

July 27, 1965

E. E. HELIN

3,197,677

SNAP ACTION RELAY WITH CLOSE OPERATE AND RELEASE VOLTAGES

Filed March 15, 1962

2 Sheets-Sheet 1

FIG. 1

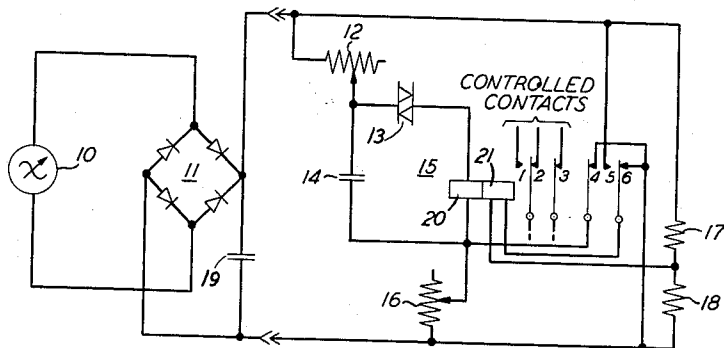
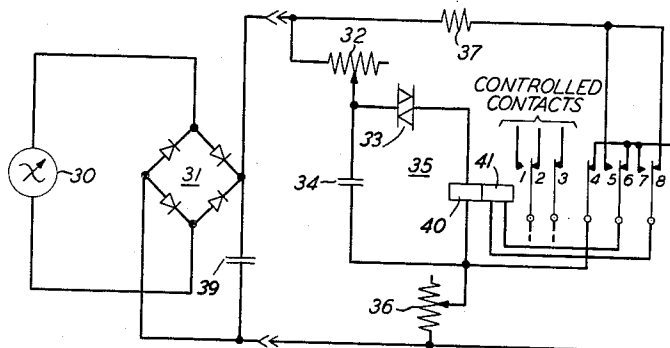


FIG. 2



INVENTOR
E. E. HELIN
BY *Ray M. Porter, Jr.*
ATTORNEY

July 27, 1965

E. E. HELIN

3,197,677

SNAP ACTION RELAY WITH CLOSE OPERATE AND RELEASE VOLTAGES

Filed March 15, 1962

2 Sheets-Sheet 2

FIG. 3

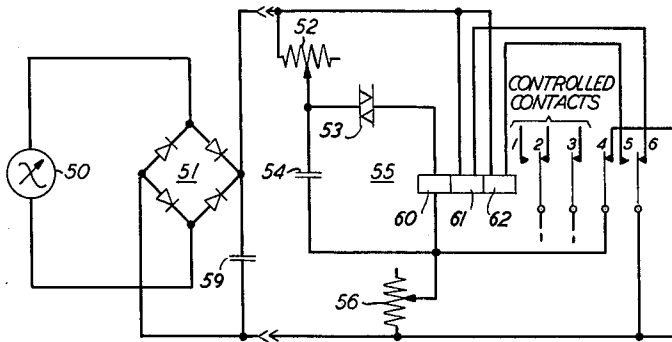
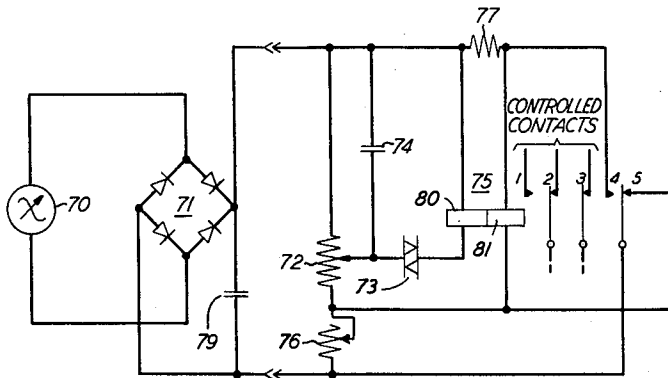


FIG. 4



INVENTOR
E. E. HELIN
BY *Ray M. Porter Jr.*
ATTORNEY

1

3,197,677

SNAP ACTION RELAY WITH CLOSE OPERATE AND RELEASE VOLTAGES

Eero E. Helin, Cold Spring Harbor, N.Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Filed Mar. 15, 1962, Ser. No. 179,971

7 Claims. (Cl. 317-155.5)

This invention relates to means for spacing the operate and release voltage values of a relay circuit at any desired separation and, more particularly, to means for bringing said values arbitrarily close together.

It is known in the prior art to raise the release value of a voltage sensitive relay by increasing the effective impedance of the relay winding circuit just before operation of the relay is complete. However, as the release value is brought very close to the operate value, the effects of spring loading cause slow or uncertain switching action.

This may be explained as follows. The change in flux occurring through variation of the air gap of the magnetic circuit aids the switching action; but the air gap variation is necessarily spread out to the end points of the switching action, while spring loading changes necessarily occur at finite separations from the end points. Thus, a precise balance of forces at the end points of relay travel, as required for nearly equal operate and release voltage values, means that a deficiency of force for completing switching occurs as some of the contacts, for instance, the last one, are picked up or released. It has generally been necessary to resort to a very precise spacing of spring loading changes with respect to air gap variation to alleviate this difficulty. The result is sluggish, uncertain operation, or a halt of switching action at mid-travel caused by manufacturing variation in relays.

An object of the invention is to achieve firm, rapid switching action in a relay circuit with arbitrarily close operate and release values.

Another object of the invention is to increase the reliability and repeatability of operation of a relay circuit with arbitrarily close operate and release values.

According to the invention, an appreciable unbalanced actuating force is provided at intermediate points in the relay travel by changing the flux in the magnetic circuit in one or more steps during relay travel, while a precise balance of forces is rapidly re-established after completion of relay travel by providing for the contrary variation of the flux contributed by one winding of the relay in a gradual or transient fashion, with an appreciable portion of the transient occurring after relay travel is complete.

Specifically, one or more secondary windings are added to the relay and are interconnected with some of the contacts of relay so that the making or breaking of those contacts will cause current changes in the secondary windings which increase the net flux of the relay during actuation and decrease the net flux during release. The result is snap action of the relay. To overcome the imbalance of forces this creates at the end of relay travel, the resistance of the primary winding is increased by switching during relay actuation and decreased during release, while the primary winding current is prevented from changing appreciably in response to the change in resistance until completion of relay travel by means of a capacitor connected across the primary winding. The circuit is arranged so that the charging or discharging the capacitor

2

adjusts the circuit for the next operation without interfering with the snap action of the relay once it has started to operate or release.

Further, it is not critical at exactly what points in the relay travel the switched changes in flux occur, so long as each change occurs at or before a point at which the relay would pause in the absence of a secondary winding. The sequence and timing of breaking and making of all the other relay contacts is noncritical.

Principal features of the invention involve simple arrangements of the relay with a voltage divider. The relay secondary winding is bridged across mutually exclusive parts of the voltage divider by a normally open contact of the relay and either an impedance or a normally closed contact of the relay, so that reversal of the secondary winding current occurs whenever the normally open contact is opened or closed.

As a feature of the embodiment of the invention in which an impedance bridges the secondary winding across one part of the voltage divider, the circuit may be greatly simplified by providing that the voltage divider will participate in reducing the effectiveness of the relay primary winding.

According to another feature of the invention, non-linear resistance in series with the primary winding increases repeatability of operation, reduces sensitivity of the relay circuit to mechanical shock, and gives temperature compensation.

Other objects and features may be obtained from the following detailed description in connection with the drawing in which:

FIG. 1 is a simple embodiment of the invention;

FIG. 2 is a modification of the embodiment of FIG. 1 for conserving input energy;

FIG. 3 is a modification of the embodiment of FIG. 1 utilizing three relay windings; and

FIG. 4 is an embodiment of the invention for reducing the number of internally utilized contacts.

In the embodiment of FIG. 1, a relay circuit in accordance with the invention is illustrated as being operated by a source 10 of alternating-current voltage, the magnitude variations of which over periods greater than one cycle are to be detected and used for switching functions. For this illustrative purpose, the input terminals of full-wave rectifier 11 are connected across source 10, and a filter capacitor 19 is connected across the output terminals of rectifier 11. It should, however, be understood that the invention has general application and may therefore be used to signal variations of a source of direct-current voltage, in which case rectifier 11 and capacitor 19 are unnecessary. Relay 15 has a primary winding, which is the left hand winding 20 appearing in FIG. 1, and a secondary winding, which is the right hand winding 21 in FIG. 1. Adjustable resistor 12, varistor 13, the left hand winding 20 of relay 15 and adjustable resistor 16 are connected in series across the output terminals of rectifier 11. Voltage divider resistors 17 and 18 are also connected in series across the output terminals of rectifier 11. Capacitor 14 is preferably connected in parallel with the series combination of varistor 13 and the left hand winding 20 of relay 15 but may also be connected in parallel with left hand winding 20 alone or in parallel with the series combination of resistor 12, varistor 13, and left hand winding 20. Normally closed contact 4 of relay 15 is connected in parallel with resistor 16.

When normally closed contact 6 is closed, the right hand winding 21 of relay 15 is connected in parallel with resistor 13, with a polarity such that the flux produced by right hand winding 21 is opposite in polarity to the flux produced by the left hand winding 20. When normally open contact 5 is closed, the right hand winding 21 is connected in parallel with resistor 17, with a polarity such that the flux produced by right hand winding 21 is of the same polarity as the flux produced by left hand winding 20. Preferably, contact 6 breaks before contact 5 makes during actuation of relay 15, and contact 5 breaks before contact 6 makes during release of the relay. Both contacts 5 and 6 are on one side of the right hand winding 21, while the other side of right hand winding 21 is connected to the common point between resistors 17 and 18. Controlled contacts 1, 2, and 3 are additional parts of relay 15 and are connected to systems in which the variations of voltage of source 10 are desired to produce an effect.

Relay 15 may advantageously be a wire spring relay. A detailed description of the structure, manufacture and operation of wire spring relays may be found in the article "A New General Purpose Relay for Telephone Switching Systems," by Arthur C. Keller, Bell System Technical Journal, November, 1952, pp. 1023-1067. The essential cooperation of the invention might be achieved with relays which are not wire spring relays, as will become more apparent in the following description.

In operation, contacts 1, 2, 3, 4, 5 and 6 are in the position shown in FIG. 1 when relay 15 is not actuated. This unactuated or unoperated condition will endure so long as the voltage of source 10 remains below a predetermined level.

As the magnitude of the voltage of source 10 increases, an increasing current is delivered by rectifier 11 and filter capacitor 19 to the left hand winding 20 of relay 15 through adjustable resistor 12, varistor 13, and normally closed contact 4 and also to voltage divider resistors 17 and 18. Capacitor 14 receives additional charge through resistor 12 and contact 4 to increase its voltage to correspond to the increased voltage of source 10. The increased voltage across resistor 18 produces an increased current through contact 6 and the right hand winding 21, thus canceling out an increasing amount of the increasing primary flux. The flux of right hand winding 21 remains an essentially constant proportion of the flux of the left hand winding 20, preferably just enough so that the elimination and subsequent reversal of the right hand winding flux will provide a safe margin of actuating force over spring loading at all points, for example, about ten per cent of the flux of left hand winding 20. Thus, the net flux produced by relay 15 continues to increase.

Finally, when a predetermined voltage level of source 10 is reached, the net flux is sufficient to initiate motion in relay 15. Such motion tends to reduce the air gap and the reluctance of the magnetic circuit, thereby increasing the flux and the actuating force; but the opposing force provided by the various restoring springs of relay 15 as contacts 1, 2, 3, 4, 5 and 6 are picked up will also increase as the motion continues. As explained in the above-cited article by Keller, at pp. 1046 and 1047, the increase in spring loading in a wire spring relay is irregular, being quite sudden as each contact is picked up. Since the force provided by the flux in the magnetic circuit does not increase as rapidly, there is a chance, attributable to manufacturing variations in relays, that the relay may hesitate in an intermediate position, particularly if a contact, for example, contact 4, is picked up very soon after actuating motion commences.

The invention avoids this difficulty by providing that contact 6 will be broken before any of the other relay contacts are picked up, or at least soon enough afterward that the momentum of the moving parts of relay 15 suffices to break contact 6.

The breaking of contact 6 interrupts the flow of current to the right hand winding 21 of relay 15, so that a rapid increase of the net flux in the magnetic circuit of relay 15 occurs. This flux increase supplies the needed force to continue actuating motion beyond the point at which it otherwise might stop. Other contacts may be picked up next; but before another critical low net force condition is reached, contact 5 is closed to provide a further increase in net flux in the magnetic circuit of relay 15, the right hand winding flux now being reversed from its original state. Relay 15 is thus assured of completing its actuating motion. Controlled contacts 1, 2, and 3 will thus perform the desired functions.

It will be noted that relay 15 is provided with only two stable states of operation and that there is reduced uncertainty about the voltage level at which relay 15 will operate for increasing voltage of source 10; for once motion is started within relay 15, it will be fully completed. A "snap action" is obtained.

It is very important that complete operation will occur no matter what the sequence of operation of contacts 1, 2, 3, 4 and 5 is among themselves or how early they are picked up in the course of actuation. The invention makes this possible because contact 6 is picked up at approximately the same time as, or before, the earliest one of the other contacts. Although in prior art circuits the breaking of contact 4, which changes the resistance in series with left hand winding 20, was preferably the last switching function, in the present circuit the timing of the actuation of contact 4 is not critical. Also, a bigger step change in resistance can be made. This is possible not only because the breaking of contact 6 provides additional total flux and hence additional actuating force but also because capacitor 14 discharges previously stored energy into the left hand winding 20 when the insertion of resistor 16 reduces energy flow from source 10, thus delaying any decrease in the flux production of winding 20. Thus, the reversal of the right hand winding 21 has the dominant effect during relay travel. Since making and breaking of the other contacts present less critical conditions than does the breaking of contact 4, complete operation will occur.

When the voltage level of source 10 is decreasing from a level above the level at which actuation or operation previously occurred, the exact level for release can be brought arbitrarily close to the operate level because the release value can be independently controlled by the value of adjustable resistor 16 without affecting the operate value. During release resistor 16 has a pronounced effect in determining the current in the left hand winding 20 because contact 4 is now open and capacitor 14 has previously completed its transient discharge into left hand winding 20.

Once release of relay 15 has commenced in response to the decreasing voltage of source 10, the increase of magnetic circuit reluctance and the restoring force of the springs all tend to make release complete. One possible countervailing effect occurs if contact 4 closes early during release; then the shorting out of resistor 16 would tend to increase the current of left hand winding 20. However, two other effects are present to counteract this tendency. First, capacitor 14 must charge through resistor 12, preventing an immediate increase in the voltage across left hand winding 20. This, again, is the gradual readjustment of the circuit. Second, contact 5 will preferably be broken before the current through left hand winding 20 can be appreciably increased. The breaking of contact 5 interrupts the flow of current through the right hand winding 21 and initiates a rapid decrease in the net flux of the magnetic circuit. As the motion continues toward release position, the net flux is further decreased by the closing of contact 6 so that right hand winding 21 produces flux in opposition to that of left hand winding 20. Complete, snap-action release is thus assured; and controlled contacts 1, 2 and 3 will again perform their as-

5

signed functions. It is readily seen that the timing of the closure of contact 4 during release, and the making or breaking of all other contacts aside from contact 5, is noncritical.

The adjustable resistor 16 is shorted out by the closing of contact 4, capacitor 14 recharges, and the parameters of the circuit are again adjusted for operation of relay 15 at the desired level as the voltage level of source 10 increases.

Varistor 13 is a nonlinear resistive device which sustains a nearly constant voltage drop as the current through it varies over a wide range. It may also have the qualities of a thermistor at the same time. A description of varistors and thermistors may be found in the "Components Handbook," MIT Radiation Laboratory Series, McGraw Hill, 1949, at pages 100-109.

Preferably, only a portion of the signal voltage of source 10 is applied to left hand winding 20 of relay 15. Then, the same relay circuit may be adjusted to widely different source voltages by adding an appropriate number of varistors in series with varistor 13, or by taking such varistors from the circuit. Although linear resistance 12 allows fine adjustment of the operate level, preferably it is kept as small as possible.

The nearly constant voltage drop across varistor 13 presents distinct advantages over the use of linear resistance in that position. First, the sensitivity of the over-all circuit, and thus the repeatability of its operation, is increased. For example, a one percent variation of the voltage of left hand winding 20 at which operation occurs from time to time will cause less than a one percent variation of the level of the voltage of source 10 at the same times, since the voltage drop across varistor 13 does not change. In contrast, both percentages would be the same if varistor 13 were replaced by linear resistance because the voltage drop across such a linear resistance would vary by the same percent as the operate voltage of the left hand winding 20. Second, the relay circuit is less susceptible to actuation by a physical shock when the voltage of source 10 is a given amount away from its desired actuation level. Since the constancy of the voltage drop across varistor 13 allows more of the variation of the source voltage to appear across winding 20 than a purely linear resistance would, the voltage of winding 20 will be correspondingly farther away from its own actuation level, for the given difference between the voltage level of source 10 and its desired actuation level. A given physical shock will be less likely to actuate relay 15, the farther the voltage of winding 20 is from its actuation level.

The thermistor properties of varistor 13 can be selected to compensate the temperature variations of the resistance of left hand winding 20.

In the modification depicted in FIG. 2, components correspond to components in FIG. 1 with the same last digit, except no counterparts of the voltage divider resistances 17 and 18 of FIG. 1 appear in FIG. 2. In addition, two more contacts appear on relay 35 than on relay 15. Resistor 37 and the right hand winding 41 of relay 35 are connected in series through normally closed contact 8 and normally closed contact 6 across the output terminals of full-wave rectifier 31, with right hand winding 41 oriented with respect to the left hand winding 40 to cancel out a portion of the flux of left hand winding 40 when relay 35 is not actuated and the contacts are in the position shown. Resistor 37 and right hand winding 41 are connected in series through normally open contact 5 and normally open contact 7 across the output terminals of rectifier 31 when relay 15 is actuated, with an orientation to reverse the previous flux of right hand winding 41. In this embodiment of the invention, it makes little difference whether contact 6 breaks before contact 5 makes or whether contact 8 breaks before contact 7 makes. Although only one step change in flux

6

may occur instead of two, the invention may utilize any number of stepwise changes in flux.

The operation of the modification depicted by FIG. 2 is similar to that described hereinbefore for the basic embodiment of FIG. 1, except that less input energy is consumed to supply the same power to the same right hand winding as in FIG. 1. The same voltage must be supplied to winding 41 as to winding 21. It follows that when the relays 15 and 35 are in the unactuated state shown resistors 17 and 37 must sustain equal voltage drops. Thus, resistor 17 must be smaller than resistor 37 because resistor 17 must carry an additional current for resistor 18. Thus, resistor 17 dissipates more power than resistor 37 because the power in resistor 17 is the square of its equal voltage drop divided by its smaller resistance. In addition, an inevitable power loss occurs in resistor 18 which can occur in no comparable resistor in FIG. 2. This energy saving is obtained with the use of an extra pair of relay contacts.

In the modification shown in FIG. 3, components correspond to components in FIG. 1 with the same last digit, except no counterpart of the voltage divider resistances 17 and 18 of FIG. 1 appear in FIG. 3 and relay 55 has three windings instead of two. The middle winding 61 of relay 55 is connected through normally closed relay contact 6 across the output terminals of full-wave rectifier 51, with middle winding 61 oriented with respect to the left hand winding 60 to cancel out a portion of the flux of left hand winding 60 when relay 55 is not actuated and the contacts are in the positions shown. The right hand winding 62 of relay 55 is connected through normally open relay contact 5 across the output terminals of full-wave rectifier 51 when relay 55 is actuated, with right hand winding 62 oriented with respect to left hand winding 60 to supplement the flux of left hand winding 60. The operation of the modified embodiment shown in FIG. 3 is similar to that described hereinbefore for the basic embodiment of FIG. 1, except that input energy is conserved by elimination of a voltage divider and use of a third winding. Also, switching is simplified, in comparison to the switching of the modified embodiment shown in FIG. 2.

In the embodiment of the invention shown in FIG. 4, the three resistors 72, 76 and 77 effectively replace the four resistors 12, 16, 17 and 18 of the embodiment of FIG. 1 and the number of required relay contacts is also reduced by one. Resistors 72 and 76 are connected in series across the output terminals of fullwave rectifier 71. The left hand winding 80 of relay 75 and varistor 73 are connected in series across an adjustable part of resistor 72 to set the operate voltage of the relay circuit. Capacitor 74 is connected in parallel with the left hand winding 80 and varistor 73. Resistor 77 and the right hand winding 81 of relay 75 are connected in series across all of resistor 72, with right hand winding 81 connected to the junction between resistors 72 and 76 and oriented to cancel out a portion of the flux of left hand winding 80 when relay 75 is unactuated and the contacts are in the position shown. Normally closed contact 5 is connected in parallel with resistor 76; and normally open contact 4 is connected from the junction of resistor 77 and right hand winding 81 to the junction of resistor 76 and the full-wave rectifier 71.

In operation, contacts 1, 2, 3, 4, and 5 are in the position shown in FIG. 4 when relay 75 is not actuated. As the magnitude of the voltage of source 70 increases, an increasing current is delivered by rectifier 71 and filter capacitor 79 to the left hand winding 80 of relay 75 by virtue of the increased voltage drop across resistor 72. An increasing current flows through the right hand winding 81 from the direction of resistor 77, since the other side of the right hand winding is tied to the negative side of rectifier 71 through normally closed contact 5. Right hand winding 81 reduces the flux produced by left hand winding 80 by an essentially constant percentage, for

example, about ten percent, so that the net flux produced by relay 75 continues to increase.

Finally, at a predetermined voltage level of source 70, relay 75 commences its switching motion. Contact 5 is broken before any of the other contacts are picked up, or at least soon enough afterward that the momentum of the moving parts of relay 75 suffices to break contact 5.

At this point, the principal difference in operation of this embodiment from the embodiment of FIG. 1 is apparent. Simultaneously, by virtue of the opening of contact 5, the energization of right hand winding 81 is changed; and the energization of left hand winding 80 from source 70 is decreased by the insertion of resistance 76 in series with resistance 72, although this latter effect is temporarily compensated by supplemental energization of left hand winding 80 from capacitor 74.

Specifically, upon the opening of contact 5, resistor 76 simultaneously appears in series both with resistance 72 and with the right hand winding 81 of relay 75. Thus, the bucking current in right hand winding 81 is decreased; and the current in resistor 72 tends to decrease, thereby drawing a current of like polarity from capacitor 74. Capacitor 74 also delivers current to the series combination of the left hand winding 80 and varistor 73, thereby tending to hold the current in left hand winding 80 substantially constant. Eventually, discharge of capacitor 74 will allow the current in left hand winding 80 to decrease, but the more rapid decrease of the current in right hand winding 81 has provided relay 75 with an increase in the net flux and a greater actuating force.

Closure of contact 4 ties the junction between the right hand winding 81 and resistor 77 to the negative side of rectifier 71. Since the other terminal of right hand winding 81 is connected to the junction between resistors 72 and 76, which is positive with respect to the negative side of rectifier 71, current now flows through right hand winding 81 from the junction with resistors 72 and 76 to the junction with resistor 77. The flux produced by right hand winding 81 now is of the same polarity as the flux produced by the left hand winding 80, and the unbalanced force tending to complete actuation of relay 75 safely exceeds the maximum spring loading. Therefore, actuation of relay 75 will be completed, and contacts 1, 2, and 3 will perform their desired control functions.

The circuit is now readjusted for release by discharge of capacitor 74. After the voltage on capacitor 74 has reached an equilibrium determined largely by the presence of resistance 76 in series with resistor 72, the flux of winding 80 has the value required for release of relay 75 to occur at the desired point as the voltage magnitude of source 70 decreases. This may be as close as desired to the operate value.

During release of relay 75, the polarity of current in the right hand winding 81 is again reversed and resistor 76 is again shorted, in order to readjust the circuit for actuation. The reversal of right hand winding 81 also aids in producing a snap action release, as described above for the embodiment of FIG. 1.

The embodiment of FIG. 4 allows a reduction in the number of switching contacts because the insertion of resistance for determining release and the first step increase in relay flux aiding actuation occur simultaneously. In addition, the simultaneous switching allows the voltage divider network used in reversing the right hand winding current to be built upon resistors which are in the circuit for other purposes.

In principle, the reversal of the current of right hand winding 81 occurs upon switching because normally open contact 4 and resistor 77 each bridge right hand winding 81 across mutually exclusive parts of the series combination of voltage divider resistors 72 and 76.

The functions of varistor 73 are the same as those described above for varistor 13 of the embodiment of FIG. 1.

Other modifications of the embodiments of the invention described herein can easily be devised by one skilled

in the art. For example, other devices can be devised to perform the function of capacitor 14, 34, 54, or 74. It should also be obvious that the independence of adjustment which allows the operate and release values to be brought arbitrarily close together also allows them to be set at any desired separation. It may also be noted that the right hand winding can be energized from an independent source of fixed polarity.

In all cases it is understood that the above-described arrangements are illustrative of a small number of the many possible specific embodiments which can represent applications of the principles of the invention. Numerous and varied other arrangements can readily be devised in accordance with these principles by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A relay circuit responsive to a variable voltage comprising a voltage divider to which said variable voltage may be applied, a relay having first and second windings and a plurality of contacts, said first winding being responsively coupled across at least part of said voltage divider, said first winding being effective to operate said relay in response to an increase in said variable voltage above a first level, means responsive to the operation of said relay for reducing the effectiveness of said first winding to permit release of said relay in response to a decrease of said variable voltage below a second level that is closer to said first level than in the absence of said reducing means, means for connecting said second winding across a first portion of said voltage divider in a polarity to oppose said first winding when said relay is released, and a normally open contact of said relay effective to connect said second winding across a second adjacent portion of said voltage divider in a polarity to aid said first winding intermediately during operation of said relay, said normally open contact being opened intermediately during release of said relay.

2. A relay circuit according to claim 1 in which the means for connecting the second winding across the first portion of the voltage divider comprises a normally closed contact of said relay, said normally closed contact being opened intermediately during actuation of said relay.

3. A relay circuit according to claim 1 in which the means for connecting the second winding across the first portion of the voltage divider comprises an impedance connected serially with said second winding across said first portion.

4. A relay circuit according to claim 3 in which the first winding is connected across at least part of the first portion of the voltage divider and in which the means for reducing the effectiveness of said first winding comprises a normally closed contact of the relay connected across the second portion of said voltage divider, said normally closed contact being opened intermediately during operation of said relay, said reducing means further comprising a capacitor interconnected with said voltage divider and said first winding in an arrangement to smooth said reduction of effectiveness.

5. A relay circuit according to claim 4 in which the second portion of the voltage divider has a resistance that makes the second voltage level substantially equal to the first voltage level.

6. In combination, a voltage divider having first and second serially connected resistive portions, a relay having first and second windings, said first winding being connected across at least part of said first portion, a capacitor connected across said first winding, a resistor connected serially with said second winding across said first portion, a normally closed contact of said relay being connected across said second portion, a normally open contact of said relay connected serially with said resistor across said voltage divider, and at least one additional contact on said relay.

7. In combination, a voltage divider, an electromagnet

9

relay, a first winding of said relay connected in parallel with a first portion of said voltage divider, a capacitive reactive circuit electrically paralleling said first winding, a normally closed contact of said relay connected in parallel with a second portion of said voltage divider, a series combination of a second winding of said relay and a normally open contact of said relay connected in parallel with said second portion, and an impedance connected from said normally open contact in parallel with the series combination of said second winding and a portion of said voltage divider not including said second portion.

5

10

10

References Cited by the Examiner

UNITED STATES PATENTS

2,313,973	3/43	Sorensen	317—155.5
2,583,328	1/52	Dimond	317—141
2,885,604	5/59	Stavrinaki	317—155.5
3,090,874	5/63	Rosene	317—148.5

FOREIGN PATENTS

563,491	8/44	Great Britain.
---------	------	----------------

SAMUEL BERNSTEIN, *Primary Examiner*.