the first, said thermal device and retaining means being electrically interassociated for concomitant energization.

9. In a control system, including coacting control members normally jointly moved, and operable by relative movement of said members: the combination of electrically operable means for frictionally engaging one of said members; and a thermal movement-effecting device whose temperature may be changed while said engaging means is operated, for moving the other of said members.

10. In a control system, including coacting control members normally jointly moved, and operable by relative movement of said members: the combination of a thermal device for moving one of said members in accordance with change of the temperature of said device; and mechanical engaging means, electrically operable during change of the temperature of said device, for rendering stationary the other of said members.

11. In a control system including a control device which comprises two control members normally having a predetermined mutual relationship and which is adapted to be operated by relative movement of said members: the combination of an electrically energizable thermal device and an electrically energizable mechanical coupling device, each associated with and adapted to influence a respective one of said members, and operating means in said control device responsive only to concomitant energizations of said thermal and coupling devices.

12. In a control system including a control device which comprises two control members normally having a predetermined mutual relationship and which is adapted to be operated by relative movement of said members: the combination of an electrically energizable thermal device and an electrically energizable mechanical coupling device, and operating means in said control device responsive only to concomitant energizations of said thermal and coupling devices, respective portions of said operating means being associated with and influencing each of said members.

13. Means for operating a control device of the type which includes movable members normally jointly moved, comprising, in combination, electrically operable means for engaging one of said members; and electro-thermal means, energized concomitantly with the operation of said engaging means, for moving the other member relative to the engaged member.

14. Means for operating a control device of the type which includes cooperating movable members normally jointly moved, comprising, in combination, an electro-thermal element and electrically operable mechanical engaging means, said element and engaging means being associated with and influencing said members respectively.

15. In a thermally operated control device including cooperating control members, a clutch adapted to engage one of said members and comprising as its operating element an electro-thermal device.

16. In a thermally operated control device including cooperating control members, a clutch adapted to engage one of said members and comprising as its operating element a wire adapted to be elongated by the passage of a current therethrough.

17. In a thermally operated control device including cooperating control members, mechanical coupling means adapted to engage one of said members and comprising two elements of which one is biased into engagement with the other, and electro-thermal means normally maintaining said one element out of such engagement but heatable to release said one element sufficiently for such engagement.

18. In a control system including coacting control members and an electro-thermal device energizable to move one of said members: the combination of means normally maintaining a predetermined mutual relationship of said members; and means, including a second electro-thermal device, for rendering said maintaining means inoperative when said moving means is energized.

19. Means for operating a control device of the type which includes cooperating movable members normally jointly moved, comprising, in combination, a thermal movement-effecting element and electrically operable mechanical engaging means, said element and engaging means being associated with and influencing said members respectively.

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