

[72] Inventor William E. Shaffer
Rochester, N.Y.
[21] Appl. No. 772,964
[22] Filed Nov. 4, 1968
[45] Patented Dec. 29, 1970
[73] Assignee Stromberg-Carlson Corporation
Rochester, N.Y.
a corporation of Delaware

837,023 11/1906 Wright 317/155.5X
2,224,885 12/1940 Sola..... 335/44X
3,108,208 10/1963 Hayter..... 317/155.5
Primary Examiner—Lee T. Hix
Assistant Examiner—William J. Smith
Attorneys—Hoffman Stone and Charles C. Krowczyk

[54] SENSITIVE PICK-UP RELAY
6 Claims, 4 Drawing Figs.
[52] U.S. Cl..... 317/155.5,
179/18: 335/180
[51] Int. Cl..... H01b 47/06
[50] Field of Search..... 317/137,
148.5, 155, 155.5; 335/177, 178, 180, 268;
179/18.8, 18.7, 18.3A
[56] References Cited
UNITED STATES PATENTS
3,425,009 1/1969 Voight et al. 335/177

ABSTRACT: An arrangement for increasing the sensitivity of a relay or other electromechanical actuator. In the preferred case, an auxiliary winding is used in series with a switching transistor and the main winding. The auxiliary winding and transistor are shunted by a pair of normally open contacts of the relay. When an energizing voltage is applied, the transistor conducts, and the auxiliary winding contributes to the sensitivity of the relay. When the relay picks up, the auxiliary winding is shunted out of the circuit, and the transistor is biased to cut off, effectively open-circuiting the auxiliary winding and making it ineffective to delay subsequent drop out of the relay when it is deenergized. An alternative arrangement omits the transistor, simply shorting the auxiliary winding when the relay picks up.

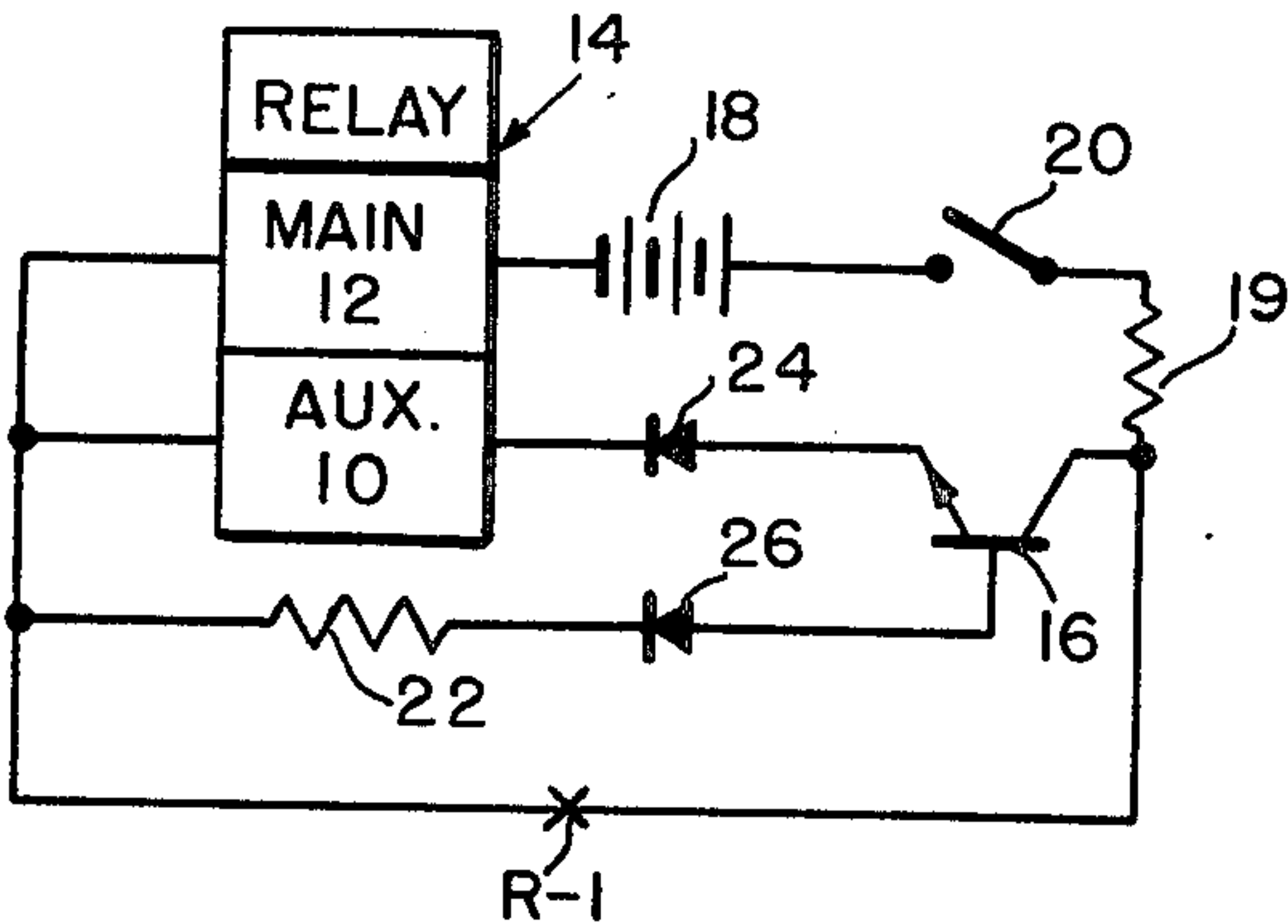


FIG. 1

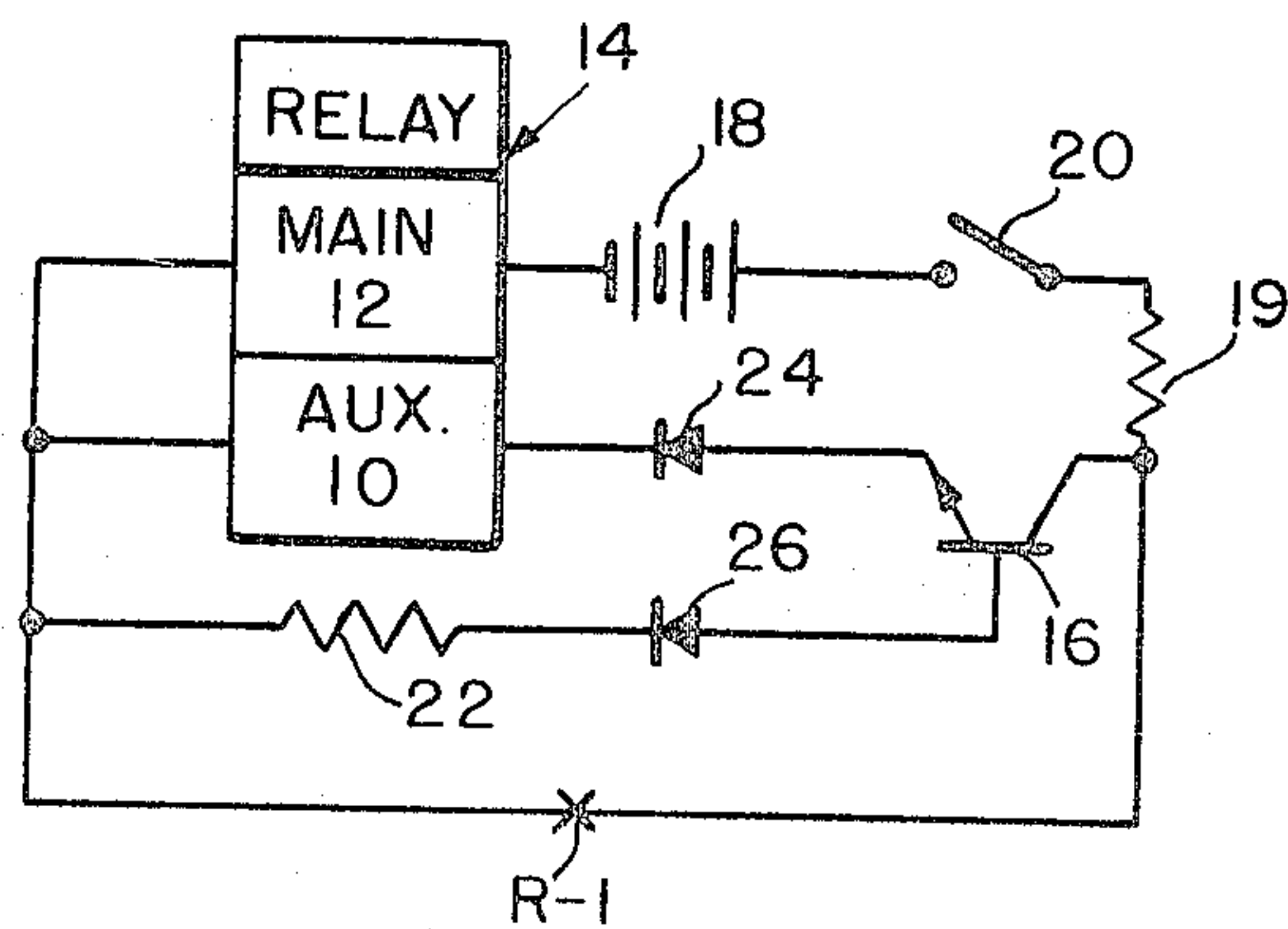
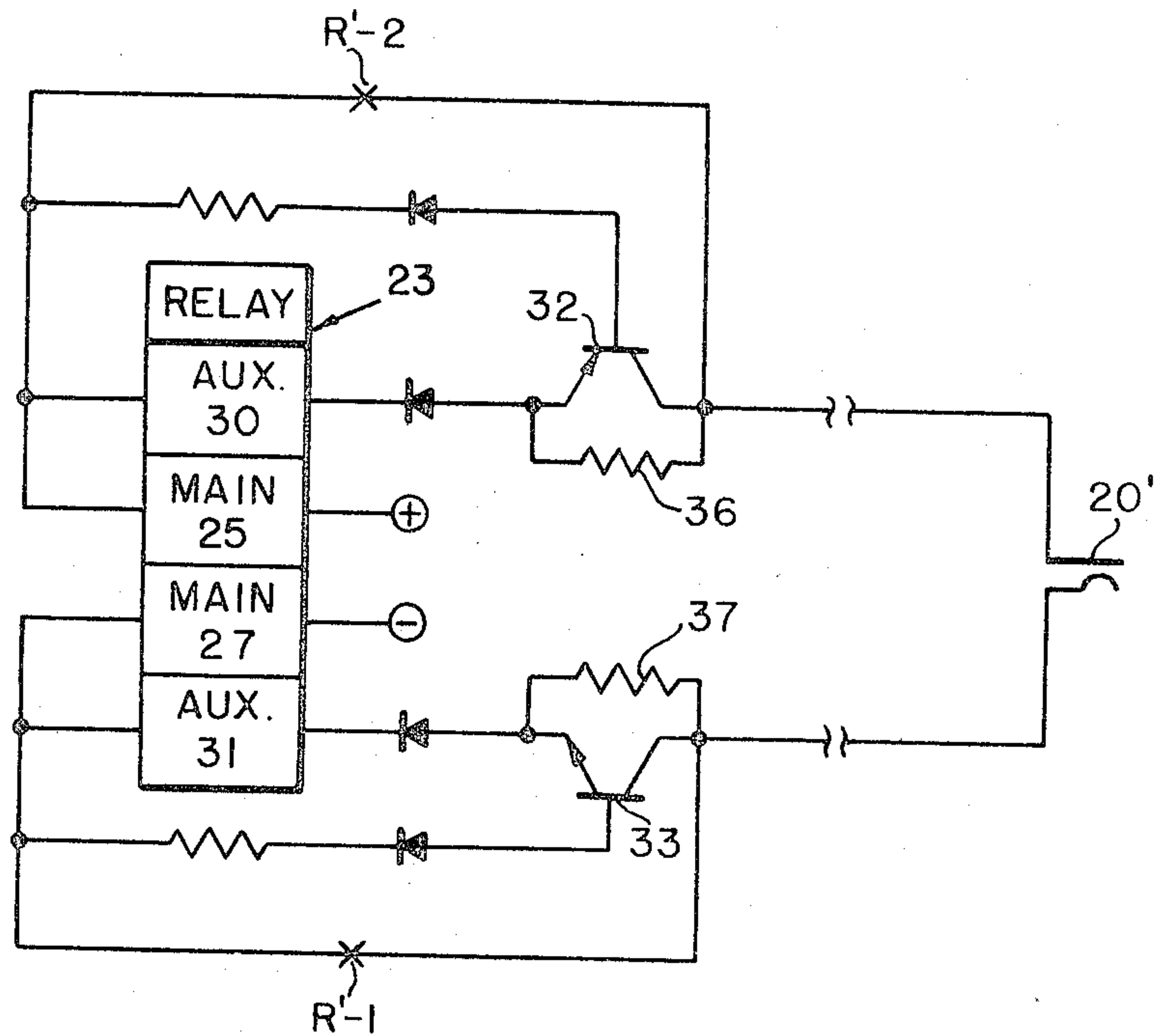


FIG. 2



INVENTOR
WILLIAM E. SHAFFER

BY *Hoffman Stone*
ATTORNEY

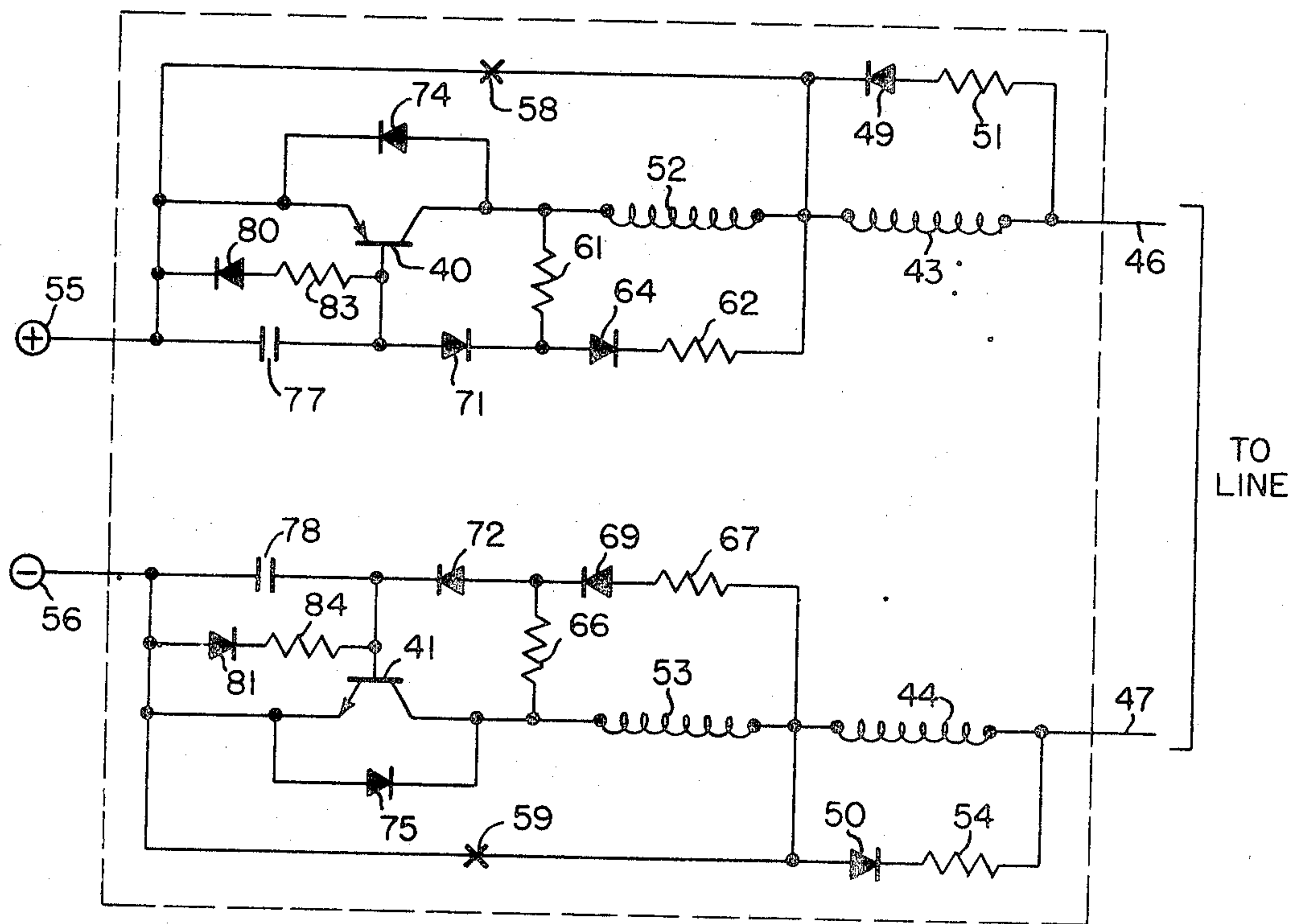


FIG. 3

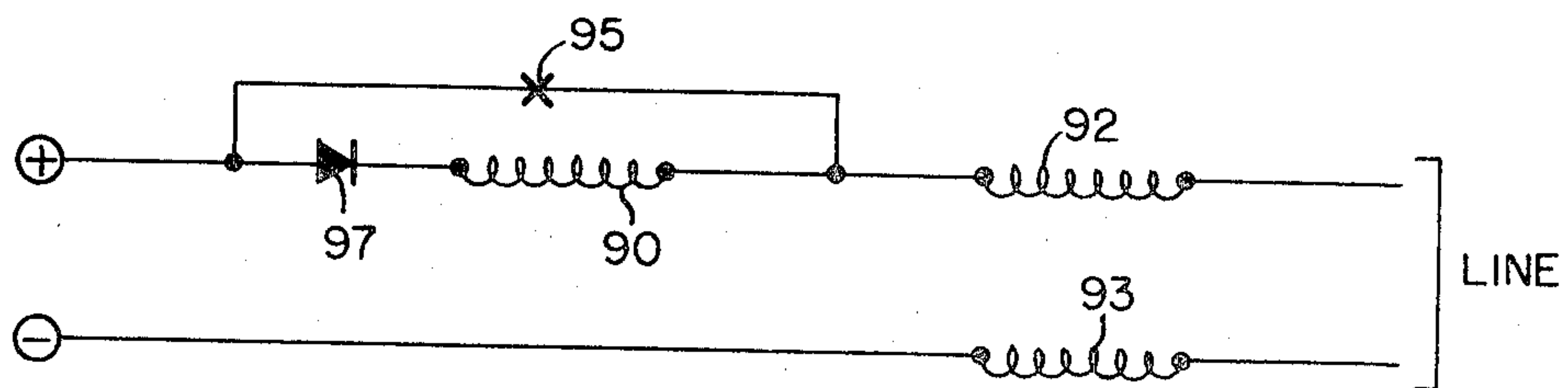


FIG. 4

INVENTOR
WILLIAM E. SHAFFER

BY *Hefner Stone*

ATTORNEY

SENSITIVE PICK-UP RELAY

BRIEF SUMMARY

This invention relates to a novel circuit arrangement for increasing the sensitivity of a relay or the like, and, more particularly, but not exclusively, to a novel arrangement of the stated type especially well adapted for use in connection with pulsing and battery feed relays in telephone systems.

Relays used in telephone systems for detecting off-hook conditions at subsets and for following dial pulses present problems, especially in cases where they must work on line loops of relatively high resistance such as 1900 ohms or higher. They are ordinarily connected across the line in series with one side of a bridge transformer and the central office battery. When the line loop resistance is high, very little current is available to operate the relay, and it must be highly sensitive if it is to pick up in response to loop closure. Increasing sensitivity by the usual means such as by increasing the number of turns in the relay winding results in delaying the release time so that often the relay fails to follow dial pulses properly.

Accordingly, one important object of the present invention is to provide a circuit arrangement for increasing the sensitivity of a relay without significantly affecting its release characteristics.

Briefly, the invention contemplates the use of an auxiliary winding on the relay core, and a switching arrangement for connecting the auxiliary winding in series with the main winding during the initial application of an energizing voltage until the relay picks up, and then effectively open circuiting the auxiliary winding until the relay releases so that the auxiliary winding does not delay the release. In an alternative form of the invention, for use where a significant delay is tolerable in the release characteristic of the relay, the auxiliary winding is simply short circuited by normally open contacts of the relay. In these cases, shunt loading of alternating current signals passing through the main winding may be minimized by connecting a diode in series with the auxiliary winding.

DETAILED DESCRIPTION

Representative embodiments of the invention will now be described in connection with the accompanying drawing, wherein:

FIG. 1 is a schematic circuit diagram of a relay arrangement according to a first embodiment of the invention;

FIG. 2 is a schematic circuit diagram of a relay arrangement according to a modified form of the invention in a balanced configuration such as would be used, for example, in many telephone systems;

FIG. 3 is a schematic circuit diagram of a relay arrangement according to a presently preferred embodiment of the invention for battery feed and pulsing in telephone service; and

FIG. 4 is a schematic circuit diagram of another embodiment of the invention for use where the relay is not required to follow rapid pulse signals.

According to a first embodiment of the invention, as shown in FIG. 1, an auxiliary winding 10 is connected in a series circuit, which includes the main winding 12 of a relay 14, the emitter-to-collector current path of an NPN transistor 16, a battery 18, a resistor 19, and a switch 20. The auxiliary winding 10 is connected between one terminal of the main winding 12 and the emitter of the transistor 16. The resistor 19 is connected between the collector of the transistor 16 and the battery 18 through the switch 20. A pair of normally open contacts R-1 of the relay 14 are connected between the collector of the transistor 16 and the junction between the auxiliary winding 10 and the main winding 12. A base resistor 22 is connected between the base of the transistor 16 and the junction between the two windings 10 and 12. The value of the base resistor 22 is greater than the resistance value of the auxiliary winding 10. Diodes 24 and 26 may be connected in series with the emitter and base, respectively, of the transistor 16 to protect the transistor against circuit transients and the application

of reverse biasing voltages. They are not essential to the circuit and in many cases may be omitted.

In operation, upon the initial application of an energizing voltage such as, for example, occurs upon closing of the switch 20, the transistor 16 is biased in its forward direction, and the auxiliary winding 10 conducts in series with the main winding 12, thus providing high sensitivity for picking up the relay. As soon as the relay picks up, its contact R-1 close, connecting the collector of the transistor 16 to the junction between the windings 10 and 12, thus cutting it off, and closing a shunt path across the transistor 16 and the auxiliary winding 10. The relay 14 remains held up by the main winding 12 only. Decay of current in the auxiliary winding 10 applies an added back-bias across the emitter junction of the transistor 16, and, following decay of current in the auxiliary winding, the base of the transistor 16 is held at the same potential as its emitter, thus keeping the transistor cut off and the auxiliary winding open circuited.

When the energizing circuit is thereafter opened to release the relay, the tendency of the auxiliary winding 10 to conduct in a parasitic mode applies a reverse bias to the emitter junction of the transistor 16, and the current through the auxiliary winding 10 is held to a negligible value so that it has no significant delaying effect upon the release characteristics of the relay.

The embodiment shown in FIG. 2 is generally similar in principle to the one shown in FIG. 1, except that it is arranged for use in a balanced telephone signalling circuit. The relay 23 shown therein includes two main windings 25 and 27, respectively, and separate auxiliary windings 30 and 31, respectively, each connected separately in series with its own respective transistor 32 and 33, respectively, and one of the main windings 25 and 27. In this case, because of the polarity of the applied voltages, one of the transistors 32 is of the PNP type and the other one 33 is of the NPN type. The circuit operates in exactly the same manner as hereinabove described responsively to operation of the subscriber's hook switch 20'.

Auxiliary resistors 36 and 37, respectively, are shown connected between the emitters and collectors of the respective transistors 32 and 33. These resistors are of relatively high value. They assist in biasing the transistors 32 and 33 immediately upon closing of the switch 20' to insure promptness of response. In many cases, depending upon the characteristics of the transistors 32 and 33, and on the other parameters of the circuit, the auxiliary resistors 36 and 37 may be omitted.

The circuit illustrated in FIG. 3 is generally similar to the one shown in FIG. 2, except that the transistors 40 and 41 are on the battery side of the relay for better protection against lightning and transient effects in the subscribers' lines.

As shown, the main windings 43 and 44, respectively, of the relay are arranged to be connected directly to the two leads 46 and 47 of the subscriber's line. They are shunted by respective diodes 49 and 50 in series with limiting resistors 51 and 54, respectively. The transistors 40 and 41, and the auxiliary windings 52 and 53 are in series between the main windings 43 and 44, respectively, and the battery terminals 55 and 56. Normally open contacts 58 and 59 are connected respectively in shunt across the auxiliary winding 52 and the transistor 40, and the auxiliary winding 53 and the transistor 41.

The auxiliary winding 52 is shunted by a voltage divider including first and second resistors 61 and 62 with a diode 64 connected between them. An exactly similar arrangement including resistors 66 and 67 and a diode 69 shunts the other auxiliary winding 53. The bases of the transistors 40 and 41 are connected to the respective diodes 64 and 69 in the shunt paths through respective protective diodes 71 and 72. Diodes 74 and 75 are respectively connected between the emitters and collectors of the two transistors 40 and 41, primarily to protect the transistors against lightning induced transients. Finally, capacitor 77 and 78 are connected between the bases of the respective transistors 40 and 41 and the respective battery terminals 55 and 56 for damping the effect of transient

voltage fluctuations. The capacitors 77 and 78 are shunted by respective diodes 80 and 81, each in series with a limiting resistor 83 and 84.

The values of the various components of an actual circuit conforming to the schematic circuit diagram of FIG. 3, which was built and successfully tested under practical operating conditions were as follows:

Resistance of the main windings 43 and 44	ohms each--	205
Resistance of the auxiliary windings 52 and 53	ohms each--	135
Resistance of the shunt resistors 51 and 54	ohms each--	3,300
Resistance of the first voltage divider resistors 61 and 66	ohms each--	680,000
Resistance of the second voltage divider resistors 62 and 67	ohms each--	20,000
Capacity of the shunt capacitors 77 and 78	μ f. each--	0.1
Resistance of the limiting resistors 83 and 84	ohms each--	200

The circuit operated successfully to enable the relay to follow telephone dialing pulses over subscriber line loops of various different characteristics and impedances up to 3000 ohms.

The much simpler circuit shown in FIG. 4 is designed for use in cases where the relay need not follow rapid dialing pulses and a significant delay can be tolerated in its release characteristic. The circuit is advantageous where high sensitivity is required, but where the resistance of the relay winding, once it is picked up, must be held to a low value.

The circuit shown in FIG. 4 includes an auxiliary winding 90 connected in series with one of the main windings 92 and 93, and shunted by a pair of normally open contacts 95 of the relay. A diode is connected in series with the auxiliary winding 90 to block low level alternating current signals.

Pulsing and battery feed relays as used in telephony are usually connected across the subscribers' lines, shunting the so-called speech signals. It is, therefore, important that they present a high impedance to the line. The auxiliary winding 90 in the arrangement shown in FIG. 4 is coupled as the secondary winding of a transformer to the main windings 92 and 93, and if it reflects a low impedance, it will cause the relay to act as a low impedance shunt for the speech signals, and adversely affect their transmission. The diode 97 insures that for the speech signals, which are of small magnitude, the auxiliary winding 90 presents a high impedance even though it is shunted by the closed contacts 95.

I claim:

1. An electrical relay comprising a main winding, an auxiliary winding electrically in series with said main winding and magnetically aiding, circuit means connecting a pair of normally open contacts across said auxiliary winding so that said contacts are closed when the relay picks up.

2. An electrical relay comprising a main winding, an auxiliary winding electrically in series with said main winding and magnetically aiding, a diode in series with said auxiliary winding, and a pair of normally open contacts connected across said auxiliary winding and said diode for shunting said auxiliary winding and said diode when the relay picks up.

3. An electrical circuit for use in conjunction with an electromechanical actuator or the like to increase its sensitivity without correspondingly delaying its release characteristic comprising:

- a. an auxiliary winding magnetically coupled to the core of the actuator; and
- b. switching means for connecting said auxiliary winding in series with the main winding of the actuator from the start of the application of an energizing voltage until the actuator picks up, and for thereupon open circuiting said auxiliary winding and closing a current path shunting it to apply the energizing voltage to the main winding only.

4. An electrical circuit according to claim 3 wherein said switching means includes a transistor with its emitter-to-collector current path in series with said auxiliary winding, and a pair of normally open contacts arranged to close when the actuator picks up, said contacts being connected in shunt across said auxiliary winding and said current path of said transistor taken together.

5. A relay and associated circuit for use as a pulsing or battery feed relay in a telephone switching system or the like comprising:

- a. a pair of main windings;
- b. a pair of auxiliary windings electrically in series respectively with said main windings and magnetically aiding;
- c. a pair of transistors with their emitter-to-collector current paths in series respectively with said auxiliary windings;
- d. two sets of normally open contacts respectively shunting said auxiliary windings and said transistors; and
- e. means connecting the bases of said transistors respectively to the junctions between said auxiliary windings and said main windings.

6. A relay according to claim 5, wherein the emitters of said transistors are connected to the terminals of a source of current, the collectors are connected to said auxiliary windings, and the terminals of said main windings opposite from said auxiliary windings are arranged for connection to a subscriber's line or the like.

55

60

65

70

75