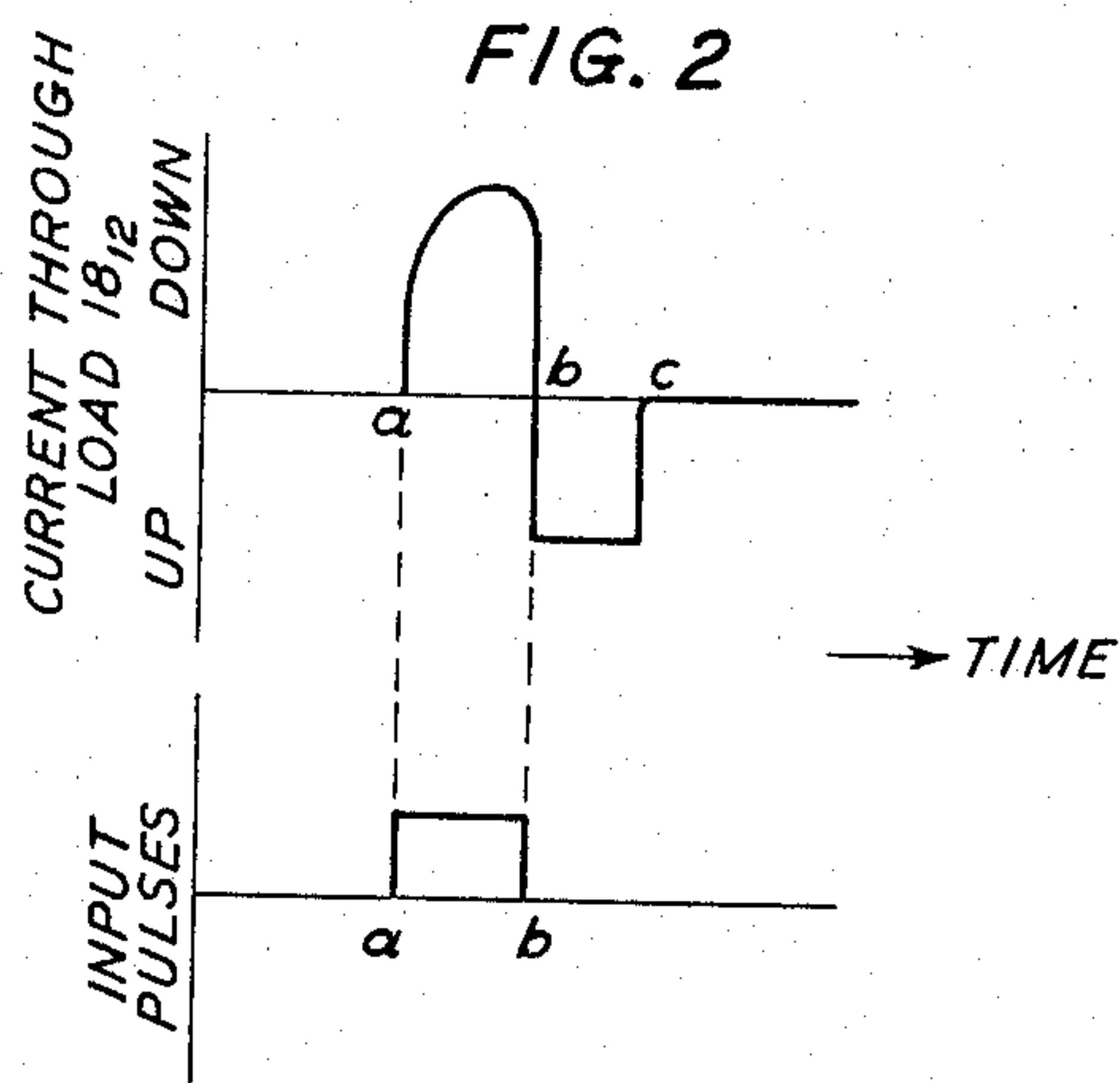
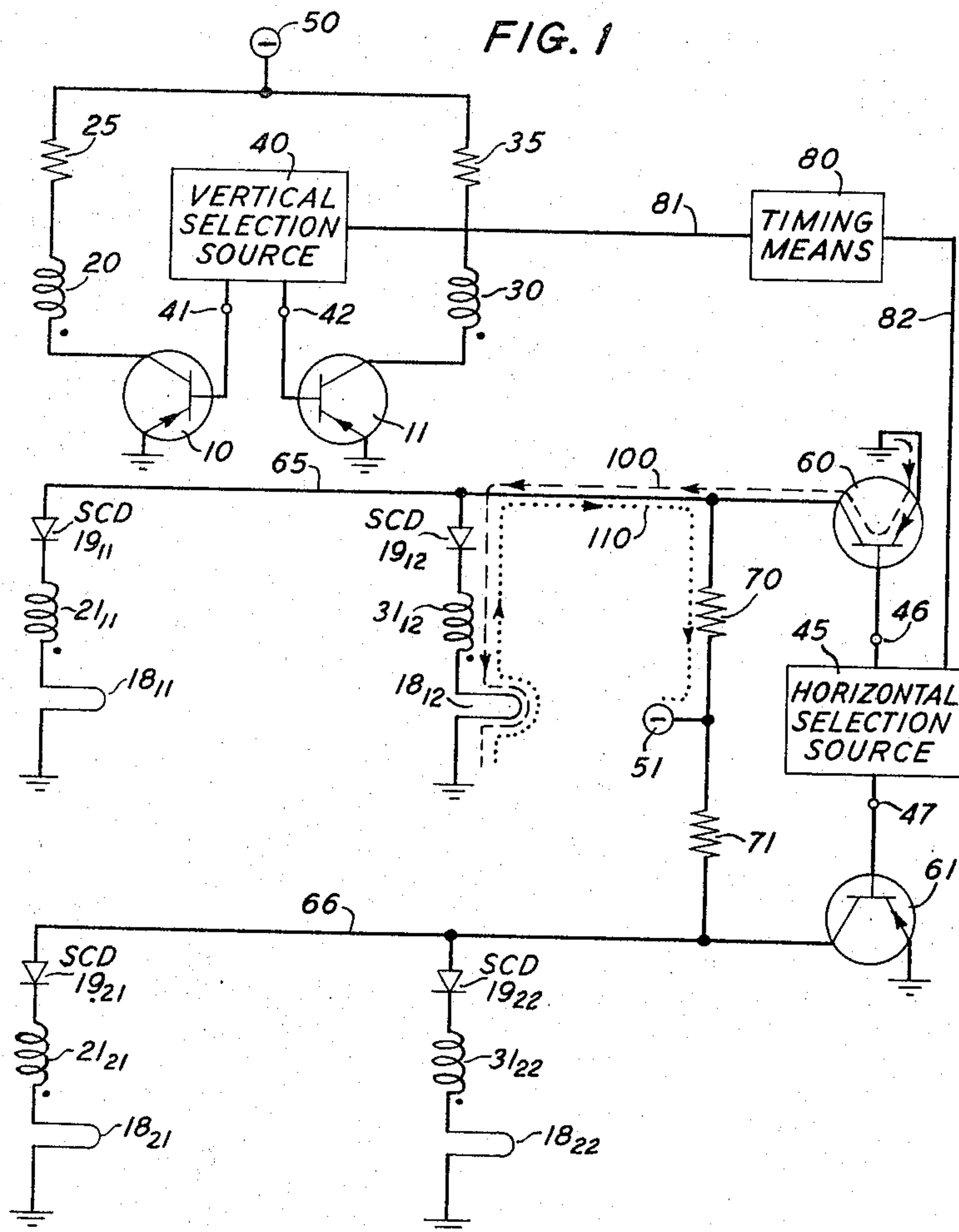


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A. H. BOBECK
LOAD SELECTION ARRANGEMENT HAVING STORED
CHARGE DIODE CURRENT CONTROL
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LOAD SELECTION ARRANGEMENT HAVING STORED CHARGE DIODE CURRENT CON- TROL

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6 Claims. (Cl. 340-166)

This invention relates to electronic selection circuits and, more specifically, to a matrix arrangement for supplying a bipolar current to a selected matrix cross point load.

Dual axis matrix arrangements have been widely employed in the data processing art to select a desired one of a plurality of load elements which may comprise, for example, driving solenoids for switching ferromagnetic storage devices. One typical arrangement, which functions as a biased-core dual axis access switch, employs a plurality of magnetic cores each coupled to an output driving solenoid, a bias winding, and two selection windings respectively included in two selection axes.

When one winding in each selection axis is energized, the appropriate core coupled to both the activated windings reverses its maximum remanent state in response thereto, thereby inducing a signal in the output solenoid coupled to the core. As the selection windings are de-energized, the selected core is re-set to its original magnetic condition under the action of the bias winding which supplies a magnetizing force to the core in a polarity opposite to that of the selection windings.

However, in the above and other prior art dual-axis selection arrangements, extraneous signals are induced in undesired output transmission elements. More particularly, spurious electrostatically coupled signals inherently present in such systems switch flux in all the unselected cores which are coupled to only one energized selection conductor. Thus, undesired output noise signals are induced in the output solenoids coupled to these cores.

It is therefore an object of the present invention to provide an improved selection arrangement. More specifically, an object of the present invention is the provision of a selection arrangement which essentially eliminates undesired, spurious output signals.

Another object of the present invention is the provision of a matrix selection arrangement which may advantageously be operated at a relatively high repetition rate, and which supplies bipolar current pulses of a relatively short time duration.

A further object of the present invention is the provision of a matrix selection arrangement which is highly reliable and relatively simply and inexpensively constructed.

These and other objects of the present invention are realized in a specific, illustrative embodiment thereof which is a dual-axis matrix selection arrangement for supplying a bipolar current signal to a selected grounded load element. Each load element has serially connected thereto a linear transformer secondary winding, a stored charge diode, and a shunt arrangement which includes a biasing network and a selected one of a first set of selection transistors. (A stored charge diode is characterized by a low impedance in its forward conduction direction, and by the capacity to conduct a current for a limited period of time in its high impedance, back-biased direction following forward conduction.) In addition, a second set of selection transistors, each connected to the primary winding of a different transformer, is included in the selection arrangement.

When an input signal is applied to one transistor included in each set, a current of a first polarity flows through the selected load and the associated stored charge diode. When the input signals are removed, a current of

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an opposite orientation flows therethrough under the action of the biasing network.

It is thus a feature of the present invention that a dual axis selection arrangement include a matrix array of grounded load elements.

It is another feature of the present invention that a matrix selection arrangement comprise a plurality of transformers each including a primary and a set of secondary windings, and further include a plurality of selection conductors each connected to a group of parallel branches each of which includes the series connection of a grounded load element, a stored charge diode, and the secondary winding associated with a different transformer.

A complete understanding of the present invention, and of the above and other features, advantages and variations thereof, may be gained from a consideration of the following detailed description of an illustrative embodiment thereof presented herebelow in conjunction with the accompanying drawing, in which:

FIG. 1 is a diagram of a specific, illustrative matrix selection arrangement which embodies the principles of the present invention; and

FIG. 2 is a timing diagram illustrating the relationship between selected circuit operations associated with the FIG. 1 arrangement.

Referring now to FIG. 1, there is shown a two-by-two selection matrix employing two horizontal selection conductors 65 and 66 which are respectively connected to the collector terminals of two horizontal selection transistors 60 and 61. Each of the horizontal selection conductors 65 and 66 is further connected to a different row of a matrix array of serially-connected arrangements each of which includes a stored charge diode 19, a load element 18, and a secondary winding 21 or 31 included in one of two linear transformers. As described hereinabove, the stored charge diodes 19 included in the FIG. 1 arrangement are characterized by a low impedance in their forward conduction direction and by the capacity to conduct a current in their back-biased normally high impedance direction for a limited period of time following forward conduction. Stored charge diodes are well known in the art and are described, for example, in an article entitled "P-N Junction Charge-Storage Diodes," by J. L. Moll et al., appearing on pages 43-53 of the January 1962 issue of the Proceedings of the I.R.E.

Each element included in the series-connected matrix-arranged structures is further designated by two subscripts which respectively identify the row and column of the matrix in which the element may be found. For example, the numeral 19₁₂ identifies the stored charge diode 19 which is included in the first row and second column of the selection matrix. It is noted at this point that the specific loads 18 shown in the FIG. 1 selection arrangement advantageously comprise driving solenoids for switching a plurality of ferromagnetic devices, such as those disclosed in my Patent 3,069,665, issued Dec. 18, 1962.

Two vertical selection switching transistors 10 and 11 are included in the FIG. 1 arrangement, with the collector terminals thereof being respectively connected to the primary windings 20 and 30 of two linear transformers. The primary winding 20 is inductively coupled to the secondary windings 21₁₁ and 21₂₁ included in the first column of the selection matrix, while the primary transformer winding 30 is inductively linked to the second column secondary windings 31₁₂ and 31₂₂. Two current-limiting resistors 25 and 35 respectively connect the transformer windings 20 and 30 to a negative voltage source 50. Also, a vertical selection source 40 has two output terminals 41 and 42 thereon respectively connected to the base terminals of the vertical selection transistors 10 and 11, and the emitter terminals of the transistors 10 and 11 are each connected to ground.

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A horizontal selection source 45 is included in the FIG. 1 arrangement, with two output terminals 46 and 47 thereon respectively connected to the base terminals of the horizontal switching transistors 60 and 61. Two biasing resistors 70 and 71 connect the collector terminals of the two horizontal switching transistors 60 and 61 to a second negative voltage supply 51, and the emitters of these transistors are grounded.

It is noted at this point that the horizontal and vertical selection sources 40 and 45 are arranged to coincidentally supply relatively high voltage pulses to a selected one of the two output terminals included thereon when energized by a signal supplied by a timing means 80 via a conductor 81 or 82, respectively. Also, note that dots are included in the FIG. 1 arrangement alongside one terminal of each of the primary windings 20 and 30 included therein, and also alongside each of the secondary windings 21 and 31 which are respectively coupled thereto. This symbolism is well known in the art and indicates that like polarity signals appear at similarly designated terminals of the primary and the associated secondary windings.

With the above organization in mind, an illustrative sequence of circuit operation for the FIG. 1 selection arrangement will now be described. Assume, for example, that it is desired to supply a bipolar selection current to the driving solenoid 18₁₂ included in the first row and second column of the matrix array. To select this matrix crosspoint load, the vertical selection source 40 supplies a relatively high voltage pulse to the output terminal 42 included thereon and the horizontal selection source 45 supplies a relatively high voltage pulse to the output terminal 46 coincidentally therewith. The lower graph included in FIG. 2 shows an input pulse with its leading edge occurring at time *a*, which pulse represents the energization signal supplied by each of the sources 40 and 45.

The pulse appearing at the vertical source output terminal 42 is supplied to the base of the transistor 11. The transistor 11 is saturated by the received input signal, thereby effectively impressing a positive-going, ground potential signal at the dotted terminal of the transformer primary winding 30. Since a positive-going voltage pulse appears at the lower, dotted end of the transformer primary winding 30, a positive-going pulse thereby also appears at the dotted end of the secondary transformer winding 31₁₂ coupled thereto.

The pulse supplied from the horizontal source 45 at time *a* to the base of the transistor 60, via the output terminal 46, saturates the transistor 60, thereby effectively impressing ground potential on the horizontal selection conductor 65. Hence, a direct current series path is completed, which path includes the stored charge diode 19₁₂, the energized transformer secondary winding 31₁₂, the load element 18₁₂ and the emitter-collector path of the saturated horizontal selection transistor 60. Thus, in response to the positive voltage increment appearing at the dotted terminal of the energized transformer secondary winding 31₁₂, a current is established in the above-described complete series path as shown by the dashed vector 100. This current, shown in the upper curve of FIG. 2 for the interval following time *a*, is limited in amplitude by the magnitude of the resistor 35 and the relative number of turns included in the coupled windings 30 and 31₁₂.

The above-described current through the load 18₁₂ persists as long as selection pulses are supplied by the vertical and horizontal selection sources 40 and 45 to the output terminals 42 and 46, respectively. Assume now that the pulses previously supplied by these sources are terminated at time *b*, as shown in the lower curve in FIG. 2. In response thereto, the vertical selection transistor 11 and the horizontal selection transistor 60 are rendered non-conductive. As the emitter-collector circuit of the transistor 60 is no longer a low impedance path to ground, the direct current path discussed above is no longer completed. Thus the forward current, represented by the dashed vector 100 and shown between the times *a* and *b* in the upper curve in FIG. 1, is terminated.

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However, as described hereinabove, a stored charge diode which has previously had a current flowing there-through is conductive in its reverse direction for a limited period of time. Hence, for an interval following time *b*, there is formed a new, counter-clockwise series conduction path, as indicated by the dotted vector 110. This path includes the load 18₁₂, the unenergized transformer secondary winding 31₁₂, the stored charge diode 19₁₂, the resistor 70, and the negative voltage source 51. Thus, following time *b* a current, supplied by the source 51, flows in the above-identified series-connected path. This current, which flows upwards through the load 18₁₂, is shown in the upper curve of FIG. 1 for the interval following time *b*. The magnitude of this current is effectively determined by the quotient of the voltage supplied by the source 51 divided by the resistance of the element 70.

The stored charge diode 19₁₂ conducts in the reverse direction for the interval between times *b* and *c* shown in FIG. 2. At time *c*, all the charge stored therein during the forward conduction portion of the cycle of operation between times *a* and *b* has been swept out, and the diode becomes essentially an open circuit in the reverse, or back-biased direction. Therefore, for the period following time *c* illustrated in FIG. 2, the current flowing through the solenoid 18₁₂ decreases rapidly, limited only by the charging time of the junction and stray capacitances associated with the diode 19₁₂.

Hence, it has been shown that when a desired load 18 is selected by coincident pulses supplied by the selection sources 40 and 45, first a positive current pulse and immediately thereafter a negative pulse are supplied to the selected, grounded driving solenoid.

It is noted that at the time *a* shown in FIG. 2, a positive voltage was supplied to the dotted terminal of the transformer secondary winding 31₂₂, as well as being supplied to the secondary winding 31₁₂ associated with the desired load 18₁₂. However, the voltage increment appearing across the winding 31₂₂ does not give rise to a current through the associated load 18₂₂ since there is no completed, direct current series path through which such an induced current could flow. Specifically, the non-conductive transistor 61 inhibits such a flow of current. Also, since the load 18₂₂ is directly connected to ground and thereby held at ground potential, the energized winding 31₂₂ does not induce any spurious, voltage-transient noise signals in the load 18₂₂.

Summarizing, an illustrative matrix selection arrangement made in accordance with the principles of the present invention supplies a bipolar current signal to a selected, grounded load element. Each load element has serially connected thereto a linear transformer secondary winding, a stored charge diode, and a shunt arrangement which includes a biasing network and a selected one of a first set of selection transistors. In addition, a second set of selection transistors, each connected to the primary winding of a different transformer, is included in the selection arrangement.

When an input signal is applied to one transistor included in each set, a current of a first polarity flows through the selected load and the associated stored charge diode. When the input signals are removed, a current of an opposite orientation flows therethrough under the action of the biasing network.

It is to be understood that the above-described arrangement is only illustrative of the application of the principles of the present invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of this invention. For example, while a two-by-two selection matrix was illustrated for the purposes of clarity, any number of rows and columns might well be employed.

What is claimed is:

1. In combination in a selection arrangement, a first set of transistors, a plurality of transformers each including one primary and a plurality of secondary windings, a second set of transistors each connected to a different

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transformer primary winding, a plurality of biasing networks each connected to a different one of said first transistors thereby forming a plurality of junction points therebetween, a plurality of sets of load elements each having one terminal thereof grounded, and a plurality of stored charge diodes, means connecting each of said junction points to a different one of said sets of load elements by a plurality of series circuits, each of said circuits including one of said diodes and a secondary winding associated with a different transformer.

2. A combination as in claim 1, wherein each of said load elements comprises a solenoid for driving magnetic elements.

3. In combination, a plurality of transformers each including one primary and a plurality of secondary windings, a plurality of sets of load elements each element having one terminal thereof grounded, said number of sets being equal to the number of transformers, and the total number of load elements being equal to the total number of secondary windings included in said transformers, a plurality of selection conductors equal in number to a number of transformers, a plurality of stored charge diodes equal in number to the total number of load elements, and means connecting each of said selection conductors to a different one of said sets of load

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elements via a plurality of series circuits each including one of said load elements, one of said diodes and a secondary winding associated with a different transformer.

4. A combination as in claim 3, further comprising a plurality of first switching means each serially connected to a different one of said transformer primary windings, and a plurality of second switching means each connected to a different one of said selection conductors.

5. A combination as in claim 4, further comprising a first selection source for activating a selected one of said first switching means and a second selection source for activating a selected one of said second switching means.

6. A combination as in claim 5, further including timing means connected to each of said selection sources.

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