March 26, 1946. J. T. L. BROWN 2,397,123

CONTACT OPERATION

Filed April 30, 1943 2 Sheets-Sheet 1

FIG. 1

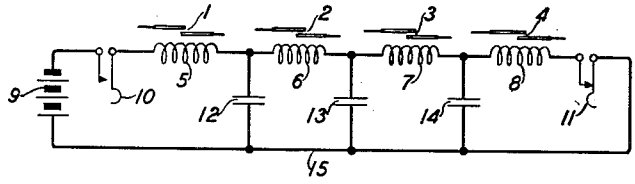


FIG. 2

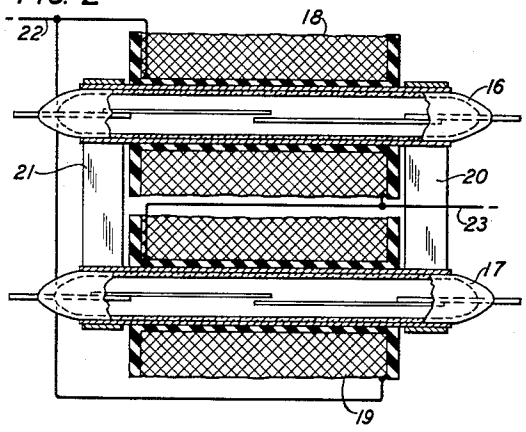


FIG. 3

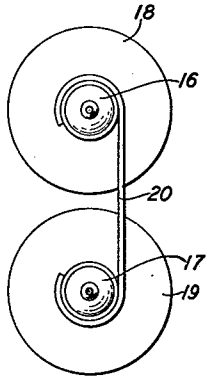


FIG. 4

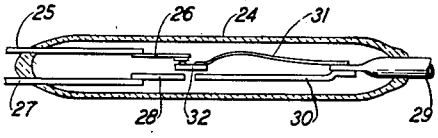
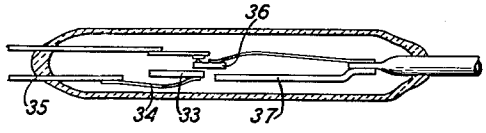


FIG. 5



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CONTACT OPERATION

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FIG. 6

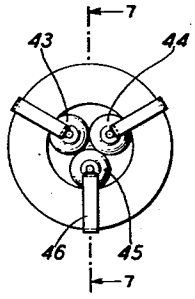


FIG. 7

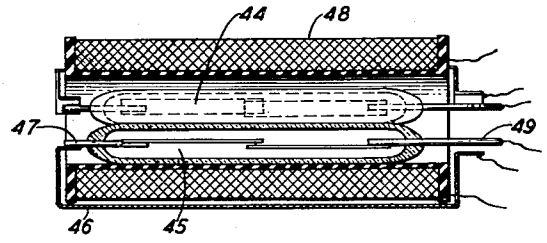


FIG. 8

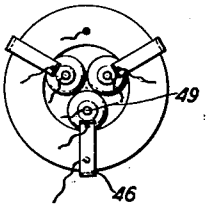


FIG. 9

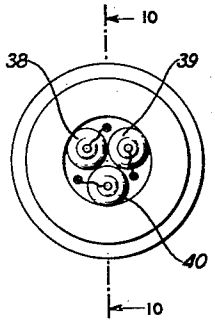


FIG. 10

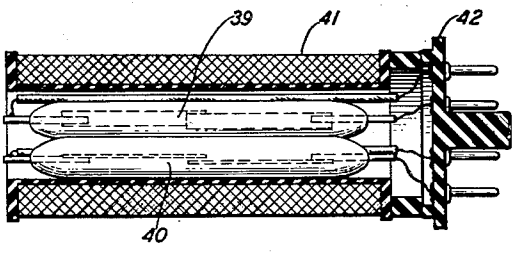


FIG. 11

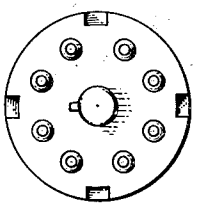
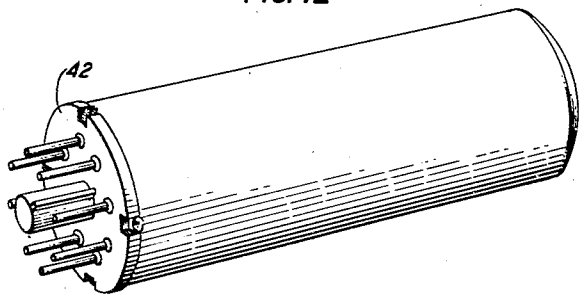


FIG. 12



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2,397,123

CONTACT OPERATION

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Application April 30, 1943, Serial No. 485,106

12 Claims. (Cl. 175—320)

This invention relates to relays and has for its object the control of the times at which a plurality of contacts will operate in response to a single circuit operation.

There has been developed a glass-sealed reed device acting as the contact means for a relay which may be placed axially within the energizing coil where it becomes extremely rapid in action and very sensitive. Such device is disclosed in Patent 2,289,830 granted to Ellwood July 14, 1942, and has been employed in numerous combinations, one of which showing sequential operation of a plurality of such contact devices is shown in Patent 2,243,399 granted to Skellett May 27, 1941.

The present invention, in one of its embodiments, contemplates the sequential operation of a plurality of contact sets in combination with means for releasing such contacts in either the same or the reverse sequence to that used in their operation.

In another of its embodiments this invention contemplates the simultaneous operation of a plurality of contacts even where such contact sets differ in their inherent operating characteristics.

Simultaneous operation may be secured in different manners. One example is that where the magnetic circuits of two or more contact sets are placed in series while the electrical circuits for energizing them are placed in parallel. This is a positive method for insuring that when one contact operates the others also will operate. Another example is where a number of contact sets are surrounded by one coil in which case each contact set is provided with an individual low reluctance return magnetic circuit. This is negative in that by this method the contacts can be made to operate together as well as when they are in separate coils.

In accordance with a feature of this invention the change of reluctance through the contact set is employed to affect a neighboring contact set. Where simultaneous operation is desired the two contact sets are placed magnetically in series so that the lowering of the reluctance in one portion of the circuit acts as a lowering of the reluctance of the circuit as a whole and thus speeds the operation of another contact set beyond its inherent characteristics. In another example where sequential operation is desired the contact sets are placed magnetically in parallel so that when one operates the consequent lowering of the reluctance therethrough results in "stealing" the field from the other with the result that the operation of such other is retarded beyond its inherent characteristics.

In accordance with the present invention a plurality of glass-sealed contact sets are linked together in an electrical or magnetic circuit in such manner that their sequence of operation is rigidly controlled.

Where sequential operation is desired a plurality of contact elements may be operated in a circuit bearing a general resemblance to a filter circuit with the energizing coils in series and a like plurality of condensers in multiple. When the circuit is closed the contacts operate in sequence as the condensers become charged. The deenergization or release of the contacts may be accomplished by opening the circuit at either end whereby the contacts will release in sequence and the order or the direction of such sequential release will depend on which end of the circuit is opened.

A feature of the invention is a plurality of contact sets each having an individual energizing coil, all of said coils being connected in a single circuit and responsive to a single circuit operation with means provided to control the sequence of operation of said contact sets.

Another feature of the invention is a plurality of contact sets each having an individual energizing coil arranged in a network in which the magnetic circuits of the contact sets are in series and the electrical circuits are in parallel.

Another feature is a plurality of contact sets energized by a common coil and each having a magnetic circuit of such low reluctance that the percentage change therein caused by the change in reluctance of a neighboring contact set is negligible.

The drawings consist of two sheets having twelve figures, as follows:

Fig. 1 is a schematic circuit diagram partly schematic in nature showing one means for controlling the sequence of operation of a plurality of contacts;

Fig. 2 is a side sectional view;

Fig. 3 is an end view of an arrangement in which a plurality of sets of contacts are placed magnetically in series while the electrical operating coils are placed in parallel;

Fig. 4 is a sectional view of one type of magnetic circuit switching element;

Fig. 5 is a view of a similar device of the same nature, in which a break-before-make operation is achieved;

Fig. 6 is a left-hand end view;

Fig. 7 is a sectional side view;

Fig. 8 is a right-hand end view of a device in which a plurality of contact sets energized by a common coil are arranged in a manner to cause simultaneous operation to such contact sets;

Fig. 9 is a left-hand end view;

Fig. 10 is a sectional side view;

Fig. 11 is a right-hand end view of a similar device in which the contact sets are arranged to operate in sequence; and

Fig. 12 is a perspective view of a device arranged either in accordance with Figs. 6, 7 and 8 or in accordance with Figs. 9, 10 and 11.

The arrangement of Fig. 1 is a circuit network arranged to cause the sequential operation of a plurality of contacts. The contact sets 1, 2, 3 and 4 are controlled by the coils 5, 6, 7 and 8, respectively, and may be conventional armature and contact arrangements or they may be of the sealed magnetic reed type such as those disclosed in the Ellwood patent. This circuit arrangement is energized by a battery 9 and controlled by two keys 10 and 11. There are also condensers 12, 13 and 14 each connected from a joint between the junction of two of the coils such as 5 and 6 to the return conductor 15. In operation, if the key 11 is first closed and the key 10 is later closed the contacts to be controlled are operated in sequence in the order 1, 2, 3 and 4, due to the well-known action of the charging of the condensers in such a filter-like network.

The deenergization of these contacts may be controlled in the order 1, 2, 3 and 4 by opening the circuit by the key 10 or in the order 4, 3, 2 and 1 by opening the circuit by the key 11 first.

The arrangement of Figs. 2 and 3 show two Ellwood units 16 and 17 each inserted in its own operating coil 18 and 19, respectively. The magnetic circuit of the two sealed reed contact sets is arranged in series through the external magnetic yokes 20 and 21 and the two coils 18 and 19 are so connected in parallel that this series magnetic circuit will be properly energized. Therefore when the circuit to which the conductors 22 and 23 is energized and the consequent energization of the coils 18 and 19 is slowly raised the two contact sets will operate together. The reason for this is that even though the two units may be different in their sensitivity the movement of one results in a lowering of the reluctance of the series magnetic circuit whereupon the other contact set will immediately follow through the increased field afforded thereby.

There are actually two types of effect involved here. One is achieved through placing the magnetic reluctances in series and the other is achieved by placing the coils properly poled in parallel. The two effects are similar, the effect being greatest when they are combined as shown in Fig. 2. Conversely, putting the magnetic reluctances in parallel has the same type of effect as putting the switches in separate coils all in series, and these magnetic and electrical arrangements can be combined in various ways.

Fig. 4 shows a sealed reed contact device having a transfer contact arrangement and which is subject to the same time control of its operation as the simple reed device known as the Ellwood unit. This device consists of a glass envelope 24 having two stationary contacts sealed in its left-hand end and a moveable contact arrangement sealed in its right-hand end. The lead in wire 25 and the contact element 26 may be non-magnetic. The lead in wire 27 and the pole-piece and contact element 28 are of magnetic material. The tube 29 and the pole-piece 30 are of magnetic material. A spring 31 holds an armature 32 normally away from the gap between the elements 28 and 30, and into electrical contact with the part 26. Upon energization the armature 32 bridges the gap between the elements 28 and 30 and makes electrical contact with the element 28. The device of Fig. 5 is an improvement on the device of Fig. 4 in that the so called stationary element 33 is given a certain degree of resiliency by means of a spring 34 by which it is attached to the lead in wire 35, through which a make-before-break operation is achieved. The corresponding elements of this device are made of the same materials as those of Fig. 4. By this means a more intimate magnetic connection may be made between the magnetic parts 33, 36 and 37 and a more sure electrical connection may be made between the elements 36 and 33. In operation the part 33 moves toward the part 36 and makes electrical connection therewith before the part 36 moves away from the back contact. Afterwards parts 33 and 36 move together until stopped by the engagement of part 36 by the part 37. In both these devices it will be seen that the reluctance of the path through the device is lowered upon its operation so that when two or more are placed magnetically in series the operation or the movement toward operation will lower the reluctance of the whole circuit and speed up the operation of the others.

In Figs. 9, 10 and 11 a relay made up of a single coil enclosing three Ellwood units is shown. Now it so happens that as in most apparatus of this nature it is difficult to produce on a mass basis a large number of these contact units having exactly the same operating characteristics or degree of sensitivity. For practical purposes this is a matter of little concern and indeed it is not difficult by test and selection to pick out of a batch of completed units any given number having like characteristics. By the same token it is as easy to pick out others having slightly different characteristics. Where it is desired to produce a relay having three sets of make contacts which will operate sequentially three units 38, 39 and 40 may be selected so that the unit 38 will operate on the least number of ampere turns, unit 39 on an intermediate value and unit 40 on the greatest. If each of these was provided with its own energizing coil and the current in the three coils was simultaneously (as in a series connection) slowly raised the contact units would operate in the order 38, 39 and 40. However, the difference is quite small and can be exaggerated by the means of Fig. 10 by placing them all together in one coil. Now as the current in coil 41 is slowly raised there will come a point where the device 38 operates. This results in a lowering of the reluctance therethrough with the result that the unit 38 "steals" the field away from the others. Therefore the operation of 39 is delayed and it in turn and in a like manner delays the operation of unit 40. The contact units 38, 39 and 40 and the coil 41 may be connected to contact pins on a base 42 so that this relay may then be covered as indicated in Fig. 12 and made to appear and to have the convenience of the modern devices of this nature.

Figs. 6, 7 and 8 show a similar arrangement where simultaneous operation of a plurality of units is desired. While the units 43, 44 and 45 may be carefully selected to have as nearly like characteristics as possible this is not necessary. In this case each unit is provided with an individual return magnetic path so that the change

of reluctance in one such magnetic circuit will have no effect on the others. A magnetic strip 46 is welded to the magnetic lead in wire 47 of the unit 45 and brought around the outside of the coil 48 into close proximity to the magnetic lead in element 49, the gap between the two being made only large enough to provide sufficient electrical contact separation. This return strap 46 may be used, as shown, as an electrical conductor for the purpose of mounting as shown in Fig. 12. Similar return straps are shown associated with the other units 43 and 44.

Generally, the effect desired with the arrangement of Fig. 7 may be heightened by quickly energizing the coil 48, as by providing a larger current therein than is actually necessary to operate the units. By the same token the effect desired with the arrangement of Fig. 10 may be heightened by slowly energizing the coil 41 as by the condenser and inductance network arrangement as in Fig. 1.

Other combinations of these elements and which come within the term of applicant's claims will occur to those skilled in the art and are intended to be covered by the instances disclosed herein by way of example.

What is claimed is:

1. A relay arrangement comprising a plurality of separate contact sets each having a separate energizing coil, all said coils being included in a single circuit including means to control the sequence of operation of said contact sets.

2. A relay arrangement comprising a plurality of separate contact sets each having a separate energizing coil, all said coils being included in a single circuit and responsive to a single circuit operation, said circuit includng means to control the sequence of operation of said contact sets.

3. A relay arrangement comprising a plurality of magnetic reed contact sets each having a separate energizing coil to energize the magnetic circuit thereof including the said contact set interlinked therewith and means for controlling the sequence of operation of said sets comprising an arrangement wherein the magnetic circuits of said contact sets are in series and the energizing coils are in parallel.

4. A relay arrangement comprising a plurality of magnetic reed contact sets placed in a common energizing coil and means to control the sequence of operation of said contact sets.

5. A relay arrangement comprising a plurality of separate contact sets each having an individual energizing coil, a circuit including all of said energizing coils responsive to a single circuit operation and means to control the sequence of operation of said contact sets.

6. A relay arrangement comprising a plurality of separate contact sets each having a separate energizing coil, all said coils being included in a single circuit, two control points in said circuit, and means in said circuit responsve to the order of operation of said control points for differently controlling the sequence of operation of said contact sets.

7. A relay arrangement comprising a plurality of separate contact sets each having a separate energizing coil, all said coils being included in a single circuit and responsive to closing and opening circuit operations at different points in said circuit for changing the sequence of operation and release of said contact sets, and means in said circuit for causing said contact sets to operate and release in different time intervals.

8. A relay arrangement comprising a make-before-break arrangement consisting of a fixed magnetic element and two relatively movable magnetic elements arranged in the form of a magnetic circuit having a plurality of air gaps in series, an electrical coil for energizing said magnetic circuit, an electrical contact closed through the closure of one of said air gaps, the closure of said one air gap acting to lower the reluctance of the said magnetic circuit and accelerate the closure of another of said air gaps and another electrical contact opened through the closure of said other air gap.

9. A relay arrangement consisting of a plurality of separate contact sets each having an individual magnetic circuit, and means for controlling the simultaneous operation of said contact sets comprising a single coil interlinked with said individual magnetic circuits.

10. A relay arrangement consisting of a coil having a plurality of contact sets axially disposed therein and means to control the relative times of the operation of said contact sets upon the energization of said coil, consisting of an individual strip of magnetic material passing over the outside of said coil from one end of each said contact set to the other end thereof comprising an individual low reluctance path for each said contact set.

11. In a relay device, a plurality of magnetic reed contact units each constituting a link in a magnetic circuit for its operation, an electrical circuit interlinked with the said magnetic reed contact units, said magnetic units being combined with said electrical circuit in a mutually controlling relationship to each other whereby the change in reluctance through one said unit upon its operation will affect and change the normal time of operation of another said unit.

12. In a relay device, a plurality of magnetic reed contact units included in a magnetic circuit and each forming a branch thereof, each of said contact units becoming operated upon the energization of said magnetic circuit, an electrical circuit for the energization of said magnetic circuit including all of its said branches, said branch circuits being arranged in a mutually controlling relationship to each other whereby the sequence of operation of said contact units may be prearranged and controlled.

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