June 29, 1943. H. O. WILSON 2,323,266

ELECTRICAL CONTROL SYSTEM

Original Filed Oct. 30, 1936

Fig. 1

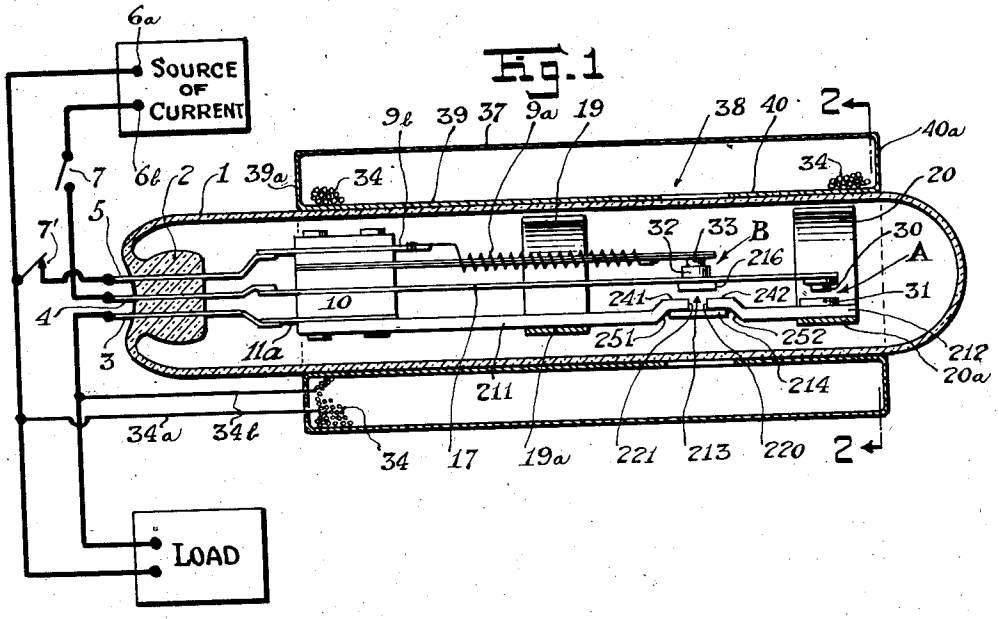
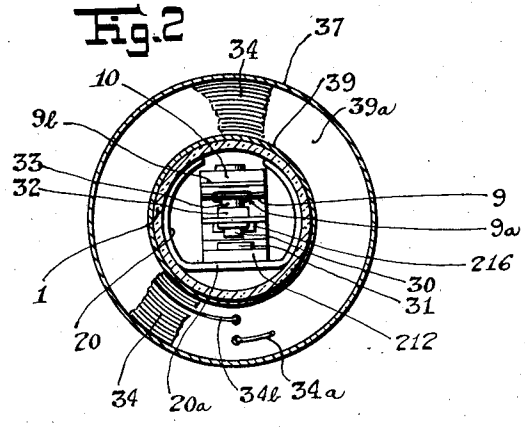


Fig. 2



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ELECTRICAL CONTROL SYSTEM

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8 Claims. (Cl. 200—88)

This invention relates to electrical control systems, and more particularly to such a system employing a switch or relay which is thermally thrown and electromagnetically maintained in thrown condition. The present application is filed as a division of my co-pending application Serial No. 108,420, filed October 30, 1936, which became Patent No. 2,242,636 on May 20, 1941. The particular illustration of the present invention has been presented in connection with a switch or relay of the so-called vacuum type (involving a sealed container, for the contacts, which is evacuated of air and may optionally contain a filling of inert gas), though obviously as to many aspects of the invention this feature of illustration is non-limitative.

It is an object of my invention to provide a generally improved control or switch system of the class first above described, and to provide improvements in such a system.

It is another object of my invention to provide an improved switch or relay, which throws after a predetermined delay, and which will quickly be conditioned for repeated throwing with a similar delay.

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 a view, generally cross-sectional, though elevational as to components within the envelope and diagrammatic as to certain circuit elements, of a control system embodying my invention, and

Figure 2 is a partial cross-sectional view taken along the line 2—2 of Figure 1.

In the drawing I have illustrated a switch or relay with a thermal element to provide a predetermined time interval between the inception of current supply to the switch and the throwing of the switch, and with electromagnetic means for maintaining the switch thrown during the continuance of current supply—this maintenance by the electromagnetic means permitting the cooling of the thermal element to recondition the device for proper quickly repeated operation should that be desired. In general in the following description, I shall first consider the armature and core system, secondly the balance of the magnetic structure, and finally the general organization of the relay and of the system in which it is employed.

In the figures there will be seen the elongated evacuated envelope 1, provided at one of its extremities with the seal 2, through which seal pass a plurality of lead-in wires, shown as three wires 3, 4 and 5, hereinafter referred to. Longitudinally within the envelope, for example near one side thereof in manner hereinafter more detailedly described, is supported a magnetic core system comprising two pole members 211 and 212 of magnetic material such as iron, and for example of rectangular cross-section (transversely of the envelope). The pole members are serially arranged and longitudinally spaced apart to form a small gap 213 between their mutually exposed respective ends or faces 221 and 222; it is convenient to hold them in the specified relationship by a flat, non-magnetic plate 214 secured to the bottom of each. Near the gap 213 and toward the center of the envelope therefrom I provide a flexibly supported armature 216 of magnetic material; this may be relatively short (i. e., longitudinally of the envelope), and of a rectangular cross-section (i. e., transversely of the envelope) of the order of that of the pole members. The flexible support of the armature is one which permits movement toward and away from the gap transversely of the envelope, and is desirably a resilient one; it may be provided by securing the armature to the core-system side of a light leaf spring 17, preferably of non-magnetic material such as phosphor bronze or beryllium copper.

The spring 17 is conveniently extended toward the seal 2 to be clamped in the usual stack or washer assembly 10, which may be secured to the pole member 211. The armature is biased away from the gap, as by a suitable tensioning of spring 17; but it is limitedly biased, in that its movement away from the gap is restricted (by means hereinafter apparent) to the originally mentioned nearby position. A system of contacts is associated with the armature in suitable manner, such as that hereinafter set forth, to be influenced by its movement.

It will be understood that upon magnetic excitation of the core system—e. g., serial excitation of the two pole members 211 and 212—the armature 216 will be attracted to movement toward the gap to effectively shorten the latter, or reduce its reluctance. In the illustrated arrangement the armature has been arranged for movement into juxtaposition with portions (241 and 242) of the top sides of both pole members. Thus these pole members may be formed with the respective offsets 251 and 252 toward the armature, and the portions 241 and 242 may lie between the respective offsets and the gap, the

armature being centralized over the gap but extending to some extent over these portions.

For producing the serial magnetic excitation of the core system a coil **34** may be provided around the envelope **1**, so that the coil axis is parallel with and near to the pole members **211—212**; and it will be understood that upon electrical excitation of the coil (as by impression of a suitable voltage across the coil leads **34***a* and **34***b* and consequent current flow through the coil) the pole members will be serially excited in the required manner. To heighten the efficiency of the excitation, however, and at the same time to provide excellent mechanical support and centralization of the elements within the envelope, the magnetic system may include certain further elements. These will be briefly described in the interest of completeness of description of a preferred embodiment; it will be understood, however, that they are not in themselves claimed herein, being both disclosed and claimed in my co-pending application above referred to.

The further elements of the magnetic system within the envelope may comprise two spring rings **19** and **20** of magnetic material such as steel, each for example in the form of a leaf spring bent into the shape of the letter C (i. e., an almost closed circle), excepting preferably for a small central flattened portion **19***a* or **20***a*. Each of these rings **19** and **20** fits snugly and preferably presses against the interior wall of the envelope **1** (excepting in its flattened portion **19***a* or **20***a*). Longitudinally they are positioned on opposite sides of the gap **213**; the interior surface of the flattened portion **19***a* of **19** is secured against the bottom or outer surface of pole member **211**, and the interior surface of the flattened portion **20***a* of ring **20** is secured against the bottom or outer surface of pole member **12**. The rings may thus form a significant mechanical support and centralizing means for the pole members or core assembly (to which in turn other elements are supported through the insulating stack **10**); at the same time they approach closely to the inside of coil **34** at separated longitudinal positions—for example either side of the center, and intermediate the coil extremities—and thus form efficient means for collecting the magnetic field of the coil and passing it through the portion of the core system which includes the gap **213**.

The further elements of the magnetic system outside the envelope, the use of which is a further contribution to the effectiveness of the magnetic system, may include magnetic cylinders **39** and **40** extending internally of the coil **34** from the respective coil extremities to overlap the respective rings **19** and **20**. These cylinders desirably fit as closely as practicable over the envelope **1**; in turn they preferably fit as closely as practicable within the coil **34**; they are of course of such length that an appreciable gap is left between them. This gap being of relatively higher reluctance, the field collected by the cylinders naturally follows the much lower-reluctance circuit from either cylinder through the envelope to the respective collecting ring **19** or **20**, through the core system across the gap **213**, and from the other collecting ring through the envelope to the other cylinder. Finally still higher efficiency may be obtained by extending the outer extremities of the cylinders **39** and **40** around the coil ends, as by the illustrated cylinder flanges **39***a* and **40***a* of magnetic material, and joining them magnetically as by the external cylinder **37** of magnetic material closely fitting the outside of coil **34**. This structure collects the external coil field and concentrates it, in its passage internally of the coil, in the desired path above outlined. The complete coil structure amounts to a coil encased in magnetic material excepting for the internal annular gap **38**.

It will of course be understood that in the interest of simplicity in the drawing the coil **34** is only fractionally shown, but that it is intended for example to fill the space bounded by **39—39***a*—**37**—**40***a*—**40**.

Attention may now be given to the general organization of the switch or relay of Figures 1 and 2. The spring **17** will be seen to be extended away from the stack **10** for a considerable distance beyond the armature, and to have secured to its bottom surface near its extremity a contact **30**. Below this contact **30** is provided a fixed contact **31**—for example secured to the top of the pole member **212**. The contacts **30** and **31** are normally in slight spaced relationship, forming the normally open switch A. On the top of spring **17** nearer the stack **10**—for example above the armature **216**—is secured a contact **32**; a cooperating contact **33** is provided thereabove to form a switch B. The contact **33** is shown carried on the bottom of a bimetallic arm **9** near one extremity thereof, the arm being clamped at its other extremity in the insulating stack **10**. The bimetallic arm **9** is surrounded by a heater winding **9***a*, of which one extremity is electrically connected with contact **33** (as by connection to the arm **9**) and of which the other extremity is connected to a lug **9***b* clamped in the stack **10**. The bimetallic arm **9** and contact **33** form the limiting means for upward movement of the upwardly tensioned spring **17**, so that switch B is normally closed. When the arm **9** temperature is at or near ambient the described normal positions, as illustrated, will be occupied by the various components. When the arm **9** is heated, however, as by passage of current through the heater winding **9***a*, the arm moves downwardly, maintaining switch B closed and forcing spring **17** downwardly to close switch A.

Contact **31** is connected with lead-in wire **3**, for example through pole member **212**, plate **214**, pole member **211**, and a lug **11***a* clamped against the pole member **211** and welded to the lead-in wire. With lead-in wire **4** is connected springs **17**, and hence contacts **32** and **30**. With lead-in wire **5** is connected the lug **9***b*, and hence, through the heater winding **9***a*, the contact **33**. Thus between lead-in wires **3** and **4** lies electrically the switch A, while between the lead-in wires **4** and **5** lie electrically the serially arranged heater winding and switch B. In Figure 1 there has been schematically indicated as **6** a current source. One terminal **6***a* of the source is connected with the lead-in wire **5** and with a lead **34***a* to coil **34**. The other terminal **6***b* of the source is connected through a control switch **7** with lead-in wire **4**, while lead-inwire **3** is connected to the other coil lead **34***b*. Thus the heater winding **9***a* is connected acorss the source through the switches **7** and B, while the coil **34** is connected across the source through the switches **7** and A.

When the control switch **7** is closed the heater winding **9***a* is energized, since switch B is normally closed; this energization heats the arm **9** and the latter moves downwardly. After a predetermined time interval switch A will be closed, the armature **216** by that time having been

moved toward but not yet fully into the position it occupies when the magnetic system is energized. But upon the closing of switch A, switch 7 of course still being closed, the coil 34 and hence the magnetic system are energized, attracting the armature 216 to move an additional distance, and thus flexing the intermediate portion of spring 17 downwardly and opening switch B. This opening of switch B breaks the current flow through the heater winding, so that the arm forthwith begins the process of cooling and restoration to its initial position; but the spring 17 is maintained downwardly, and switch A closed, by the excitation of coil 34, which continues until the control switch 7 is opened.

The completed downward movement of any portion of the spring 17—which after closing of switch 7 is thermally delayed and electromagnetically maintained—may be utilized for any desired purpose and in any desired manner. By way of simple illustration I have shown a load 8 intended to receive current only during intervals of downward spring position, and have indicated the simple connection of the load in parallel with the coil 34.

The switch system so organized presents, over various combinations of devices directed to a generally similar purpose, the distinct advantage of extreme simplicity. Broadly this results, among other things, from the electromagnetic means operating directly on the thermally responsive switch A itself, to take over the control of that switch from the thermal element; or, in a slightly different view, from the community of structure and of response to the coil of both the switches A and B.

It will be understood that in respect of the thermal device which closes the switch A there is no necessary limitation to a bimetallic strip such as 9, as obviously other thermal devices may be employed. It is also to be understood that while the device has been shown as an electro-thermal one—i. e., heated by an electric current—this is not essential for certain purposes. Thus the heating winding 9a and connections thereto may be omitted, or equivalently the switch 7' (shown in series with lead-in wire 5 in Figure 6) opened: the system will then function, assuming switch 7 closed, to close switch A and keep it closed when and after the thermal element (e. g., bimetallic arm 9) has been heated to a predetermined temperature by any means, such as ambient temperature.

While I have illustrated and described my invention in terms of a particular embodiment thereof, it is to be understood that I intend no unnecessary limitations by virtue of the details of that embodiment, which may obviously be varied within wide limits without departure from the spirit of my invention, or from its scope as expressed in the following claims.

I claim:

1. In a control system to which operating current may be supplied and which includes an electro-thermal device normally energized, for movement thereof, upon the supply of said operating current: the combination of a switch normally mechanically responsive to said device for throwing from first to second conditions and vice versa upon said movement and the opposite movement, respectively, of said device; and means, electrically connected with said switch and rendered effective thereby upon a throwing thereof to said second condition in response to said supply of current, for discontinuing the energization of said device and maintaining said switch in said second condition throughout the continuance of said supply of currents.

2. In a control system to which operating current may be supplied and which includes an electro-thermal device normally energized, for movement thereof, upon the supply of said operating current: the combination of a movable member normally positioned for mechanical response to said device, whereby said member is normally moved in respective directions upon said movement and the opposite movement of said device; means, electrically actuated by said member upon a movement thereof in response to said supply of current, for moving said member out of position for response to said device and maintaining the same out of such position throughout the continuance of said supply of current; and means, responsive to the movement of said member out of such position, for discontinuing the energization of said device throughout said continuance of current supply.

3. The combination according to claim 2, further including switch means mechanically thrown by the movement of said member out of the recited position.

4. In a control system to which operating current may be supplied and which includes an electro-thermal device normally energized, for movement thereof, upon the supply of said operating current: the combination of a movable member normally mechanically responsive to said device for movement in first and second directions upon said movement and the opposite movement, respectively, of said device; and means, electrically actuated by said member upon a movement thereof in said first direction in response to said supply of current, for discontinuing the energization of said device and retaining said member against movement in said second direction throughout the continuance of said supply of currents.

5. In a control system to which operating current may be supplied and which includes an electro-thermal device normally energized, for movement thereof, upon the supply of said operating current: the combination of a movable member normally mechanically responsive to said device for movement in first and second directions upon said movement and the opposite movement, respectively, of said device; means, electrically actuated by said member upon a movement thereof in said first direction in response to said supply of current, for effecting a further movement of said member in said first direction and rendering said member unresponsive to said device throughout the continuance of said supply of current; and means, responsive to said further movement, for discontinuing the energization of said device throughout said continuance of current supply.

6. The combination according to claim 5, further including switch means mechanically thrown by said further movement of said member.

7. In a control system to which operating current may be supplied and which includes an electro-thermal device normally energized, for movement thereof, upon the supply of said operating current: the combination of a switch normally mechanically responsive to said device for closing and opening upon said movement and the opposite movement, respectively, of said device; and electromagnetic means, magnetically influencing said switch and electrically connected in series therewith for actuation upon closure there-

of, for discontinuing the energization of said device and maintaining said switch closed throughout the continuance of said supply of currents.

8. In a thermally thrown, electromagnetically maintained switch system: the combination of a bimetallic arm and a cooperating switch arm carrying respective contacts, said switch arm being biased in the direction of said bimetallic arm for closure of said contacts, and said bimetallic arm being heatable for movement of itself and said switch arm in the opposite direction while maintaining said contacts closed; a heater wound on said bimetallic arm and connected in series with said contacts for energization therethrough; and means, including a switch operated by said switch arm upon a predetermined movement of said bimetallic and switch arms in response to said energization of said heater, for further moving said switch arm to place and maintain said contacts in an open condition and said heater in a de-energized condition.

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