May 2, 1939. A. W. FISHER ET AL 2,156,684

ELECTRICAL RELAY

Filed Dec. 30, 1937 2 Sheets-Sheet 1

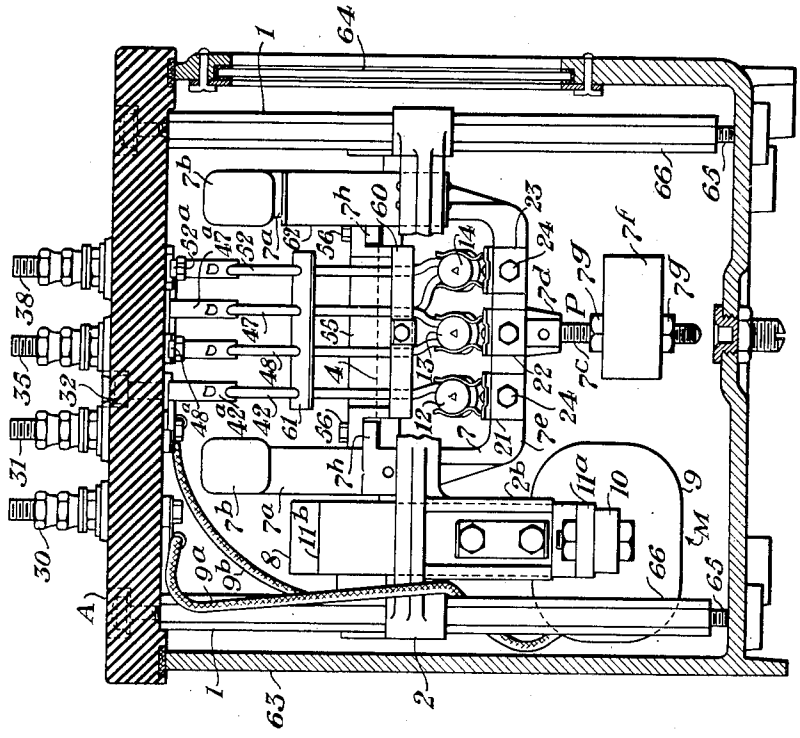


Fig. 2.

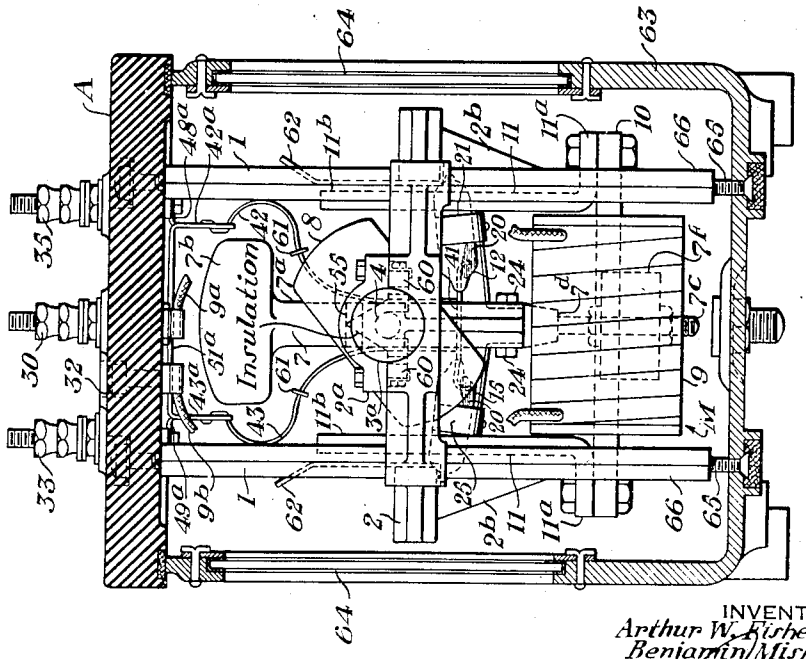


Fig. 1.

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ELECTRICAL RELAY

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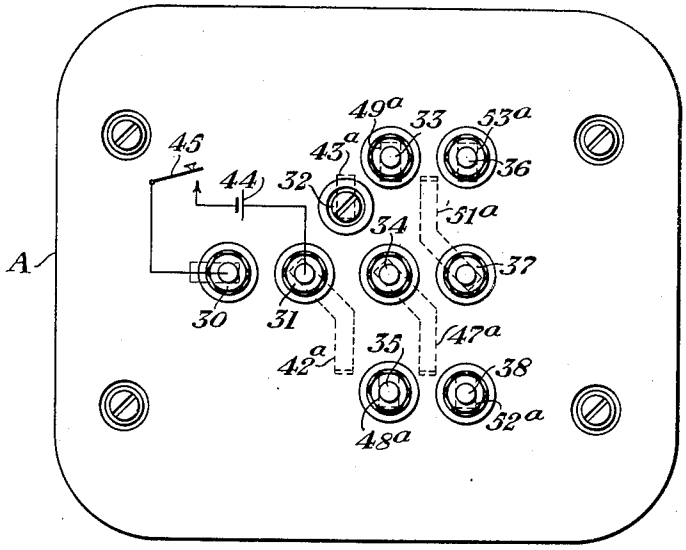


Fig. 3.

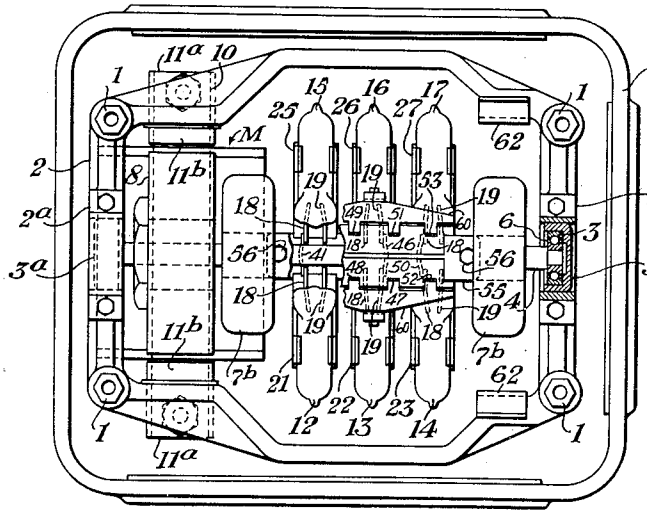


Fig. 4.

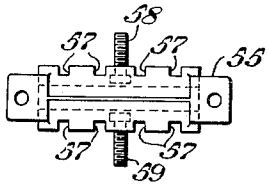


Fig. 5.

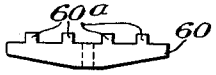


Fig. 6.

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UNITED STATES PATENT OFFICE

2,156,684

ELECTRICAL RELAY

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Application December 30, 1937, Serial No. 182,506

11 Claims. (Cl. 200—90)

Our invention relates to electrical relays, and particularly to relays which are adapted for flashing danger signals at highway-railroad crossings upon the approach of a train.

More particularly, our present invention relates to a pendulum type flasher relay having mercury contacts for controlling both its own operating circuit and the signal control circuits, and one object of our invention is to provide an improved relay of this type.

Other objects and characteristic features of our invention will appear as the description proceeds.

We shall describe one form of relay embodying our invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a view partly in end elevation and partly in section showing one form of relay embodying our invention. Fig. 2 is a view partly in side elevation and partly in section of the relay shown in Fig. 1. Fig. 3 is a top plan view of the relay illustrated in Fig. 1. Fig. 4 is a top plan view with the top plate removed of the relay illustrated in Fig. 1. Figs. 5 and 6 are detail views of parts of the relay shown in the preceding views.

Similar reference characters refer to similar parts in each of the several views.

Referring to the drawings, the reference character A designates an insulating top plate, which top plate supports all of the operating parts of the relay. Suspended from the top plate A by means of hangers 1 is a cast rectangular frame 2, and journaled at its ends in ball bearings 3 mounted in bearing cups 3a secured to the frame 2 by means of bearing caps 2a is a rockshaft 4. This rockshaft is biased to one position by a compound pendulum P, and is arranged to be oscillated at a predetermined frequency which depends upon the proportioning and adjustment of the parts by means of a suitable motor device M which we shall describe presently. The bearing cups 3a are preferably constructed in such manner that the bearing opening is eccentric with respect to the outside of the bearing cup for a purpose which will appear hereinafter, and are provided with spring washers 6 which enclose and protect the ball bearings from dirt.

The compound pendulum P may have any suitable form but in the form here shown, this pendulum comprises a cast U-shaped bracket 7 the upwardly extending arms 7a of which are pinned to the rockshaft 4 intermediate their ends, and are provided at their upper ends with enlarged portions 7b to provide the desired mass. A depending threaded post 7c is secured at its upper end within a boss 7d formed on the underside of the yoke 7e of the bracket 7, and this post carries a counterweight 7f which is mounted eccentrically to the post 7c, and which serves both as a means for regulating the period of oscillation of the rockshaft within certain limits, and also as a means for varying the position to which the rockshaft is biased by means of the pendulum. The counterweight 7f is arranged to be locked in an adjusted position by means of nuts 7g one of which is screwed onto the post 7c on each side of the counterweight.

The previously referred to motor device M for oscillating the rockshaft 4 comprises an armature 8 which is pinned to the rockshaft at one side of the bracket 7, and an electromagnet which cooperates with the armature 8. This electromagnet may have any preferred construction, but in the form here shown, this electromagnet comprises a winding 9 mounted on a backstrap 10 secured to the short arms 11a of L-shaped pole pieces 11, the long arms 11b of which extend upwardly past the opposite sides of the armature 8 and are secured to depending lugs 2b formed on the frame 2. One lead 9a of the winding 9 is connected to a terminal post 30 mounted on the top plate A, and the other lead 9b is connected to a connecting post 32 mounted on the top plate A. The angular disposition of the armature 8 with respect to the rockshaft 4 is such that, when the rockshaft occupies the position to which it is biased by the pendulum P, the longer axis of the armature will be inclined from the vertical at an acute angle with the magnetic field which is set up between the pole pieces 11 when the winding 9 is energized. This acute angle may be varied through relatively wide limits, but we have found that the best operating characteristics are obtained for most conditions of operation when this angle is approximately 40 degrees.

The relay also comprises a plurality of contacts, here shown as six in number and designated by the reference characters 12, 13, 14, 15, 16 and 17, respectively. These contacts are of the well-known mercury type, and each comprises a pair of electrodes 18 and 19 disposed in an evacuated bulb containing a quantity of mercury 20 which flows into or out of engagement with the electrodes to make or break a circuit passing through the electrodes. The contacts 12, 13 and 14 are mounted in spring clips 21, 22 and 23, respectively, which are secured to the lower side of the yoke 7e of the bracket 7, as viewed in Fig. 4, by means of bolts 24, and the contacts 15, 16

and 17 are mounted in spring clips 25, 26 and 27, respectively, which are secured to the other side of the yoke 7e of the bracket 7 by means of the bolts 24 in such manner that the contacts 12 and 15, the contacts 13 and 16, and the contacts 14 and 17 are directly opposite each other.

The two contacts 12 and 15 together control the supply of energy to the winding 9 of the motor device M, and to this end the two electrodes 18 of these contacts are connected together by a member 41, while the other electrodes 19 of these contacts are connected respectively by means of flexible connectors 42 and 43 and conducting strips 42a and 43a to a terminal post 31 mounted on the top plate, and to the previously described connecting post 32. A source of electromotive force, here shown as a battery 44, is connected with the terminal posts 30 and 31 through a switch 45. It will thus be apparent that if the switch 45 is closed, winding 9 will be supplied with current when the contacts 12 and 15 are both closed, but that when either one of these contacts becomes opened due to the motion of the rockshaft, the supply of current to the winding 9 will be interrupted. The position of the rockshaft at which the contacts 12 and 15 are adjusted to open will depend upon the angular position of the armature with respect to the rockshaft and the proportioning of the parts, but when the armature is secured to the rockshaft in the position shown, the contact 12 will preferably be so adjusted that it will break the operating circuit when the rockshaft swings approximately 7 degrees in a clockwise direction as viewed in Fig. 1 from the position to which it is biased by the pendulum, while the contact 15 will preferably be adjusted so that it will break the operating circuit when the rockshaft swings approximately 10 degrees in a counterclockwise direction as viewed in Fig. 1 from the position to which it is biased by the pendulum P. It should be particularly pointed out, however, that satisfactory operation of the relay can be obtained with a variation of several degrees in either direction from the above described adjustment of the contacts 12 and 15.

The remaining contacts 13, 14, 16 and 17 may be used for controlling the flashing lights of a highway crossing signal or any other signaling device, and are so adjusted that oscillation of the rockshaft to its intended amplitude will cause these contacts to become alternately opened and closed. To facilitate making electrical connection with these contacts, the two electrodes 19 of the contacts 13 and 16 are connected together by a jumper 46 and are also connected to a terminal post 34 mounted on the top plate A, by means of a flexible connector 47 and a conducting strip 47a, while the remaining electrodes 18 of these contacts are connected by means of flexible conductors 48 and 49 and conducting strips 48a and 49a to terminal posts 35 and 33, respectively, mounted on the top plate A. In a similar manner, the two electrodes 18 of the contacts 14 and 17 are connected together by a jumper 50 and to a terminal post 37 mounted on the top plate A by means of a flexible conductor 51 and a conducting strip 51a, while the electrodes 19 of these latter contacts are connected by means of flexible conductors 52 and 53 and conducting strips 52a and 53a to terminal posts 38 and 36 mounted on the top plate A.

It is desirable in order to minimize the stresses in the flexible conductors and the amount of torque required to flex them, that these conductors should flex as little and as uniformly throughout their lengths as possible, and to this end we provide means for clamping the conductors adjacent their lower ends in positions close to the rockshaft. As here shown, these means comprise an insulating member 55 (see Fig. 5) which straddles the rockshaft 4 between the arm 7a of the bracket 7 and which is secured at its end by means of machine screws 56 to inwardly extending lugs 7h provided on the arm 7a. The member 55 is provided at its opposite sides with spaced notches 57 which receive the flexible connectors 42, 43, 48, 49, 47, 51, 52 and 53, and with studs 58 and 59 by means of which clamping members 60 (see Fig. 6) having projections 60a which extend into the notches and grip the conductors, are secured to the opposite side of the member 55. These means also comprise insulating strips 61 provided with holes through which the conductors extend, and which strips control both the manner in which the conductors flex and the spacing between the conductors. It should be noted that the members 55 and 60 in addition to controlling the manner of flexing of the flexible conductors further serve as a means for preventing these members from coming into contact with any of the metal parts of the relay, thereby eliminating the possibility of short circuits.

Two metal stops 62 are secured to the opposite sides of the frame 2 directly opposite the one arm 7a of the bracket 7, and these stops cooperate with the enlarged portion 7b of the arm to limit the extreme positions to which the rockshaft 4 is free to rotate.

The operating mechanism of the relay is all enclosed within a suitable casing 63 which in the form here shown is a box-like metal casting, three of the sides of which are provided with glass windows 64 through which the operating mechanism may be viewed. The casing is held in position against the underside of the top plate A by means of screws 65 which pass through clearance holes provided in the bottom of the casing, and are screwed into tapped holes provided in the lower ends of depending lugs 66, the upper ends of which are secured to the underside of the frame 2.

The operation of the relay as a whole is as follows: When the switch 45 is open, as shown in the drawings, so that the winding 9 of the electromagnet is deenergized, the rockshaft 4 will occupy the position to which it is biased by the pendulum P, and under these conditions all of the contacts 12, 13, 14, 15, 16 and 17 will be closed. When, however, the switch 45 is closed, current will flow from battery 44 through switch 45, terminal post 30, lead wire 9a of winding 9, winding 9, lead wire 9b, connecting post 32, conducting strip 43a, flexible connector 43, contact 15, jumper 41, contact 12, flexible connector 42, conducting strip 42a, and terminal post 31 back to battery 44. The current in winding 9 will, of course, set up a magnetic field between the pole pieces 11 of the electromagnet, which field will cause the armature to turn in a clockwise direction as viewed in Fig. 1 in order to assume the position of minimum reluctance. This rotation of the armature will, of course, be transmitted to the rockshaft, and as soon as the rockshaft has been rotated to the position at which the contact 12 opens, winding 9 will become deenergized and will thus remove the torque tending to rotate the armature, but the shaft and armature will

continue their motion beyond this position due to the momentum of the parts. After this momentum of the parts is spent, however, the shaft will start to rotate in the opposite direction due to the action of gravity on the pendulum, and as soon as the pendulum returns to the position in which the contact 12 becomes closed, winding 9 will again become energized and will cause a retarding force to be exerted on the armature. This retarding force will be small, however, because the air gaps between the pole pieces and the armature will then be increasing rapidly, and also because as soon as the armature has rotated to the position in which the contact 15 opens, winding 9 will again become deenergized. As a result, the rockshaft will swing in a counterclockwise direction to a position which is displaced from the position to which it is biased by the pendulum only a few degrees less than the previous clockwise displacement. As soon as the energy of the rotating parts has been spent in the counterclockwise direction, the action of gravity on the pendulum will cause a clockwise torque to be again exerted on the shaft, and as soon as the shaft is rotated in a clockwise direction to the position in which contact 15 closes, winding 9 will again become energized and will subsequently remain energized until the rockshaft has swung to the position in which contact 12 opens. The energization of winding 9 will cause a pulse of energy to be exerted on the rockshaft which assists the clockwise rotation on the shaft, and the parts are so proportioned that this pulse at normal operating voltages will be sufficient to supply to the shaft the loss of energy during each cycle caused by friction and the retarding force of the magnet during the previous counterclockwise rotation of the rockshaft. It follows, therefore, that when switch 45 is closed, the rockshaft will oscillate at substantially the natural period of the pendulum. This oscillation will cause the contacts 13, 15, 16 and 17 to alternately open and close in an obvious manner, and it will be apparent that by connecting these contacts in suitable control circuits they may be used to alternately energize and deenergize the flashing lights of a highway crossing signal of the well-known type, or to control any other apparatus requiring alternate energization and deenergization at a predetermined constant frequency.

It should be pointed out that relays embodying our invention can be made to oscillate without the use of the contact 15, but that this contact materially aids in controlling the stroke of the pendulum, and thereby assures smooth operation of the relay. This is due to the fact that this contact is closed over a rather wide angle of displacement of the shaft from its biased position, and the contact therefore maintains the control circuit closed through a longer portion of the total time of each operation and in the proper section on the stroke than would be possible with only one control contact, which fact helps in giving a satisfactorily long stroke and in easing up the stroke in each direction. The armature passes through the energized position at a greater speed at higher voltages, and there is some compensation due to the contact 15 tending to limit the total stroke although, of course, there is an increase in the length of the stroke in all cases with increases in voltage.

It should also be pointed out that, since the bearing cups are eccentric, by rotating these bearing cups the shaft can be moved laterally to positions in which the armature is properly centered between the pole pieces, thus providing an adjustment to take care of minor variations in manufacture.

It should further be pointed out that while the contacts 13, 14, 16 and 17 are all adjusted to be normally closed when the relay is deenergized, these contacts can be adjusted so that some or all of them will be normally open, if desired.

It should still further be pointed out that the adjustment of the position of the operating contacts 12 and 15 is very important from the standpoint of efficient power consumption and proper and efficient operation of the relay. The importance of the adjustment and arrangement of these contacts can readily be understood from the fact that the starting voltage, pendulum stroke, power consumption, uniformity of timing and uniformity of swing, etc. depends upon this adjustment and arrangement.

One advantage of relays embodying our invention is that the contacts are capable of carrying large currents over a very large number of operations of the relay without material change in resistance or deterioration.

Another advantage of relays embodying our invention is that the contacts are uniformly operated thus providing uniform flashing of the light signals controlled by the relay.

A further advantage of electrical relays embodying our invention is that inasmuch as there are no striking parts, the life of the relay is exceptionally long.

Although we have herein shown and described only one form of electrical relays embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. A relay comprising a rockshaft, a pendulum attached to said rockshaft and effective to bias said rockshaft to one position, an electromagnet, an armature secured to said rockshaft and cooperating with said electromagnet in such manner that said armature will exert a torque in one direction on said rockshaft when said electromagnet is energized, and two contacts operatively connected with said rockshaft in such manner that the one contact will become opened when said rockshaft is rotated through a predetermined angular distance in one direction from said one position and the other contact will become opened when said rockshaft is rotated through a predetermined angular distance in the other direction from said one position, the parts being so proportioned that if the winding of said electromagnet is supplied with current over said contacts said rockshaft will oscillate at substantially the natural period of said pendulum.

2. A relay comprising a rockshaft, a pendulum attached to said rockshaft and effective to bias said rockshaft to one position, an electromagnet, an armature secured to said rockshaft and cooperating with said electromagnet in such manner that said armature will exert a torque in one direction on said rockshaft when said electromagnet is energized, two contacts operatively connected with said rockshaft in such manner that the one contact will become opened when said rockshaft is rotated through a predeter-

mined angular distance in one direction from said one position and the other contact will become opened when said rockshaft is rotated through a predetermined angular distance in the other direction from said one position, the parts being so proportioned that if the winding of said electromagnet is supplied with current over said contacts in series said rockshaft will oscillate at substantially the natural period of said pendulum, and another contact controlled in accordance with the position of said rockshaft.

3. A relay comprising a rockshaft, a pendulum attached to said rockshaft and effective to bias said rockshaft to one position, an electromagnet, an armature secured to said rockshaft and cooperating with said electromagnet in such manner that said armature will exert a torque in one direction on said rockshaft when said electromagnet is energized, and two mercury contacts operatively connected with said rockshaft in such manner that the one contact will become opened when said rockshaft is rotated through a predetermined angular distance in one direction from said one position and the other contact will become opened when said rockshaft is rotated through a predetermined angular distance in the other direction from said one position, the parts being so proportioned that if the winding of said electromagnet is supplied with current over said contacts in series said rockshaft will oscillate at substantially the natural period of said pendulum.

4. A relay comprising a rockshaft, a pendulum secured to said rockshaft, mercury contacts secured to said pendulum, and means controlled by said contacts for causing said rockshaft to oscillate at the natural period of said pendulum.

5. A relay comprising a rockshaft, a pendulum comprising a U-shaped bracket the arms of which are provided at their free ends with enlarged portions, means for securing said pendulum to said rockshaft with the arms extending up upwardly, a depending threaded post secured to the yoke of said bracket, a counterweight mounted eccentrically on said post and serving as a means for regulating the period of said pendulum within certain limits and also as a means for varying the position to which said rockshaft is biased by means of said pendulum, and means for oscillating said rockshaft at the natural period of said pendulum.

6. A relay comprising a rockshaft, a pendulum secured to said rockshaft and comprising a U-shaped bracket provided with a depending counterweight for regulating the period of said pendulum, mercury contacts secured to the yoke of said bracket, and means controlled by said contacts for exerting a periodic torque on said rockshaft in a manner to cause said rockshaft to oscillate at the natural period of said pendulum.

7. A relay comprising a rockshaft, a pendulum secured to said rockshaft and comprising a U-shaped bracket provided with a depending counterweight for regulating the period of said pendulum, two mercury contacts secured to the opposite sides of the yoke of said bracket in such manner that rotation of said rockshaft through an angle of approximately 7 degrees in one direction from the position to which it is biased by said pendulum will open the one contact and that rotation of said rockshaft through an angle of approximately 10 degrees in the other direction from the position to which it is biased by said pendulum will open the other contact, an electromagnet having pole pieces disposed on opposite sides of said rockshaft and having its winding connected in series with said two contacts, and an armature secured to said rockshaft in a position to cooperate with said pole pieces and having its longer axis inclined at an angle of approximately 40 degrees with respect to the magnetic field which is set up between said pole pieces when said electromagnet is energized.

8. A relay comprising a rockshaft, a pendulum comprising a U-shaped bracket secured intermediate the ends of its arms to said rockshaft and an adjustable counterweight secured to and depending from the yoke of said bracket, clips secured to the yoke of said bracket on opposite sides of said yoke, mercury contacts mounted in said clips, said clips being so adjusted that oscillation of said rockshaft through a predetermined amplitude will alternately open and close said contacts, a magnet provided with pole pieces, an energizing circuit for said magnet including two of said contacts disposed on opposite sides of the yoke of said bracket connected in series, and an armature secured to said rockshaft and positioned between said pole pieces.

9. A relay comprising a top plate, a frame suspended from said top plate, a rockshaft journaled in bearings mounted in said frame, a pendulum comprising a U-shaped bracket secured intermediate the ends of its arms to said rockshaft and provided at the upper ends of its arms with enlarged portions to provide a predetermined amount of mass, a counterweight secured to the underside of the yoke of said bracket for adjusting the period of said pendulum, clips secured to the opposite sides of said yoke, mercury contacts mounted in said clips, terminal posts on said top plate connected with said contacts by means of flexible connectors, means for oscillating said rockshaft at the natural period of said pendulum, and insulating members secured to the arms of said bracket and engaging said flexible connectors in a manner to minimize the flexing of said connectors and to cause said connectors to flux uniformly throughout their lengths.

10. A relay comprising a top plate, a frame suspended from said top plate, a rockshaft journaled in bearings mounted in said frame, a pendulum comprising a U-shaped bracket secured intermediate the ends of its arms to said rockshaft and provided at the upper ends of its arms with enlarged portions to provide a predetermined amount of mass, a counterweight secured to the underside of the yoke of said bracket for adjusting the period of said pendulum, clips secured to the opposite sides of said yoke, mercury contacts mounted in said clips, terminals posts on said top plate connected with said contacts by means of flexible connectors, means for oscillating said rockshaft at the natural period of said pendulum, and insulating members secured to the arms of said bracket and engaging said flexible connectors in a manner to minimize the flexing of said connectors and to cause said connectors to flux uniformly throughout their lengths, said insulating members also serving to insulate said connectors from said shaft.

11. A relay comprising a top plate, a frame suspended from said top plate, a rockshaft journaled in bearings mounted in said frame, a pendulum comprising a U-shaped bracket secured intermediate the ends of its arms to said rockshaft and provided at the upper ends of its arms with enlarged portions to provide a predetermined amount of mass, a counterweight secured

to the underside of the yoke of said bracket for adjusting the period of said pendulum, clips secured to the opposite sides of said yoke, mercury contacts mounted in said clips, terminal posts on said top plate connected with said contacts by means of flexible connectors, means for oscillating said rockshaft at the natural period of said pendulum, an insulating member straddling said shaft and secured at its ends to said arms and provided in its opposite sides with notches which receive said flexible connectors and with threaded inserts, and two other insulating members secured to the opposite sides of said first mentioned member by means of said threaded inserts and provided with projections which extend into the notches in said first mentioned member and grip said flexible connectors.

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