

[72] Inventors Christian Fernand Michel Quenet
Cachan;
Jacques Louis Jean-Pierre Rochereau,
Villejuif, France
[21] Appl. No. 802,932
[22] Filed Feb. 27, 1969
[45] Patented June 28, 1971
[73] Assignee Societe De Telecommunications
Electronique, Aeronautique, Et Maritime
"T.E.A.M."
Paris, France
[32] Priority Feb. 29, 1968
[33] France
[31] 141882

[50] Field of Search..... 178/70

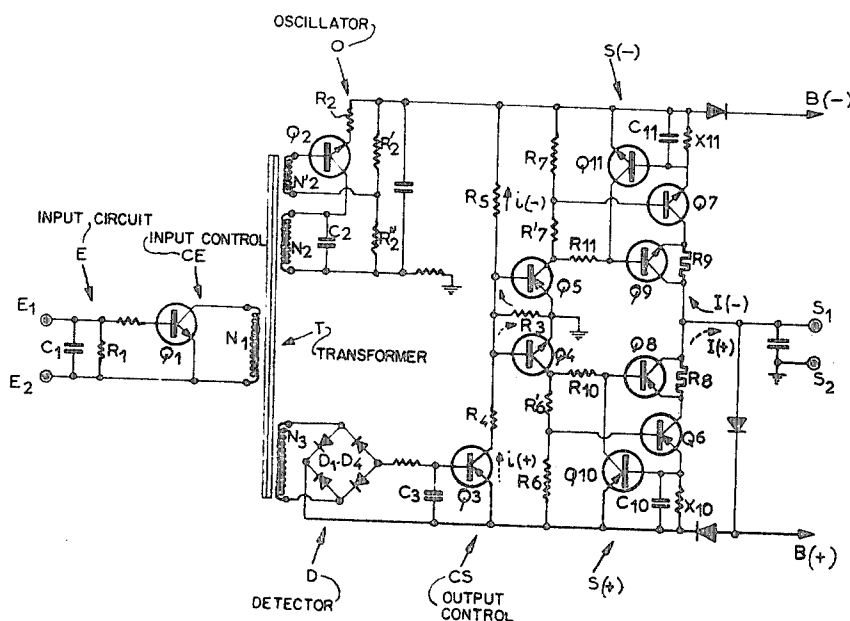
[56] References Cited
UNITED STATES PATENTS
3,384,711 5/1968 Boxall 178/70

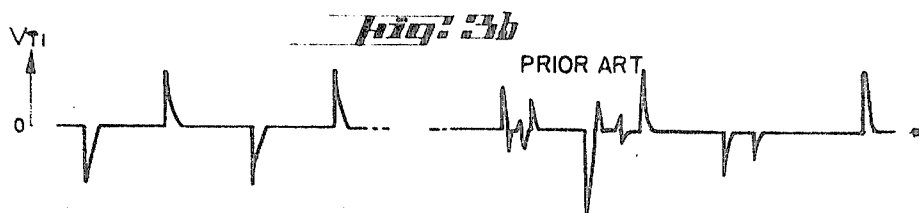
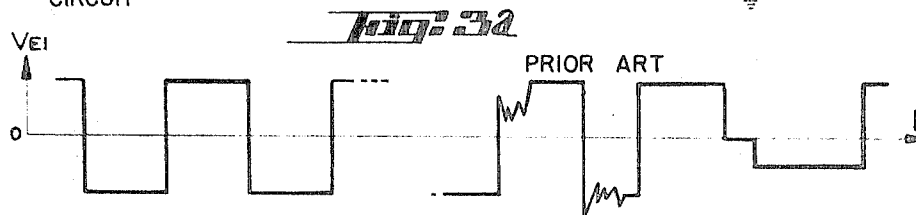
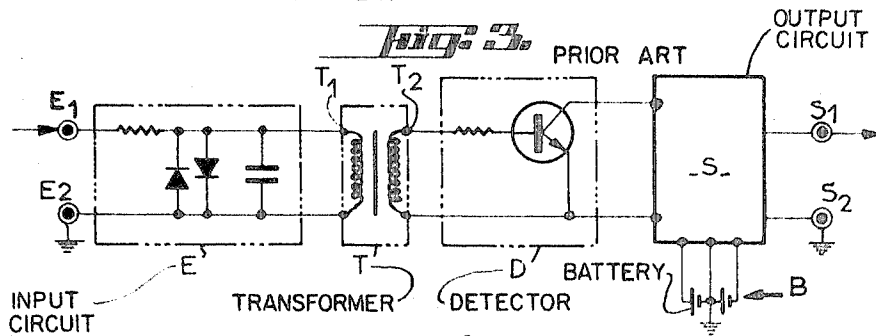
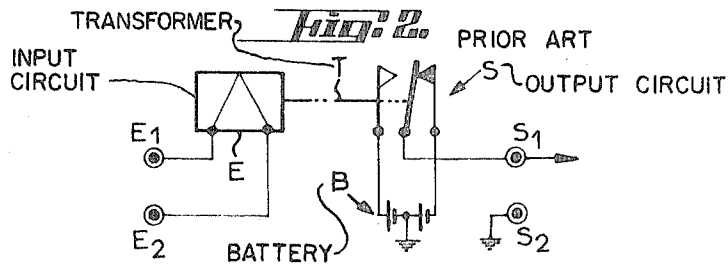
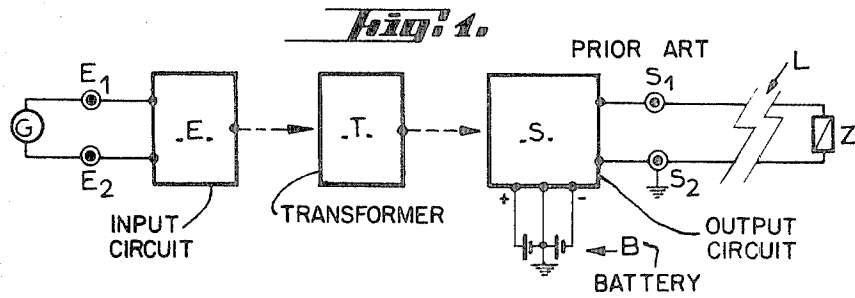
Primary Examiner—William C. Cooper
Assistant Examiner—William A. Helvestine
Attorney—Nolte and Nolte

[54] ELECTRON RELAY ADAPTED TO BE USED
NOTABLY AS A UNIVERSAL TELEGRAPH RELAY
7 Claims, 9 Drawing Figs.

[52] U.S. Cl. 178/70R
[51] Int. Cl. H04I 25/52

ABSTRACT: The input and output circuits of an electronic universal telegraph relay are coupled by an information transfer circuit including an oscillator and a rectifier operatively coupled to a transformer having a separate winding, the circuit of which is closed by an input control element for blocking said oscillator when the signal applied to said input circuit is of a predetermined polarity. The voltage generated by said rectifier selectively controls the conduction state of an output control element, which in turn controls the switching of said output circuit.

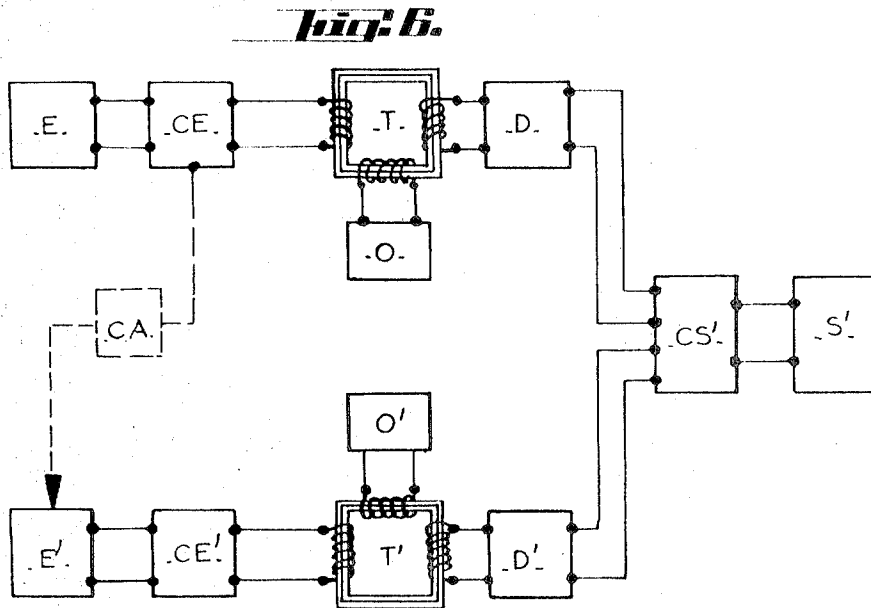
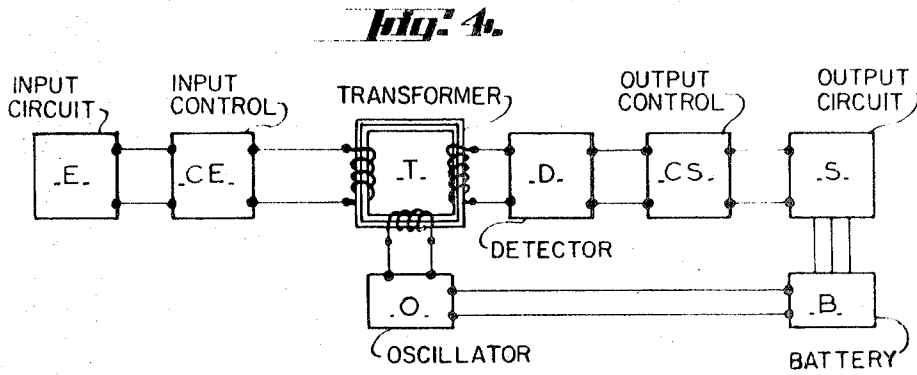
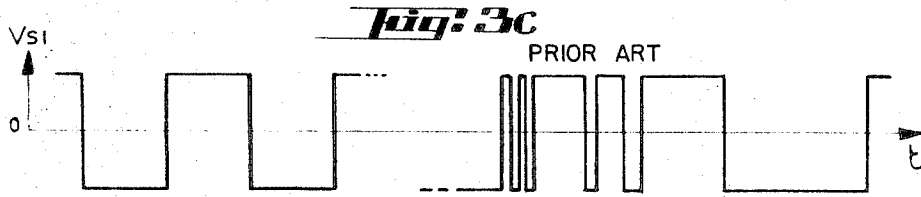




INVENTORS
CHRISTIAN FERNAND MICHEL QUENET
JACQUES LOUIS JEAN-PIERRE ROCHEREAU

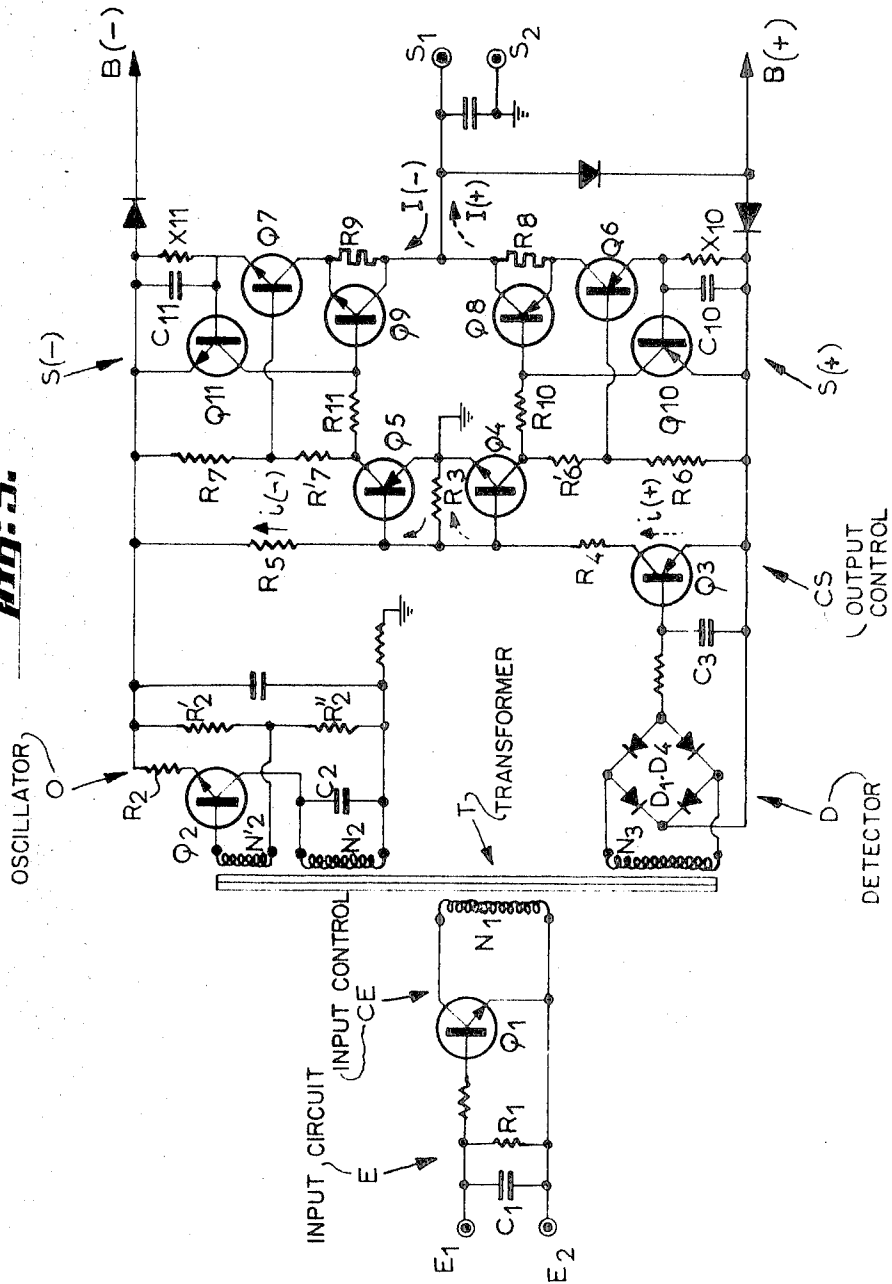
BY

Nolle & Nolle
ATTORNEYS



INVENTORS
 CHRISTIAN FERNAND MICHEL QUENET
 JACQUES LOUIS JEAN-PIERRE ROCHEREAU
 BY
Nolte & Nolte
 ATTORNEYS

Fig. 3.



INVENTORS
 CHRISTIAN FERNAND MICHEL QUENET
 JACQUES LOUIS JEAN-PIERRE ROCHEREAU
 BY *Nolle & Nolle*
 ATTORNEYS

ELECTRON RELAY ADAPTED TO BE USED NOTABLY AS A UNIVERSAL TELEGRAPH RELAY

The present invention relates generally to electron relays constituted exclusively by static components, notably by semiconductors, and concerns more particularly such relays intended for use as universal telegraph relays. The advantages of electron relays with respect to conventional electromechanical relays are well known, consisting notably in a low response time combined with an almost zero switching time, the low energizing power required for such relays and the elimination of all problems arising from adjustments, bouncing, wear and sticking of moving contacts, as well as arcing between the latter and overvoltages resulting therefrom.

These advantages are more particularly pronounced in electron relays using semiconductors, the inherent favorable features of which, from the standpoint of overall dimensions voltage and power requirements, cost and reliability, are well known.

However, the electron relays used up to the present instead of conventional electromechanical relays in telegraph, telephone or industrial switching systems are characterized, in comparison with said electronic relays, by a dual drawback consisting in that they do not ensure electrical isolation of the input and outputs circuits and they are particularly sensitive to input signal distortions.

The present invention is essentially directed to providing electron relays which are free from the aforesaid drawbacks, and, therefore, susceptible of being used as universal relays capable of fulfilling any required complex transmission and/or switching function.

An electron relay according to the invention, intended in particular to be used as a universal telegraph relay, is remarkable notably in that it comprises an input circuit and an output circuit coupled by an information transfer circuit, electrically isolating them from one another, the said transfer circuit comprising at least one isolated voltage-generating unit, the operation of which, either authorized or forbidden by the polarity of the signal applied to the input circuit, directly or indirectly controls the switching of the output circuit.

It is thus immediately evident that the relay according to the invention is actually free from the aforesaid drawbacks, since the switching of the output circuit is not controlled by the input signal, but by a signal supplied by a generating unit incorporated in the relay and the operation of which is controlled by the input signal, the input and output circuits thus being effectively isolated from one another electrically. Further, the control of the operation of the said generating unit according to the polarity of the input signal eliminates the effect of disturbances or distortions susceptible of affecting the said input signal. Lastly, the restoring of the input signal by the said generating unit obviously offers the widest possibilities for, on the one hand, regenerating the correct signal shape and, on the other hand, amplifying the latter to any desired level.

According to another characteristic feature of the relay of the invention, the said voltage generating unit is constituted by a converter comprising an oscillator and a rectifier coupled to separate windings of one and a same transformer.

According to a further characteristic feature of the relay of the invention, the said transfer circuit comprises at least one input control unit which blocks the said oscillator when the signal applied to the said input circuit is of a predetermined polarity.

The above-mentioned two characteristic features on the one hand clearly denote the fact that the input and output circuits are electrically isolated from one another and, on the other hand, they offer the essential advantage of permitting positive and quick switching of the output circuit by means of an input signal of very low level, since the blocking of an oscillator occurs abruptly the moment its feedback-loop gain falls below 1 or as soon as the phase of the feedback signal is modified, this being obtained by providing minor modifications in its operating characteristics.

According to a preferred form of embodiment of the relay of the invention, the said oscillator, which is of the tuned type, comprises a feedback winding carried by the said transformer, the latter carrying a fourth winding capable of being short-circuited by the aforesaid control unit.

Thus, the blocking of the oscillator resulting from a reduction of the coupling coefficient of its tuned and feedback windings is ensured purely magnetically, the coupling transformer perfectly isolating electrically from one another the input and output circuits as well as the oscillator.

The aforesaid input control unit is advantageously constituted by a transistor, the conduction state of which depends on the polarity of the signal applied to the said input circuit.

Such an arrangement offers the advantage of permitting the blocking of the oscillator by short-circuiting the fourth winding of the aforesaid transformer by means of an input signal of very low level and by very simple means, the transistor used for this purpose being itself capable of discriminating between the polarities of the input signal.

According to still another characteristic feature of the relay of the invention, the aforesaid transfer circuit comprises at least one output control unit associated with the said rectifier and ensuring the switching of the output circuit, the said output control unit being advantageously constituted by a transistor, the conduction state of which depends on the polarity or the amplitude of the voltage supplied by the said rectifier.

Thus, the transfer circuit of a relay according to the invention comprises input and output control units which are identical to, but electrically isolated from one another, and this clearly denotes the functions of information transfer and electrical isolation fulfilled by the said transfer circuit, as well as the wide possibilities offered for signal amplification and regeneration.

Of course, the constitution of the transfer circuit and, in particular, the presence of a coupling transformer enable to combine at will any required number of input and output circuits of any desired kind so as to provide complex relays capable of fulfilling all required combinations of functions; in particular, several identical or different input circuits operating dependently or independently may be coupled to the transformer, to which may also be coupled several oscillators with different blocking thresholds; on the other hand, one and the same output unit may be controlled by voltages provided by different converters; lastly, the number and kind of output circuits may be selected at will.

Other characteristics and advantages of the invention will appear more clearly as the following detailed description proceeds with reference to the appended drawings, in which:

FIG. 1 is a block diagram illustrating the principle of insertion of a circuit ensuring information transfer and electrical isolation between the input and output circuits of a telegraph relay;

FIG. 2 is a diagram intended to recall the application of the above-mentioned principle to a conventional electromechanical relay;

FIG. 3 is a partial diagram of a known type of electron relay wherein the said principle is applied;

FIGS. 3A, 3B and 3C are waveshapes illustrating the operation of the electron relay of FIG. 3;

FIG. 4 is a block diagram of an electron relay according to the present invention;

FIG. 5 is a diagram illustrating one form of embodiment of an electron relay according to the invention;

FIG. 6 is a block diagram illustrating a multiple function electron relay according to the invention.

The block diagram in FIG. 1 is a functional representation of the ideal constitution of a universal telegraph relay. This relay comprises an input circuit *E1*, *E2* supplied by a generating unit *G* with positive, zero or negative continuous control-current, taking as a reference one of two wires maintained at telegraphic zero. The circuit *E* is coupled by a unit *T* to the output circuit *S*, the terminals *S1*, *S2* of which are connected

by a telegraph line L to a customer load Z. The output circuit S is symmetrical and fed by a twin battery B, so that one of the wires of the line L (for instance the one connected to the terminal S2) being at telegraphic zero and taken as a reference, the other wire can be made at will positive or negative at rest. The unit T simply transfers the information received from the input circuit E to the output circuit S, so that the said circuits are isolated with respect to one another and, consequently, between the input and output circuits there is only a polarity dependence; the input circuit E can thus be adapted to receive very-low level signals, whereas the output circuit fed by the battery B can supply signals of sufficiently high level to ensure good-quality transmission of the latter. The properties of the telegraph relay thus constituted can be turned out to advantage for isolating the connecting lines of terminal apparatus, transposing the value of the supply voltages, amplifying and/or regenerating the signals, adapting additional apparatus to existing installations and combining several input and/or output circuits, etc.

The conventional electromechanical relay as shown in FIG. 2 has the above-mentioned various properties: as a matter of fact, the input and output circuits E and S thereof are respectively constituted by a control electromagnet connected to the input terminals E1, E2 by a set of reversing contacts supplied by the battery B and connected to the output terminals S1, S2, the transfer unit T being constituted by a system of rods or any other mechanism connecting the electromagnet E with the reversing contacts S, the latter thus being connected mechanically, but isolated electrically.

This conventional electromechanical relay involves, however, several drawbacks related essentially to the signal level required to energize the electromagnet E and to the quality of the contact occurring in the reversing unit S, the latter being liable to corrosion and bouncing. Furthermore, the electromagnetic inertia of the input circuit and the mechanical inertia of the output circuit lead to excessive switching times.

To avoid the aforesaid inconveniences, it has been proposed to use entirely static telegraph relays wherein the transposition of the polarity and amplitude of the input signals is obtained only electrically; however, the design of such static relays gives rise to severe problems if the most advantageous properties of the electromechanical relay are to be preserved, namely, level amplification and independence of input and output signal polarities, while at the same time enabling electrical isolation of the input and output circuits from one another. As a matter of fact, signal level amplification requires the use of a source of electric energy and, moreover, of operative electronic components such as transistors, the operation of which depends on polarity and requires a common alternate reference point.

In order to avoid the latter two conditions, it has been suggested to couple the input and output circuits of the relay through a unit ensuring information transfer and electrical isolation and constituted solely by a transformer, the alternate reference point being for instance constituted by the telegraphic zero. FIG. 3 shows a static telegraph relay of this type, the input circuit E of which is constituted by a differentiation circuit which converts the rectangular-pulse signal applied to the terminals E1, E2 into alternate impulses applied to the primary winding of a transformer T; the impulses picked at the secondary winding are used for controlling the conduction state of a transistor incorporated in a detecting circuit D which in turn ensures the switching of the conduction state of the positive and negative chains of a symmetrical output circuit S supplied by a battery B. Thus, the transformer T allows the information to be transferred from the input circuit E to the output circuit S, while at the same time electrically isolating the said circuits from one another and ensuring the independence of input-circuit and output-circuit polarities with respect to one another.

The operation of the static telegraph relay of FIG. 3 is illustrated by the waveforms of FIGS. 3A, 3B and 3C showing the voltages applied to the terminal E1 of the input circuit E, to

the terminal T1 of the primary winding of the transformer T and to the terminal S1 of the output circuit S as functions of time t , the terminals E2 and S2 being maintained at the telegraphic zero constituting the reference potential. It is evident from these waveforms that the operation of the relay of FIG. 3 is perfectly satisfactory so long as it receives a correctly-shaped signal, for instance a signal produced by a relay of the same type, but when the received signal is affected by disturbances, the relay becomes practically inapplicable.

In order to avoid this inconvenience and thus eliminate the consequences of input signal disturbances, the solution according to the present invention consists in controlling the output circuit of the relay not by means of input-signal polarity reversals, as is the case in the relay of FIG. 3, but by means of the very state of the signal polarity applied to the input. For this purpose, a relay according to the invention comprises one or several units adapted to generate a voltage of appropriate amplitude and polarity, the said generating units being isolated from the input circuit, but controlled by the polarity of the signal applied to the latter, the said generators ensuring, directly or, if necessary, through amplifier stages, the control of the output circuit so as to produce a signal of appropriate polarity and level.

Thus, the static telegraph relay whose block diagram is shown in FIG. 4 comprises a converter constituted by an oscillator O supplied by a battery B and coupled through a transformer T to a detector D, the output voltage of which is applied to a circuit CS controlling the polarity of the signal provided by the output circuit S; the operation of the converter and, therefore, the polarity of the output signal are controlled by the blocking of the oscillator O when a signal of predetermined polarity is applied to the input circuit E to which is associated for this purpose a control circuit CE coupled to the transformer T.

It is thus immediately evident that the relay thus constituted has the various properties required from a telegraph relay while at the same time being free from the above-mentioned inconveniences of prior-art static telegraph relays. As a matter of fact, the transformer T ensures perfect electrical isolation of these input and output circuits; the polarity of the output signal is directly dependent on that of the input signal, even if the latter is notably disturbed, and the polarity reversals ensured by the blocking or unblocking of the oscillator O are extremely positive and quick; since the blocking of the oscillator O requires only very low power, the level of the input signal is not critical and the relay is therefore capable of ensuring correct reception of strongly attenuated signals; the level of the output signal is independent of that of the input signal and may be selected at will, since it depends only on the characteristics of the output chain which is electrically independent of the input chain. Lastly, owing to its constitution, the relay according to the invention is particularly suitable for the adjunction of additional inputs and/or outputs enabling it to fulfill complex functions. Owing to all these properties, the static telegraph relay according to the invention is suitable for universal use.

An actual example of embodiment of a static telegraph relay according to the invention is shown in the diagram of FIG. 5. The constitution of this relay corresponds to the block diagram of FIG. 4 and comprises essentially an input circuit E and an associated control circuit CE coupled to the transformer T of the converter constituted by the oscillator O and the detector D; the latter supplies the output control circuits CS which in turn control the operation of one or the other of the positive and negative output chains S(+) and S(-) connected respectively to the positive and negative terminals of the telegraph battery B.

The input circuit E comprises a simple resistor R1 connected between the input terminals E1 and E2 and bypassed by a filter capacitor C1. The input control circuit CE comprises a switching transistor Q1, the emitter-base junction of which is polarized by the voltage across the resistor R1, the emitter and the collector of the said switching transistor being directly interconnected by a winding N1 of the transformer T.

The oscillator *O* is essentially constituted by an NPN-type transistor *Q2* whose emitter is connected through a resistor *R2* to the negative terminal of the telegraph battery *B* and whose collector is connected to the middle point of the said battery through a buffer resistor and a resonant circuit constituted by a capacitor *C2* and one winding of the transformer *T*. The base of the transistor *Q2* is provided with DC-polarization by means of a resistor *R'2* and with AC-polarization by means of a feedback winding *N'2*.

The detector *D* is simply constituted by a diode bridge circuit *D1-D4* supplied by a winding *N3* of the transformer *T*; the positive terminal of the rectifier bridge circuit *D1-D4* is connected to the positive terminal (+) of the telegraph battery, the rectified voltage being applied through a protective resistor to the emitter-base junction of a transistor *Q3* shunted by a filter capacitor *C3*.

The transistor *Q3* constitutes the driver stage of an output control circuit *CS* comprising also two transistors *Q4*, *Q5* controlling respectively the operation of the positive and negative chains *S(+)* and *S(-)* of the relay output circuit. The emitters of the transistors *Q4* and *Q5*, of the NPN- and PNP-type respectively, are connected to the middle point of the telegraph battery, the emitter-base junctions of the said transistors being mounted across the terminals of a polarization resistor *R3* connected on the one hand to the positive terminal *B(+)* of the battery through a resistor *R4* and the emitter-collector junction of the transistor *Q3* and, on the other hand, to the negative terminal *B(-)* of the battery through a resistor *R5*, the ohmic value of which is considerably above that of the resistance *R4*. The collectors of the transistors *Q4* and *Q5* are connected to the positive and negative terminals of the telegraph battery through respective voltage dividers *R6-R'6* and *R7-R'7* providing respectively the control voltages of the positive and negative branches *S(+)* relay *S(-)* of the relay output circuit.

As a matter of fact, the latter is symmetrical, the output terminal *S1* being connected to the positive, *B(+)*, and negative, *B(-)*, terminals of the telegraph battery through identical branches with opposed conducting directions, the positive branch being essentially constituted by the emitter-collector junction of a PNP-type transistor *Q6*, the base of which is polarized by the voltage across the resistor *R6*, while the negative branch is constituted by the emitter-collector junction of a NPN-type transistor *Q7*, the base of which is polarized by the voltage across the resistor *R7*. The transistors *Q6* and *Q7* are protected against any overload resulting, for instance, from a line short circuit. These means are constituted essentially by a protective resistor *R8*, *R9* shunted by the emitter-collector junction of a transistor *Q8*, *Q9*, the base of which is polarized by the voltage across a resistor *R10*, *R11* constituting the collector load of a transistor *Q10*, *Q11* fulfilling the function of an overload detector, the base of the said transistor being for this purpose polarized by the voltage across the terminals of a preferably nonlinear impedance element *X10*, *X11* connected in series in the emitter circuit of the transistor *Q6*, *Q7* to be protected; the impedance elements *X10*, *X11* are advantageously decoupled by a capacitor *C10*, *C11* serving to prevent the protection means from becoming operative in case of an instantaneous overload or an overload too brief to be capable of damaging the protected transistor.

The static telegraph relay which has just been described operates as follows.

The telegraphic signal to be processed, after being modulated by polarity reversal, is applied to the terminals *E1*, *E2* of the input circuit, any one of the said terminals being maintained at the reference potential. Depending upon whether the terminal *E1* is negative or positive with respect to the terminal *E2*, the transistor *Q1* of the input control circuit *CE* is either blocked or conducting, so that the circuit including the winding *N1* of the transformer *T* is respectively either open or closed; this switching, taking into account the gain of the transistor *Q1*, requires only very low power, so that signals of very low level can be received correctly.

When the circuit including the winding *N1* of the input control circuit *CE* is open, the coupling coefficient of the windings *N2*, *N'2* is sufficient to enable the oscillator *O* to operate; as a result, an alternating voltage is induced in the winding *N3* of the detector *D*, so that the diode bridge circuit *D1-D4* polarizes negatively the base of the transistor *Q3* and the latter becomes conducting. Conversely, when the circuit including the winding *N1* is closed by the transistor *Q1*, the coupling coefficient of the windings *N2*, *N'2* becomes insufficient to enable the oscillator *O* to operate and, therefore, the detector *D* supplied low polarization voltage to the transistor *Q3*, and the latter is blocked.

When the transistor *Q3* is nonconducting, the resistor *R3* is traversed by a current *i(-)* flowing back to the negative terminal *B(-)* of the telegraph battery through the resistor *R5*, so that the emitter-base junction of the transistors *Q4*, *Q5* are polarized negatively; conversely, when the transistor *Q3* is conducting, the emitter-base junction of the transistors *Q4* and *Q5* are polarized positively, the resistor *R3* being traversed by a current equal to the sum of the said current *i(-)* and a current *i(+)* flowing from the positive terminal *B(+)* of the battery through the emitter-collector junction of the transistor *Q3* and the resistor *R4*, the ohmic value of which is less than that of the resistor *R5*, so that the intensity of the current *i(+)* exceeds that of the current *i(-)*. Since the transistors *Q4* and *Q5* are of opposed types, one or the other becomes conducting according to the direction of the voltage drop across the resistor *R3*, that is according to the conduction state of the transistor *Q3* which, in turn, depends on the state of the oscillator *O* and, therefore, on the polarity of the signal applied to the input terminals *E1*, *E2* of the relay.

Depending on whether the transistor *Q4* or the transistor *Q5* of the output control circuit *CS* is conducting, the line connected to the terminal *S1* of the output circuit is supplied either by the positive branch *S(+)* or by the negative branch *S(-)* of the said output circuit. As a matter of fact, if the transistor *Q4* is conducting, the transistor-interrupter *Q6* controlling the positive branch *S(+)* is made conducting by the voltage drop across the resistor *R6*, whereas the transistor *Q7* of the negative branch *S(-)* is blocked, no polarization voltage being supplied to it by the resistor *R7* mounted in the collector circuit of the transistor *Q5* which is blocked. Conversely, when the transistor *Q5* is conducting, the output terminal *S1* is supplied by the negative branch *S(-)*. This means that the polarity of the output signal appearing between the terminals *S1* and *S2*, the latter being connected to the middle point of the telegraph battery, depends on the conduction state of the transistor *Q3* and, therefore, as already mentioned above, on the polarity of the signal applied to the input terminals *E1*, *E2*.

Either the positive branch *S(+)* or the negative branch *S(-)* of the relay output circuit being conducting, any abnormal increase in current, resulting for instance from a line short circuit, automatically causes the protective resistor *R8*, *R9* to be connected in series with the branch concerned; as a matter of fact, when the voltage drop across the detecting impedance element *X10*, *X11* is sufficient to render conducting the associated detecting transistor *Q10*, *Q11*, the collector current of the latter produces across the resistor *R10*, *R11* an additional voltage drop sufficient to block the transistor *Q8*, *Q9* which up to that moment was shunting the resistor *R8*, *R9*. The intensity of the line current is thus brought to a value compatible with the possibilities of heat dissipation of the transistor *Q6*, *Q7*, and unless short circuits occur on the line, the transmission of information is assured, if only the user device is sensitive enough.

Of course, the form of embodiment of a relay according to the invention as just described is not to be construed as being limitative and is susceptible of many modifications. Thus, according to the types of the transistors *Q1* and *Q3*, four combinations of input and output signal polarities are possible and, in addition, it makes no difference whether the reference of the input signal is taken at the terminal *E1* or *E2*; on the other

hand, the detector D may supply, during the operation of the oscillator O, either a positive voltage instead of a negative voltage or a negative voltage as well as a positive voltage. Of course, the oscillator O described may be replaced by any other type of oscillator provided with feedback and having appropriate characteristics; the said oscillator may also be associated with several detecting circuits in order to facilitate or particularize the control of the relay stages placed downstream. Lastly, the constitution of the output circuit and the manner of driving the same may be modified.

In order to illustrate the adaptability of the relay according to the invention, there is shown in FIG. 6, in the form of a block diagram, a complex relay comprising a second control chain E'-CE' and an associated converter O'-T'-D', the operation of which is controlled for instance from an input control circuit CE of the main chain through an auxiliary circuit CA; the two control chains are coupled, either in series or in parallel, with one and the same output control circuit CS', the voltages being either of the same polarity or of opposed polarities and having either equal or unequal polarities in one direction or the other. The combination of the two control chains enables to obtain at will a positive or negative quiescent state at the output when the main input circuit E is not fed. Such a relay may be used for instance in a teleprinter so as to combine the functions of reception, transmission, typing and printing. Of course, a larger number of control chains may be combined, the number of feasible combinations being practically limited only by considerations of cost, dimensions and power consumption.

Of course, the invention is by no means to be construed to be limited to the forms of embodiment described and illustrated, as the latter have been given by way of example only; on the contrary, the invention comprises all the means constituting technical equivalents to the means described and illustrated as well as their combinations, should the latter be within the spirit of the invention.

We claim:

1. An electron relay to be used as a universal telegraph relay, comprising at least one input circuit and one output circuit coupled by an information transfer circuit electrically

isolating said input and output circuits from one another and operatively controlling the switching of said output circuit according to the polarity of an input signal applied to said input circuit, said transfer circuit including at least one voltage generating converter formed of a tuned oscillator and of a rectifier coupled to respective separate windings of one and the same transformer, and at least one input control unit coupled to a further separate winding of said transformer and operative to substantially short circuit same when said input signal is of a predetermined polarity.

2. An electron relay according to claim 1, wherein said input control unit comprises at least one input transistor connected across said further winding of said transformer, and operatively connected to said input circuit, so that said transistor is brought to conduction when the signal applied to said input circuit is of said predetermined polarity.

3. An electron relay according to claim 1, wherein said transfer circuit comprises at least one output control unit fed by said rectifier for operatively controlling the switching of said output circuit.

4. An electron relay according to claim 3, wherein said output control unit comprises at least one control transistor, the conduction state of which depends on the voltage supplied by said rectifier.

5. An electron relay according to claim 4, wherein said output circuit comprises two symmetrical branches including respective switching transistors of opposed types mounted in parallel with one and the same polarization resistor, one end of which is connected to a point of reference voltage and the other end of which is connected to two voltage sources of opposed polarities respectively through a first resistor and through said control transistor.

6. An electron relay according to claim 5, wherein said control transistor is connected in series with a second resistor, the ohmic value of which is less than that of said first resistor.

7. An electron relay according to claim 4, wherein said output circuit comprises at least one output transistor and is provided with overload protection means comprising a normally shunted resistor connected in series with said output transistor.

45

50

55

60

65

70

75