March 10, 1959 J. W. OLIVER 2,877,315

ELECTROMAGNETIC RELAY

Filed June 19, 1956

FIG. 1

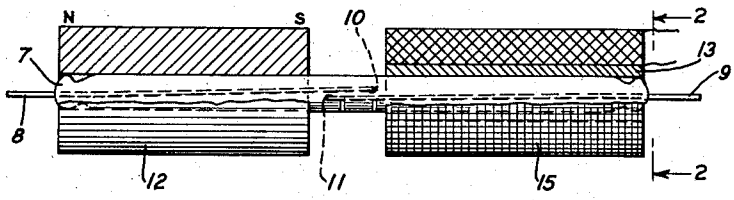



FIG. 3

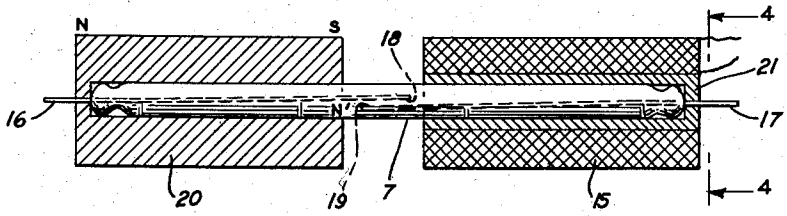



FIG. 5

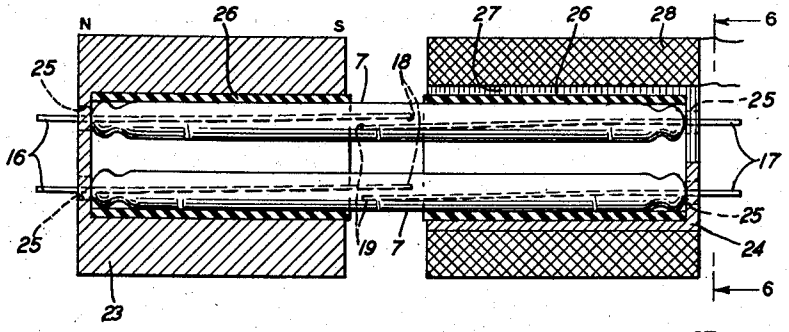



FIG. 2

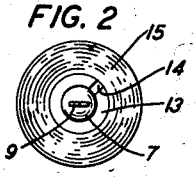



FIG. 4

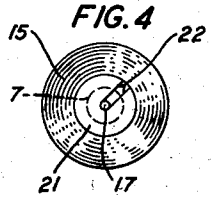
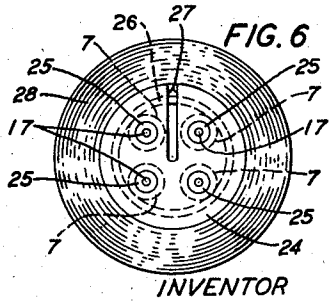



FIG. 6




INVENTOR

J. W. OLIVER

BY

ATTORNEY

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2,877,315

# ELECTROMAGNETIC RELAY

John W. Oliver, Trenton, Mich., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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15 Claims. (Cl. 200—87)

This invention relates to circuit controlling devices and, more particularly, to such devices of the type commonly referred to as reed switches.

In electrical systems it is often necessary to operate a switching device and to hold it so operated for a considerable period of time. For example, certain of the relays used in telephone systems become operated when a subscriber initiates a call and remain in an operated condition throughout the duration of a call. There has been developed a glass-sealed reed device acting as the contact means for a relay of this type which may be placed axially within an energizing coil where it becomes extremely rapid in action and very sensitive. Such a device is disclosed in Patent 2,289,830, issued July 14, 1942, to W. B. Ellwood. Obviously, however, when a device of this type is to remain operated over a considerable period of time, current is required in the energizing coil throughout the duration of the reed contact engagement, and this current drain becomes of considerable importance when multiplied by the large number of such devices which may be utilized in an average telephone system. In certain instances, it has been possible to reduce to some extent the adverse effects of this current drain by either reducing the energizing current in the coil to a holding value after the reed contacts have been operated or by providing a permanent magnet or mechanical holding means inside the switch enclosure to maintain the contacts in an operated condition. However, the manufacturing cost of such devices has on occasion sufficiently offset the savings realized through reduced current drain so that these devices are of little value for most commercial applications. Furthermore, the holding means employed in these previous devices has frequently adversely affected many of the operating characteristics thereof to such an extent that the many advantages obtainable through the use of devices of the Ellwood type cannot be fully realized.

One general object of this invention is to improve switching devices of the type wherein a pair of contact members are energized by means of an encompassing winding to open or close a conductive path.

More specifically some objects of this invention are to enable the switch to remain in an operated condition after an energizing current is removed, to permit the switch contacts to operate upon energization by current in one direction but not to operate when energized by current in the opposite direction, and to minimize chatter and reduce the current requisite for operation of such devices.

Additional objects of this invention are to facilitate the fabrication of such switches, to simplify the structure thereof and to reduce the size of circuit controlling devices capable of performing multiple functions, for example, make and break of plural circuits or transfer.

In one illustrative embodiment of this invention a circuit controlling device comprises a switch unit consisting of a switch envelope and two contact members enclosed in said envelope, a permanently magnetized sleeve disposed about one of the contact members, a sleeve of magnetically retentive material disposed about the other contact member and an energizing coil disposed about and coextensive with the magnetically retentive sleeve.



In accordance with one feature of this invention the magnetic flux from the permanent magnet and the residual magnetism remaining in the magnetically retentive sleeve after energization and deenergization of the coil by current in a given direction will produce a magnetic field of sufficient strength to hold the contact members in an operated position after the energizing current is removed. The contacts may thereafter be returned to their initial unoperated position by applying energizing current to the coil in the reverse direction.

In accordance with another feature of this invention the permanent magnet sleeve provides a biasing flux which will permit operation of the contact members when the coil is energized by current in one direction but which will prevent the contact members from operating when the coil is energized by current in the opposite direction. The biasing flux from the permanent magnet remains relatively constant; and, since the energizing coil is coextensive with the magnetically retentive sleeve and does not extend over the entire switch enclosure, the permanent magnet biasing flux is for the most part unaffected by energization of the coil.

In accordance with a further feature of this invention the resultant flux from the two sleeves creates a force which aids the force produced by the energizing coil in causing the contact members to operate. Consequently, the amount of energizing current necessary to operate the device can be greatly reduced, and the high forces across the contact gap insure a minimum of contact chatter when the coil is energized.

The above-noted and other features of the invention will be understood more clearly and fully from the following detailed description, when read in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal view, partially in cross section, illustrative of one embodiment of the invention;

Fig. 2 is an end view of a device of the type depicted in partial cross section in Fig. 1 and looking in the direction of the arrows 2—2 in Fig. 1;

Fig. 3 is a longitudinal view, partially in cross section, illustrative of a second embodiment of the invention;

Fig. 4 is an end view of a device of the type depicted in partial cross section in Fig. 3 and looking in the direction of the arrows 4—4 in Fig. 3;

Fig. 5 is a longitudinal view, partially in cross section, illustrative of a third embodiment of the invention; and

Fig. 6 is an end view of a device of the type depicted in partial cross section in Fig. 5 and looking in the direction of the arrows 6—6 in Fig. 5.

Referring to Fig. 1 of the drawings, there is shown the preferred structure and assembly of the invention. The elements of the switch are enclosed in an envelope 7 made of a vitreous material such as glass. An inert gas such as helium or nitrogen may be inserted in this enclosure for the purpose of reducing arcing across the contact gap, but this is by no means essential for successful operation of the invention. Inserted in the envelope 7 at either end thereof are reed contact members 8 and 9 having overlapping contact areas 10 and 11, respectively. The contact members 8 and 9 may be formed of any suitable magnetic material of high electrical conductivity. As shown in Fig. 2, the contact members 8 and 9 in the first embodiment of the invention are made from a flat reed, but it will readily be apparent that round contact members or members of other cross sectional configuration may readily be substituted for the reeds 8 and 9 without departing from the spirit or scope of the invention. Contact areas 10 and 11 comprise the over-

lapping portions of contact members 8 and 9, respectively, and may be plated with gold or other precious metal to improve the over-all operating characteristics of the device. However, this is by no means essential for successful operation of the invention.

A permanent magnet sleeve 12 surrounds the contact member 8 at one end of the envelope 7, and a sleeve 13 made from a tool steel or other magnetically retentive material surrounds the contact member 9 at the other end of the envelope 7. In order to reduce magnetic interference and to insure against false operation or release of the contact members 8 and 9, the sleeves 12 and 13 are disposed about a substantial portion of their respectively adjacent contact members 8 and 9 but preferably do not extend over the contact areas 10 and 11. This construction will increase the speed of operation of the over-all device and will enable the contact members 8 and 9 to close on an extremely small current input. As shown in Fig. 2, the sleeve 13 may be provided with a slot 14 which splits the sleeve 13 in a longitudinal direction and which greatly reduces the adverse effects of eddy currents. However, for some applications the slot 14 may safely be omitted. An energizing coil 15 surrounds one end of the envelope 7 and is substantially coextensive with the sleeve 13. Since the coil 15 does not extend around the permanent magnet sleeve 12 at the other end of the envelope 7, the sleeve 12 is substantially unaffected when the coil 15 is energized; and, consequently, the magnetic flux from this sleeve remains at a relatively constant value.

Other details will be understood from the following description of the mode of operation of the device.

When the switch is in its unoperated position (contact areas 10 and 11 out of contact with each other), a magnetic flux is created by the permanent magnet sleeve 12 which follows a path from the north pole thereof along the contact member 8 and back to the south pole of sleeve 12. The sleeve 12 is not sufficiently magnetized to create additional flux patterns which would cause the contact members 8 and 9 to close, and consequently the device will remain in its unoperated position. When the coil 15 is energized by current in a forward direction, such that a magnetic flux is created in aiding relationship with the flux from the sleeve 12, a force will be created across the contact areas 10 and 11 which will cause contact members 8 and 9 to close, thereby creating a continuous electrically conductive path from the contact member 8 to the contact member 9. This contact closure is assisted by the flux from the permanent magnet sleeve 12, and consequently high forces are realized across the contact gap which substantially reduce the adverse effects of chatter and increase the speed of operation of the device. After the energizing current is removed, the residual magnetism remaining in the sleeve 13 will provide a magnetic flux which will aid the flux from the permanent magnet sleeve 12 in keeping the contact members 8 and 9 firmly locked in their operated position. By coupling the magnetic flux between the sleeves 12 and 13 in this manner, an extremely tight and electrically sound connection is obtained between contact members 8 and 9, and this connection is unaffected by jarring or vibration of the over-all device.

When the coil 15 is thereafter energized by current in the reverse or opposite direction, the residual magnetism in the sleeve 13 will be substantially reduced. Furthermore, the coil 15 will set up a magnetic flux which will oppose the flux from the permanent magnet sleeve 12 and will cause the contact members 8 and 9 to return to their unoperated position, thereby opening a circuit. If the coil 15 is energized by current in this latter direction when the switch is in its unoperated position, an electromagnetic flux will be set up which will oppose the flux from the permanent magnet sleeve 12. The flux due to sleeve 12 will in effect neutralize the electromagnetic flux from the coil 15, and consequently the contact members 8 and 9 will remain in an unoperated position. It will thus be apparent that the device will operate and lock up when energized by current in one (forward) direction and then deenergized; but, it will remain in an unoperated position (or will be moved to an unoperated position) when energized by current in the opposite or reverse direction.



In the embodiment of the invention disclosed in Figs. 3 and 4, round contact members 16 and 17 have been substituted for the flat reed contact members 8 and 9 of Fig. 1, and the overlapping portions of contact members 16 and 17 comprise contact areas 18 and 19. Although contact areas 18 and 19 are narrower and hence provide less contacting surface than contact areas 10 and 11 of Fig. 1, a particular advantage of using areas of the configuration shown in Fig. 3 is that the adverse effects of contact sticking when the winding 15 is energized by reverse current are reduced to a minimum.

A permanent magnet sleeve 20 and a sleeve 21 of magnetically retentive material surround contact members 16 and 17, respectively, at either end of the envelope 7. The sleeves 20 and 21 are similar in most respects to the sleeves 12 and 13 of Fig. 1, except that they are substantially closed at one end and are in close physical proximity to their respectively adjacent contact members 16 and 17. Consequently, a closed magnetically conductive path is formed from the sleeves 20 and 21 to the contact members 16 and 17, with the result that the contact area 18 of contact member 16 has approximately the same magnetic potential N' as does the outer end N of the permanent magnet sleeve 20. Likewise, the contact area 19 of contact member 17 has approximately the same magnetic potential as does the outer end of the magnetically retentive sleeve 21. Since air gaps have been substantially removed from this portion (outer ends of the switch unit) of the magnetic circuit of the device, the overall magnetic reluctance thereof has been considerably diminished. Consequently, the sleeves 20 and 21 may be reduced in size and the device will operate effectively on an extremely small amount of current in the coil 15. The magnetically retentive sleeve 21 has a longitudinal slot 22 therein as shown in Fig. 4, for the purposes hereinbefore enumerated.

Referring now to Fig. 5 of the drawings, there is disclosed an embodiment of the invention wherein four switch units of the type disclosed in Fig. 3 are aligned in juxtaposed relation to each other and are mounted in a single assembly to provide a variety of make, break or transfer contact combinations. Each of the switch units employed in this embodiment of the invention comprises the elongated envelope 7 in which are sealed contact members 16 and 17 having contact areas 18 and 19, respectively. A permanent magnet sleeve 23 surrounds the contact members 16 at one set of adjacent ends of the envelopes 7, and a sleeve 24 of magnetically retentive material surrounds the contact members 17 at the other set of adjacent ends of the envelopes 7. The sleeves 23 and 24 are substantially closed at one end so that they are in close physical proximity to the contact members 16 and 17, respectively, for the purposes hereinbefore described.

In order to avoid short-circuiting adjacent contact members 16 and 17 at respective ends of the envelopes 7, four insulating bushings 25 are located at each end of this embodiment of the invention. The bushings 25 are positioned in the closed ends of the sleeves 23 and 24, and each bushing is provided with an axially located hole therethrough to accommodate its corresponding contact member 16 or 17. Furthermore, cylindrical coatings 26 of insulating material may be placed at each end of the device between the sleeves 23 and 24 and the envelopes 7 to provide additional insurance against short-circuiting contact members 16 and 17. However, it will readily be apparent that the coatings 26 may safely be omitted with-

out departing from the spirit and scope of the invention. As shown in Fig. 6, the magnetically retentive sleeve **24** is provided with a longitudinal slot **27** and is encompassed by an energizing coil **28** which is coextensive therewith.

When the coil **28** is energized by current in a forward direction which produces a magnetic flux in aiding relation with the flux from the permanent magnet sleeve **23**, the four mating pairs of contact members **16** and **17** will come into contact with each other, thereby closing four independent electrical circuits. The contact members **16** and **17** will remain in an operated position after the energizing current is removed because of the combined effect of the permanent magnet sleeve **23** and the magnetically retentive sleeve **24**. A current in a reverse direction will cause the contact members **16** and **17** to return to their initial position and thereby open the circuits connected therewith. Although four normally open switch units have been shown and described in this embodiment of the invention, it will be apparent that any number of switch units may be employed in various combinations to produce a variety of circuit makes or breaks when the coil **28** is energized. Furthermore, the contact members of the individual switch units may be strapped or otherwise electrically interconnected to provide circuit transfer.

Although several specific embodiments of the invention have been shown and described, it will be understood that the various modifications of the component parts of these embodiments are, in many instances, interchangeable with each other and that certain of the mechanical and electrical details shown may be modified without departing from the scope and spirit of the invention.

What is claimed is:

1. A switching device comprising a switch unit including two contact members in operable relation to each other, a permanently magnetized member disposed about a part of only one of said contact members, a magnetically retentive member disposed about a part of only the other of said contact members and energizing means disposed about said magnetically retentive member and substantially coextensive therewith.

2. A switching device comprising a switch unit including two contact members having contact areas in operable relation to each other, a permanent sleeve magnet disposed about a part of one of said contact members except the contact area thereof, a magnetically retentive member disposed about a part of the other of said contact members except the contact area thereof and energizing means disposed about said magnetically retentive member.

3. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope, a permanently magnetized member disposed about a substantial part of one of said contact members, a magnetically retentive member disposed about a substantial part of the other of said contact members and energizing means disposed only about said magnetically retentive member.

4. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope, a permanently magnetized member disposed about a substantial part of one of said contact members, a magnetically retentive member disposed about a substantial part of the other of said contact members and energizing means disposed only about said magnetically retentive member and substantially coextensive therewith.

5. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope, a permanently magnetized sleeve disposed about a substantial part of one of said contact members, a sleeve of magnetically retentive material disposed about a substantial part of the other of said contact members and an energizing winding disposed only about said magnetically retentive sleeve.

6. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope, a permanently magnetized sleeve disposed about a part of one of said contact members, a sleeve of magnetically retentive material disposed about a part of the other of said contact members and an energizing winding disposed only about said magnetically retentive sleeve and substantially coextensive therewith.

7. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope and having contact areas in operable relation to each other, a permanently magnetized sleeve disposed about a substantial part of one of said contact members except the contact area thereof, a sleeve of magnetically retentive material disposed about a substantial part of the other of said contact members except the contact area thereof and an energizing winding disposed only about said magnetically retentive sleeve.

8. A switching device comprising a switch unit including an elongated envelope and two contact members enclosed in said envelope and overlapping in spaced relation to each other to form contact areas, a permanent magnet sleeve disposed about one end of said envelope so as to enclose a part of one of said contact members except the contact area thereof, a sleeve of magnetically retentive material disposed about the other end of said envelope so as to enclose a part of the other of said contact members except the contact area thereof and an energizing winding disposed about said magnetically retentive sleeve.

9. A switching device comprising a switch unit including an elongated envelope and two magnetic contact members enclosed in said envelope and overlapping in spaced relation to each other to form contact areas, a permanently magnetized sleeve disposed about one end of said envelope so as to enclose a substantial part of one of said contact members except the contact area thereof, a sleeve of magnetically retentive material disposed about the other end of said envelope so as to enclose a substantial part of the other of said contact members except the contact area thereof and an energizing winding disposed about said magnetically retentive sleeve and substantially coextensive therewith.

10. A switching device comprising a switch unit including an elongated envelope and two movably supported magnetic contact members enclosed in said envelope and overlapping in spaced relation to each other to form contact areas, a permanently magnetized sleeve surrounding one end of said envelope so as to enclose a substantial part of one of said contact members except the contact area thereof, a longitudinally split sleeve of magnetically retentive material surrounding the other end of said envelope so as to enclose a substantial part of the other of said contact members except the contact area thereof and an energizing winding surrounding said magnetically retentive sleeve and substantial coextensive therewith.

11. A switching device comprising a switch unit including an elongated tubular glass envelope and two movably supported magnetic contact members sealed in and extending through respective ends of said envelope and overlapping inside said envelope in spaced relation to each other to form contact areas, a permanently magnetized sleeve surrounding one end of said envelope so as to enclose a substantial part of one of said contact members except the contact area thereof, a longitudinally split sleeve of magnetically retentive material surrounding the other end of said envelope so as to enclose a substantial part of the other of said contact members except the contact area thereof and an energizing winding surrounding said magnetically retentive sleeve and substantially coextensive therewith.

12. A switching device comprising a switch unit including a switch envelope and two flat contact reeds enclosed in said envelope, a permanently magnetized sleeve

surrounding one end of said envelope, said permanently magnetized sleeve being disposed about a substantial part of one of said contact reeds and physically separated therefrom, a sleeve of magnetically retentive material surrounding the other end of said envelope, said magnetically retentive sleeve being disposed about a substantial part of the other of said contact reeds and physically separated therefrom, and an energizing winding disposed about said magnetically retentive sleeve.

13. A switching device comprising a switch unit including an elongated tubular glass envelope and two movably supported flat magnetic contact reeds sealed in and exending through respective ends of said envelope and overlapping inside said envelope in spaced relation to each other to form contact areas, a permanently magnetized sleeve surrounding one end of said envelope so as to enclose a substantial part of one of said contact reeds except the contact area thereof, said permanently magnetized sleeve being physically separated from said one reed, a longitudinally split sleeve of magnetically retentive material surrounding the other end of said envelope so as to enclose a substantial part of the other of said contact reeds except the contact area thereof, said magnetically retentive sleeve being physically separated from said other reed, and an energizing winding surrounding said magnetically retentive sleeve and substantially coextensive therewith.

14. A switching device comprising a switch unit including a switch envelope and two contact members enclosed in said envelope, a permanently magnetized sleeve surrounding one end of said envelope, said permanently magnetized sleeve being disposed about a substantial part of one of said contact members and having a portion thereof in close physical relation to said one member, a sleeve of magnetically retentive material surrounding the other end of said envelope, said magnetically retentive sleeve being disposed about a substantial part of the other of said contact members and having a portion thereof in close physical relation to said other member, and an energizing winding disposed about said magnetically retentive sleeve.

15. A switching device comprising a switch unit including an elongated tubular glass envelope and two movably supported round magnetic contact members sealed in and extending through respective ends of said envelope and overlapping inside said envelope in spaced relation to each other to form contact areas, a permanently magnetized sleeve surrounding one end of said envelope so as to enclose a substantial part of one of said contact members except the contact area thereof, said permanently magnetized sleeve having one end thereof in intimate physical magnetic relation to said one member, a longitudinally split sleeve of magnetically retentive material surrounding the other end of said envelope so as to enclose a substantial part of the other of said contact members except the contact area thereof, said magnetically retentive sleeve having one end thereof in close physical relation to said other member, and an energizing winding surrounding said magnetically retentive sleeve and substantially coextensive therewith.

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