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ELECTRICAL CONTROL DEVICE AND CIRCUIT

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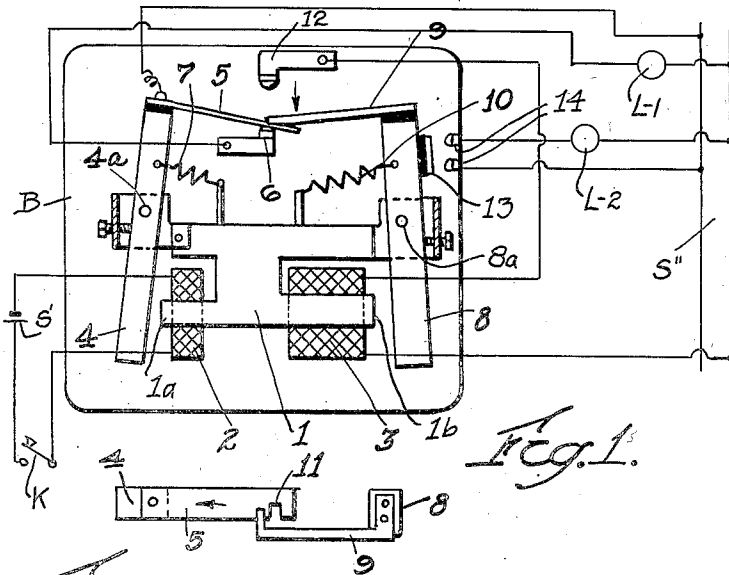


Fig. 1.

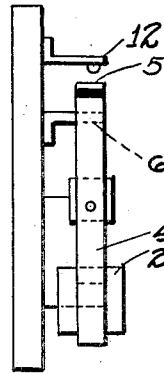


Fig. 2.

Fig. 3.

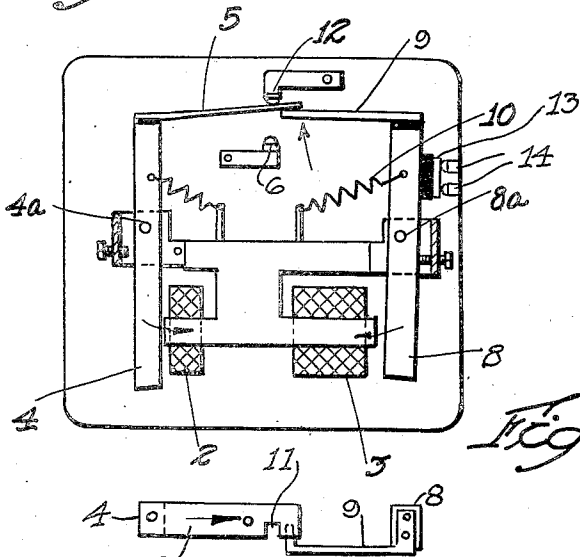


Fig. 4.

Fig. 5.

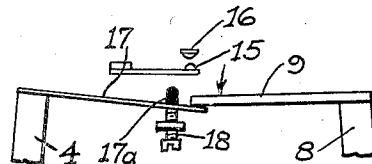


Fig. 6.

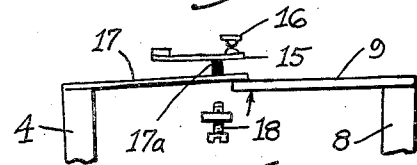


Fig. 7.

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ELECTRICAL CONTROL DEVICE AND
CIRCUIT

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The present invention relates to electrical control devices such as relays, circuit breakers, and other types of contactors, and has for its object to provide an improved contact operating arrangement for devices of this character that will insure the maintenance of adequate pressure between cooperating contacts under conditions where the primary controlling or actuating circuit can provide only a limited amount of energy.

The control device and circuit of the present invention relates particularly to relays of the type that are adapted to operate in response to initial energization from a controlling circuit providing a limited amount of electrical energy, with resulting operation of the relay serving to control the flow of current from another source of electrical energy from which power is available in an amount greatly in excess of the power available from the controlling circuit.

In circuit controlling devices of this character as heretofore constructed and operated, the energy available from the controlling circuit has provided a definite limitation on the amount of contact pressure developed by the pull of the relay's operating winding. Therefore, when the contact holding pressure is limited by the energy available, the contacts are liable to separate when the relay is subjected to sudden shocks or severe vibrations, such as occur in high powered airplanes where relays are used extensively for control purposes. In fact, experience has shown that many failures of airplane control apparatus to function properly, is due primarily to separation or chattering of relay contacts under conditions of severe vibration, or sudden lurches in the flight of the plane.

According to the present invention, there is provided an improved contact operating arrangement for circuit controllers characterized by the provision of means for automatically maintaining a high holding pressure between contacts, the actuation of which is primarily responsive to a controlling circuit of limited power output, with said high holding pressure being developed from the energy available at a source of high potential power output. As a result, circuit controllers embodying the present invention are particularly adapted for operation under conditions in which they are subjected to sudden shocks, or severe and sustained vibrations. The above and other advantageous features of the invention will hereinafter more fully appear from the following description, considered in connection with the accompanying drawing, in which—

Fig. 1 is a view in front elevation of a control

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device embodying the invention, with the actuating windings in deenergized condition.

Fig. 2 is a view in side elevation of the device shown in Fig. 1.

Fig. 3 is a fragmentary plan view of the controller contacts, in the position of Fig. 1.

Fig. 4 is a view in front elevation of the device of Fig. 1, with its windings in energized condition.

Fig. 5 is a fragmentary plan view of the contacts shown in Fig. 4.

Figs. 6 and 7 show a modification of the device shown in Figs. 1 and 4, as regards operation of the current carrying contacts.

Referring first to Figs. 1 and 2, the invention is shown for purposes of illustration as being embodied in a circuit controller of the relay type, comprising a H-shaped core 1 suitably mounted on an insulating base B, with oppositely disposed core legs 1a and 1b carrying separate energizing windings 2 and 3. The winding 2 is adapted to be energized from a source S' of electrical energy having a low potential power output, while the winding 3 is adapted to be energized from a source S'' of electrical energy having a potential power output greatly in excess of the limited power output available at source S'.

A light or "pilot" armature 4 is pivotally mounted at 4a so as to be movable in response to energization of winding 2. The armature 4 carries an arm 5 connected to one side of source S'' and normally engaged with a stationary contact 6 by the pull of a spring 7, with the engaged contacts 5 and 6 conducting current flowing through a load device L—1 under control of the relay. Because of the limited amount of power available for energizing the winding 2, the spring 7 exerts a relatively light pull, tending to maintain the contacts 5 and 6 in engagement. As will hereinafter appear, the contact arm 5 may also be normally maintained against a stationary stop instead of the current carrying contact 6.

A heavy or "working" armature 8 is pivotally mounted at 8a so as to be turnable in response to energization of winding 3, and as best shown in Fig. 3, the armature 8 carries a stiff pressure finger 9 insulated from the armature and bearing upon the contact 5 by the pressure of finger 9. The finger 9 is maintained in its pressure exerting position by a spring 10, exerting a much stronger pull than the spring 7. Therefore, as long as both windings 2 and 3 are in a deenergized condition, the contacts 5 and 6 are held closely engaged and will not tend to separate

even when subjected to sudden shock or conditions of severe vibration.

An energizing circuit for the winding 2 is adapted to be completed from source S' through control devices, such as key K, and when this occurs the pilot armature 4 is attracted. The resulting turning of the armature about its pivot 4a serves to move the contact 5 lengthwise from under the finger 9, without leaving the contact 6, and this sliding movement of the contact 5 continues until the end of the finger 9 enters a gate or notch 11 in the contact 5. The contact 5 is then free to complete its turning movement under the pull of the winding 2 so as to engage a stationary contact 12, as shown in Fig. 4.

The contact 12 is connected to one terminal of the winding 3, the other terminal of which is connected to one side of the source S''. Since the contact 5 is connected to the other side of source S'', engagement between the contacts 5 and 12 completes the circuit of winding 3, thereby pulling in the working armature 8 to the position of Fig. 4. When this occurs, the end of the pressure finger 9 engages the contact 5 on the right hand side of gate 11, as shown in Fig. 5, so that the finger holds the contacts 5 and 12 firmly together as long as the winding 3 remains energized from the source S'' which is of high potential power output.

As previously pointed out, the relay of the present invention is adapted by its primary energization from the low energy source S' to control the flow of current from the high energy source S'', and to this end the working armature 8 carries a bridging member 31 insulated therefrom and adapted to engage spaced stationary contacts 14. Bridging of the contacts 14 is adapted to control the flow of current from the source S'' through a suitable load device, indicated at L—2, and it is obvious that with the working armature 8 being held in by energization of winding 3 from the source S'', ample contact pressure will be developed between the bridging member 31 and contacts 14, as well as between holding contacts 5 and 12. That is to say, the contact pressures in the main load circuit and the holding circuit are both entirely independent of the electrical energy available for initiating operation of the relay from source S'.

The position of the parts shown in Figs. 4 and 5 is maintained, and the contacts 5 and 12 held firmly closed against separation by sudden shock or vibration as long as the winding 2 remains energized from the low energy source S'. However, when the winding 2 is deenergized, as by opening of the key K, the light spring 7 exerts enough pull to move the contact 5 with a sliding action under the finger 9 until the end of the finger engages the gate 11. The contact 5 is then free to move to the position of Fig. 1, in re-engagement with contact 6, and as soon as the circuit of the winding 3 is broken at contact 12, the finger 9 re-engages the top of contact 5, as shown in Fig. 3, in response to the return of the working armature 8 to the position of Fig. 1 under the pull of its heavy spring 10. Therefore, the contacts 5 and 6 are again held in close engagement by the pressure of the finger 9, so that as long as the winding 2 remains deenergized from the low energy source S', the engaged contacts will hold the first load circuit in an energized condition, with the pressure of the finger 9 being such as to hold these contacts closed against accidental separation by shock or vibration.

From the foregoing, it is apparent that con-

tact pressure is always positively maintained by the stiff finger 9 in either position of the contact 5, depending upon which side of the contact is engaged and the relation of the end of the finger 9 to the gate 11. However, due to the fact that turning of the pilot armature 4 about its pivot 4a tends to slide the contact 5 with relation to the finger 9, energization of the winding 2, or the pull of the spring 7, is sufficient to release the contact 5 as soon as the end of the finger 9 enters the gate 11 in either direction of movement. In other words, the limited energy available at the source S', or the pull of the spring 7, is sufficient to cause relative sliding movement between the contact 5 and the finger 9, since the pressure exerted by the finger 9 in the direction of either stationary contact 6 or 12 is at right angles to lengthwise movement of the contact 5.

Referring now to Figs. 6 and 7, there is shown a modification of the contact arrangement wherein the pilot armature 4 is adapted to actuate cooperating contacts, without any sliding action between the current carrying parts, such as occurs between the contact 5 and the stationary contacts 6 and 12. In this modified showing, the same reference characters are employed to designate parts having functions corresponding to the construction shown in Fig. 1.

The modified construction of Fig. 6 provides a pair of relatively movable contacts 15 and 16 mounted on the base B, with the contacts normally spaced apart and respectively connected to the winding 3 and to the source S''. The pilot armature 4 carries an arm 17 which is normally maintained against a stop 18 by the pull of the spring 7, with the stiff finger 9 on the working armature 8 serving to firmly hold the arm 17 in this position. When energization of the winding 3 pulls in the armature 4, the arm 17 is released from the finger 9 by action of the gate on arm 17 as previously described with reference to the contact 5, whereupon the arm 17 moves upwardly to cause an insulating button 17a to engage the contact 15 and flex this contact into engagement with the other contact 16. The resulting energization of the winding 3 thereupon causes the finger 9 on the working armature 8 to press upon the arm 17 and hold the contacts 15 and 16 in close engagement, as indicated in Fig. 7. It is to be noted that engagement between contacts 15 and 16 occurs without any sliding action between the current carrying members.

When deenergization of winding 2 permits release of the pilot armature 4 under the pull of the spring 7, the free end of the arm 17 moves between the contact 15 and the finger 9 until the gate on arm 17 clears the finger, with the contacts 15 and 16 remaining in close engagement while movement of the arm 17 occurs. Therefore, there is no sliding action between the current carrying members, and the circuit of the winding 3 is maintained through the engaged contacts 15 and 16 until the end of the finger 9 passes through the gate on arm 17. As a result, the movement separating the contacts 15 and 16 occurs rapidly in a direction at right angles to the movement of the arm 17 with respect to the pressure finger 9. Obviously, the same result would be obtained were the stop 18 against which the arm 17 rests in Fig. 6 to be replaced by a pair of normally spaced contacts similar to the contacts 15 and 16.

The present invention therefore provides an improved electrical control device and circuit, in which adequate pressure between cooperating contacts is always maintained even under condi-

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tions where the primary controlling circuit provides only a limited amount of energy insufficient of itself to maintain the engaged contacts tightly closed when subjected to shocks or severe vibrations.

While for purposes of illustration the pilot armature has been described as being movable in response to intermittent energization of the winding 2 through operation of the key K, it is obvious that the contact holding arrangement would function in substantially the same manner were the winding 2 to be continuously connected to the source S', with energization of the winding being in accordance with a rising or falling voltage. In that event, the pilot armature 4 would pull in at a predetermined value of rising voltage and would pull out at a predetermined value of falling voltage, with the working armature serving to maintain a high contact holding pressure during the period that the contacts remain closed between the different voltage levels. Under such conditions, the pressure finger 9 would exert a continuous stabilizing influence on the engaged current carrying contacts, thereby eliminating any tendency for the contacts to chatter and arc as the voltage approaches a critical value at either level.

We claim:

1. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power output, relatively movable contacts, a winding energized from the source of lower power output for initiating closure of said contacts, a member movable independently of said contacts and a second winding responsive to said contact closure for increasing the contact holding pressure by power developed from the source of higher power output and imparted to said member.

2. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power outputs, relatively movable contacts, a winding energized from the source of lower power output for initiating closure of said contacts, a member movable independently of said contacts and a second winding responsive to the flow of current through said closed contacts from the source of higher power output for increasing the contact holding pressure by movement of said member.

3. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power outputs, relatively movable contacts, a winding energized from the source of lower power output for initiating closure of said contacts, a member movable independently of said contacts and a second winding responsive to the flow of current from the source of higher power output through said contacts for causing said member to develop a contact holding pressure greatly in excess of the contact pressure developed at the moment of closing.

4. An electrical control device and circuit comprising in combination, sources of electrical energy of different potential power outputs, windings independently energizable from said sources, a pilot armature turnable about one pivot in response to energization of one winding, a working armature turnable about a second pivot in response to energization of the other winding, relatively movable contacts, and a member movable with the working armature in response to energization of said other winding by the flow of current from the source of higher power output

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through the closure of said contacts by the pilot armature for causing said member on the working armature to exert an increased contact holding pressure.

5. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power output, relatively movable contacts, means energized from the source of lower power output for moving one of said contacts into engagement with the other, a member independently movable with respect to said contacts, and means responsive to closure of said contacts for imparting movement to said member to cause it to engage said closed contacts and increase the contact holding pressure therebetween by power developed from the source of higher power output.

6. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power output, relatively movable contacts, a winding energized from the source of lower power output for moving one of said contacts into engagement with the other, a member independently movable with respect to said contacts, and a second winding energizable from said source of higher power output, upon initial closure of said contacts, for moving said member into engagement with the closed contacts to increase the contact pressure therebetween.

7. An electrical control device and circuit comprising in combination, independent sources of electrical energy of different potential power output, relatively movable contacts, a winding energized from the source of lower power output for moving one of said contacts into engagement with the other, a member independently movable with respect to said contacts, and a second winding energizable from said source of higher power output upon initial closure of said contacts for moving said member into engagement with the closed contacts to increase the contact pressure therebetween, and means responsive to deenergization of said first winding from the source of lower power output to disengage said movable contact from said other contact and thereby remove said pressure exerting member from its operative position through deenergization of said second winding.

8. An electrical circuit controlling device comprising in combination, a magnetic circuit including separate windings and armatures of different weights independently responsive to energization of said windings, relatively movable contacts, one of which is operable by the lighter of said armatures to engage the other contact, in response to energization of one of said windings, and a relatively stiff member operable by the heavier armature, and freely movable independently of the lighter armature, with energization of the other of said windings in response to flow of current through the closed contacts serving to move said member into engagement with said closed contacts to exert an increased contact holding pressure through movement of the heavier armature.

9. An electrical circuit controlling device comprising in combination, a magnetic circuit including separate windings and armatures of different weights independently responsive to energization of said windings, relatively movable contacts, one of which is operable by the lighter of said armatures to engage the other contact, in response to energization of one of said windings, and a relatively stiff member operable by the

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heavier armature, and freely movable independently of the lighter armature, with energization of the other of said windings in response to flow of current through the closed contacts serving to move said member into engagement with said closed contacts to exert an increased contact holding pressure through movement of the heavier armature, and with deenergization of the first winding serving to disengage said movable contact from said stationary contact and to withdraw said stiff member in response to deenergization of said second winding upon opening of said contacts.

10. An electrical circuit controlling device comprising in combination, a magnetic circuit including separate windings and armatures movable about separate fixed pivots in response to separate energization of said windings, relatively movable contacts operable into closed position by turning movement of one of said armatures, in response to energization of one of said windings, and a relatively stiff member movable freely with the other of said armatures about its pivot in response to energization of the other winding through said closed contacts to engage said member with the closed contacts to exert an increased contact holding pressure, with retractile movement of said first armature about its pivot upon

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deenergization of its winding serving to release said contacts from the pressure exerted by said stiff member.

11. An electrical circuit controlling device comprising in combination, a magnetic circuit including separate windings and armatures movable about fixed pivots in response to separate energization of said windings, relatively movable contacts operable into closed position by turning movement of one of said armatures, in response to energization of one of said windings, and a relatively stiff member movable freely with the other of said armatures about its pivot in response to energization of the other winding through said closed contacts to engage said member with the closed contacts to exert an increased contact holding pressure, with retractile movement of said first armature about its pivot upon deenergization of its winding serving to release said contacts from the pressure exerted by said stiff member, and with deenergization of said second winding through opening of said contacts serving to cause movement of said rigid member by its armature to a non-pressure exerting position.

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