

Oct. 18, 1960

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2,957,168

DIODE GATE TRANSLATOR

Filed Dec. 21, 1956

FIG. 1

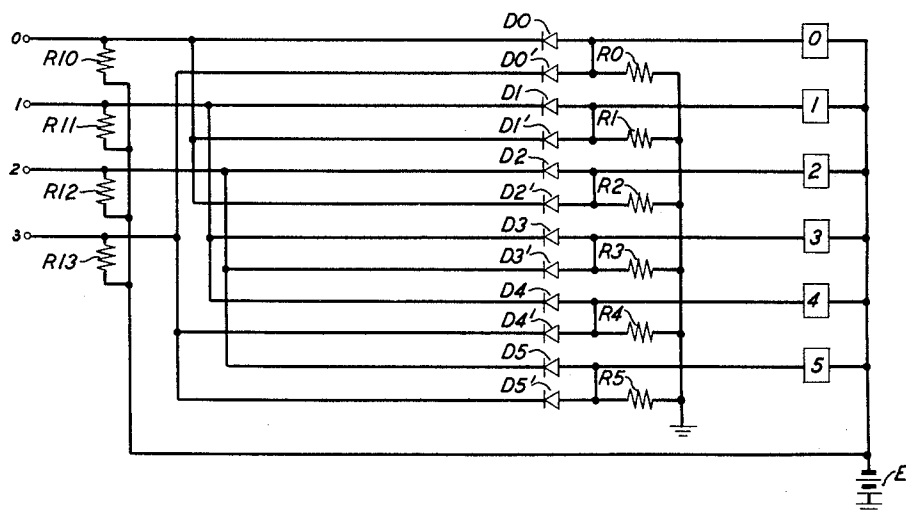
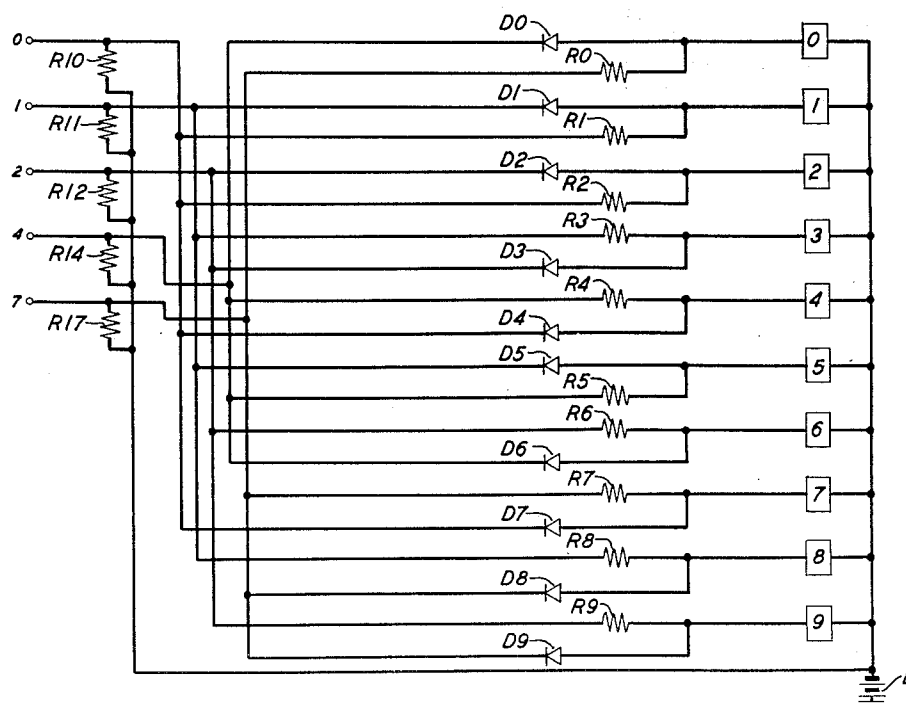


FIG. 2



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DIODE GATE TRANSLATOR

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Filed Dec. 21, 1956, Ser. No. 629,817

6 Claims. (Cl. 340—347)

This invention relates to code translating apparatus and more particularly to such apparatus in which information expressed in a two-out-of-M code is translated into a one-out-of-N code.

A variety of code translators have heretofore been proposed, illustrative of which is that disclosed in Patent 2,369,474 granted on February 13, 1945, to H. P. Luhn. Known translators vary widely with respect to the kinds of codes employed and the types of active elements utilized therein. Some of these translators are restricted to one specific type of translation, whereas others are more flexible. It has been continuously sought to improve code translators by reducing the number of active elements required therein, by decreasing the operating time thereof, by minimizing power requirements, and by reducing bulk and cost.

It is one general object of this invention to improve code translators.

Most specifically, objects of this invention are to increase reliability, to reduce the number of active elements required, to decrease operating time and to reduce bulk and cost.

In accordance with one feature of this invention, the relay total is reduced to a number equal to the number of elements in the output code, thereby increasing reliability of operation.

In accordance with another feature of this invention, instantaneously responsive miniature electronic elements are arranged to cooperatively act with the relays to effect translation, thereby reducing bulk, cost and operating time.

In one of the two specific illustrative embodiments herein described, the operating coil of each of a plurality of relays is normally shunted by two paths each comprising an asymmetrical current device serially connected to a resistor. Each shunt is low in resistance and is normally effective to prevent actuation of the associated relay. It is therefore necessary that both shunts associated with a given relay be effectively open-circuited in order to activate the relay coil.

When two of a plurality of input terminals are grounded, certain of the asymmetrical current devices are back-biased to prevent the flow of current therethrough, thereby effectively opening the shunt of which the asymmetrical current device is a part. However, it is only with respect to one of the relays that both shunts are thus effectively disconnected, and therefore only one of the relays will operate in response to the grounding of a pair of input terminals. Translation is thus effected from a two-out-of-M to a one-out-of-N code, each relay representing in the latter code the item of information expressed by the grounding of the corresponding two input terminals.

In another specific illustrative embodiment herein disclosed, the above-described apparatus is advantageously modified to reduce the number of required resistors and asymmetrical current devices. According to this adaptation, each relay is selectively actuated by the concurrent connection thereof to ground and the back-biasing of its

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single associated diode. The two input terminals which represent a given relay are effective, when grounded, one to provide the required ground and the other to effectively cut-off, i.e., back-bias the associated diode.

The above-mentioned and other objects and features of the invention will be apparent from the following detailed description by way of example, with reference to the drawing, in which:

Fig. 1 is a schematic diagram of the first-mentioned illustrative embodiment of the invention; and

Fig. 2 is a schematic diagram of the aforementioned advantageous adaptation thereof.

Now referring to Fig. 1, it will be noted that the circuit elements therein depicted comprise six relays 0-5, ten resistors R0-R5 and R10-R13, twelve asymmetrical current devices D0-D5', a source of activating potential E, four input terminals 0-3 and interconnecting circuitry.

In operation, any two of the four input terminals are selected and grounded. In response thereto, one and only one of the relays will be actuated in the following manner. If, for example, terminals 0 and 1 are grounded, relay 1 will be actuated and the other relays will remain inactive. Normally, current will flow from ground through resistors R0-R5 and thence in two directions to battery E: in one direction through asymmetrical current devices D0-D5' and thence over the obvious paths through resistors R10-R13; and in the other direction through the coils of the relays 0-5. Resistors R10-R13 are of relatively low resistance, whereas the resistances of resistors R0-R5 and the coils of relays 0-5 are relatively high in magnitude. Accordingly, the major portion of the voltage E is developed across resistors R0-R5 and very little is developed across resistors R10-R13 which therefore effectively shunt the relay coils and prevent the relays from operating. However, when terminals 0 and 1 are grounded, asymmetrical current devices D1 and D1' are both back-biased by the ground potential which is conducted thereto from the grounded terminals over the obvious paths, thereby effectively disconnecting shunting resistors R10 and R11 from the coil of relay 1.

That both D1 and D1' are back-biased will be apparent from a consideration of the circuit of relay 1 wherein the right-hand terminal of devices D1 and D1' must reside at a potential negative with respect to ground since they are connected through the coil of relay 1 to negative voltage source E and are connected to ground through a resistance, i.e., R1. Since the left-hand terminals of devices D1 and D1' are connected directly to ground through grounded terminals 0 and 1, it will be obvious that the left-hand terminals will be at a potential more positive than that of the right-hand terminals, and the devices are therefore back-biased and effectively cut off. Accordingly, the only effective circuit for the relay coil is that which is extended from ground through resistor R1 and the coil of relay 1 to battery E, and in this circuit sufficient voltage is developed across the coil to operatively activate it.

Although in grounding the terminals 0 and 1, asymmetrical devices D0, D2', D3 and D4 are also back-biased, no one of the remaining relays is activated thereby since devices D0', D2, D3' and D4' continue to effectively shunt current away from the associated relay coils. Therefore, in response to the grounding of terminals 0 and 1, only relay 1 is operated.

If any one of the remaining pairs of terminals, i.e., combinations of two terminals, is grounded, a corresponding one of the relays is actuated in a similar manner, and it is therefore apparent that the circuits of Fig. 1 are effective to provide translation of information from a two-out-of-four code to a one-out-of-six code.

In order to simplify the description thereof, the circuits in Fig. 1 include but four input terminals and six

relays, thus being effective, as hereinbefore stated, to translate information from a two-out-of-four to a one-out-of-six code. It will be obvious that four additional relays and one additional input terminal could be added in accordance with the hereinbefore described principles underlying this embodiment, and the circuit, thus modified, would be effective to translate information from a two-out-of-five to a one-out-of-ten code.

In telephone switching systems, the need often arises for apparatus capable of effecting translation from the two-out-of-five to one-out-of-ten codes. Accordingly, an advantageous adaptation of the circuits of Fig. 1 are illustrated in Fig. 2 in a form capable of providing this type of translation.

In Fig. 2 it will be noted that there are shown ten relays 0-9, five input terminals denominated 0, 1, 2, 4 and 7, fifteen resistors R0-12, R14 and R17, ten asymmetrical current devices D0-D9, a source of activating potential E and suitable interconnecting circuitry. In this embodiment, as in the former, the grounding of any given pair of input terminals results in the actuation of one and only one of the relays, each relay being thus specifically representative of a different terminal pair.

Normally each of the ten relays remains unoperated for two reasons: the first is that there is no complete circuit for the passage of current therethrough since terminals 0, 1, 2, 4 and 7 are normally ungrounded; the second reason is that even when such path is completed by the grounding of a terminal, the associated asymmetrical current device normally shunts current away from the relay coil through a low resistance path to battery, thus preventing activation thereof. Two conditions must therefore coincide in order for any one of the relays to be activated. The first of these is the completion of a path for the flow of operating current, and the second is the back-biasing, i.e., effective cutting off, of the associated asymmetrical current device. Thus, for example, in order to operate relay 0, it would be necessary to ground terminals 4 and 7, the grounding of terminal 7 being effective to extend a path for the flow of operating current from ground through terminal 7, resistor R0 and the coil of relay 0 to battery; and the grounding of terminal 4 being effective to raise the potential at the left-hand terminal of asymmetrical current device D0 to a value more positive than the right-hand terminal thereof, thereby back-biasing the device and effectively open-circuiting it. Current will now flow from ground at terminal 7 through resistor R0 and thence through the coil of relay 0 to source of potential E instead of being diverted away from the relay coil over the aforementioned shunting path which, if terminal 4 were not grounded, would comprise forward-biasing device D0 and low impedance resistor R14.

No other one of the relays will be operated in response to the grounding of terminals 4 and 7, since both of the aforementioned required conditions are not satisfied for any relay other than relay 0. Accordingly, it will be apparent that the grounding of terminals 4 and 7 is effective to translate an item of information represented thereby from a two-out-of-five to a one-out-of-ten code.

The grounding of any other pair of terminals will similarly result in the actuation of a different corresponding one of the relays, and the apparatus is therefore effective to translate any one of ten items of information expressed in a two-out-of-five code to a one-out-of-ten code.

Although the invention has been illustrated by two particular embodiments thereof, it is not limited to the specific apparatus and the particular arrangement therein disclosed. Various applications, modifications, adaptations and arrangements of the invention will readily occur to those skilled in the art.

What is claimed is:

1. Code translator apparatus for converting a two-out-of-M code to a one-out-of-N code including, in combination, M input points, N output devices responsive to current flow exceeding a preassigned magnitude, a source of operating potential, a plurality of asymmetrical conducting impedance devices not exceeding 2M in number, a source of reference potential, and interconnecting network means comprising a first plurality of electrically conductive paths, each path being devoid of all circuit elements except symmetrically conducting impedance elements, directly connecting each of said input points with every other of said input points, a second plurality of electrically conducting paths each in shunt relation to a respective one of said first paths and each including not more than a respective two of said asymmetrical conducting impedance devices, similarly poled, a third plurality of electrically conducting paths, each including at least a part of a respective one of said first paths, each being devoid of all circuit elements except symmetrically conducting impedance elements, connecting each of said input points to said source of operating potential, and a fourth plurality of electrically conducting paths, each including a respective one of said output devices, and each connecting said source of operating potential to one terminal of not more than a respective two of said asymmetrical conducting impedance devices, whereby upon the application of said source of reference potential to any two of said input points a current of said preassigned magnitude is applied to a respective one of said output devices.

2. Apparatus as defined in claim 1 wherein said output devices comprise relays.

3. Apparatus for converting a two-out-of-M code to a one-out-of-N code including M input points, N output devices responsive to current flow exceeding a preassigned magnitude, a source of operating potential, 2M asymmetrical conducting impedance devices, a source of reference potential, and interconnecting network means comprising a first group of N electrically conducting paths connecting each of said input points to each other input point through a respective pair of said asymmetrical conducting impedance devices connected in series relation and oppositely poled, a second group of N electrically conducting resistive paths each in shunt relation to a respective one of said first group, impedance means each connecting a respective one of the terminals of a respective one of each of said asymmetrical conducting impedance devices to said reference potential, N connecting means, each between a respective junction of one of said respective pairs of asymmetrical conducting impedance devices and said source of operating potential, each including a respective one of said output devices, and impedance means connecting each of said input points to said source of operating potential, whereby upon the application of said source of reference potential to any two of said points, a current of said preassigned magnitude is applied to a respective one of said output devices.

4. Apparatus as defined in claim 3 wherein said output devices comprise relays.

5. Code translator apparatus for converting a two-out-of-M code to a one-out-of-N code including M input points, N output devices responsive to current flow exceeding a preassigned magnitude, a source of operating potential, M asymmetrical conducting impedance devices, a source of reference potential, and interconnecting network means comprising a first group of electrically conducting resistive paths connecting each of said input points with each other of said input points, a second group of electrically conducting paths, each in shunt relation to a respective one of said first paths, and each including a respective one and only one of said asymmetrical conducting impedance devices, a third group of electrically conducting paths each including at least a

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part of a respective one of said first group of paths connecting each of said input points to said source of operating potential, and a fourth group of electrically conducting paths, each including a respective one of said output devices, and each connecting said source of operating potential to one terminal of a respective one of said asymmetrically conducting impedance devices, whereby, upon the application of said source of reference potential to any two of said input points, a current of said pre-assigned magnitude is applied to a respective one of said output devices.

6. A code translator for converting between a two-out-of-M and a one-out-of-N code, where

$$N = \frac{M}{2}(M-1)$$

comprising, in combination, a plurality of M input points including N different combinations of two, N indicating means each associated with a respective one of said combinations of input points, first connecting means between each of said input points and each other of said input points, each of said connecting means including a respective one and only one of a group of N symmetrically conducting impedance devices and one and only one of a group of N asymmetrically conducting impedance devices in series relation, second connecting means,

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in shunt relation to said first connecting means, between each of said input points and each other of said input points, each of said second connecting means including a respective two and only two of a group of M symmetrically conducting impedance devices in series relation, means each including a respective one of said indicating means connecting the junction of said devices included in said first connecting means to the junction of said devices included in said second connecting means, a source of operating potential, means connecting said source to said second named junction, and a source of reference potential, whereby each of said indicating means is made responsive to the application of said reference potential to both of the input points comprising a respective one of said combinations of input points.

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