Feb. 24, 1942. P. W. SWENSON 2,274,013

TIME DELAY RELAY

Filed June 28, 1940

FIG. 1

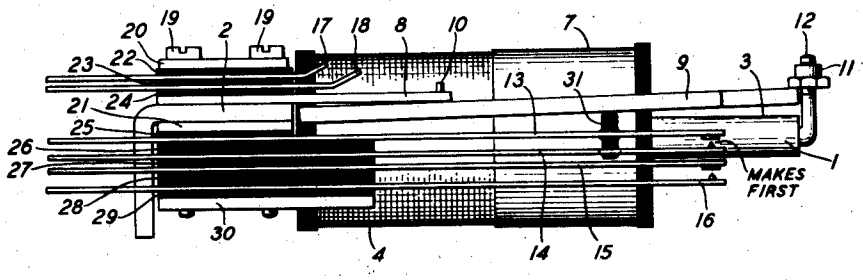
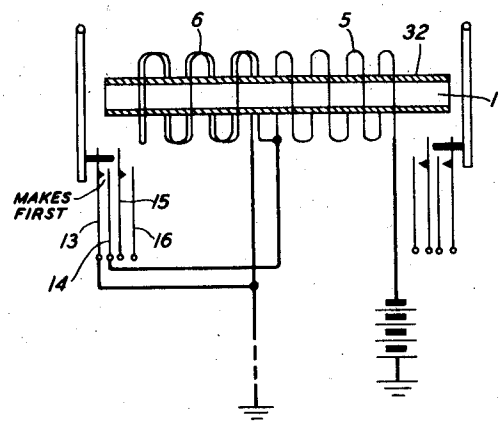


FIG. 2



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TIME DELAY RELAY

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2 Claims. (Cl. 175—328)

This invention relates to relays and more particularly to relays which are arranged to be slow to close their contacts.

It is a well-known expedient to render a relay slow in operation by placing a sleeve of copper or other conducting material around its core and within its operating winding or to place a copper slug or sleeve on the end of its core adjacent the working air-gap. It is sometimes difficult to obtain an appreciable time delay by means of such relay structures due to voltage variations, resistance variations, adjustment variations and the necessary margin required between the worst operating circuit condition and the test current condition. Since a slow-to-operate relay must be designed to have the necessary margin between the worst operating circuit condition and test currents, with minimum voltage and maximum resistance, it follows that there will be considerable margin between the maximum circuit current, that is, with maximum voltage and minimum resistance, and the current which will operate the weakest relay, that is, the non-operate testing current. For example, with an operating voltage between 45 and 50 volts, a resistance variation of ±5 per cent and a 75 per cent non-operate adjustment, it is possible to obtain a minimum operating time of .04 second with a relay of the type disclosed, for example, in Patent 2,178,656 granted to me on November 7, 1939, equipped with a copper sleeve on the core. If a 90 per cent non-operate adjustment is provided, a minimum operating time of .06 second may be secured.

In many cases, however, a longer operating time is required which heretofore has necessitated the use of expensive time delay relays or the use of two or more slow-to-operate relays of the type hereinbefore discussed connected in cascade.

It is the object of the present invention to secure a longer operating time with a relay of the well-known slow-to-operate type without materially increasing the cost thereof or sacrificing the operating efficiency thereof.

This object is attained by providing a slow-to-operate relay having a short-circuited sleeve surrounding its core or a short-circuited slug on the forward end of its core, with two windings, one of which is an operating winding and the other of which is a non-inductive winding and in so arranging the operating circuit of the relay that the armature thereof is operated from its normal or released position to its fully operated position in two steps.

Normally the operating circuit for the relay extends in series through both windings and when closed, the armature is attracted only to such an extent as to close one pair of the contact springs, this initial first step movement of the armature being delayed by the retarded building up of the flux in the magnetic circuit due to the short-circuited sleeve or slug. When the pair of contact springs engage in response to the first step operation of the armature, the non-inductive winding becomes short-circuited thereby increasing the current flowing through the operating winding to such an extent as to cause a second step operation of the armature to control the remaining contact springs of the relay. As before, the second step operation of the armature is delayed by the retarded building up of flux in the magnetic circuit due to the shirt-circuited sleeve or slug.

By means of this two-step operation of a relay, with a 90 per cent non-operate adjustment, a minimum operating time of .10 second and a maximum operating time of .35 second is possible and if a relay of the type disclosed in the application of F. A. Zupa, Serial No. 335,723, filed May 17, 1940, were so modified for two-step operation, it would be possible to obtain a minimum operating time of .15 second and a maximum operating time of .4 second.

For a clearer understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a top elevational view of a relay embodying the invention; and

Fig. 2 is a circuit diagram of the operating circuit of the relay of Feb. 1.

Referring first to Fig. 1, the invention has been shown embodied in a relay of the type disclosed in Patent 2,178,656, granted to me on November 7, 1939. This relay comprises a core 1, the rear end of which is secured in any desired manner to an L-shaped heel-piece or mounting bracket 2 and the forward end of which is provided with a pole face 3. Supported on the core between the heel-piece 2 and the pole face 3 of the core is a coil 4 which, as more clearly disclosed in Fig. 2, is composed of an operating winding 5 and a non-inductive winding 6. Also mounted on the forward end of the core is a copper slug 7 which serves as a low resistance short-circuited winding for the relay.

Supported on the heel-piece 2 is a U-shaped armature hinge bracket 8, the two arms of which extend forwardly on opposite sides of the coil 4. A U-shaped armature 9 is provided having its cross-reach overlying the pole face 3 of the core 1 and its legs extending rearwardly on either side of the coil 4 in alignment with the arms of the hinge bracket 8. The legs of the armature 9 are provided with pivot pins 10 near their rear ends which extend freely through holes in the ends of the arms of the bracket 8 by means of which the armature is pivoted to the bracket 8. For a full disclosure of the U-shaped hinge

bracket and the U-shaped armature, reference may be had to my patent hereinbefore referred to. The forward end of the armature is normally biased against the backstop nut 11, threaded upon the end of the backstop screw 12 which is secured to the end of the core 1. The nut 11 serves as a means for adjusting the normal air-gap between the cross-reach of the armature and the pole face 3 of the core.

Supported on each end of the heel-piece 2 is a spring pile-up, each pile-up comprising a plurality of contact springs of which some are active or operating springs, such as 13 and 15, and of which others are passive springs such as 14 and 16, and a pair of winding terminal lugs 17 and 18. Each pile-up is clamped to the heel-piece 2 by screws 19 which extend through aligned holes in the clamping plate 20, in the terminal lugs 17 and 18, in the bracket 8, in the heel-piece 2, in the spacer 21, in the springs 13 to 16, inclusive, and in the strips of insulation 22 to 29, inclusive, into threaded holes in the clamping plate 30. The insulating strips 22 to 29 serve to insulate the terminal lugs 17 and 18 and the springs 13 to 16, inclusive, from each other, from the clamping plates 20 and 30 and from the heel-piece 2. The screws 19 are also suitably insulated in the well-known manner from the terminal lugs 17 and 18 and from the contact springs 13 to 16, inclusive, by insulated bushings which surround their threaded shanks.

For operating the springs of each pile-up, an operating stud 31 of insulating material is associated with each pile-up and is engaged against the armature 9. The stud 31 is ring-staked to the operating spring 13, extends freely through the passive spring 14 with its outer end separated from the operating spring 15 by a stud gap, whereby when the armature is attracted, the springs 13 and 15 are successively operated into engagement with springs 14 and 16. The springs 13 are tensioned to normally bias the end of the armature against the backstop nut 11. It will be noted that the contact gap between springs 13 and 14 is adjusted to be narrower than the contact gaps between the other pairs of springs of the relay, so that upon the attraction of the armature toward the core, the springs 13 and 14 make their contacts first.

The relay may be provided with a sleeve 32 surrounding its core between the core and the coil 4 as disclosed in Fig. 2 in lieu of the slug 7. It is to be further understood that the spring pile-ups of the relay may comprise any desired number and combination of contact springs within the operating capacity of the relay.

The operation of the relay will now be considered in connection with the circuit diagram of Fig. 2 in which the two legs of the armature 9 have been disclosed as separate armatures, each operating a separate spring pile-up. When the operating circuit of the relay is initially closed, it extends from ground through any desired circuit closer, thence serially through the non-inductive winding 6 and the operating winding 5 to grounded battery. The non-inductive winding 6 may, for example, have a resistance of 750 ohms and the operating winding may have a resistance of 1000 ohms. With the non-inductive winding 6 connected in series with the operating winding 5, the operating winding sets up a flux in the magnetic circuit of the relay which is only sufficient to operate the armature to such a position as to close the contact springs 13 and 14 but not to move spring 15 into engagement with spring 16 or to operate the other contact springs. The building up of this flux is delayed due to the provision of the short-circuited sleeve 32 or slug 7. When after an interval the armature causes the engagement of the contact springs 13 and 14, the non-inductive winding 6 becomes short-circuited whereupon the strength of the operating current flowing through the operating winding 5 becomes increased whereby the flux flowing through the magnetic circuit of the relay is increased to a value requisite to fully operate the armature. The building up of this increased flux value is, however, delayed due to the provision of the short-circuiting sleeve 32 or the slug 7. When after this second interval, the armature becomes fully operated, the remaining springs of the spring pile-ups, such as springs 15 and 16, become engaged.

From the foregoing description it will be seen that the applicant has, simply by the provision of an additional relay winding, of armature-operated contacts for removing such winding from the normal series connection with the operating winding of the relay, and of a short-circuiting sleeve or slug, devised a relay which operates its armature in two slow-to-operate steps thereby securing a longer operating time. It will be obvious to those skilled in the art that the relay may be further simplified by placing the non-inductive winding 6 as a separate resistance external to the relay, but normally connected in series with the operating winding 5.

What is claimed is:

1. In combination, a core, an armature cooperating therewith, a plurality of contact springs operable by said armature, a short-circuited sleeve and an operating winding on said core, a resistance, a source of current, an operating circuit including said source of current, said operating winding and said resistance in series, whereby upon the closure of said circuit said winding produces a flow of flux in said core retarded in its build up by said sleeve to operate said armature only sufficiently to close one pair of said contact springs, and a shunt around said resistance closed by said one pair of springs whereby said winding produces a further flow of flux in said core, retarded in its build up by said sleeve, to fully operate said armature to operate the remaining contact springs.

2. In combination, a core, an armature cooperating therewith, a plurality of contact springs operable by said armature, a short-circuited sleeve an operating winding and a non-inductive winding on said core, a source of current, an operating circuit including said source of current and said windings in series, whereby upon the closure of said circuit said operating winding produces a flow of flux in said core retarded in its build up by said sleeve to operate said armature only sufficiently to close one pair of said contact springs, and a shunt around said non-inductive winding closed by said one pair of springs whereby said operating winding produces a further flow of flux in said core, retarded in its build up by said sleeve, to fully operate said armature to operate the remaining contact springs.

PAUL W. SWENSON.