C. C. WHITTAKER.

RELAY DEVICE.

APPLICATION FILED JUNE 19, 1917.

1,354,152.

Patented Sept. 28, 1920.

2 SHEETS—SHEET 1.

Fig. 1.

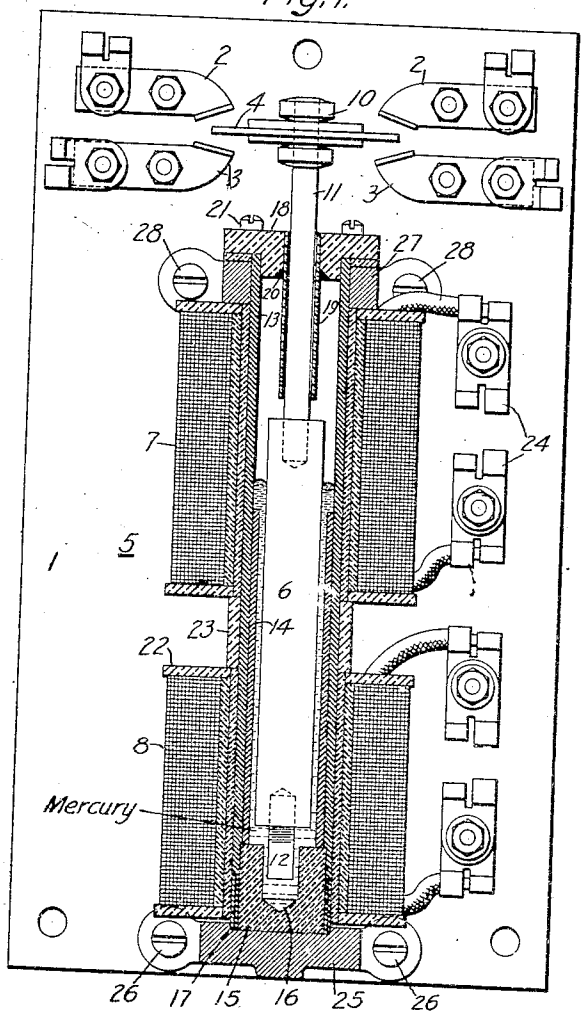


Fig. 2

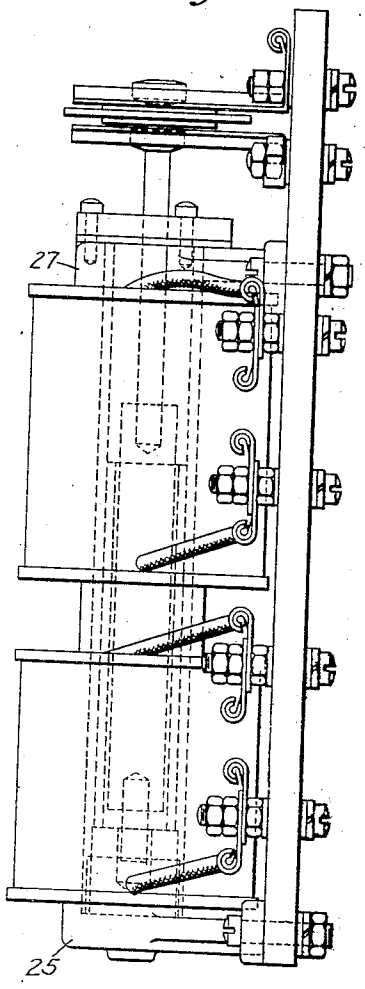


Fig. 3

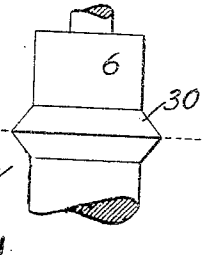
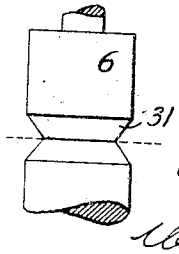


Fig. 4



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2 SHEETS—SHEET 2.

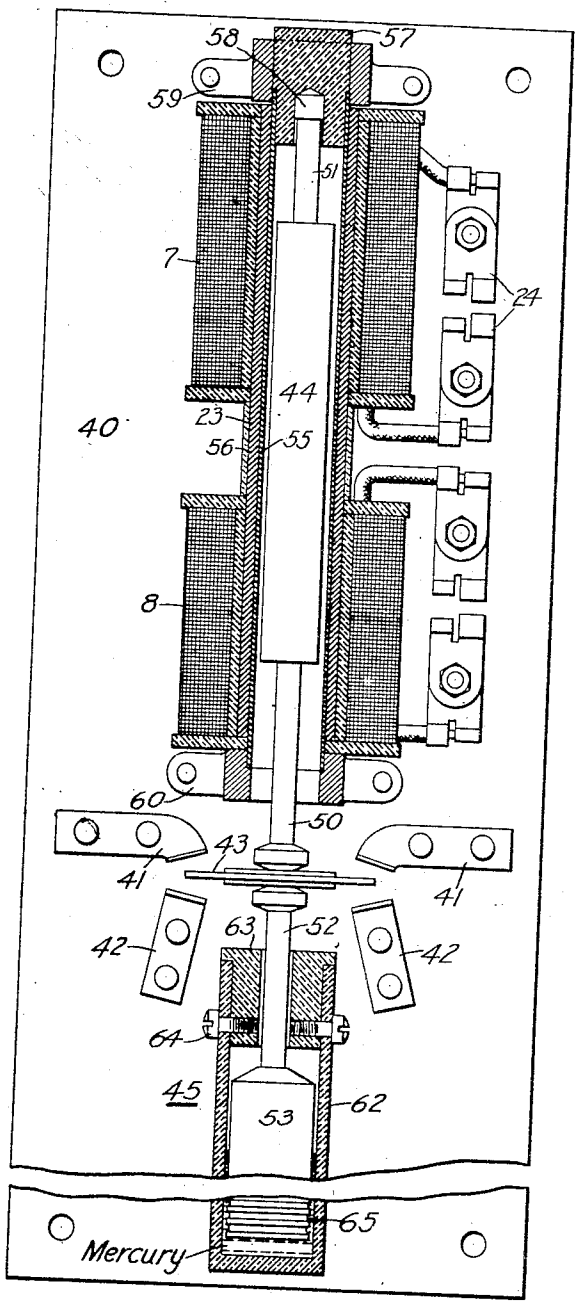
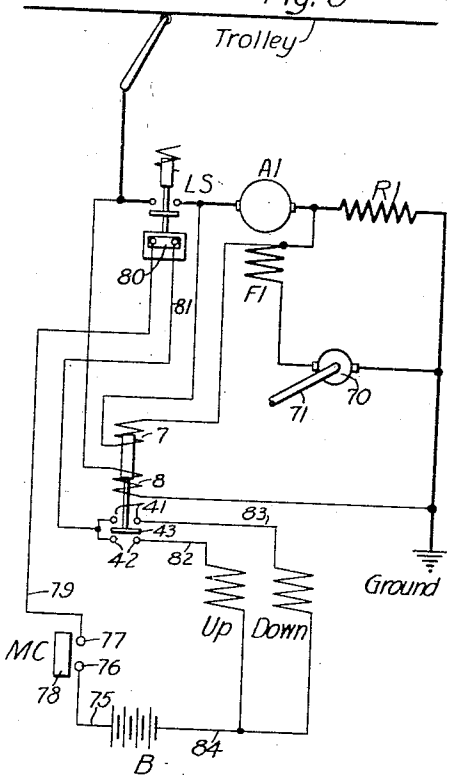


Fig. 5

Fig. 6



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RELAY DEVICE.

1,354,152. Specification of Letters Patent. Patented Sept. 28, 1920.

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To all whom it may concern:

Be it known that I, CHARLES C. WHITTAKER, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Relay Devices, of which the following is a specification.

My invention relates to control apparatus and especially to differentially-acting relay devices of the solenoid or movable-core type.

The object of my invention is to provide an electromagnetic relay device embodying a magnetizable core and fluid means in the form of mercury, for example, for alone supporting the core, whereby oscillations thereof are substantially completely damped out and an extremely "dead-beat" relay, which is nevertheless very sensitive to slight differences of voltage, is provided.

More specifically stated, it is the object of my invention to provide a relay device comprising a movable magnetizable core member, a plurality of actuating coils for actuating the core in the one or the other direction and a body of mercury for so supporting the core in its normal position that it may be quickly actuated in either direction.

Other minor objects of my invention, such as compactness of structure and relatively small size of parts, will be evident from the following detailed description.

My invention may best be understood by reference to the accompanying drawings, wherein Figure 1 is a view, partially in front elevation and partially in longitudinal section, of a relay device constructed in accordance with my present invention; Fig. 2 is a view, in side elevation, of the apparatus shown in Fig. 1; Fig. 3 and Fig. 4 are enlarged fragmentary views illustrating certain modifications of a portion of the relay-device movable member; Fig. 5 is a view, similar to Fig. 1, of a modified form of my relay device; and Fig. 6 is a diagrammatic view of a control system employing the relay device for a purpose to be set forth.

Referring to Fig. 1 and Fig. 2 of the drawings, the apparatus shown comprises a base or mounting slab 1 of any suitable insulating material near the upper end of which are positioned a plurality of upper stationary contact members 2 and lower stationary contact members 3 that are adapted to be respectively engaged by a movable disk contact member 4 under predetermined operating conditions of my relay device 5 which, in general, comprises a movable magnetizable core member or cylindrical plunger 6 that floats in a body of mercury and a plurality of differentially-acting coils 7 and 8 that inclose the respective ends of the core member for the purpose of actuating it in the one or the other direction, as subsequently set forth in detail.

The movable contact member or disk 4 is rigidly positioned, by means of suitable collars or nuts 10, near the upper end of a rod 11, the other end of which is threaded into the upper end of the magnetizable core proper. A pin or short rod 12 is threaded into the lower end of the core for a guiding purpose that is hereinafter more fully described.

Loosely surrounding and extending beyond the ends of the core proper, is a main tube 13, within the lower half of which a second tube 14 may be tightly positioned. An insulating plug 15 of bakelite or other suitable material having a central downwardly-extending recess 16 that incloses the pin 12, is tightly driven into the lower end of the tube 13, abutting against the tube 14, and a brass ferrule or other suitable clamping member 17 is wedged around the lower end of the main tube, for the purpose of preventing any leakage of mercury from the tube when the relay device occupies its normal upright position.

Another plug 18 fits within, and over the upper edge of, the tube 13, and a sleeve member 19 is cemented, at 20, into a central aperture of the plug 18, the sleeve extending downwardly and providing a running fit for the core rod 11. The upper plug 18 may be secured to the adjacent portion 27 of the supporting frame for the relay device, by means of screws 21, for example.

The coils 7 and 8 respectively inclose the upper and the lower portions of the magnetizable core and its surrounding tube 13 and may be of any suitable type. The coils are shown as provided with the customary mounting spools 22 which fit around the tube 13, and the respective spools are separated by an intermediate collar member 23.

Suitable contact clips or terminal members 24 are provided for the coils 7 and 8 to permit ready connection thereof to the desired external circuits, as traced in connection with Fig. 6.

For the purpose of suitably supporting the relay device as a whole and for also providing a rigid assembly of parts, a lower bracket member 25 is secured to the base 1 by means of bolts 26, and the lower end of the tube 13, with the inclosed plug 15, is suitably positioned in the bracket member. An upper bracket member 27 incloses the tube 13 intermediate the plug 18 and the upper end of the actuating coil 7 and is secured to the base 1 by a plurality of bolts 28.

The operation of my improved relay device may be briefly stated as follows: In the illustrated normal position wherein the movable contact disk 4 occupies an open position intermediate the sets of stationary contact members 2 and 3, the entire weight of the magnetizable core member and the movable contact disk is supported by the body of mercury alone. By reason of the differential action of the coils 7 and 8, to be more fully set forth in connection with Fig. 6, the predominant coil effects an actuation of the magnetizable core 6 upwardly or downwardly, as the case may be, to produce electrical engagement of the movable contact disk 4 with the upper stationary contact members 2 or the lower stationary contact members 3, respectively.

By reason of the flotation of the magnetizable core in mercury or other fluid of relatively greater density than the core, small oscillations caused by the inertia of the core or its tendency to overshoot the desired position are almost entirely eliminated or damped out. On the other hand, the buoyant force exerted by the body of mercury serves to permit movement of the core member in the one or the other direction upon relatively slight difference in the forces exerted by the coils 7 and 8. In brief, a relay device that is very sensitive to changes of voltage or other predetermined operating conditions, without being subject to undesirable oscillations or movements, is provided.

The function of the upper plug 18 and of the sleeve 19, in addition to the guidance feature thereof, is the prevention of leakage of the mercury from the upper end of the tube 13, in case the device is located on its side or held upside-down. This non-leaking feature is very important, as regards shipment, etc., as will be appreciated. To describe this function more specifically, in case the relay device is gradually turned upside-down, the mercury will run along the walls of the tube 13 and gather in a pool around the sleeve 19, which, by reason of its cemented relation to the plug 18, prevents any leakage. On the other hand, if the relay device is rapidly inverted, by reason of the fact that the diameter of the core proper 6 is materially greater than that of the sleeve 19, the end of the core member acts like an umbrella and guides the mercury outside of the sleeve 19, so that none of the fluid can possibly gather inside of the sleeve.

If it is desired to construct a relay of the type just described which will have a tendency to normally remain in either an upper or a lower, rather than the illustrated intermediate, position, this result may readily be accomplished by providing a V-shaped enlarged portion or bead 30 upon the magnetizable core 6, as illustrated in Fig. 3, the dotted line passing through the greater diameter of the enlarged portion representing the neutral or intermediate position of the top mercury surface. The structure of Fig. 3 tends to keep the plunger on the one or the other side of the neutral position, dependent upon which of the actuating coils 7 or 8 has last caused actuation of the core.

The inverse construction, namely, a V-shaped peripheral groove, is illustrated at 31 in Fig. 4, and such proportioning of the parts strongly tends to keep the core member or plunger in the neutral or intermediate position of the mercury, represented by the dotted line. However, by immersing the major part of the core member 6, as illustrated in Fig. 1, the desired sensitiveness of action and tendency to remain in the neutral position is also secured, while a substantially cylindrical plunger is used.

Reference may now be had to Fig. 5, wherein the apparatus illustrated comprises a base or slab 40, upon the lower portion of which a plurality of sets of coöperating stationary contact members 41 and 42 are suitably mounted for the purpose of engaging, under predetermined conditions, a movable contact disk 43 which normally occupies the illustrated open position intermediate the sets of stationary contact members. The relay device also embodies a movable magnetizable core or plunger 44 with which is suitably associated the actuating coils 7 and 8 and also a dash-pot or oscillation-damping device 45.

A rod 50 carrying the contact disk 43 is threaded, or otherwise secured, to the lower end of the magnetizable core proper 44, the upper end of which is provided with a guiding pin 51. An extension 52 of the rod 50 below the contact disk 43 is provided with an enlarged portion or cylindrical piston 53 which floats in a body of mercury within the dash-pot device 45, as subsequently more fully set forth.

A tube 55 loosely surrounds the core member 44 and is, in turn, inclosed by a second tube 56, upon which the actuating coils 7 and 8 are mounted, an intermediate spacing collar 23 being again provided. A plug

member 57 fills the upper end of the tube 55 and is provided with a recess 58 for the purpose of guiding the core pin 51.

To suitably support the entire relay device upon the base 40, an upper and a lower bracket member 59 and 60, respectively, surround the plug 57 and the tube 55, respectively.

The oscillation-damping device 45 comprises a receptacle or cup 62, the upper end of which is tightly closed by a suitable plug 63 which is held in position through the agency of screws 64, for example. The rod 52 has a sliding fit with a central aperture of the plug 63, whereby leakage and evaporation of the mercury, under ordinary conditions, is precluded.

To further reduce the amplitude of oscillations of vertical surges, a plurality of grooves 65, for example, may be provided in the surface of the piston 53.

By reason of the generic similarity between the relay device just described and that previously set forth, no further description of the operation thereof is deemed to be requisite.

Referring now to Fig. 6, the system shown comprises supply-circuit conductors Trolley and Ground, a main dynamo-electric machine having an armature A1 and a field winding F1 of the series type, an auxiliary exciting armature 70, a main-circuit resistor R1, a line switch LS, my differential relay device having the actuating coils 7 and 8, and an auxiliary system comprising a battery B or other suitable source of energy, a master controller MC and a plurality of actuating coils respectively marked "Up" and "Down" for governing any desired system of circuit regulation.

Inasmuch as the particular system of control with which my relay device is utilized is immaterial to the invention, only a brief outline of the various circuits will be necessary to afford a thorough comprehension of the general functions of the relay device.

The exciting armature 70 is shown as provided with an operating shaft 71 which may be driven from an auxiliary motor or in any other suitable manner.

When the switch LS is closed, the main circuit is completed from the trolley through the switch LS, main armature A1 and main-circuit resistor R1 to the negative supply-circuit conductor Ground. The exciting circuit is established from one terminal of the auxiliary armature 70, through the resistor R1 and the main field winding F1 to the negative terminal of the armature 70.

However, if the line switch LS occupies its illustrated open position and the master controller MC occupies an operative position, a circuit is established from the positive terminal of the battery B through conductor 75, control fingers 76 and 77, which are bridged by contact segment 78 of the master controller, conductor 79, interlock 80 of the line switch LS in its open position, and conductor 81 to one contact member of each of the sets of contact members 41 and 42 of my relay device. The circuit is normally dead-ended at these contact members, by reason of the normal intermediate position of the movable contact disk 43.

The upper actuating coil 7 of the relay device is connected directly across the armature A1, while the lower actuating coil 8 is connected to the supply-circuit conductors. Consequently, while the line switch is open, the relay device is actuated in accordance with the differential relation existing, at any time, between the armature voltage of the main momentum-driven machine during a coasting period and the supply-circuit voltage.

If the generated voltage of the momentum-driven armature A temporarily predominates over the supply-circuit voltage, the relay device is actuated by the coil 7 to its upper position, whereupon the movable contact disk 43 bridges the stationary contact members 41, and the previously described auxiliary circuit is completed from the conductor 81 through the coöperating contact members 41 and 42, conductor 83, actuating coil Down and conductor 84 to the negative battery terminal. Thus, a suitable regulating device in the main-field-winding circuit, for example, may be manipulated to reduce the voltage of the momentum-driven armature A1 until a balance again exists between such voltage and the electro-motive force of the supply circuit.

On the other hand, if the voltage of the armature A1 becomes relatively low, the supply-circuit-excited actuating coil 8 temporarily predominates to move the relay device to its lower position and thereby complete an auxiliary circuit from the conductor 81 through coöperating contact members 42 and 43 of the relay device, conductor 82 and the actuating coil Up to the negative conductor 84. Thus, the above-mentioned regulating device may be actuated in the opposite direction to effect an increase of voltage of the main armature A1, and, as soon as equalized conditions obtain, the relay device will again assume its illustrated intermediate position.

It will be appreciated that the system just described is merely illustrative of one application of my relay device, which may also be employed for many other purposes, such, for example, as the automatic application of sand to vehicle rails when one motor of a locomotive "slips," which produces a difference of voltage between that motor and the others on the vehicle.

I do not wish to be restricted to the specific structural details or arrangement of parts

herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of my invention. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. A relay device comprising a movable magnetizable core member, two windings for actuating the core member in opposite directions and a body of mercury for so supporting the core member that it may be acted upon with equal promptness by both windings.

2. A relay device comprising a body of fluid of relatively great density, a magnetizable movable member supported therein, and a plurality of differentially-acting coils associated with different portions of said member.

3. A relay device comprising a movable magnetizable core member, differentially-acting coils associated with different portions of said member for actuating it in the one or the other direction, and fluid means surrounding the core member for freely supporting said member to dampen oscillations thereof.

4. A relay device comprising a movable magnetizable core member, differentially-acting coils associated with different portions of said member for actuating it in the one or the other direction, and a body of mercury for alone supporting said member.

5. A relay device comprising a movable magnetizable core member, differentially-acting coils associated with different portions of said member for actuating it in the one or the other direction, a receptacle surrounding the lower end of said member, and a body of liquid of relatively great density contained in said receptacle to float said member.

6. A relay device comprising a movable magnetizable core member, differentially-acting coils associated with different portions of said member for actuating it in the one or the other direction, a hollow member surrounding said core member, and a body of liquid of relatively great density contained in said hollow member to float said core member.

7. A relay device comprising a movable core member, differentially-acting coils inclosing the respective ends of said member for actuating it in the one or the other direction, a hollow member loosely surrounding said core member, and a body of mercury contained in said hollow member to float said core member.

8. A relay device comprising a movable core member, differentially-acting coils inclosing the respective ends of said member for actuating it in the one or the other direction, a tube with closed ends loosely surrounding said core member, and a body of mercury contained in said tube to support said core member.

9. A relay device comprising a movable core member, differentially-acting coils inclosing the respective ends of said member for actuating it in the one or the other direction, a tube loosely surrounding said core member, a body of mercury contained in said tube to support said core member, and means for preventing leakage of mercury from either end of said tube.

10. A relay device comprising a movable core member, differentially-acting coils inclosing the respective ends of said member for actuating it in the one or the other direction, a tube loosely surrounding said core member, a body of mercury contained in said tube to float said core member, a plug for the lower end of said tube having a recess for guiding the core member, a plug for the upper end of the tube having a guiding aperture for the core member, and a contact member secured to the upper end of the core member.

In testimony whereof, I have hereunto subscribed my name this 31st day of May, 1917.

CHARLES C. WHITTAKER.