May 26, 1964 R. S. WINSHIP 3,134,867

MULTIPLE-FLUX ELECTRICAL REED RELAY

Filed July 26, 1961

Fig. 1

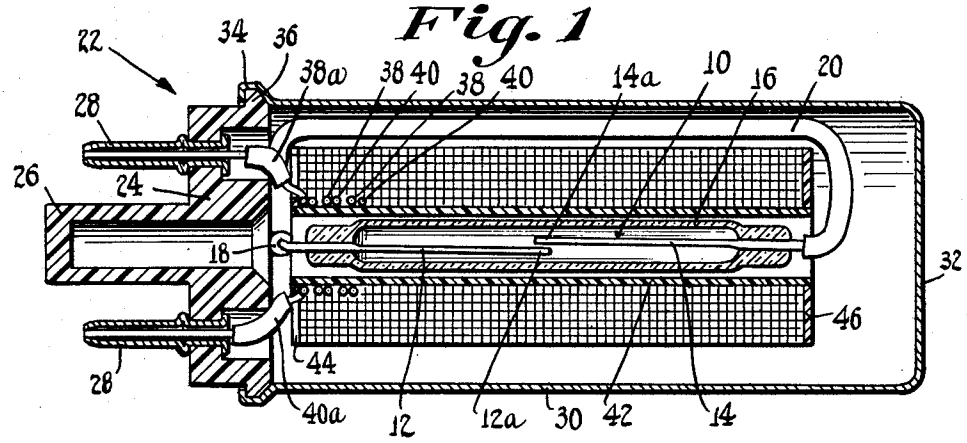


Fig. 2

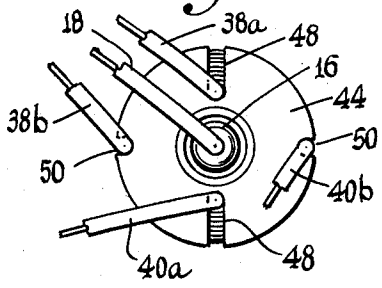


Fig. 3

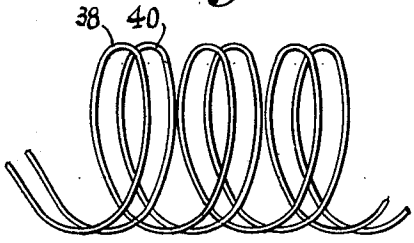
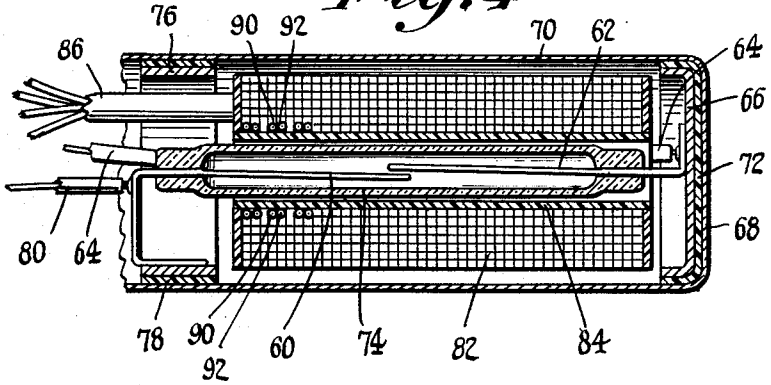


Fig. 4



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MULTIPLE-FLUX ELECTRICAL REED RELAY

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This invention relates to sensitive electrical relays, and more particularly to relays of the type wherein the mechanical action is obtained as a consequence of interaction of two or more separate or individual magnetic fluxes.

Relays of the above-identified type as currently being produced in quantity on the market comprise an electric switch means having at least one movable magnetic member which responds to flux to open or close the switch contacts, such flux being provided by a small permanent magnet. To effect actuation of the switch, there is further provided an electrical coil constituting an electromagnet which is so arranged as to oppose or buck the flux from the permanent magnet whereby the nullified magnetism has a lesser effect on the magnetic switch component, relieving the switch member of magnetic force whereby a spring action may effect the desired movement. Upon de-energization of the electrical coil, the full effect of the flux from the permanent magnet is experienced by the magnetic switch member, to cause movement of the latter against the spring action.

While relays of the above type appear to have operated satisfactorily, I have found that the electrical coil eventually causes a deterioration of the permanent magnet whereby the latter looses strength to such an extent that ultimately the relay becomes inoperative for the purpose desired. I have further discovered that with this prior type of relay it is difficult to attain closely controlled values of flux, whereby individual adjustments and re-adjustments are often necessary and whereby in spite of these and the attendant expense there results a lack of uniformity in performance. The above drawbacks and disadvantages of prior electrical relays of the identified type are obviated by the present invention, and one object of the invention is to provide a novel and improved bucking-flux electrical relay having two or more separate and individual magnetic operating fluxes, which relay is reliable in operation throughout an extended period of use.

Another object of the invention is to provide an improved relay as above characterized, which is especially rapid or fast-acting in its response.

A further object of the invention is to provide an improved multi-flux relay in accordance with the foregoing, which is efficient and sensitive in its operation.

Still another object of the invention is to provide a novel multiple-flux relay as set forth, which is small and compact whereby it does not require appreciable space.

A feature of the invention resides in the provision of an improved multiple-flux relay as outlined, which is not adversely affected by external magnetic fields.

Another feature of the invention resides in the provision of a multiple-flux relay as above set forth, which is simple in its construction, involves relatively few parts or components, and which is especially economical to fabricate and produce.

Other features and advantages will hereinafter appear.

In the accompanying drawings showing several embodiments of the invention, similar characters of reference have been used to designate like components wherever possible throughout the several views, in which:

FIG. 1 is an axial sectional view through an improved multiple-flux electrical relay as provided by the invention.

FIG. 2 is an end elevational view of the bucking coil and switch means assemblage of the relay.

FIG. 3 is a diagrammatic representation of the bucking coil organization, illustrating the method of winding the coil in bifilar fashion.

FIG. 4 is an axial sectional view of an improved multiple-flux relay illustrating a modification of the invention wherein the metal casing or can for the relay mechanism also constitutes a return magnetic path for the flux-responsive switch means.

Referring first to FIG. 1, the improved quick-acting relay as provided by the invention comprises an electrical switching device designated generally by the numeral **10**, the said switching device having a pair of magnetic members or blades **12** and **14**, disposed substantially in alignment with each other, at least one of such blades constituting a movable switch member, and adjoining end portions of the blades or strips being arranged in overlapping relation. As shown, an end portion **12***a* of the blade **12** and an end portion **14***a* of the blade **14** overlap each other whereby these portions constitute contacts which are engageable with and disengageable from each other. The switch blade **14** may constitute solely the movable member of the switch device, or as preferred, both blades **12** and **14** are movable by virtue of being flexible and resilient, being constituted of thin metal stock by which they may be readily flexed.

The switch blades **12** and **14** may be mounted in any suitable manner. As shown herein, the blades are carried within a sealed capsule **16** which may be advantageously formed of glass, and preferably the air is evacuated from the capsule and an inert gas such as helium is used to replace the same.

The extrenal ends or extremities of the strips **12, 14** constituting the switch **10** are connected with suitable lead wires **18** and **20** respectively, said wires being joined to contact pins of a plug-type connector **22** of standard design. The connector **22** may, for example, be in the form of the well known vacuum tube base, having a disk-like body portion **24**, a central locator pin **26** formed integral with the body portion, and a plurality of metallic hollow contact pins **28** disposed in a circle. Where eight such contact pins are provided, the tube base is known as an "octal" base.

Carried by the plug-type connector or base **22** is an external metallic casing **30** in the form of a deep cylindrical shell or cup, having at one end an integral transverse wall **32** and at its other end a gripping flange **34** by which it is secured to an annular shoulder **36** on the tube base. Preferably the shell or casing **30** is of magnetic metal such as steel, by which the switch device is completely shielded and prevented from being effected by external stray fields.

In accordance with the present invention, a fast acting, positive and reliable electro-magnetic means is provided for actuating the sealed-in switch device **10**, the said means comprising a pair of bucking electrical coils **38** and **40**, see FIGS. 1 and 3, which are preferably wound in bifilar fashion on a common bobbin **42** having disk-like ends **44** and **46**. The bobbin end **44**, see FIGS. 1 and 2, is provided with radial slots **48** and **50**, preferably located 90° apart, through which the ends of the two coils **38, 40** may pass. As seen in FIG. 2, end wires **38***a* and **40***a* may constitute the beginning portions of the two coils **38, 40**, and the wires **38***b* and **40***b* may constitute the end portions of the two coils. The winding of the two coils is preferably done at one and the same time, as by starting with two wires and winding the bobbin **42** in layer fashion, feeding the two wires as a single one, so to speak, this fashion of winding being clearly illustrated in FIGS. 1 and 3.

When the winding has been completed, the four leads **38***a*, **38***b* and **40***a*, **40***b* are brought out to the connector pins **48** of the plug connector **22**, as illustrated in FIG. 1. As shown in this figure, the sealed capsule **16** closely fits within the core portion of the bobbin **42** whereby

a mutual support is had. The stiffness of the lead or connector wires is sufficient to fully support the assemblage of switch device, sealed capsule and bucking coil winding within the case **30**. If desired, a potting compound may be further utilized within the case **30**, to embed and support the assemblage, or sponge insulating or other type material may be employed in the spaces, to hold the coil assembly roughly centralized.

I have found that an electrical relay device as constituted in the above manner, comprising a pair of bucking electrical coils which are arranged in tightly coupled relationship, provides an extremely fast and reliable switching action, as follows:

Normally one of the two coils **38**, **40** may be continually energized. For example, the coil **38** may be the one that is energized. This effects a strong magnetization of the magnetic strips **12**, **14** making up the switch device, and the attraction between the overlapping ends of such strips will be quite strong, causing these portions to firmly contact each other, whereby the switch device is in closed condition. When it is desired to open the circuit of the switch device, the second coil **40** is energized with the direction of current opposite to that in the coil **38** and to an extent roughly equal to the energization of the coil **38**. In consequence, the fluxes or magnetic fields of the coils will be in bucking relation and will tend to cancel out each other, whereby but little resultant flux will exist at the capsule **16**. The switch blades **12**, **14** will accordingly be only very lightly magnetized, if at all, and virtually no magnetic attraction will therefor exist between the overlapping ends thereof. In consequence, the normal mechanical bias which is experienced by the resilient contact blades will effect a separation of the same, as illustrated in FIG. 1.

I have found that by virtue of the double, bucking coil construction where dependence is not had upon permanent magnetism, the switching action is reliable throughout an extended life period of the relay. This is in sharp contrast to relays involving permanent-magnet, flux-generating means, wherein an opposing magnetic flux tends to weaken the permanent magnetism to such an extent that it impairs the proper, normal operation of the relay.

With the above construction, if the switch device **10** is to be normally open, then both of the coils **38**, **40** are normally energized equally and in opposition. De-energization of either one or the other of the coils **38**, **40** will result in a strong flux being manifested in the capsule **16**, and a closing of the switch contacts comprising the blades **12**, **14**. On the other hand, if the switch device **10** is to be normally closed, then either one or the other of the two coils **38**, **40** is continually energized, to effect such condition. Proper energization of the other coil at any time will result in the switch device **10** being open-circuited as will now be understood.

Another embodiment of the invention is illustrated in FIG. 4, wherein a more complete magnetic circuit and path is provided, in conjunction with the magnetic switch blades or strips, whereby the relay action is more sensitive in response to weaker currents and magnetism in the opposing or bucking coils. In FIG. 4, the switch blades of magnetic material are designated by the numerals **60** and **62**. The switch blades have adjoining portions arranged in overlapping relation as shown, and the blade **62** is connected to a lead wire **64**, and also physically affixed to a magnetic disk or shallow cup **66** which is disposed against the closed end **68** of a magnetic casing **70**. A thin film of insulating material **72** may be provided between the disk **66** and the casing **70**, to electrically insulate these from each other. The switch blades **60** and **62** are carried in a sealed capsule **74**, and the blade **60** at the exterior of the capsule **74** is bent into a U-shape and is secured to a ring or annulus of magnetic material **76**, in the form of a section of a cylinder. The ring **76** is disposed within the open end portion of the casing **70**, and is insulated from the latter by a thin film or strip of insulating material **78**. A lead wire **80** is joined to the switch strip **60**, as shown.

A bucking coil assemblage **82** wound on a bobbin **84** is disposed within the casing **70**, surrounding the sealed capsule **74**, and the four lead wires from the two opposing coils are brought out in a cable **86**, as shown.

By the above construction as illustrated in FIG. 4, the magnetism from the coil assemblage **82** when either one or the other of the two coils thereof is energized, finds a magnetic path through the switch blades **60**, **62**, through the magnetic disk **66**, through the magnetic casing **70**, and through the ring **76**. Accordingly, virtually a complete magnetic path is provided both inside and outside of the coil assemblage **82**, whereby a given flux or magnetomotive force in one coil or the other will result in a much stronger magnetism and flux in the complete path outlined above. Accordingly, the relay will respond to weaker currents and hence be more sensitive. The opposing action of the two coils making up the coil assemblage **82** is similar to that described above in connection with FIGS. 1–3. In FIG. 4 a diagrammatic representation of the coil wires is shown, one wire being designated by the numeral **90** whereas the other wire is labelled **92**.

As with the relay illustrated in FIGS. 1–3, the absence of permanent magnetism and dependence on the same results in extreme reliability in the relay, since the fluxes from the coils will not deteriorate, but instead are a function of the ampere turns.

It will now be understood from the foregoing that I have provided a novel and improved electrical relay device which is small and compact, reliable in its operation at all times, and especially fast-acting by virtue of the sealed switch construction and the bucking or opposing coils providing the motivation.

The relay is seen to consist of relatively few parts and components, and to involve a simple construction and assemblage whereby it may be economically fabricated and produced.

Variations and modifications may be made within the scope of the claims, and portions of the improvements may be used without others.

I claim:

1. An electric relay comprising a single solid-wound coil means constituted of a pair of hollow bucking tightly wound electrical coils having equal numbers of turns, interwound and arranged in tightly coupled relationship whereby at least major portions of the flux patterns thereof may occupy substantially the same predetermined central core space, said coils being capable of nulling each other; and a flux-operated electric switch means disposed in said predetermined space and comprising contacts and magnetic blades carrying the contacts, at least one of said blades being movable and responsive by movement to flux from said coils for shifting at least one contact toward and away from the other contact and effecting actuation of the switch as one coil is energized and de-energized while the other coil remains energized, said coils being wound bifilar fashion and having a common hollow-core bobbin the central core space of which comprises the bore space of the coils, and said switch means being disposed in the said common hollow space, said coils being layer wound and having substantially the same number of turns of equal diameter, located in alternation, in each layer; means outside of the coils, constituting a return magnetic circuit for the flux-operated switch means, said means comprising a generally cylindrical can of magnetic material, constituting a casting for the relay, said can having an integral closed end commensurate in size with its diameter and an open end; a magnetic disk spaced within and commensurate in size with the closed can end and

closely juxtaposed thereto, and also a magnetic ring constituting a cylindrical section closely juxtaposed to the interior surface of the can and disposed and spaced within the open end, said disk and ring being closely magnetically coupled to and electrically insulated from the can, said magnetic switch blades having polar portions physically and magnetically connected with said ring and disk respectively to conduct flux thereto, said disk being coextensive with the closed can end whereby relatively large surface areas of the disk and can end are broadside to each other, and juxtaposed to effect a good magnetic coupling, and said ring having an axial length which is appreciably greater than the wall thickness of the can and being closely spaced therefrom to effect a good magnetic coupling between the can and ring, to the end that the relay is sensitive in its response.

2. A relay as in claim 1, wherein the magnetic switch blades overlap portions of the disk and ring respectively and are secured thereto to provide areas of appreciable contact therewith.

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