

Feb. 22, 1966

W. F. SOMMER

3,236,964

PLURAL ARMATURE ELECTROMAGNETIC SWITCH

Filed March 30, 1964

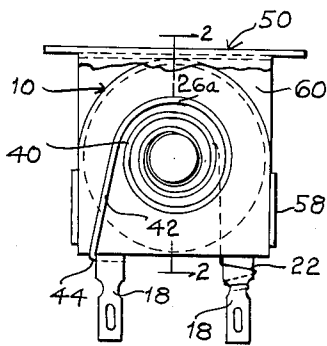


FIG. 1

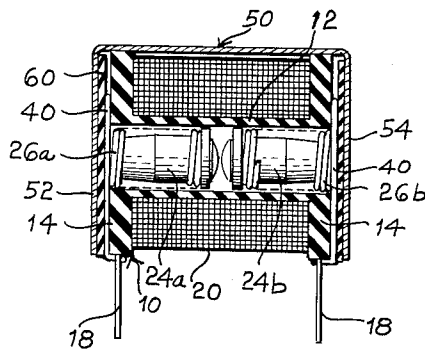


FIG. 2

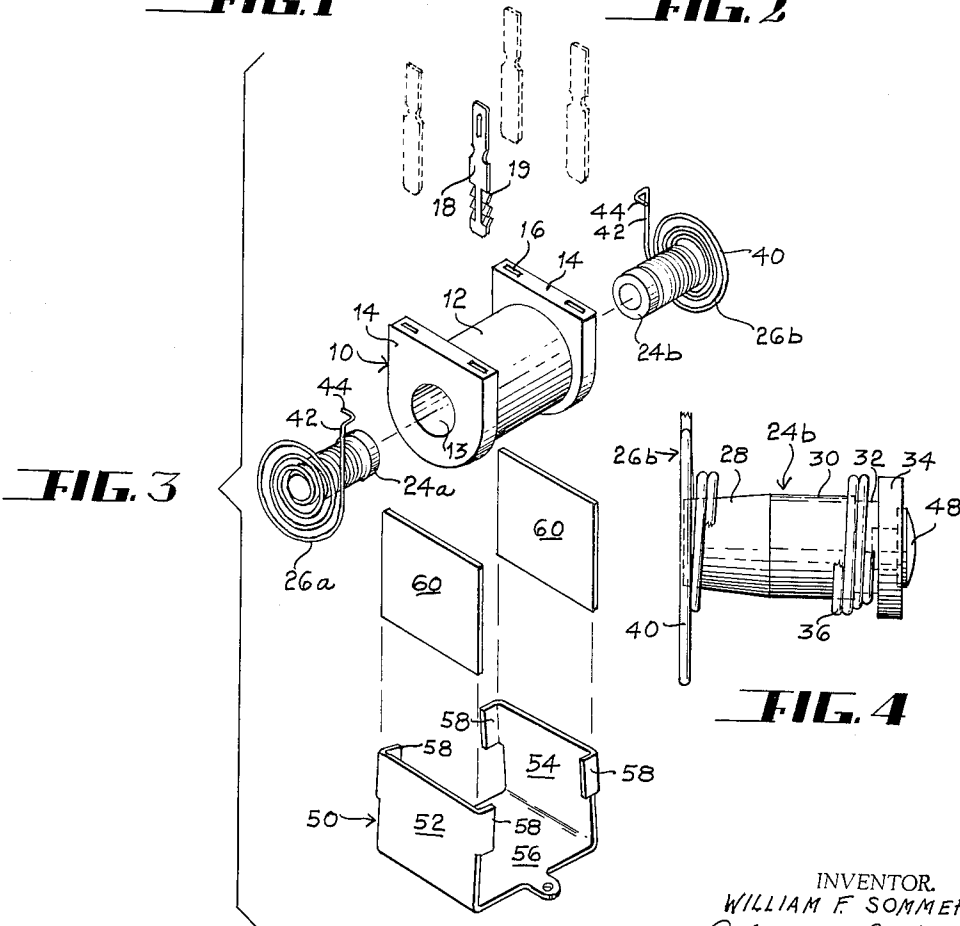


FIG. 3

FIG. 4

INVENTOR.
WILLIAM F. SOMMER
BY *Dybing and Dybing*
HIS ATTORNEYS

1

3,236,964

PLURAL ARMATURE ELECTROMAGNETIC SWITCH

William F. Sommer, Brookville, Ohio, assignor to Ledex, Inc., Dayton, Ohio, a corporation of Ohio
Filed Mar. 30, 1964, Ser. No. 355,714
12 Claims. (Cl. 200-87)

This invention relates to an electromagnetically operated relay and more particularly to a relay which controls the current flow along a path coaxial with respect to an operating coil, however, the invention is not necessarily so limited.

An object of the present invention is to produce a relay which switches current flow in a path disposed coaxial with respect to an operating coil.

Another object of the present invention is to provide a coaxial relay of simplified construction.

A further object of the present invention is to provide an improved relay device which, by minor adjustment of the dimensions thereof, can be constructed for operation either as a normally open relay or as a normally closed relay.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture and the mode of operation, as will become more apparent from the following description.

In the drawing,

FIGURE 1 is an end elevational view, with a portion broken away, illustrating a relay device embodying the present invention.

FIGURE 2 is a sectional view, taken substantially along the line 2-2 of FIGURE 1.

FIGURE 3 is an exploded perspective view of the relay device of FIGURE 1.

FIGURE 4 is an enlarged fragmentary side elevational view illustrating a core piece assembly employed in the present invention.

Referring to the drawing in greater detail, the reference numeral 10 designates an electrically insulating housing or spool upon which the relay device is assembled. The housing comprises a tubular sleeve portion 12 having integral end plates 14. A straight through aperture 13 passes through the end plates 14 and through the center of the sleeve 12. Spaced openings 16 formed in a base margin of each of the end plates 14 receive terminal posts 18. The material of the housing 10 is preferably a flexible thermo-plastic material, such as nylon or polyethylene. The terminal posts 18 are provided with jagged barbs 19 which fit snugly into the openings 16 and resist removal of the terminal post from the opening into which it has been positioned.

The tubular sleeve portion 12 of the housing is surrounded by a solenoid coil 20 having leads, as shown at 22, engaging terminal posts 18. In accordance with well understood electrical phenomena, energization of the coil 20 by application of a potential to the terminal posts engaged by the leads 22 results in production of an axially disposed magnetic field within the interior of the sleeve 12. Such field is utilized to effect a switching function in the following manner.

Disposed within the interior of the sleeve 12 are two core pieces 24a and 24b. The core pieces are gripped by springs 26a and 26b respectively. Each of the core pieces comprises a soft iron of high magnetic susceptibility. As noted in FIGURE 4, each core piece has a convergent end portion 28, an intermediate cylindrical portion 30 and an opposite end portion 34 of enlarged diameter, separated from the cylindrical portion 30 by a channel 32 of reduced diameter. The spring 26a or 26b which engages each core piece comprises a cylindrically coiled portion 36 and at one end of such cylindri-

2

cal portion an end portion 40 which is spirally wound in a single plane. The dimensions of the core pieces and the springs are such that the cylindrical body portion 36 of each spring may be forced on to the convergent end of a core piece where its diameter becomes slightly expanded, and then moved over the cylindrical portion 30 and over the channel 32, with the result that the first few convolutions of the cylindrical portion 36 snap into the channel 32, thereby retaining the springs 26a and 26b on the core pieces 24a and 24b respectively. The length of the cylindrical portion 36 of each spring 26a or 26b is such that upon assembly of the springs on the core pieces, the planar spirally wound ends 40 of the springs are substantially at the convergent ends of the core pieces.

Each of the core pieces 24a and 24b has an axially disposed aperture in the end portion 34 thereof which receives a contact button 48 press-fitted therein. The contact buttons 48, which may be of primarily steel construction, each have a relatively heavy layer of non-magnetic material, such as a palladium alloy, welded or otherwise fixedly secured to the outer face thereof. As will become more apparent in the following, the heavy palladium layer performs two important functions, one function being that of providing a non-corrosive contact surface and the other function being that of establishing a gap in the magnetic flux path to be described.

As best seen in FIGURE 2, the core pieces 24a and 24b are supported in the interior of the sleeve 12 with their contact buttons 48 in confronting relation. For mounting the core pieces within the sleeves 12, the spirally wound end portions 40 of the springs 26a and 26b are positioned in contact with the external faces of the plates 14 and terminal portions 42, integral with the springs 26a and 26b, are attached to terminal posts 18 by means of hook portions 44 formed on the terminal portions 42. By this construction, the spring 26a and its respective core piece 24a is connected electrically to one of the terminal posts 18 and the spring 26b and its respective core piece 24b is connected electrically to another terminal post 18.

The core pieces and their respective springs are positively locked in position by means of a bracket 50 having end walls 52 and 54 supported in spaced relation by a side wall 56. The bracket 50 is designed for fitting over the housing 10 in such position that the end walls 52 and 54 overlie the end plates 14, also overlying the spirally wound end portions 40 of the springs 26a and 26b. The bracket is initially formed with its end walls 52 and 54 turned inwardly at an acute angle to the side wall 56, whereby the bracket must be stressed for attachment to the housing 10, the resultant restoring force pressing the end walls 52 and 54 against the housing plates 14 with a sufficient force for retaining the bracket on the housing.

The bracket 50 is prevented from twisting about the axis of the sleeve 12 by means of ears 58 formed on the end walls 52 and 54 and engaging the end plates 14 of the housing 10.

For reasons which will appear more fully in the following, the bracket 50 is preferably fabricated from a ferromagnetic metal sheet. To prevent the bracket 50 from providing a conductive path between the springs 26a and 26b and for other reasons to be described, insulating wafers 60 are inserted between the spirally wound end portions 40 of the springs 26a and 26b and the end walls of the bracket 50.

The core pieces 24a and 24b with their springs 26a and 26b cooperate to provide a selectively controllable current path through the sleeve 12. In addition, these same elements cooperate with the bracket 50 to form an annular flux path surrounding a portion of the coil 20.

This flux path is rendered discontinuous by the presence of three gaps therein. The first gap exists between the end portion 40 of the spring 26a and the end wall 52 and has a minimum thickness determined by the thickness of a wafer 60. The second gap exists between the end wall 54 and the end portion 40 of the spring 26b and also has a minimum thickness determined by a wafer 60. The third gap exists between the contact buttons 48 of the core pieces 24a and 24b. The thickness of this third gap depends upon the condition of the springs 24a and 24b and, in any event, the third gap has a minimum thickness corresponding to twice the thickness of the palladium surface on each contact button. Upon energization of the solenoid, the core pieces will move to close and open the gaps in the aforesaid flux path, the direction of motion being dependent on the geometric arrangement of parts.

In the preferred mode of operation, the palladium surface on each contact button 48 is approximately .015" thick. Also, in the preferred mode of operation, the springs 26a and 26b, when relaxed, support their respective core pieces in spaced relation, whereby the contact buttons 48 are not in contact, the gap therebetween being approximately .020". With such geometric arrangement, energization of the coil 20 to an operating level induces the core pieces 24a and 24b to move together, so as to close the gap therebetween. Of course, the palladium surfaces on the contact buttons 48 prevent complete closure of the gap and thereby prevent any sticking of the core pieces due to magnetic retentivity. The aforesaid mode of operation results in a normally open relay circuit which is closed by energization of the operating coil.

As an alternate mode of operation, the thickness of the wafers 60 may be substantially reduced, as to .005", and the springs 26a and 26b adjusted, so that when relaxed the springs hold the contact buttons 48 in contacting relation. With such geometric arrangement, energization of the coil 20 to an operating level can be used to induce the core pieces 24a and 24b to seek to close the gaps at the end walls of the bracket 50, the ultimate result being that energization of the coil opens a normally closed circuit. While specific gap thicknesses have been set forth in the present description, it is to be understood that the movements of the core pieces 24a and 24b of the present device, while affected by gap thicknesses as described, are also affected by the geometric configurations of all ferromagnetic elements in the relay structure and, accordingly, it is found that the behavior of the core pieces in any specific relay construction must be determined through techniques familiar to those skilled in the art.

The relay construction of the present invention offers a number of practical advantages. For example, in the preferred mode of operation previously described, the dual spring mounting of the core pieces provide a snap action in the switching function. Thus, upon energization of the coil 20 so as to induce a magnetic flux in the core pieces, the core pieces are drawn one to another. This attraction between the core pieces increases exponentially due to the reducing gap therebetween, with the result that the core pieces move together very quickly.

The housing 10 is preferably, but not necessarily, of nylon or polyethylene construction. With such construction, it is found that static friction between the core pieces and the interior wall of the sleeve has an initial retarding effect upon the movement of the core pieces. However, as the magnetic flux density approaches a level sufficient to overcome the static friction between the core pieces and the interior wall of the sleeve 12, a very much lower sliding friction resistance is encountered, with the result that the core pieces snap together in an exceedingly short interval of time.

It will be noted, of course, that the springs 26a and 26b which are preferably of non-magnetic material, such as beryllium copper, serve as current carriers in the circuit

controlled by the coil 20. By using these springs as current carriers, exceptionally high currents for a relay of the present size may be controlled. A further advantage to the present construction resides in the protection afforded the palladium contact surfaces which are fully enclosed within the sleeve 12.

Although the preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportion and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. A device of the class described comprising, in combination, an insulating housing member including a tubular sleeve portion, an operating coil surrounding said sleeve portion, first and second ferromagnetic core bodies disposed for relative axial movement in said sleeve portion, one core body including a non-magnetic electrically conductive surface element in confronting relation to the other core body within said sleeve portion, first and second mounting means on said housing, first conductor means including a resilient spring portion connecting said first core body with said first mounting means and second conductor means connecting said second core body with said second mounting means, said first conductor means restraining axial movement of said first core body but yielding to the magnetic field of said coil upon energization of said coil, said first and second conductor means cooperating with said core bodies to establish a make and break current path extending through said surface element and subject to the control of said operating coil, ferromagnetic bracket means disposed externally of said coil and having end walls disposed at the ends of said sleeve portion, there being a magnetic flux path extending through said bracket externally of said coil and through said ferromagnetic core bodies internally of said coil, means establishing a first gap in said flux path between said first core body and one end wall of said bracket, said surface element included on said one core body establishing a second gap in said flux path.

2. An electromagnetically operated switch device comprising, in combination, an insulating housing member including a tubular sleeve portion, an operating coil surrounding said sleeve portion, first and second ferromagnetic core bodies disposed for relative axial movement in said sleeve portion, each core body including a non-magnetic electrically conductive surface element, said surface elements being disposed in confronting relation within said sleeve portion, first and second mounting means on said housing, first conductor means including a resilient spring portion engaging said first core body and passing through one end of said sleeve portion to engage said first mounting means, and second conductor means engaging said second core body and passing through the opposite end of said sleeve portion to engage said second mounting means, said first and second conductor means cooperating with said core bodies to establish a make and break circuit between said mounting means subject to the control of said operating coil, said first conductor means restraining axial movement of said first core body, ferromagnetic bracket means disposed externally of said coil and having end walls disposed at the ends of said sleeve portion, there being a magnetic flux path extending through said bracket externally of said coil and through said core bodies internally of said coil, means establishing a first gap in said flux path between said first core body and one end wall of said bracket, said surface elements included on said core bodies establishing a second gap in said flux path.

3. An electromagnetically operated switch device comprising, in combination, an insulating housing member including a tubular sleeve portion, an operating coil sur-

5

rounding said sleeve portion, first and second ferromagnetic core bodies disposed for relative axial movement in said sleeve portion, each core body including a non-magnetic electrically conductive surface element, said surface elements being disposed in confronting relation within said sleeve portion, first and second mounting means on said housing, first conductor means including a resilient spring portion connecting said first core body with said first mounting means and second conductor means including a resilient spring portion connecting said second core body to said second mounting means, said first and second conductor means restraining axial movements of said first and second core bodies respectively, said first and second conductor means cooperating with said core bodies to establish a make and break conductive circuit between said mounting means subject to the control of said operating coil, ferromagnetic bracket means disposed externally of said coil and having end walls disposed at the ends of said sleeve portion, there being a magnetic flux path extending through said bracket externally of said coil and through said ferromagnetic core bodies internally of said coil, means establishing a first gap in said flux path between said first core body and one end wall of said bracket, said surface elements included on said core bodies establishing a second gap in said flux path.

4. An electromagnetically operated switch device comprising, in combination, an insulating housing member including a tubular sleeve portion, an operating coil surrounding said sleeve portion, first and second ferromagnetic core bodies disposed for relative axial movement in said sleeve portion, each core body including a non-magnetic electrically conductive surface element, said surface elements being disposed in confronting relation within said sleeve portion, first and second mounting means on said housing, first conductor means including a resilient spring portion connecting said first core body with said first mounting means, and second conductor means including a resilient spring portion connecting said second core body to said second mounting means, said first and second conductor means restraining axial movements of said first and second core bodies respectively, said core bodies and said conductor means cooperating to establish a make and break conductive circuit between said mounting means, ferromagnetic bracket means disposed externally of said coil and having end walls disposed at the ends of said sleeve portion, there being a magnetic flux path extending through said bracket externally of said coil and through said core bodies internally of said coil, means establishing a first gap in said flux path between said first core body and one end wall of said bracket, means establishing a second gap in said flux path between said second core body and the other end wall of said bracket, said surface elements included on said core bodies establishing a third gap in said flux path.

5. An electromagnetically operated switch device comprising, in combination, an insulating housing member including a tubular sleeve portion, an operating coil surrounding said sleeve portion, first and second ferromagnetic core bodies disposed for relative axial movement in said sleeve portion, each core body including a non-magnetic electrically conductive surface element, said surface elements being disposed in confronting relation within said sleeve portion, first and second mounting means on said housing, first conductor means including a resilient spring portion connecting said first core body with said first mounting means and second conductor means including a resilient spring portion connecting said second core body to said second mounting means, said first and second conductor means restraining axial movements of said first and second core body respectively and, when the spring portions thereof are relaxed, supporting said first and second core bodies in axially spaced relation within said sleeve portion, ferromagnetic bracket means disposed ex-

6

ternally of said coil and having end walls disposed at the ends of said sleeve portion, there being a magnetic flux path extending through said bracket externally of said coil and through said core bodies internally of said coil, means establishing a first gap in said flux path between said first core body and one end wall of said bracket, means establishing a second gap in said flux path between said second core body and the other end wall of said bracket, said surface elements included on said core bodies establishing a third gap in said flux path, said core bodies cooperating with said conductor means to establish a normally open conductive circuit between said mounting means and said core bodies cooperating upon energization of said coil to close said conductive circuit by overcoming the restraint of said conductor means and moving their respective contact elements into contact one with the other.

6. A device of the class described comprising an operating coil, insulating sleeve means disposed axially within said coil, a pair of electrical contact means disposed for axial movement within said sleeve means, each said contact means including a ferromagnetic body portion, a pair of resilient conductor elements, one conductor element being disposed adjacent one end of said sleeve means and engaging one of said contact means and the other conductor element being disposed adjacent the other end of said sleeve means and engaging the other of said contact means, said conductor elements each restraining axial movement of and providing a conductive path to the contact means engaged thereby, said conductor elements, when relaxed, supporting said contact means in axially spaced relation, and, upon energization of said operating coil, yielding to permit movement of said contact means into contact one with the other in response to the magnetic field of said coil, contact between said contact means establishing a conductive path between said conductor elements.

7. A switch device comprising an operating coil, insulating sleeve means disposed axially within said coil, a pair of electrical contact means disposed for axial movement within said sleeve means, each said contact means including a ferromagnetic body portion, a pair of resilient conductor elements, each said conductor element comprising a cylindrical coiled spring portion surrounding and engaging one of said contact means, and an integral spirally wound spring portion occupying a plane substantially normal to the axis of said cylindrical spring portion, one conductor element being disposed adjacent one end of said sleeve means with its spirally wound portion outside of said sleeve means and its cylindrical portion projecting into said sleeve means and the other conductor element being disposed adjacent the other end of said sleeve means with its spirally wound portion outside said sleeve means and its cylindrical portion projecting into said sleeve means, said conductor elements each restraining axial movement of and providing a conductive path to the contact means engaged thereby, said conductor elements, when relaxed, supporting said contact means in axially spaced relation, and, upon energization of said operating coil, yielding to permit movement of said contact means into contact one with the other in response to the magnetic field of said coil, contact between said contact means establishing a conductive path between said conductor elements.

8. A switch device comprising an insulating spool having a central sleeve and having end plates at the opposite ends of said sleeve, there being an aperture passing axially through said sleeve and through said end plates, an operating coil disposed around said sleeve between said end plates, a pair of electrical contact means disposed for axial movement within said sleeve, each said contact means including a ferromagnetic body portion, a pair of resilient conductor elements each having a cylindrical coiled spring portion surrounding the body portion of one of said contact means and each having an integral spirally

wound portion occupying a plane substantially normal to the axis of said cylindrical coil portion, said conductor elements being disposed at the opposite ends of said sleeve with their respective spirally wound portions disposed outside said sleeve adjacent said end plates and with their respective cylindrical coiled portions disposed inside said sleeve, said conductor elements each restraining axial movement of and providing a conductive path to the contact means engaged thereby, said conductor elements, when relaxed, supporting said contact means in axially spaced relation, and, upon energization of said operating coil, yielding to permit movement of said contact means into contact one with the other in response to the magnetic field of said coil, contact between said contact means establishing a conductive path between said conductor elements.

9. A relay device according to claim 8 including ferromagnetic bracket means disposed externally of said coil and having end walls disposed adjacent said end plates of said spool, and including insulating means between said end walls of said bracket and said spirally wound portions of said conductor elements.

10. A relay device according to claim 8 including a terminal element supported by each said end plate of said spool, the spirally wound portion of each said conductor element engaging the terminal element supported by the adjacent end plate.

11. A device of the class described comprising an operating coil, a pair of electrical contact means disposed for axial movement within said coil, said contact means each including a ferromagnetic body portion, a pair of resilient conductor elements, one conductor element engaging one of said contact means and leading to the exterior of said coil through one end thereof, and the other conductor element engaging the other of said contact means and leading to the exterior of said coil through the other end thereof, said conductor elements each restraining axial movement of and providing a conductive path to the contact means engaged thereby, said conductor

elements, when relaxed, supporting said contact means in axially spaced relation and, upon energization of said operating coil, yielding to permit movement of said contact means into contact one with the other in response to the magnetic field of said coil, contact between said contact means establishing a conductive path between said conductor means.

12. A device of the class described comprising, in combination, an operating coil, first and second ferromagnetic core bodies disposed for relative axial movement within said coil, one core body including a non-magnetic electrically conductive surface element in confronting relation to the other core body, first and second mounting means supported fixedly with respect to said coil, first conductor means including a resilient spring portion connecting said first core body with said first mounting means and second conductor means connecting said second core body with said second mounting means, said first conductor means restraining axial movement of said first core body but yielding to the magnetic field of said coil upon energization of said coil, said first and said second conductor means cooperating with said core bodies to establish a make and break current path extending through said contact surface and subject to control of said operating coil, ferromagnetic bracket means disposed externally of said coil and having end walls disposed at the ends of said coil, there being a magnetic flux path extending through said bracket externally of said coil and through said ferromagnetic core bodies internally of said coil, means establishing a first gap in said flux path between said first core body at one end wall of said bracket, said surface element included on said one core body establishing a second gap in said flux path.

No references cited.

BERNARD A. GILHEANY, *Primary Examiner.*