July 12, 1966 B. W. FISHER ETAL 3,260,818

RELAY

Filed Nov. 27, 1963

FIG. 1

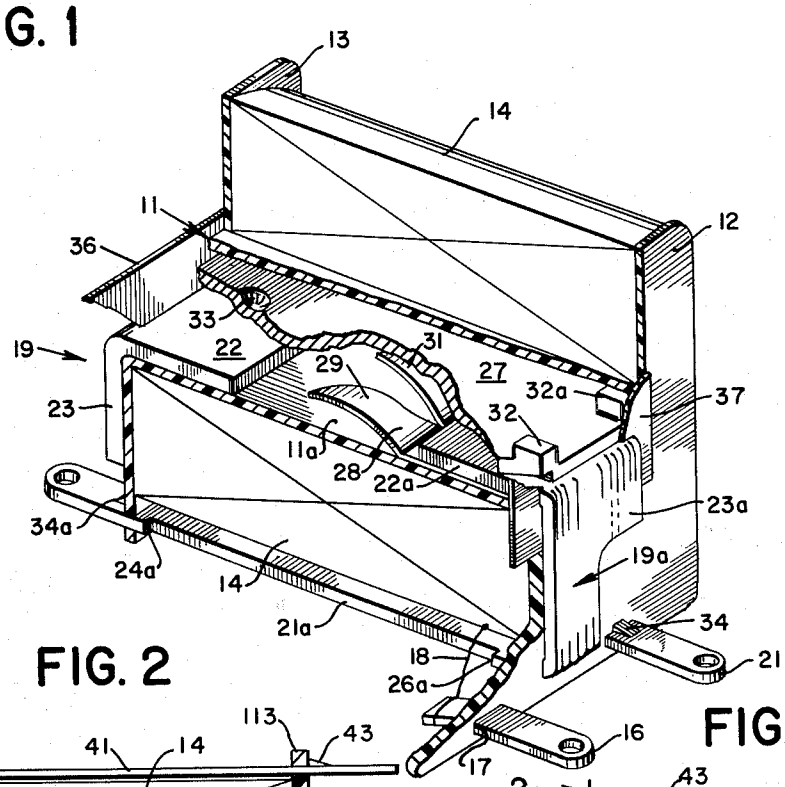


FIG. 2

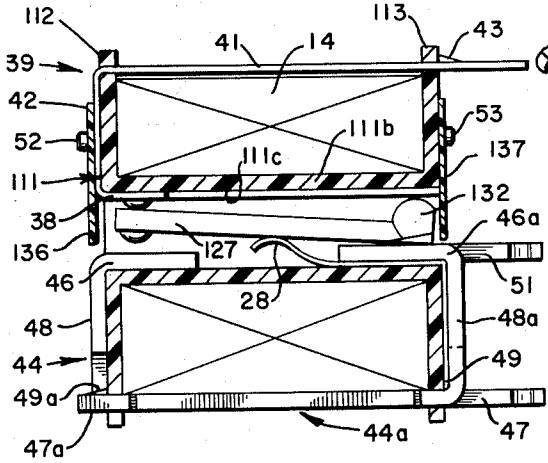
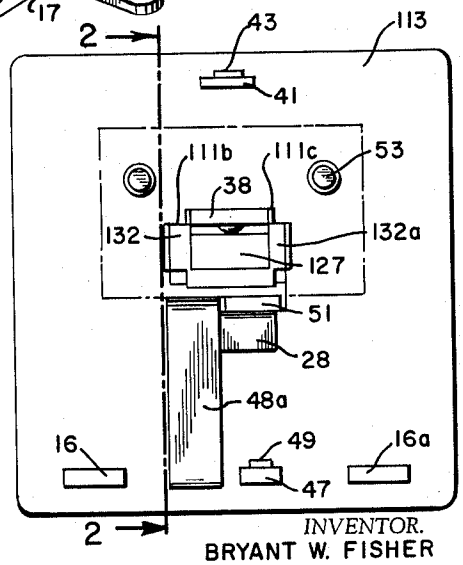


FIG. 3



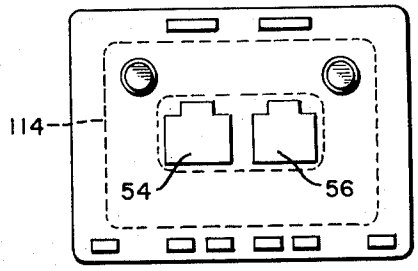


FIG. 4

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RELAY

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This invention relates to electromagnetically-operated relays and particularly to extremely simple relays suitable for use in toys and the like.

It is a principal object of this invention to produce a simple, inexpensive relay which will have enough sensitivity to be operated by a small current and yet will be capable of interrupting a much larger current repeatedly.

A second object of the invention is to provide a simple relay which can be manufactured without soldering and without threaded fasteners or other similar devices which would require hand assembly.

Since cost reduction is one of the main goals of this invention, simplicity of construction is essential. Not only must the parts be few in number, but they must be simple to form and easy to assembly. The present invention accomplishes the desired goals by using conductive magnetic members, both as parts of the magnetic core and as electrical contacts and terminals. Two such members are inserted into the coil from each end and are essentially wrapped around the coil to form a magnetic return path external to the coil. A floating conductive armature within the coil short-circuits the ends of the magnetic members (cores) together within the coil when a suitable current is applied. At other times, the armature is spring-biased away from one of the core members.

The core members are formed so that they lock into flanges at the end of the hollow coil bobbin, and a pair of end washers closes the remainder of the open area of the coil bobbin to keep the armature from slipping out.

The invention will be described in greater detail in connection with the drawing in which:

FIG. 1 is a perspective view of a relay constructed according to the invention, with parts broken or cut away to reveal the inner construction;

FIG. 2 is a cross-sectional view of a modified form of the relay in FIG. 1;

FIG. 3 is an end view of the relay in FIG. 2; and

FIG. 4 is an end view of a bobbin for a multi-pole relay similar to those shown in FIGS. 1–3.

The relay in FIG. 1 is built around a hollow, tubular bobbin **11**, preferably of insulating plastic, with a pair of radial flanges **12** and **13**. A coil **14**, which is indicated schematically, is mounted on the bobbin. A pair of coil lugs, of which only lug **16** is shown, is inserted in suitably provided apertures **17** in the two flanges. It should be noted that the flanges may be formed separately from the bobbin and, if so, are preferably identical to keep the number of different parts to a minimum. The lug **16** is connected to the coil **14** by a wire **18**, and in order to facilitate attachment of this wire to the lug, the lug is bent, slightly, away from the surface of the coil, as shown.

Two identical members **19** and **19***a* of ferromagnetically soft material form the core and contacts and terminals, as well, of the relay. To improve their conductivity they may be suitably plated, but frequently, the conductivity of the soft iron out of which these parts are usually made is sufficient to carry the necessary current without too much loss. Since both of these members are identical, in the preferred embodiment, it is necessary to describe only member **19***a* in detail. It is formed in the shape of a U, or, to be more accurate, a J, since one branch **21***a* is longer than the other branch **22***a*. These two

branches are joined by a flat section **23***a*. It will be noted that the member is formed of strip stock somewhat wider than it is thick and that it is bent about axes substantially parallel to the surface of the material so that the thickness of each branch in the plane that includes the U (or J) is less than the thickness in a direction perpendicular to that plane. Furthermore, the width of the branch **22** is greater than the width of the branch **21***a*. In fact, the width of branch **21** is slightly less than half that of branch **22***a*. This may be accomplished by cutting away more than half of the width of the base strip in forming branch **21***a* and part of section **23***a*.

As a result, the branch **21***a* of member **19***a* and the branch **21** of member **19** extend through identically formed holes in the two flanges **12** and **13**, and the total width of the two branches **21** and **21***a* lies between imaginary planes through the edges of the branch **22***a*. Since the branches **21** and **21***a* lie outside of the coil **14** and form magnetic return paths for flux produced when the coil is energized by a current, it is desirable for these branches to be as close as possible. To help achieve this, at least the central portion of the branches **21** and **21***a* may be displaced toward each other, as indicated by offsets **24***a* and **26***a*.

The armature **27** is a flat piece of electrically conductive, ferromagnetically soft material. As in the case of the members **19** and **19***a*, the conductivity of the armature may be improved by applying a suitable coating to it. The lefthand end of the armature is normally resiliently-biased away from contact with the inwardly-directed end of the branch **22** by means of a spring **28**. This spring is a bifurcated blade which has two contact points or areas **29** and **31** that press upon the armature **27** near the edges thereof. This spring is locked in place against the lower wall **11***a* of the bobbin by the branch **22***a* with which it may make electrical contact, in order to reduce the total resistance between the terminal ends of the branches **21** and **21***a*. In order to keep the righthand end of the armature **27** close to or in contact with the branch **22***a* to reduce the magnetic reluctance at the moment the coil is energized, the righthand end has two protuberances **32** and **32***a* pressed upwardly at the time the armature is formed. These protuberances bear on the upper inner wall surface **11***b* of the bobbin opposite the wall surface **11***a* against which the spring **28** presses. The central area of the armature between the protuberances **32** and **32***a* is flat so as to provide the desired low reluctance. The armature has a contact projection **33** at the proper place to make contact with the branch **22**.

The members **19** and **19***a* may be held in place on the flanges **12** and **13**, and may even hold the flanges, themselves, in place by a pair of pressure tangs, or catches, **34** and **34***a*.

Some means must be provided to keep the armature **27** in place when the coil is not energized. The armature may be welded to the spring **28**, but this is inconvenient and may adversely affect the characteristics of the spring. We have found that, with the construction shown, a pair of end washers **36** and **37** may be held in place by the flat sections **23** and **23***a* and may, in turn, close the remaining open area at each end of the bobbin **11** to prevent the armature from falling out.

FIG. 2 shows a cross-section of a modified form of relay arranged for double-throw operation and for mounting on a printed circuit board with all terminals at one end of the relay. The relay of FIG. 2 comprises a modified form of a bobbin **111** with integral end plates, or flanges, **112** and **113**. In place of a simple rectangular channel, the bobbin **111** has a channel with a groove **111***c* in its upper wall **111***b*. This provides space for the inwardly extending branch **38** of a U-shaped non-magnetic contact **39**. The contact **39** has another branch

41 that extends through the flanges 112 and 113 outside of the coil 14, and the branches 38 and 41 are joined together by a flat portion 42. A catch 43 holds the contact 39 firmly in place once it is inserted through flange 113.

The stationary ferromagnetic members of the relay, which also serve as frames and contacts, are indicated by reference characters 44 and 44*a*. The ferromagnetic member 44 has a branch 46 that extends into the lefthand end of the bobbin 111 and a second branch 47 that extends through both of the flanges 112 and 113, outside of the space set aside for the coil 14. The two branches are joined by a flat section 48 at the lefthand end of the relay and the member 44 is held in place by a catch 49 which is only partly visible in this view.

The other corresponding ferromagnetic frame member 44*a* has, generally, similar components to the member 44, except that the branch 47*a* extends only slightly beyond the lefthand flange 112, just enough to provide space for the catch 49*a* that holds the member 44*a* in place. The contact terminal portion of the member 44*a* is bent out at the same end as the contact portion of the branch 47 and is indicated by reference character 51. Thus, all of the terminal portions of the contact members 39, 44 and 44*a* extend from the righthand end of the relay and may be suitably spaced and shaped to fit into printed circuit terminal boards. While these contact members are referred to as being U-shaped, they should more accurately be considered as J-shaped.

The armature 127 is generally similar to the armature in FIG. 1, except that the pivot protuberances 132 (protuberance 132*a* is out of sight, behind the protuberance 132) are rounded to provide smoother action. The spring 28 is shown held in place by the member 44*a* and formed so that one end of the spring is bent over the outer surface of the flange 113 so as to hold better. This spring holds the movable end of the armature against the contact projection on the branch 38 of the normally-closed contact. At the same time the pivot end of the armature bears against branch 46*a* to complete the normally-closed circuit through the relay.

The armature 127 is held in place by a pair of end washers, or plates, 136 and 137 which are staked in place by stub members 52 and 53, respectively. As may be seen, the washers 136 and 137 may be put on after the remainder of the parts have been assembled, since they fit over the tops of the members 44 and 44*a*. In order to be insulating, these washers may be made out of plastic material.

FIG. 3 shows an end view of the relay of FIG. 2, just before the end washer 137 is placed in the area indicated by the broken lines. The armature 127 is in its unenergized position, making contact with the contact projection on the normally-closed contact member 38.

A part of the outer portion of the spring 28 is visible because of the fact that the material of the flat section 48*a*, which would normally cover this portion of the spring, has been bent straight out to form the terminal portion 51.

FIG. 4 shows a modified form of bobbin with two channels 54 and 56 therethrough to hold separate ferromagnetic frame members, such as members 19 and 19*a* of FIG. 1 or members 44 and 44*a* of FIGS. 2 and 3. In addition, a single coil 114 may be wound around both of the channels 54 and 56 in the space indicated in the dotted line, to energize both sections of the relay simultaneously.

While this invention has been described in specific terms, it will be understood by those skilled in the art that modifications may be made therein within the scope of the following claims.

What is claimed is:

1. A relay comprising: a bobbin; a coil of wire thereon; a pair of electrically conductive ferromagnetic members extending into said bobbin within said coil of wire from opposite ends of said bobbin, said ferromagnetic members being electrically insulated from each other; an electrically conductive ferromagnetic armature within said bobbin overlapping the proximal ends of said ferromagnetic members to be drawn magnetically into electrical contact with both said members when said coil is energized by an electric current; a spring bearing against said armature to hold said armature out of electrical and mechanical contact with one of said ferromagnetic members, except when said coil is energized by an electric current; and a pair of washers holding said armature within said bobbin.

2. A relay comprising: a hollow, tubular bobbin having a pair of radial flanges, one at each end; a coil on said bobbin; a pair of substantially identical, U-shaped, electrically conductive, ferromagnetically soft members, each having a first and a second branch, the first branch of each of said U-shaped members extending into one end, respectively, of said bobbin toward the corresponding end of the first branch of the other of said members and the second branch of each of said U-shaped members extending through one of said flanges, respectively, and alongside the outer surface of said coil, said second branches cooperating with each other to form a magnetic return path, said U-shaped members being insulated from each other; an electrically conductive, ferromagnetically soft two-ended armature floating freely within said bobbin and overlapping the ends of both of said first branches; a spring having one end between one of said first branches and the inner wall of said bobbin and the other end pressing against said armature to bias one end of the latter away from the other of said first branches, said armature comprising, at its other end, a raised portion extending toward a diametrically opposite inner wall of said bobbin to the wall closest to one end of said spring whereby said raised portion keeps said other end of said armature closest to said one of said first branches, said armature being magnetically attracted to make electrical contact with both of said first branches to connect said members together when said coil is energized by an electric current; and a pair of washers substantially closing both ends of said hollow bobbin to retain said armature.

3. A relay comprising: a hollow, tubular bobbin having a pair of radial flanges, one at each end; a coil on said bobbin; a pair of U-shaped, electrically conductive, ferromagnetically soft members, each having a first and a second branch, the first branch of each of said U-shaped members extending into one end, respectively, of said bobbin toward the corresponding end of the first branch of the other of said members, and the second branch of each of said U-shaped members extending through both of said flanges and alongside the outer surface of said coil, said second branches being closely adjacent to each other to form a magnetic return path of low reluctance outside of said coil, said U-shaped members being insulated from each other, one of said U-shaped members having a terminal extending in the opposite direction from its first branch, and the second branch of the other of said U-shaped members extending parallel thereto; an electrically conductive ferromagnetically soft armature within said bobbin; a spring resiliently biasing said armature away from said first branch of one of said members, said armature being moved into contact with said last-named branch when said coil is energized by an electric current; and a pair of washers substantially closing both ends of said hollow bobbin to retain said armature.

4. The relay of claim 2 in which said first branches are wider in a direction perpendicular to the plane of the U than they are in the plane of the U, and said second branches are approximately half of the width of said first branches, whereby the combined widths of both of said second branches lie substantially between planes bounding the outer edges of said first branches, and the first branch of one of said U-shaped members has a contact

portion extending in the opposite direction from said first branch, and the second branch of the other of said U-shaped members extends substantially parallel to said contact portion to form a second contact portion at the same end of said relay for connection to a terminal member.

5. A relay comprising: a hollow, tubular bobbin having a pair of integral radial flanges, one at each end; a coil on said bobbin; a pair of U-shaped, electrically conductive, ferromagnetically soft members, one branch of each of said U-shaped members extending into the end of said bobbin toward the corresponding end of the other of said members and in line therewith, and the other branch of each of said U-shaped members extending through both of said flanges and alongside the outer surface of said coil, said other branches cooperating with each other to form a magnetic return path, said U-shaped members being insulated from each other; a catch on each of said other branches to engage said flanges and hold said members in place; an electrically conductive ferromagnetically soft armature within said bobbin; a spring resiliently biasing said armature away from the branch of one of said members extending into said bobbin, said armature being moved into contact with said last-named branch when said coil is energized by an electric current; and a pair of washers substantially closing both ends of said hollow bobbin to retain said armature.

6. The relay of claim 5 in which each of said U-shaped members has a flat section joining one end of the branches of that U-shaped member on the outer surface of one of said flanges, respectively, and said catches engage the outer surface of the other of said flanges, respectively.

7. The relay of claim 5 comprising: a pair of stub members on the outer surface of each of said flanges, each of said washers having holes fitting over said stub members, said washers extending across the ends of said bobbins adjacent to the areas in which said one branch of each of said U-shaped members extends into said bobbin.

8. The relay of claim 5 comprising: an additional normally-closed U-shaped non-magnetic contact consisting of a flat portion and two branches, one at each end of said flat portion, one of said branches extending into said bobbin in the region adjacent to said one of said

members, but adjacent to the diametrically opposite interior wall from said one of said members and in position to engage said armature when said coil is not energized.

9. A relay comprising: a bobbin having a pair of substantially parallel channels therethrough and a pair of radial flanges, one at each end; a coil wound on said bobbin around both of said channels; first and second pairs of substantially identical, J-shaped, electrically conductive ferromagnetic soft frame members, each having a short branch and a long branch, the short branch of each of said J-shaped members extending into one end, respectively, of each of said channels in said bobbin and toward the corresponding end of said short branch of one of the other of said J-shaped members, and the long branch of each of said J-shaped members extending through both of said flanges and alongside the outer surface of said coil, said long branches cooperating with each other to form a pair of magnetic return pads with each of said long branches electrically insulated from all others; a pair of electrically conductive, ferromagnetically soft armatures, each of said armatures floating freely within one of said channels and overlapping the ends of both of said short branches within their respective channel; a pair of springs, one in each of said channels between one of said short branches and one portion of the inner wall of said bobbin and the other end pressing against said armature to bias one end of the latter away from the other of said short branches, said armature being magnetically attracted to make electrical contact with both of said short branches to connect said members together electrically when said coil is energized by an electric current; and a pair of washers substantially closing both ends of each of said channels to retain said armatures.

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