

Jan. 14, 1964

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3,118,090

REED RELAY TRANSFER CIRCUIT

Filed Aug. 9, 1961

FIG. 1

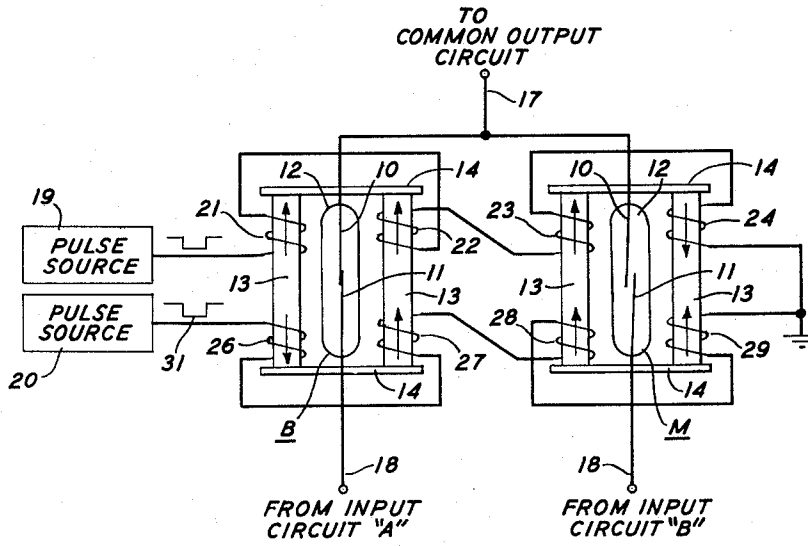
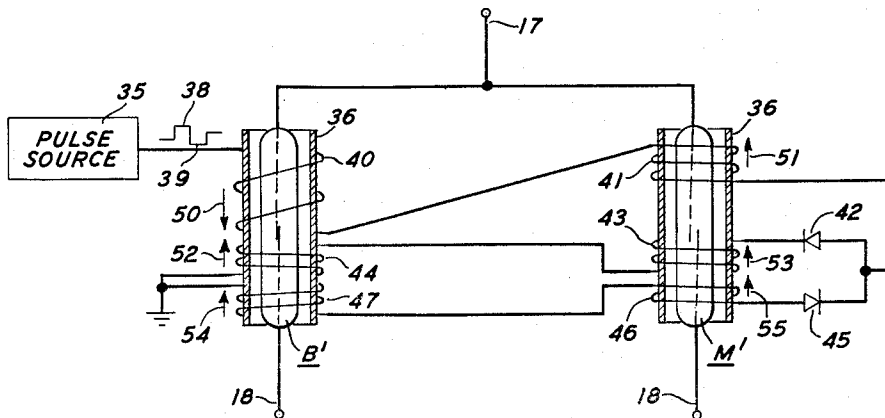


FIG. 2



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REED RELAY TRANSFER CIRCUIT

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Filed Aug. 9, 1961, Ser. No. 130,321

8 Claims. (Cl. 317-137)

This invention relates to electrical circuits employing relays and more particularly to such circuits for obtaining a transfer operation.

In electrical circuits it is frequently required to transfer an electrical path or connection from one circuit to another and relays have in the past been extensively used for this purpose. Such relays, to obtain the transfer action, have utilized a make and a break contact, sometimes referred to as a front and a back contact, with an armature or swinger which moves between them. The swinger and the contacts may be so adjusted that there is continuity between the circuits, i.e., that the front contacts make before the back contacts break, or so that there is no continuity, i.e., that the back contacts break before the front contacts make.

Recently glass enclosed reed switches, of the type disclosed in an article "Development of Reed Switches and Relays" by O. M. Hovgaard and G. E. Perreault, Bell System Technical Journal, vol. 34, page 309 (March 1955), have been extensively employed. These switches have proven to be both exceedingly efficient and inexpensive. However, these switches utilize only a single pair of make contacts. While numerous arrangements have been proposed for utilizing glass sealed relays having both a make and a break contact in a single enclosure, these arrangements have proven relatively expensive to manufacture and are more difficult to control in their characteristics.

Prior attempts to interconnect individual make-contact relays to define a transfer circuit have utilized specific energizing current levels and have proven quite marginal, being dependent not only on current amplitude but also being sensitive to the direction of the current through the relay contacts themselves. For example, in one prior approach a permanent magnet is coupled to one of a pair of reed switches for the purpose of magnetically biasing that one switch in a normally closed condition with the other switch being in a normally open condition. To effect a transfer operation a control current has been applied to the series connected operate coils of the two switches. This current has had to be of a predetermined polarity and magnitude so as to produce a magnetic field in opposition to the permanent magnet bias of the normally closed switch. It is readily apparent that the amplitude of this control current has been critical, as it must be of sufficient amplitude to cancel the bias of the permanent magnet, thereby allowing the spring action of the reed contacts to effect release of the contacts, while at the same time it must not be of such a magnitude as itself to become dominant and to effect a reclosure of the contacts. This false reclosure problem has proven especially troublesome in these miniature reed switches as the magnetic margins between switch release and switch closure are relatively narrow. Furthermore, designs of this type may result in make-before-break at some current levels and change to break-before-make at other current levels, a condition which many circuit applications cannot tolerate.

In these prior circuits the two relays have not been substantially identical, as in the above case where one is magnetically biased. Accordingly, they have had dissimilar characteristics preventing a positive, guaranteed break-before-make functioning regardless of the

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present states of the relays, and causing the transfer characteristic to be different depending on the direction of the transfer.

Accordingly, it is an object of my invention to provide a reliable relay transfer circuit utilizing only reed switches having but a single pair of make contacts each.

It is another object of my invention to provide such a transfer circuit wherein a positive break-before-make transfer occurs and such a circuit which is not sensitive to current amplitudes. Thus, it is an object of my invention to obtain large current margins in a transfer relay circuit.

It is a further object of my invention to obtain a miniature reed relay transfer circuit which is positive in its action, which is not susceptible to false reclosure of the switch contacts, and which has the same transfer characteristic regardless of the state of the two relays.

In accordance with one specific embodiment of my invention these and other objects are obtained by a circuit arrangement in which two substantially identical miniature reed switches, each having but a single pair of make contacts, are utilized. Such reed switches as normally manufactured have shorter release than operate times. In accordance with my discovery this fact is utilized to obtain a reliable, positive, non-marginal transfer action that assures proper break-before-make operation.

Specifically, in this specific embodiment of my invention two reed switches are utilized with remanent magnetic members, i.e., members having a substantially square hysteresis characteristic; the switches are thus of the ferreed type as set forth in Patent 2,995,637 of Feiner et al. of August 8, 1961, and the article "The Ferreed—A New Switching Device" by Feiner, Lovell, Lowry, and Ridinger, Bell System Technical Journal, vol. 39, page 1 (January 1960). Each switch is provided with two pairs of windings, one pair being energized to effect closure of the contacts and the other pair to effect their release. The windings of the pair that effects closure of the first switch are connected in series with the windings of the second pair that effects release of the second switch. The other four windings are similarly connected in series.

One contact of the first switch is connected to one contact of the second switch and to the common terminal of the circuit. The other contact of each switch is independently connected to a separate terminal.

In the normal state one contact pair is closed while the other contact pair is released or opened. To effect the transfer operation, one set of the series connected four windings is pulsed. This causes release of the closed contacts and closure of the open contacts. However, because of the inherent characteristics of the reed switches, the release occurs before the closure, thereby assuring a positive break-before-make transfer action. In the now operated state the remanent members maintain the reeds in the desired positions without additional current or power being expended. The circuit is returned to its original condition by pulsing the other set of four series connected windings.

By utilizing substantially identical reed relays for the two switches, the operating characteristic of the circuit is the same regardless of the direction of the transfer. Thus, in accordance with this aspect of my invention the two switches have substantially equal and identical dynamic characteristics, the dynamic characteristics including the effects of inertia, mass, and physical arrangements of the structural parts. Further, as no biasing magnetic fields are employed, the energizing current pulse may be of substantial magnitude without the prior margin requirements to prevent reclosure of the released switch.

Thus, by including remanently magnetic material in

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each relay structure I obtain this further advantage of preventing current overdrive causing false operation or reoperation of the relay. At higher current levels, where prior magnetically biased relays used for transfer operation would not operate properly, the remanent material saturates and prevents the occurrence of current overdrive misfunctioning. Accordingly, the transfer action in circuits in accordance with my invention is independent of the current level applied to the operating windings.

The inclusion of the remanent material in the relay structures further allows increase in the speed of operation together with operation in response to very short pulses and in response to a lesser amount of total energy than in prior polar relays. Additionally, the sensitivity of operation is increased.

It is a feature of my invention that a pair of substantially identical reed switches each having but a single make-contact pair be connected together to define a relay transfer circuit, the reed switches each having associated therewith at least one magnetic member and two independent series energizing paths, each path including windings on each of the magnetic members.

It is another feature of my invention that the two reed switches, which, in accordance with my invention, are substantially identical, as opposed to the prior arrangements utilizing relays of different characteristics, have shorter release than closure times.

It is a further feature of my invention that the magnetic members be of a remanent material and that each series energizing path include four windings.

A complete understanding of this invention and of these and various other features thereof may be gained from the following detail description and the accompanying drawing, in which:

FIG. 1 is a schematic representation of one specific illustrative embodiment of my invention utilizing parallel type ferreeds and in which the four series windings in each energizing path are distinct; and

FIG. 2 is a schematic representation of another specific illustrative embodiment of my invention utilizing series type ferreeds and in which certain windings of the four series windings in each energizing path are common to the two paths.

Turning now to the drawing, the specific embodiment of my invention depicted in FIG. 1 includes a pair of reed relay switches B and M each of which includes a pair of reed contacts 10, 11 sealed within a glass envelope 12. Associated with each switch are a pair of remanently magnetic rods or members 13 having end members 14 to form a substantially rectangular magnetic circuit. The end members 14 are advantageously of a non-remanent magnetic material such as 45 permalloy, while the members 13 may advantageously be of a heat treated high carbon tool steel having the desired remanent magnetic properties.

Reed switches B and M in this specific embodiment may be miniature switches of the type known as "G-29" switches, as described in Proceedings 1959 Electronics Components Conference, pages 32 through 37, Philadelphia, Pennsylvania, May 1959, the reeds 10, 11 being of a suitable magnetic alloy, for example 51 percent nickel and 49 percent iron; these switches are approximately three-quarters of an inch long without external leads and one-eighth of an inch in diameter. One of the properties of such switches is that their release time is shorter than their closure time and specifically in the illustrative embodiment being described the release time may be of the order of .5 millisecond while the closure time is of the order of 1.0 millisecond. In accordance with my discovery, this characteristic is utilized together with the particular electrical interconnections of the circuitry, as set forth more fully below.

Thus, in accordance with my invention the two substantially identical reed switches B and M, each having only a single make-contact pair 10, 11, are interconnected

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at their contacts and by their energizing windings to comprise a positive break-before-make transfer combination. The contacts 10 of each switch are connected together and to a single common output terminal or lead 17 while each of the contacts 11 is connected to a distinct and independent input terminal or lead 18. In the normal state of the circuit depicted in this specific embodiment reed switch B is normally closed and represents the break contact while reed switch M is normally open and represents the make contact of the circuit.

I provide two series energizing path each comprising four windings, each path thus having a winding on each of the remanent legs or members 13 and each path being connected to a pulse source 19, 20. The first path, which establishes the above-defined normal condition of the circuit, comprises the windings 21, 22, 23, and 24, while the second series energizing path, which establishes the operated or transfer condition of the circuit, comprises the windings 26, 27, 28, and 29. Each winding is wound on its respective leg so that when energized it produces a magnetomotive force in the leg 13 in the direction indicated by the arrow shown within the winding.

The operation of my transfer circuit can now be readily understood. On application of a negative energizing pulse 31 from pulse source 20 to the lower series path, including windings 26, 27, 28, and 29, the remanent states of the left leg 13 of switch B and the right leg 13 of switch M are reversed, thereby establishing a magnetic potential across the reeds 10, 11 of switch M while destroying the magnetic potential across the reeds 10, 11 of switch B, the magnetic flux flowing circumferentially in the outer path provided by the legs 13 and end pieces 14 of switch B. Accordingly, switch M will close its contacts and switch B will open them. However, because of the respective operating times, as set forth above, the switch B will operate before the switch M providing the required positive break-before-make transfer operation.

As is apparent, the transfer operation of circuits in accordance with my invention is not sensitive to energizing current levels and, by the provision of a pair of series windings and remanent magnetic members in each path on each switch, false operation cannot occur. Further reoperation of the contacts being released will not occur. The transfer is also independent of the direction of the current through the contacts of the switches themselves.

In FIG. 2 there is depicted another specific illustrative embodiment of my invention wherein ferreeds utilizing remanent sleeves 36 are employed, as described in Patent 3,075,059 of Blaha et al. of January 22, 1963, with series of ferreed operation, as described in Patent 3,002,066 of Ketchledge et al. of September 26, 1961, and the above-mentioned Feiner et al. article. Further, in this specific embodiment a single bipolar pulse source 35 is employed, the positive pulse 38 causing release of the contact reeds of the switch B' and closure of the contact reeds of the switch M' and the negative pulse 39 returning the transfer circuit to its normal state, with switch B' closed and switch M' released.

In this specific embodiment windings 40 and 41, on switches B' and M', respectively, are common to both series energizing paths; thus the series energizing path for the positive pulse 38 which effects the transfer from the normal state of the circuit includes the windings 40 and 41, diode 42, and the windings 43 and 44, while the series energizing path for the negative pulse 39 which returns the circuit to its normal state includes the windings 40, 41, diode 43, winding 46, and winding 47. The arrows 50 and 51 depicted adjacent the windings 40 and 41, respectively, in the drawing represent the direction of the magnetomotive force for the positive pulse 38 applied to the series path. As can be seen, the arrow 50 is in the opposite direction to the arrow 52, representing the direction of magnetomotive force due to pulse 38 through winding 44, thereby causing the reeds of switch B' to open, while the arrow 51 is in the same direction as the

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arrow 53, representing the direction of the magnetomotive force through the winding 43 due to pulse 38, thereby causing the reeds of switch M' to close. For the negative pulse 39 the direction of the magnetomotive forces due to the windings 40 and 41, and thus the direction of the arrows 50 and 51, are reverse and the pairs of arrows that depict the operation of the switches B' and M' are 50 (reversed), 54 and 51 (reversed) and 55, respectively.

It is to be understood that the above-described arrangements are illustrative of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of this invention. Thus, while miniature reed switches, such as the above-identified "G-29" switch, may advantageously be employed, other types of sealed contact or reed switches, including mercury wetted types, may be employed. Further, additional switches may be utilized in various combinations in accordance with my invention so as to effect two or more transfers or so as to effect various combinations of transfer functions together with simple make and/or break functions.

What is claimed is:

1. A relay transfer circuit comprising a first reed switch having at least one remanently magnetic member associated therewith and a second reed switch having at least one remanently magnetic member associated therewith, said reed switches being substantially identical and each consisting of a single pair of make contacts and having shorter release than operate times, a first and a second pair of windings magnetically coupled to said first switch for determining the remanent state of said first switch remanent member, a third and a fourth pair of windings magnetically coupled to said second switch for determining the remanent state of said second switch remanent member, access control means coupled to said first reed switch comprising dual information pulse source means, means connecting said first and third pairs of windings in series to cause said first switch to release and said second switch to operate in response to a first of said dual information pulse source means, means connecting said second and fourth pairs of windings in series to cause said first switch to operate and said second switch to release in response to the subsequent operation of a second of said dual information pulse source means, and means connecting one contact of each of said switches together.

2. A break-before-make reed relay transfer circuit comprising a first and a second substantially identical reed relay each having but a single make-contact pair and having shorter release than closure times, at least one magnetic member magnetically coupled to each of said relays, a pair of energizing paths for said relays, a single pulse source connected to each of said paths, said paths including distinct winding means on said magnetic members, means for applying pulses from a first of said sources to one of said paths to cause closure of one of said relays and release of the other of said relays and means for subsequently applying pulses to the other of said paths from a second of said sources to cause closure of said other relay and release of said one relay, and means connecting one contact of each said contact pair together.

3. A reed relay transfer circuit in accordance with claim 2 wherein said magnetic members are of a remanently magnetic material and wherein said paths each include four windings on said magnetic members.

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nently magnetic material and wherein said paths each include four windings on said magnetic members.

4. A relay transfer circuit comprising two relays having substantially identical dynamic characteristics including different operate and release times per relay, each of said relays including a pair of contacts, means connecting together one contact of each said pair, control means individual to each said relay controlled in one manner to operate said relay and in a second manner to release said relay, and means for controlling in different manners the respective control means of said two relays including dual pulse source means comprising means for delivering a pulse from a first of said pulse source means to said control means to operate one of said relays and release the other said relay, and means for subsequently delivering a pulse from a second of said source means to said control means to operate said other relay and release said one relay.

5. A relay transfer circuit in accordance with claim 4 wherein said relays are reed relays each having but a single make-contact pair within an enclosed glass envelope.

6. A relay transfer circuit in accordance with claim 4 wherein each said relay includes at least one remanently magnetic member and said control means includes a pair of windings coupled to said magnetic member.

7. A relay transfer circuit comprising a pair of relays having substantially identical dynamic characteristics and each including a contact pair, means connecting one contact of each of said relays together, each of said relays having a shorter release than operate time, and access control means comprising a bipolar pulse source for controlling said relays to cause closure of one of said relays and release of the other of said relays in response to a first polarity pulse from said bipolar pulse source and to cause closure of said one relay and release of the other of said relays in response to a subsequent second polarity pulse from said bipolar pulse source.

8. A relay transfer circuit comprising a pair of relays having substantially identical dynamic characteristics including shorter release than operate times, each of said relays including a contact pair, access control means comprising dual pulse signal means, a pair of control paths for said relays, each of said paths including serially connected winding means on said relays, means for applying a first signal from said signal means to one of said paths to cause closure of one of said relays and release of the other of said relays and applying a subsequent second signal from said signal means to the other of said paths to cause closure of said other relay and release of said one relay, and means connecting one contact of each of said relays together.

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