

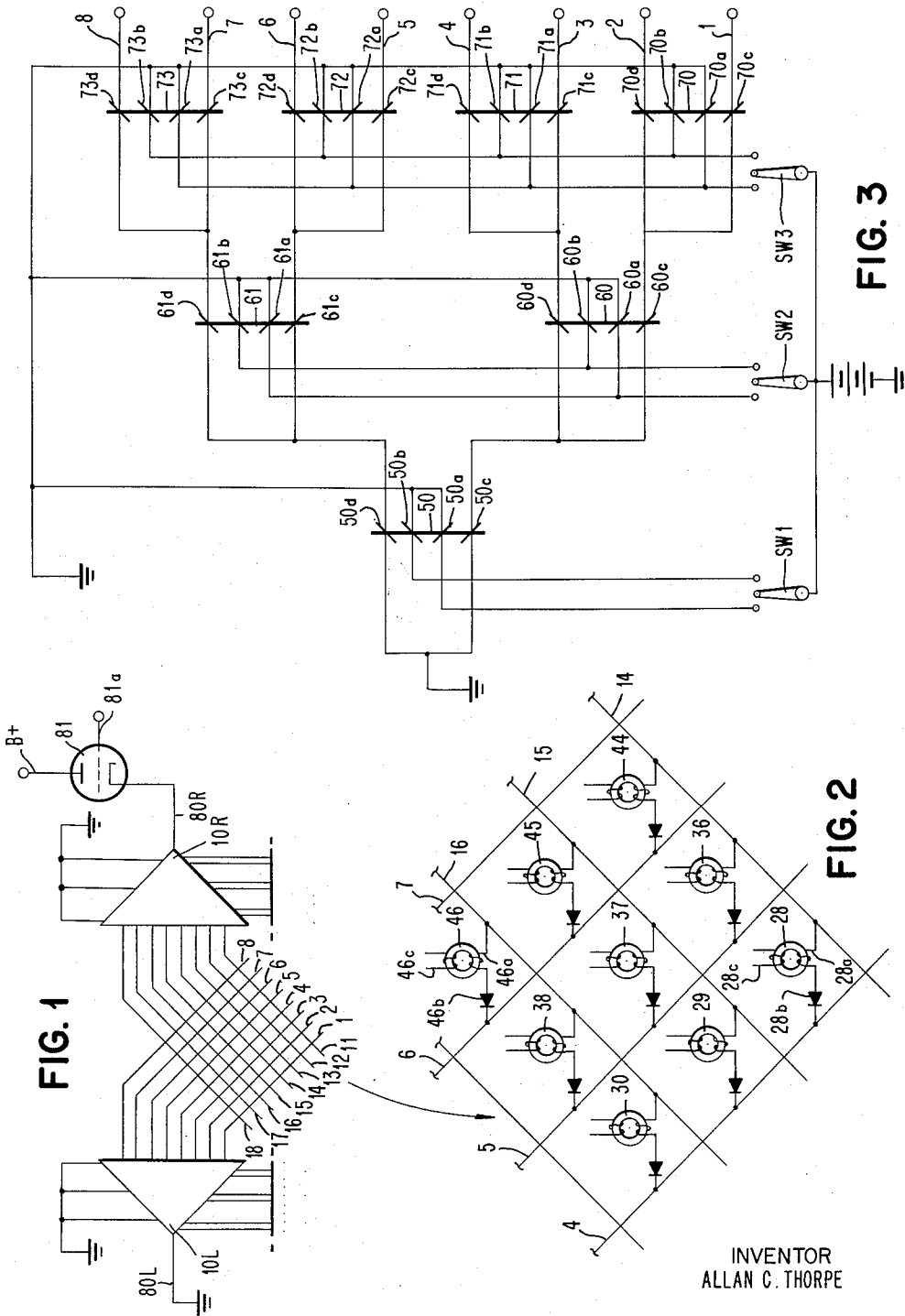
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SWITCHING DEVICE

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1

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SWITCHING DEVICE

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This invention relates to switching devices and more particularly to devices of this type employing magnetic cores as current steering elements so as to effect the selection of one of a plurality of output lines under the control of a lesser plurality of input controls.

Switching circuits for directing a signal from a single source to a desired one of a plurality of outputs find wide application. Familiar in the art is the conventional pyramid or tree employing a succession of relay transfer points. Also familiar are core matrices wherein selected X and Y lines are pulsed to switch a core having a winding connected to each of these lines to produce an output signal on an output winding also wound on the core. Inherent in these prior art systems either the need for an undue multiplicity of driving elements or a disadvantageously small signal-to-noise ratio.

Although the instant invention is of general utility, it has been found to be particularly useful as a decoding device for converting a six bit code into a single signal for energizing a core matrix used as a control in the formation of dot magnetic images on a magnetic drum for the purpose of magnetic printing. Such a machine is exemplified in U.S. Patent 2,820,956 wherein the instant invention would be employed in lieu of the decode matrix 46 shown in FIG. 3 of said patent.

In view of the foregoing and other applications requiring a high signal to noise ratio it is a primary object of this invention to provide a switching device employing magnetic cores wherein the signal appearing on the selected line bears a high ratio to any unwanted signals on the non-selected lines.

A further object is to provide a switching device employing magnetic cores for the selection of a single line from a plurality of lines wherein the selected path contains serially connected impedances which are selectively conditioned to present a low impedance to the flow of current to the desired output.

Another object is to provide a switching device having a plurality of output connections the selection of one of which for the transmission of an output signal is controlled by a lesser plurality of control signals which selectively condition magnetic cores so as to present a single low impedance path to current flow in the desired output circuit.

Yet another object is to provide a switching device employing magnetic cores which are selectively saturated in a positive or negative sense in accordance with input information and have wound thereon coils which are disposed in a serial pyramidal disposition so as to provide a plurality of output paths only one of which presents a low impedance path by virtue of the saturated condition of the cores.

An even further object of the invention is to provide a switching device employing magnetic cores preset in accordance with codal input information to one or another of two saturated conditions in which the thus preset cores are arranged in two pyramidal arrays with windings thereon connected in two branching circuits each having a single input and a plurality of outputs which outputs are connected to a matrix containing further magnetic cores each having a winding connected across the matrix intersections whereby a single low impedance signal path is formed in the two branching cir-

2

cuits to select a core in the matrix upon whose energization a single output signal is generated.

A final and specific object of the invention is to provide a magnetic core switching device in which there is provided a matrix of horizontal and vertical conductors with a uni-directional current device and a core winding disposed across each of the intersections of the conductors, the horizontal and vertical conductors being respectively connected to the outputs of two branching circuits composed of a plurality of sub-branching circuits so as to form pyramidal branching array wherein each branching circuit contains bulking core windings, the cores of which are preset in accordance with input information to one or the other saturated condition, so as to direct a serial current flow through the sub-branching circuits in the low impedance path thereof whereby a single low impedance path is provided in each of the branching circuits so as to energize a single horizontal and vertical matrix conductor for current flow through the associated uni-directional current device and connected core winding to switch the core and provide an output on a further winding of the thus-switched core.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing.

In the drawing:

FIG. 1 is a schematic showing of the interconnection of the tree networks with the matrix.

FIG. 2 is a detailed showing of a segment of the matrix shown in FIG. 1.

FIG. 3 is a detailed showing of the core tree circuit shown in FIG. 1.

The overall function of the apparatus constituting the instant invention will be readily apparent from an examination of FIG. 1, wherein it will be seen that two pyramidal branching circuits 10L and 10R are respectively connected to the individual orthogonally disposed conductors in the series 1 to 8 and 11 to 18 whereby a single conductive path established in each of the branching circuits 10L and 10R will form a single conductive path in the matrix which path (as shown in FIG. 2) includes a uni-directional current conducting device 46b (for example) and a winding 46a on a core 46 having an output winding 46c which will have induced therein an output signal to the exclusion of output signals on any other similarly disposed cores in the matrix. In the exemplarily structure shown sixty-four potential outputs are provided under the control of six input controls disposed three each for each branching circuit. Thus in FIG. 1 when the input controls are properly set and the grid 81a of tube 81 is potentialized to permit the tube to conduct, current flow will proceed from B+ through the input line 80R to the branching circuit 10R and through the selected path thereof to one of the conductors 11-18 through that core winding and rectifier in the matrix connected to the selected one conductor of the series 1-8 and the selected path in the left branching circuit 10L to ground. The current flow thus induced through the selected coil (for example 46a) in the matrix will switch the core material which change in flux will produce an output signal on a second coil (for example 46c) wound on the same core. Other cores in the matrix will remain in their opposite remanent state inasmuch as there is insufficient current flow in any of the non-selected conductors in the matrix. Consequently, as the non-selected cores are not switched negligible signals will appear at their respective output windings.

The schematic blocks of FIG. 1 are detailed in FIGS. 2 and 3, FIG. 2 showing a segment of the matrix, and

FIG. 3 showing one of the branching circuits 10L or 10R which are mere mirror images of one another.

With reference to FIG. 3 it will be seen that there is provided the familiar pyramid or tree circuit having a single input 80L and eight outputs 1 to 8 controlled by the selective status of the switches SW1, SW2, and SW3. By mere expansion or contraction of the circuitry a greater or lesser number of outputs can be easily had there being 2^N outputs for N inputs having two control positions. As will be further apparent the branching circuit of FIG. 3 consists further of seven sub-branching circuits 50, 60, 61, 70, 71, 72, and 73 arranged in three echelons containing respectively one, two, and four sub-branching circuits each. Each of the sub-branching circuits has a magnetic core and associated windings thereat which controls the path in which the current flow is directed depending on whether the core is saturated in the north or south direction. Each of the sub-branching circuits is identical in configuration making for an ease of fabrication. Specifically each sub-branching circuit includes a toroidal magnetic core fabricated of a magnetic material having a substantially square hysteresis loop, known in the art as a "hard" material. Upon each core are wound two signal windings in bucking relationship and either a single set winding or a pair of set windings wound also in bucking relationship with respect to one another. In FIG. 3 the mirror notation has been employed to illustrate the bucking relationship of the coils of which 50c and 50d are signal windings and 50a and 50b are set windings. The set windings 50a and 50b are selectively energized through switch SW1 so that only one at a time can be energized. In an actual construction only one set winding is employed and the current reversed therethrough by a double-pole-double-throw switch to effect the desired input control. For purposes of clarity of illustration and the mirror notation the two winding expedient has purposely been chosen, however. Thus, if the switch SW1 is thrown to the left the set winding 50a will be energized, this winding and the current flowing therein inducing a flux sufficient to switch the magnetic core material to one of its remanent states. In the example chosen current flow from battery B through the left contact of SW1, winding 50a to ground will switch the core south. A corresponding energization of coil 50b will switch the core north. Inasmuch as current flow in the signal windings 50c and 50d is from right to left (B+ to ground), the signal coil 50d is aided by the energization of 50a and bucked by the energization of 50b. A similar aiding and bucking relationship exists with respect to signal winding 50c and the coils 50b and 50a. Thus if the coil 50a be energized so as to saturate core 50 in the south direction any current flow through the signal coil 50c will face a high impedance, whereas current flow through winding 50d will flow through a low impedance path. Thus in all sub-branching circuits, depending on the set of the core either the "c" or "d" winding in each sub-branch will present a low impedance to current flow while the corresponding other coil will present a high impedance. Thus it will be apparent that as between the input 80L to the branching circuit and any one of the outputs 1 to 8 only one path will present a low impedance to current flow while all of the other paths present a high impedance. In actual tests it has been found that in any one sub-branch 93% of current flow is directed in the low impedance path while 7% flows in the high impedance path. Thus the overall current division in the whole of the branching circuit results in roughly 80% of the current flow in the low impedance path while only 6% flows in the next nearest low impedance path, producing in the branching circuit 10L or 10R considered alone a signal-to-noise ratio of more than 13:1. When two branching circuits are serially connected back to back the signal to noise ratio is increased to an even greater extent when this signal is fed

to the matrix to switch only the selected core, as will be apparent in the succeeding discussion.

In the ensuing explanation it must be remembered that current flow in the branching circuit 10L is from the lines 1 to 8 to the common line 80L, while in the comparable mirror-imaged branching circuit 80R current flow is from the common line 80R to the output lines 11 to 18, as will be apparent from an examination of FIG. 1. Thus the aiding and bucking relationship of the "a" and "b" coils with respect to the "c" and "d" coils will be reversed.

As an illustration of the current flow through the circuit let it be assumed that in the branching circuit 10R, SW1 is thrown so as to energize coil 50b, SW2 to energize 61a and 60a, SW3 to energize 72b, 73b, 71b, and 70b. With these switches in these respective positions the core 50 will be switched north, cores 60 and 61 south and cores 70, 71, 72, and 73 north. Further, with the cores switched in the respective directions noted the signal winding 50d will present a low impedance to current flowing from common line 80R toward any of the output lines 11 to 18. Similarly winding 50c will present a high impedance. In the second echelon the "c" coils will present a low impedance while the "d" coils will present a high impedance. In the third echelon with the "b" coils energized the "d" coils will offer a low impedance while the "c" coils offer a high impedance. Thus a single low impedance path will be established from line 80R through winding 50d, 61c, and 72d to matrix conductor 16.

In the left hand branching circuit current flow is from the lines 1-8 to the line 80L and ground. Thus with SW1 thrown to energize 50a, SW2 to energize 61b and 60b, and SW3 to energize 70a, 71a, 72a, and 73a the core 50 will be switched south, cores 60 and 61 north, and cores 70, 71, 72, and 73 south. Thus any attempted current flow from the lines 1-8 toward 80L will find in the third echelon of cores (70 to 73) a low impedance in the "d" coils and a high impedance in the "c" coils. In the second echelon (cores 60 and 61) the "c" coils will have a low impedance while the "d" coils will have a high impedance. Finally the coil 50d will have a low impedance while the coil 50c will have a high impedance. Thus a single low impedance path will be established from conductor 6, coil 72b, coil 71c, coil 50b, line 80L and ground.

With lines 16 and 6 established at a low impedance relative to all other lines in the branching circuits, a current flowing from B+ (FIG. 1) through tube 81 (when it is permitted to conduct) will be passed through the matrix via signal winding 46a and diode 46b which serially connect lines 16 and 6. The current through the winding 46a is of sufficient strength to switch the core 46 to opposite remanent state, which switching action produces an output on winding 46c.

As all other lines in the branching circuits 10L and 10R present a high impedance current path no other pair of conductors other than 6 and 16 in the chosen example will carry sufficient current to switch the cores connected thereto. Consequently the output signal on any of the non-selected cores will be very insubstantial in view of the use of a "hard" core material in the matrix.

In the example chosen each of the coils 72d, 61c, and 50d carries 93% of the current entering the sub-branching circuit associated therewith. Thus of the total current entering 80R 80% (.93 × .93 × .93) passes serially through these coils and into the matrix. Any other combination of lines can only approach this with two aiding coils and one bucking coil through which will pass 6% of the current (.93 × .93 × .07). Whereas the 93% current flow through the matrix is sufficient to switch the selected core, the 6% current flow produces only a small perturbation in the remaining cores which occurs in the region of the nearly horizontal shape of the hysteresis curve so as to produce a negligible output pulse.

Reference has been made hereinabove to switching the cores in the matrix from one remanent state to the oppo-

site state. Obviously this presupposes that the cores initially all occupy the same remanent state. To achieve this the cores in the matrix are initially reset to a common state by a reset winding which serially threads all of the sixty-four cores in the matrix in well known fashion. Such reset winding has not been shown in FIG. 3. No reset is required of any of the cores 50, 60, 61, 70, 71, 72 or 73 as each of these is selectively set by the closure of the switches SW1, SW2, and SW3 which remain closed to saturate the cores during the energization of the signal circuit.

From the foregoing explanation it will be appreciated that with this circuitry and the serial disposition of aiding and bucking windings arrayed in a double pyramid with a core matrix disposed therebetween an extremely simple decoding circuit with a high signal-to-noise ratio is achieved.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A switching device for selectively providing an output signal on one of a plurality of output terminals under the control of a lesser plurality of control signals comprising; a matrix having horizontal and vertical conductors with a uni-directional current conducting device and a signal winding serially connected between each of said horizontal and vertical conductors; a plurality of magnetic core devices constructed of a material having a substantially square hysteresis loop disposed one each within said signal windings and each having a further winding connected to one of said output terminals; a pair of pyramidal branching circuits each having a single input connection and a plurality of output connections, the output connections of each of said pair of branching circuits being respectively connected to said horizontal and vertical conductors, each of the said branching circuits including a plurality of serially connected windings between each of said output connections and said single input connection, the said windings being joined in pairs having a common input and separate output connections, the common input to any pair of windings being connected with one of said output connections of a preceding pair of windings; a magnetic core disposed within each said pair of windings such that the individual windings of the pair are disposed thereon in bucking relationship; a set winding for each said core having the paired windings; circuit means connected to said set winding and adapted to saturate its associated core selectively in one of two magnetic states, whereby a single low impedance path is established in each of said pair of branching circuits; means for applying a potential across the single input connections to said pair of branching circuits so as to induce a current flow in the selected low impedance paths, the respective ones of said horizontal and vertical conductors connected thereto, and the uni-directional current device and signal winding connected therebetween to produce a flux change in the thus selected core in said matrix, whereby an output signal is generated in said further coil on said matrix core.

2. The switching device of claim 1 wherein a further winding is provided on each of said cores in said matrix together with circuit means for resetting each said core

to a remanent state opposite to that produced by energization of said signal winding.

3. A switching circuit comprising first and second branching circuits each having a single input connection and a plurality of output connections and each adapted to provide a single low impedance current path from said one input connection to a selected one of said output connections; a matrix having horizontal and vertical conductors disposed between said branching circuits, with the output connections of said first and second branching circuits being respectively connected to said conductors; a magnetic core having a trio of independent windings and a uni-directional current device disposed between each of said horizontal and vertical conductors with one of said windings and said device being serially connected therebetween; means for inducing a current flow through the selected low impedance paths of said first and second branching circuits and the respective device and core winding connected therewith whereby a flux change is induced in said core to produce in a second of said trio of windings an output signal, the said core being constructed of a material having a substantially square hysteresis loop; each of the said branching circuits comprising a plurality of sub-branching circuits connected in pyramidal array between said single input connection and said plurality of output connections, each of said sub-branching circuits having an input terminal, two output terminals, a magnetic core, and a pair of windings on said core connected between said output terminals and said input terminal such that the windings are disposed in bucking inductive relationship with respect to the core; and a further winding on said core in each of said sub-branching circuits adapted to magnetically saturate said core so as to induce in one winding of said pair of windings a low impedance path and in the other a high impedance path to current flow, whereby a single low impedance series circuit is formed in each of said branching circuits.

4. A pyramidal branching circuit having a single input terminal and a plurality of output terminals, comprising a plurality of serially connected windings between each of said output terminals and said single input terminal, the said windings being joined in pairs having a common input and separate output connections, the common input to any pair of windings connected with one of said output connections of a preceding pair of windings; a magnetic core disposed within each said pair of windings such that the individual windings of the pair are disposed thereon in bucking relationship; a set winding for each said core having the paired windings; and circuit means connected to said set winding and adapted to saturate its associated core selectively in one of two magnetic states, whereby a single low impedance path is established between said input terminal and one of said output terminals.

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