July 18, 1950 R. T. PIERCE 2,515,314

ELECTRICAL CONTROL DEVICE

Filed Sept. 23, 1946

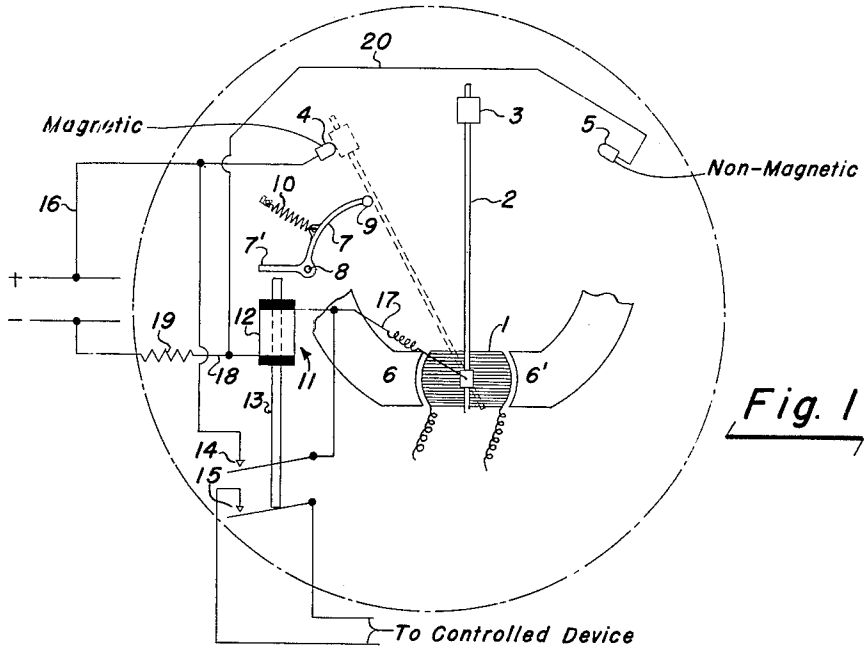


Fig. 1

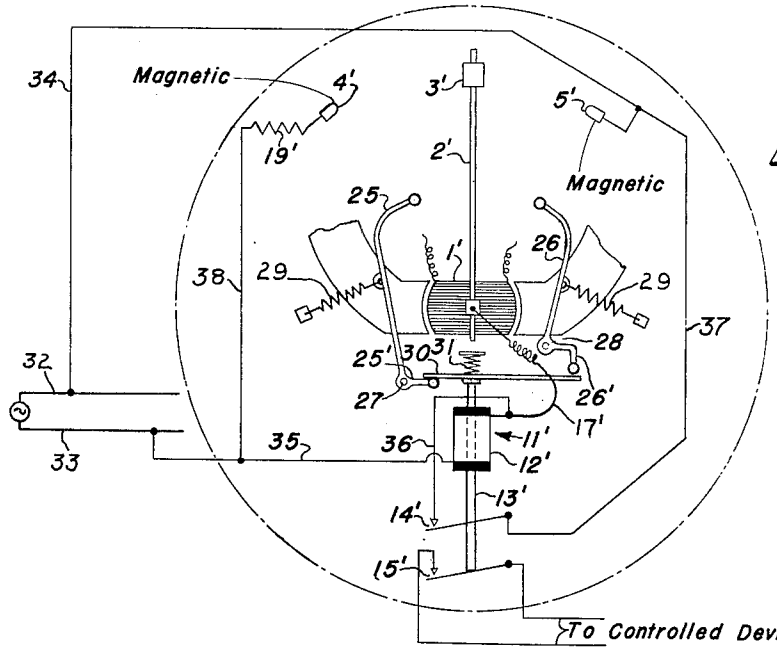


Fig. 2

Inventor

Raymond T. Pierce

By Pierce, Scheffler & Parker,

Attorneys

Patented July 18, 1950

2,515,314

UNITED STATES PATENT OFFICE

2,515,314

ELECTRICAL CONTROL DEVICE

Raymond T. Pierce, Millburn, N. J., assignor to Weston Electrical Instrument Corporation, Newark, N. J., a corporation of New Jersey

Application September 23, 1946, Serial No. 698,676

4 Claims. (Cl. 175—320)

1

This invention relates to electrical control devices and particularly to control devices of the type in which a sensitive instrument relay responsive to small current values is used to control a load circuit carrying substantial power.

An object of the invention is to provide electrical control devices including a magnetic contact type relay having a contact arm movable between spaced stationary contacts, and a solenoid for resetting the magnetic contacts and controlling a load circuit.

A more specific object is to provide an instrument relay of the magnetic pull-in type and a solenoid energized thereby when the relay contact arm has moved a predetermined distance in one direction; the arrangement being such that motion of the solenoid armature closes a holding circuit for the solenoid and resets the instrument relay by separating the magnetic contacts, the solenoid then remaining in the energized condition until the relay contact arm moves a predetermined distance in the other direction momentarily to short-circuit the solenoid holding circuit.

An object is to provide electrical control devices of the type stated in which the solenoid is provided with a holding circuit which is completed when the relay contact arm engages one stationary contact and is opened when the relay contact arm engages the other stationary contact, whereby the open or closed condition of the load circuit contacts of the solenoid depends upon the last prior closure of the relay contacts.

A further object is to provide an instrument type relay having "high" and "low" magnetic contacts, and a solenoid controlled thereby, the armature of the solenoid also being utilized in a mechanical manner for resetting one set of magnetic contacts as the solenoid is energized and for resetting the other set of magnetic contacts as the solenoid is subsequently deenergized, thus eliminating the need for the power relay previously employed to control the load circuit.

These and other objects and advantages will become more apparent from the detailed description and drawings of two preferred embodiments which follow.

Fig. 1 is a schematic view of one embodiment, wherein the instrument is reset in one direction only by the solenoid, while Fig. 2 is a similar view of a second embodiment where the instrument is reset in both directions of motion of the moving system.

Referring now to Fig. 1, the sensitive relay is shown as an electrical measuring instrument

2

having a moving coil 1 that carries a contact arm 2 on which a small, soft iron rider 3 is fixed. The rider 3 constitutes the moving contact member of the instrument relay and is cooperative with a pair of fixed contacts 4 and 5. Contact member 4 is in the form of a small permanent magnet while the contact 5 is non-magnetic. The coil 1 may be connected for example across a control device (not shown) such as a thermocouple, photoelectric cell or some other electric device having a very small but variable current output upon which the control is based. The coil 1 is pivotally supported in the magnetic field set up by a permanent magnet of which only the poles 6, 6' have been shown in the drawing. The coil may turn either clockwise or counterclockwise with increasing current, but, for convenience of description, it will be assumed that the construction is such that the coil turns clockwise with increasing current. Hence as current through coil 1 increases, the contact arm 2 will move clockwise from the "low" contact 4 towards the "high" contact 5.

Since contact 4 is a small permanent magnet, a pusher arm or bell-crank lever 7 is provided for resetting the relay when the rider 3 of contact arm 2 has moved into engagement with the contact 4. The lever is mounted on a pivot 8 and has an outer end 9 for engaging the contact arm 2 to separate the contacts 3, 4 upon rocking movement of the lever 7 clockwise against the force exerted by a restoring spring 10. A solenoid 11, comprising a winding 12 and armature 13, is located beneath the tail 7' of the resetting lever 7 for actuating the same.

The solenoid armature 13 actuates a holding circuit switch 14 and a load circuit switch 15 of a controlled device having a higher power requirement than can be handled directly by the contacts of the instrument relay. The energizing circuit for the solenoid 11 includes a lead 16 connecting magnetic contact 4 to a source of direct current, indicated by conventional polarity symbols, a lead 17 from the contact arm 2 to the winding 12, and a lead 18 and current-limiting resistor 19 between the other end of the winding 12 and the current source. The holding circuit switch 14 is shunted across the leads 16, 17; and the non-magnetic contact 5 is connected to the lead 18 by a lead 20.

Assuming, as stated above, that magnetic contact 4 is the "low" contact, the contact arm 2 will move counterclockwise as current through coil 1 decreases with a change in the magnitude of the measured quantity, and the soft iron rider

3 will enter the magnetic field of the contact 4 when the measured quantity reaches one limit of the control range. The rider 3 is then drawn quickly to the magnetic contact 4 and strikes it with sufficient force to establish a good electrical contact, thereby completing the energizing circuit for the solenoid winding 12. Armature 13 then pulls in to close the holding circuit switch 14 and the load circuit switch 15, and to rock the resetting lever 7 to separate the moving contact 3 from the magnetic contact 4. Obviously, the load circuit switch 15 may be of the normally closed type when the design requirements are such that the load circuit should be opened when the measured quantity reaches the critical value at which contacts 3, 4 engage. The solenoid remains energized after the separation of the contacts 3, 4 as the holding circuit switch is connected in parallel with those contacts. The contact 3 is held away from the contact 4 by the resetting lever 7 and armature 13, and this condition of the several circuit elements is maintained until the magnitude of the measured quantity reaches its other critical limit at which the increasing current through coil 1 carries the contact arm 2 clockwise to engage the contact 3 with the stationary contact 5. This contact engagement completes a shunt circuit around the solenoid winding 12, through the leads 17 and 20, and the solenoid armature 13 drops out to open the holding circuit and to reverse the condition of the load circuit switch 15. The continued engagement, or repeated engagements, of the contacts 3, 5 will not result in a change in the load circuit conditions, and the contact arm 2 must move counterclockwise with decreasing current through coil 1 to permit engagement of contacts 3, 4 to effect the next change in the adjustment of the load circuit switch 15.

In the embodiment which is illustrated in Fig. 2, those elements which are or may be substantially identical with corresponding elements of the Fig. 1 construction are identified by corresponding but primed reference numerals. The "high" contact 5' is a magnetic contact and the solenoid actuating resetting system includes two pusher arms or bell-crank levers 25, 26 on pivots 27, 28 for engaging the contact arm 2' to separate the soft-iron rider contact 3' from the stationary magnetic contacts 4', 5' respectively. The resetting levers 25, 26 are biased towards inoperative positions out of the path of movement of the contact arm 2' by springs 29, and they are alternately moved into operative positions by a bar 30 on the upper end of the solenoid armature 13', the tail 25' of the lever 25 being beneath the cross-bar 30 and the tail 26' of the lever 26 being above the same.

As illustrated, the solenoid winding 12' is not energized and a spring 31 has forced the armature 13' and bar 30 downwardly, thereby rocking the resetting lever 25 clockwise to project its outer end into the path of the contact arm 2'. Upon energization of the solenoid winding 12', the armature 13' is lifted and carries the bar 30 upwardly to release the resetting lever 25 and to rock the resetting lever 26 counterclockwise to project into the path of the contact arm 2'.

The current source for actuating the solenoid 11' is indicated by the conductors 32, 33 from a schematically indicated alternating current generator, and the current source may conveniently be the customary light and power circuit of about 110 volts, 60 cycles per second. The energizing circuit for solenoid 11', includes the lead 34 from the power conductor 32 to the magnetic contact

5', rider 3' and contact arm 2', jumper 17' from contact arm 2' to the solenoid winding 12', and return connection 35 from the winding to the other power conductor 33. The holding switch 14' for the solenoid winding 12' is connected in parallel with contacts 3', 5' by a lead 36 to the jumper 17' and a lead 37 to the power conductor 32. A current-limiting resistor 19' and lead 38 connect the magnetic contact 4' to the power conductor 33. Inspection of the described circuit connections will show that an engagement of relay contacts 3', 4' closes a shunt circuit around the solenoid winding 12', i. e. returns the holding circuit lead 36 to the power conductor 33 through the jumper 17', contact arm 2' and contacts 3', 4', current-limiting resistor 19', and lead 38.

Assuming that the moving coil 1' is so wound and connected to the control element, not shown, that increasing current moves the contact arm 2' clockwise towards the contact 5', the several movable parts of the Fig. 2 apparatus are shown in the positions which they occupy after the current had dropped to a value which resulted in a closure of the relay contacts 3', 4'. The next closure will be of contacts 3' and 5' when the current through coil 1' increases to the upper limit of the control range. The energizing circuit of solenoid 11' will be completed by that closure of contacts 3', 5', and the solenoid armature will lift to close the holding switch 14' and, as illustrated, the load circuit switch 15'. As explained with respect to the Fig. 1 apparatus, the switch 15' could be constructed to open by the lifting of armature 13'. The resetting lever 26 is rocked counterclockwise by bar 30 when the solenoid armature pulls in, and the outer end of lever 26 engages the contact arm 2' to move the rider contact 3' a short distance from the magnetic contact 5'. The resetting lever 26 remains in this actuated position so long as the solenoid winding 12' is energized through the holding circuit switch 14'. The next operation of the relay takes place when the current through coil 1' drops to a preselected low value at which contacts 3', 4' engage to complete the shunt circuit around the solenoid winding 12'. The armature 13' and bar 30 are then forced downward by the spring 31, thereby opening the holding switch 14' and load switch 15'. This movement of the bar 30 rocks the resetting lever 25 to separate the contacts 3', 4', and to release the "high" resetting lever 26 to permit its clockwise movement into inoperative position by its spring 29. This completes one cycle of operation and the several moving parts again assume the positions shown in Fig. 2 when the current in coil 1' has increased somewhat above the "low" control value at which relay contacts 3', 4' engaged.

The described embodiments of the invention differ in that, if both instrument type relays are similarly designed and connected to their control elements, the resetting and load switch solenoid is energized at opposite limits of the control range of current inputs to the relay coil 1 or 1'. As stated above, it has been assumed for purpose of description that the relay contact arms move clockwise with increasing current through the relay coil 1 or 1'. Identical control operations may of course be obtained by an appropriate reversal of circuit connections when the design is such that the contact arms move counterclockwise with increasing current.

In conclusion, it will be evident that while the load switches in Figs. 1 and 2 have been illustrated as being of the single-pole, single-throw

type, other types of load switches such as for example a double-pole, double-throw type could be substituted depending upon the particular application made of the relay. Furthermore while the relay in Fig. 1 is illustrated as being powered by direct current and the relay in Fig. 2 by alternating current, it will be evident that both relays will work on either direct current or alternating current. Other minor changes in the illustrated construction may likewise occur to those familar with the design and construction of magnetic contact relays without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In an instrument type relay for controlling a load circuit in accordance with variation in a control current between predetermined upper and lower limits, an instrument having a moving system displaceable in accordance with the magnitude of the control current, a contact carried by the moving system of said instrument and movable between a pair of spaced stationary contacts, said movable contact and said stationary contacts being magnetically attractive to assure firm engagement therebetween, a pair of pusher arms for separating said movable contact from each of said stationary contacts, a solenoid energized by engagement between said movable contact and one of said stationary contacts, said solenoid having an armature movable upon energization thereof to actuate one of said pusher arms to separate said contacts and close a solenoid holding circuit, and a shunt circuit for said solenoid holding circuit completed upon engagement between said movable contact and the other stationary contact to effect deenergization of said solenoid and reverse movement of said armature to actuate the other pusher arm to separate the contacts last engaged.

2. In an instrument type relay for controlling a load circuit in accordance with variation in a control current between predetermined upper and lower limits, an instrument having a moving system displaceable in accordance with the magnitude of the control current, a contact carried by the moving system of said instrument and movable between a pair of spaced stationary contacts, said movable contact and said stationary contacts being magnetically attractive to assure firm engagement therebetween, a solenoid having an armature, an energizing circuit for said solenoid completed upon engagement between said movable contact and one of said stationary contacts, a holding circuit for said solenoid completed upon energization of said solenoid, a shunting circuit for said holding circuit completed upon engagement between said movable contact and the other stationary contact, a pair of pusher arms for separating said movable contact from said stationary contacts respectively, and means linking said arms for operation by said armature to reset one of said arms upon energization of said solenoid and to reset the other arm upon deenergization of said solenoid.

3. In an instrument type device for controlling a load circuit in accordance with variation in a control current between predetermined upper and lower limits, an instrument having a moving system displaceable in accordance with the magnitude of the control current, a contact carried by the moving system of said instrument and movable between a pair of spaced stationary contacts, said contacts being magnetically attractive to assure firm engagement therebetween, a pair of pusher arms for resetting said movable contact from each of said stationary contacts, means actuating said pusher arms to alternately move each to a contact reset position, a solenoid having a holding circuit including a switch actuated by the solenoid armature, an energizing circuit for said solenoid completed upon engagement between said movable contact and one of said stationary contacts, the armature being actuated by said solenoid upon energization thereof to actuate said pusher arm actuating means to reset the instrument contacts whose engagement effected energization of said solenoid, and a shunting circuit for said solenoid completed upon engagement between said movable contact and the other stationary contact, whereby said solenoid is deenergized and said last pair of contacts are reset.

4. In an instrument type relay for controlling a load circuit in accordance with variation in a control current between predetermined upper and lower limits, an instrument having a moving system displaceable in accordance with the magnitude of the control current, a contact carried by the moving system of said instrument and movable between a pair of spaced stationary contacts, said movable contact and said stationary contacts being magnetically attractive to assure firm engagement therebetween, a pair of pusher arms for separating said movable contact from each of said stationary contacts, a solenoid energized by engagement between said movable contact and one of said stationary contacts, said solenoid having an armature movable upon energization thereof to effect movement of one of said pusher arms to separate said contacts and close a solenoid holding circuit, and a shunt circuit for said solenoid holding circuit completed upon engagement between said movable contact and the other stationary contact to effect deenergization of said solenoid and reverse movement of said armature to effect movement of the other pusher arm to separate the contacts last engaged.

RAYMOND T. PIERCE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,014,385	Lamb	Sept. 17, 1935
2,014,386	Lamb	Sept. 17, 1935
2,189,846	Valtat	Feb. 13, 1940