Aug. 30, 1932. F. H. WINTER 1,873,950

ELECTRICAL RELAY

Filed July 25, 1931

Fig. 1.

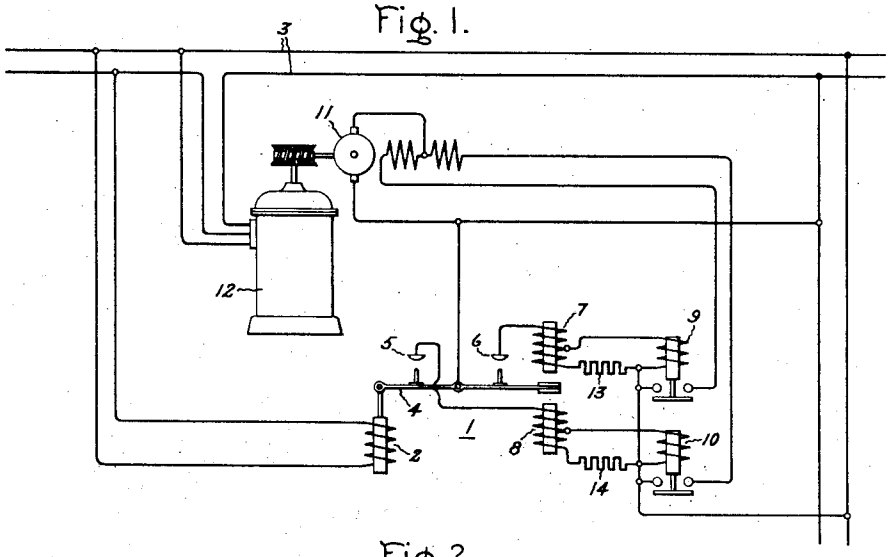


Fig. 2.

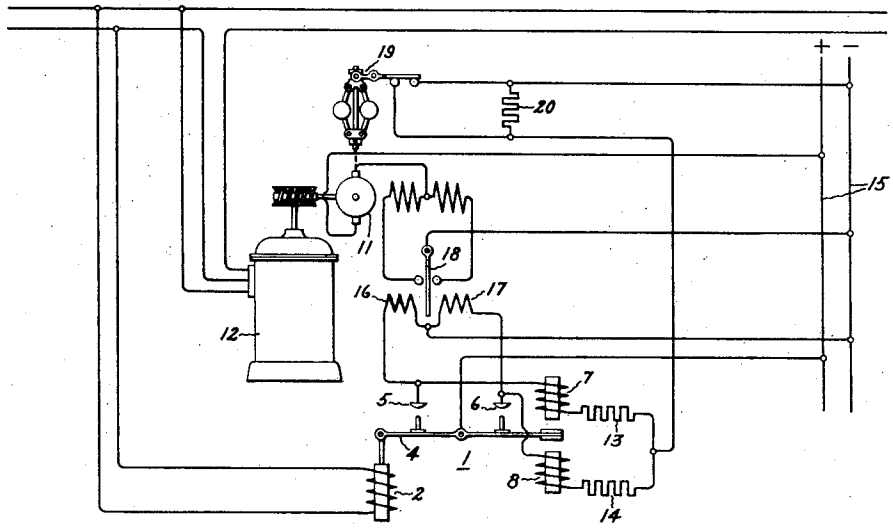
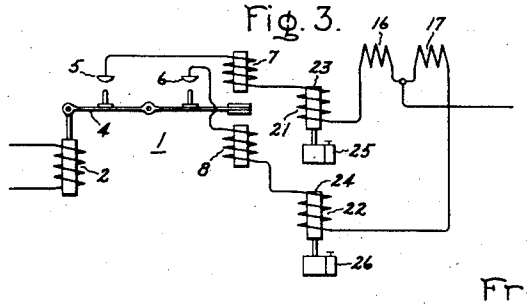


Fig. 3.



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UNITED STATES PATENT OFFICE

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ELECTRICAL RELAY

Application filed July 25, 1931. Serial No. 553,134.

My invention relates to electrical relays and more particularly to improvements in the operation of contact making voltmeter type electrical relays.

Most contact making voltmeters, of the type used to control a voltage regulator in a voltage regulating system, are provided with holding coils. These coils are energized when the meter makes contact and they act to cause a firm positive engagement of the contacts. This is usually necessary because the contact making meters are often placed on panels which are subject to vibration and also because many of the meters respond to the voltage of an alternating current circuit, which causes a vibration of the meter elements. If some sort of holding means were not provided, the contacts would usually come into trembling engagement due to these vibrations and this would cause arcing and sparking at the contacts which would materially reduce their life and impair their operation. Furthermore, this trembling engagement of the contacts causes the circuits controlled by the meter to be broken almost immediately after it is closed. As the translating devices, such as electromagnetic relays or servo motors, which are controlled by contact making meters usually draw a much larger starting current than their normal steady state operating current the trembling engagement of the contacts causes them to make and break relatively large currents, which of course is very injurious to their proper operation.

Holding coils, however, have the disadvantage that they tend to produce over-regulation. This is because their pull must be overcome by a pull of the main control magnet of the meter which is represented by a difference between the normal value of the regulated condition and a higher or lower value of this condition. This over-regulation caused by the holding coils, when combined with the inherent over-regulating tendency of most regulating systems which have overrunning or lost motion characteristics, results in a sometimes very objectionable over-regulation.

In accordance with my invention, I provide means associated with the holding coils for giving them a strong initial holding effect which insures a firm positive initial engagement of the contacts and which also practically insures that the contacts will stay closed long enough for steady state operating conditions to be attained in the circuit controlled by the contacts of the meter. I also provide means for causing a tapering energization of the holding coils whereby their holding effect is decreased after a predetermined time, so that it will be easier for the main control means for the meter to restore the meter to its normal position against the pull of the holding coils. This has the effect of reducing the objectionable over-regulation which ordinary holding coils tend to produce.

An object of my invention is to provide a new and improved holding coil arrangement for electrical relays.

Another object of my invention is to provide a new and improved contact making voltmeter.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 represents diagrammatically an embodiment of my invention which requires no auxiliary apparatus; Fig. 2 illustrates a modified arrangement in which the energization of the holding coils is controlled in accordance with an operating condition of a translating device controlled by the contact making voltmeter, while Fig. 3 illustrates a further modification in which a special variable impedance element is connected in series with the holding coils.

Referring now to Fig. 1 of the accompany-

ing drawing, 1 is a contact making voltmeter, of conventional type, having an operating magnet 2 connected to be responsive to the voltage of an alternating current feeder circuit 3. Controlled by magnet 2 is a pivotally mounted contact arm 4 which is arranged for engagement with a pair of relatively fixed contacts 5 and 6. A pair of coils 7 and 8 are arranged to act as holding coils for meter 1. A pair of relays 9 and 10 have their operating coils connected to be controlled by the contacts of meter 1 and have their contacts arranged to control the energization, and direction of operation, of a pilot motor 11, which is mechanically connected to operate a voltage regulator 12, which is shown as of the induction type. As shown, circuit 3 is utilized as a source of current supply for operating motor 11, the holding coils, and the coils of relays 9 and 10. However, any other suitable source of alternating current supply might also be used. Suitable current limiting resistors 13 and 14 may be connected in circuit with holding coils 7 and 8 if desired.

In general, the operation of the arrangement illustrated in Fig. 1 is such that if the voltage of circuit 3 goes up, or down, contact 5, or 6, will be engaged, thereby energizing relay 10, or 9, which in turn controls the energization of motor 11, through one or the other of its reversing field windings, so that this motor will operate in a direction to cause regulator 12 to lower, or raise, the voltage of circuit 3, respectively.

It will be noted that the operating coils of relays 9 and 10 are connected in parallel with parts of the holding coils 7 and 8 respectively and also in series with parts of these coils respectively. Thus, for example, if contact arm 4 engages contact 5, due to a rise in voltage on circuit 3, for example, current will flow from one side of circuit 3 through contact 5, the upper part of coil 8, where it will divide, part flowing through the operating coil of relay 10 and part through resistance 14, and back to the other side of circuit 3. The operating effect of such a connection is that when contact 5 is first engaged a relatively large rush of current flows through the upper, or series, connected part of holding coil 8 because the reactance, or current limiting ability, of relay 10 is low at this time, due to the fact that its plunger or armature is not drawn up. As soon as relay 10 operates, and its armature is drawn up into its actuated position, its reactance becomes relatively high, as it only requires a relatively small exciting current to hold the relay in its operated position. Consequently the current through holding coil 8 is decreased.

If holding coil 8 is connected entirely in series with the operating coil of relay 10, it has been found that the sudden initial inrush of current to the holding coil is so great as to cause a rebound of the contacts with the result that the heavy inrush current is broken, thus causing injurious contact arcing. If, on the other hand, holding coil 8 is connected entirely in parallel with the operating coil of relay 10, the initial pull, or holding effect, of this coil will be weaker than its final effect due to the fact that most of the initial current will flow through the relay coils rather than through the holding coils. However, by connecting the relay coils partly in parallel and partly in series with the holding coil, it is possible to obviate rebounding of the contacts while obtaining the desired strong initial holding.

What has been said above with respect to holding coil 8 and the operating coil of relay 10 obviously also applies to holding coil 7 and the operating coil of relay 9.

The modification illustrated in Fig. 2 differs from Fig. 1 in the following particulars: The operating motor 11, the holding coils 7 and 8, and the intermediate relays are all energized from a direct current supply bus 15, although this is not necessary and an alternating current supply might equally well be employed. Also, a different type intermediate relay is provided having operating coils 16 and 17, connected respectively to the contacts 5 and 6 of meter 1 and a common contact arm 18 for completing one or the other of the operating circuits of motor 11, depending upon which of its operating coils are energized. Also, the operating coils of the intermediate relay and the holding coils are connected in parallel with each other, and the energization of the holding coils is modified by means which operates in accordance with an operating condition of the motor 11. As shown, this means is a centrifugal switch 19 for controlling a short circuit around a resistance 20 in series with the common return of the holding coils. This switch 19 responds to the speed of motor 11, although it will be obvious to those skilled in the art that I might provide a switch which operates in accordance with any one of a number of other operating conditions of motor 11, such for example, as current, torque, etc. This switch 19 is arranged to normally short circuit resistance 20 and upon motor 11 having attained a predetermined speed, it opens this short circuit.

The general operation of the arrangement shown in Fig. 2, so far as voltage regulation is concerned, is similar to the general operation of the arrangement shown in Fig. 1. Thus the direction of operation of motor 11, which controls the regulation of regulator 12, is determined by the operation of relay 18, whose operation in turn depends upon whether contacts 5 or 6 are engaged.

Due to the fact that resistance 20 is normally short circuited, it will be seen that a heavy initial current will flow through either holding coil 7, or 8, when voltmeter 1 is actu-

ated to cause engagement of either contact 5, or contact 6. At the same time, the intermediate relay is operated and motor 11 starts to turn. After the motor attains its normal operating speed, centrifugal speed switch 19 will operate to open its contacts thereby inserting resistance 20 directly in series with the particular holding coil which happens to be energized. This reduces the current through this coil and consequently reduces its holding effect.

Although I have shown speed switch 19 as of the centrifugal type, any other suitable type may obviously also be employed without departing from my invention in its broader aspects.

In the modification shown in Fig. 3, the control of the holding effect of holding coils 7 and 8 is by means of variable impedance means connected in circuit with these coils, and these means are current responsive rather than speed responsive as in Fig. 2. Thus in the illustrated embodiment I employ solenoid magnets having coils 21 and 22 connected in series with holding coils 7 and 8. These coils 21 and 22 are provided with movable cores, or plungers, 23 and 24 which are arranged to be drawn up into their respective coils and which are restrained from movement in this direction by means of suitable retarding mechanisms, such as dashpots 25 and 26, respectively.

In the operation of the modification shown in Fig. 3, when contact arm 4 engages contact 5 for example, a relatively heavy initial rush of current will flow through holding coil 7, magnet coil 21 and relay coil 16, because of the fact that the reactance of solenoid coil 21 is relatively low as its core is not drawn up all the way into the coil. However, the rush of heavy current causes a force tending to pull this plunger up into the coil and after a predetermined time, depending upon the setting of the dashpot 25, this core will be pulled up into the coil thereby increasing the reactance, or current limiting ability, of the solenoid magnet arrangement and thereby decreasing the current in the holding coil 7. The operation with respect to the holding coil 8 and solenoid coil 22 is similar to the operation with respect to holding coil 7 and solenoid coil 21 previously described.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention, and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In combination, a relay having relatively movable cooperating contacts, a holding coil adapted to hold said contacts in firm engagement when it is energized, and variable electrical impedance means for giving said coil a tapering energization which is initially strong.

2. In combination, a contact-making meter type control relay having a movable contact arm and a pair of cooperating contacts, holding coils mounted adjacent said arm and adapted to be energized upon engagement of said arm with said contacts, and means for causing a tapering energization of said coils which is initially relatively strong.

3. In combination, a contact-making meter type control relay having a fixed contact, a movably mounted contact for engaging said fixed contact, a holding coil adapted when energized to urge said contacts together, and variable electrical impedance means for giving said holding coil an initially strong energization which tapers to a relatively weak energization, said initial energization being below a value which causes a rebound of the contacts.

4. In combination, a circuit controlling relay having a contact making position, a holding coil adapted when energized to hold said relay in said position, an intermediate relay having a coil arranged to be energized when said first-mentioned relay is in its contact making position, said relay coil being connected in parallel with a part of said holding coil and in series with a part of said holding coil.

5. In combination, a contact-making voltmeter having holding coils, electromagnetic relays controlled by said meter, said relays having their operating coils connected in parallel with a portion of said holding coils and in series with another portion of said holding coils.

6. In combination, a circuit controlling relay having a contact-making position, a holding coil for urging said relay to its contact-making position when it is energized, a translating device, means for energizing said holding coil and said translating device when said relay attains its contact-making position, and means operative in accordance with an operating condition of said translating device for modifying the energization of said holding coil.

7. In a regulating system, a contact-making voltmeter having holding coils, an electric motor, circuits under the control of said contact-making meter for controlling the energization of said motor and of said coils, and means operative in accordance with the speed of said motor for decreasing the energization of said holding coils.

8. In combination, a contact-making voltmeter, an alternating current circuit controlled thereby, a holding coil for said meter connected in said circuit, a relay translating device connected in said circuit, and a mov-

able core solenoid connected in said circuit.

9. In combination, a contact-making voltmeter, an alternating current circuit controlled thereby, a holding coil for said meter connected in said circuit, and means for causing a decreasing current to flow in said circuit after it is completed by said meter comprising, a coil connected in said circuit, a core arranged to be pulled into said coil, and means for retarding the motion of said core.

In witness whereof, I have hereunto set my hand.

FRED H. WINTER.