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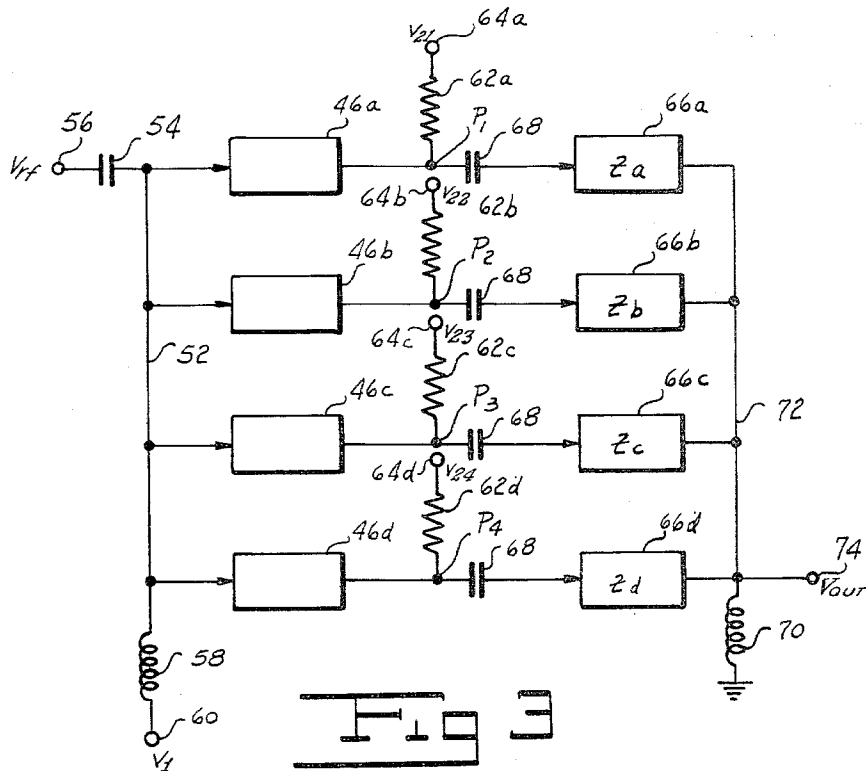
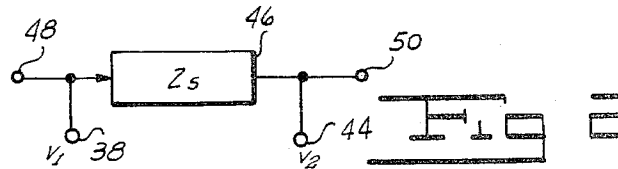
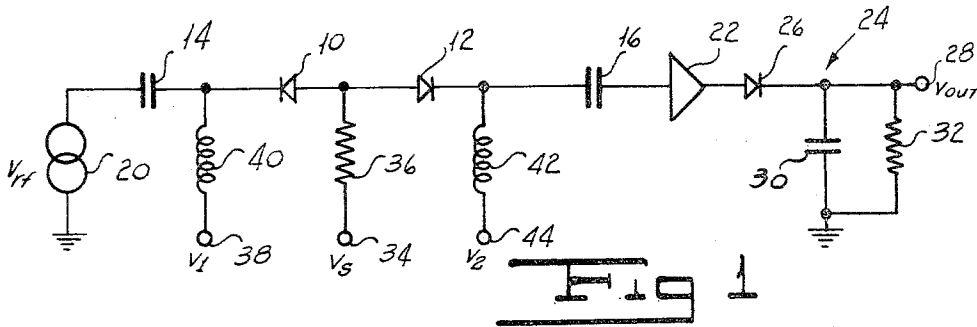
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BIAS CONTROLLED BILATERAL SWITCHING ARRANGEMENT FOR THE
SELECTIVE INTERCONNECTION OF ELECTRICAL CONDUCTORS

Filed Feb. 20, 1961

2 Sheets-Sheet 1



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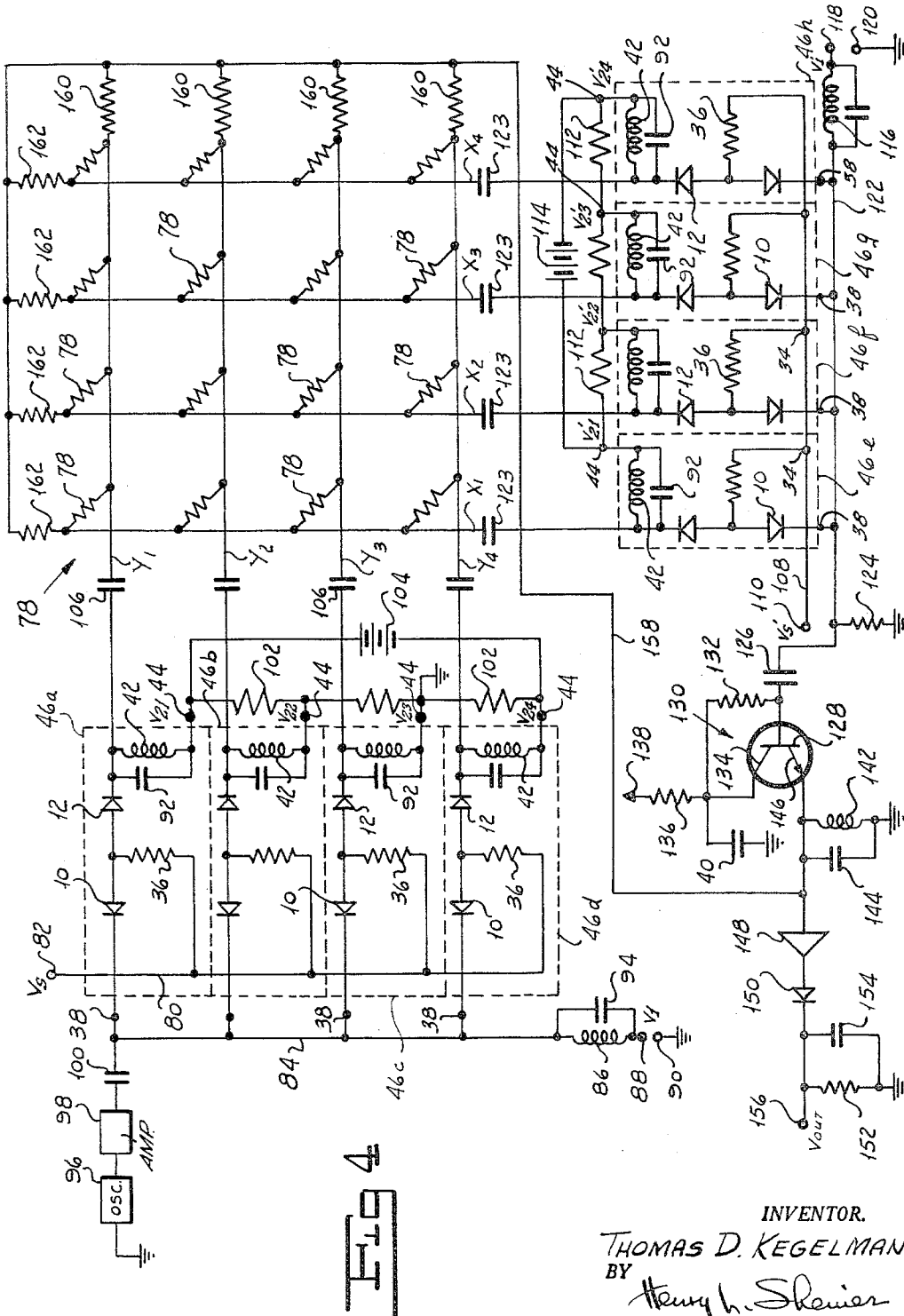
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BIAS CONTROLLED BILATERAL SWITCHING ARRANGEMENT FOR THE SELECTIVE INTERCONNECTION OF ELECTRICAL CONDUCTORS

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My invention relates to a matrix sampling system and more particularly to a system for storing and presenting data which is highly versatile.

There are known in the prior art various systems for storing data which is to be read out of the system at a later date. The systems may provide serial access to the information stored in the system; they may provide a random access; or the manner in which access may be had to stored information may be part serial and part random. While the systems known in the prior art are satisfactory for certain purposes, they are as a rule limited in application. Many of the systems provide for only the storage of representations of "ones" or "zeros" which encode the intelligent information.

I have invented a matrix sampling system which permits high speed access to any point in the matrix at random. My matrix sampling system may be used to store information of any kind such as a plurality of respective analogue values. My system may also be employed to transform an analogue input voltage to a pulse code. It may be used as an analogue or digital encoder. By employing radiation-sensitive elements in my matrix, I may produce an output signal which represents the pattern of external physical radiation focused on the elements of the matrix. By employing an external control for matrix impedances, I may adapt my matrix sampling system to many and varied uses.

One object of my invention is to provide a matrix sampling system which permits high speed random access to the information stored in the matrix.

Another object of my invention is to provide a matrix sampling system which is extremely versatile in its application.

A further object of my invention is to provide a matrix sampling system which may be employed as an encoder.

A still further object of my invention is to provide a matrix sampling system which may be employed to transform an analogue voltage into a pulse code.

Yet another object of my invention is to provide a matrix sampling system which may be used as a transducer for external radiation focused on the elements of the matrix.

A still further object of my invention is to provide a matrix sampling system which is readily adapted to more sophisticated application.

Other and further objects of my invention will appear from the following description.

In general my invention contemplates the provision of a matrix sampling system in which a signal is selectively coupled to an output terminal through any element of the matrix by applying predetermined potentials to coordinate input terminals to provide an output representing the information stored by the particular matrix element under interrogation.

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIGURE 1 is a schematic view illustrating one circuit which may be employed as the basic component of my matrix sampling system.

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FIGURE 2 is a schematic view of the basic component of my matrix sampling system in generalized form.

FIGURE 3 is a schematic view of a form of my matrix sampling system for applying a signal selectively to one of a plurality of impedances.

FIGURE 4 is a schematic view of a higher dimensional form of my matrix sampling system.

Referring now to FIGURE 1 of the drawings, in order to understand the operation of my matrix sampling system it is necessary first to understand the operation of the basic component illustrated in FIGURE 2. Referring to FIGURE 1, one circuit which may be used as the basic component includes a pair of diodes 10 and 12 connected in back-to-back relationship in series with an input capacitor 14 and an output capacitor 16 between a suitable source 20 of radio frequency voltage and an RF amplifier 22. I connect a detector, indicated generally by the reference character 24, including a diode 26 connected between amplifier 22 and an output terminal 28 and a smoothing capacitor 30 and resistor 32 connected in parallel between the output terminal 28 and ground. I apply a relatively high direct current potential V_S to an input terminal 34 connected by resistor 36 to the common terminal of diodes 10 and 12. An input terminal 38 connected to the other terminal of the diode 10 by the inductor 40 which acts as an RF choke is adapted to have applied thereto a potential V_1 . An inductor 42 connects another input terminal 44 to which a potential V_2 is applied to the other terminal of diode 12. The relative magnitudes of the potentials at the terminals 34, 38, and 44 is such that the potential at terminal 34 is very much larger than the potential at either terminal 38 or terminal 44. Assuming for the moment that V_1 at terminal 38 is larger than V_2 at terminal 44 then a bias current flows from terminal 34 through resistor 36 and diode 12 to the terminal 44. As the voltage V_2 is increased, bias current flows through the diode 10 to the terminal 38. When a condition is reached at which $V_1 = V_2$, then a bias current equal to V_S/R , where R is the resistance of resistor 36, flowing through resistor 36 is shared equally between the diodes 10 and 12. By proper selection of the circuit parameters the individual diode bias current $V_S/2R$, where R is the resistance of resistor 36, may be made sufficient to force both the diodes 10 and 12 into a low impedance condition. When this condition prevails, the RF signal from the source 20 which is applied to the diode 10 will appear at the output terminal of the diode 12. This output signal is amplified by the amplifier 22 and detected by the detector 24 to produce an output voltage V_{out} at the terminal 28 which is proportional to the amplitude of the RF signal from source 20. If in the arrangement illustrated in FIGURE 1, either the diode 10 or 12 is placed in the high impedance condition by removing either the voltage V_1 or the voltage V_2 then the RF signal will not pass to the amplifier 22 and detector 24. This condition results whenever V_1 is not within a narrow voltage range centered about V_2 . The width of the voltage range within which V_1 , for example, must be in order that both diodes are in the low impedance condition depends upon the type diode selected and the bias current resulting from the application of voltage V_S to the diodes through the resistor 36.

From the structure described above, it will be apparent that as indicated schematically in FIGURE 2 the arrangement of diodes shown in FIGURE 1 can be represented as a logical AND circuit which operates as a simple switch, indicated generally by the block 46 in FIGURE 2. In its idealized form shown in FIGURE 2, the impedance Z_S of switch 46 between an input terminal 48 and an output terminal 50 is infinity for V_1 at terminal 38 unequal to V_2 at terminal 44 and the impedance Z_S is zero for V_1 equal to V_2 . It will readily be appreciated that other specific arrangements could be employed to perform

the function of the generalized component shown in FIGURE 2.

Referring now to FIGURE 3, I have shown an arrangement of the elements or switches 46 by means of which an alternating voltage can selectively be presented at any one of a plurality of respective elements 46a, 46b, 46c, and 46d between a common input conductor 52 and the respective points P₁ and P₄. A capacitor 54 is adapted to couple a radio frequency signal from an input terminal 56 to the conductor 52. An inductor 58 carries an input potential V₁ from a terminal 60 to the conductor 52. A plurality of respective resistors 62a to 62d apply potentials V₂₁ to V₂₄ at respective terminals 64a to 64d to the points P₁ to P₄. From the structure described it will be seen that when the potential V₁ is equal to any one of the potentials V₂₁ to V₂₄, the corresponding one of the elements 46a to 46d is in its low impedance condition so that the radio frequency voltage at terminal 56 appears at the corresponding one of the points P₁ to P₄. For example, if V₁ equals V₂₃ then element 46c assumes its low impedance condition and the input voltage at terminal 56 appears at point P₃. In this manner the voltage at the input terminal 56 is selectively applied to any one of the points P₁ to P₄.

This system can be used readily to measure the impedance of any one of a number of respective impedances Za to Zd represented by the blocks 66a to 66d in FIGURE 3. Respective capacitors 68 connect the points P₁ to P₄ to input terminals of the impedances 66a to 66d. I connect an RF choke 70 between a common output conductor 72 of the impedances 66a to 66d and ground. When the voltage V₁ is equal to any one of the voltages V₂₁ to V₂₄, then the corresponding impedance 66 is connected in series between the input terminal 56 and the choke 70. As a result the magnitude of the output voltage at a terminal 74 is a measure of the impedance.

Referring now to FIGURE 4, I have shown a form of my matrix sampling system in which the matrix, indicated generally by the reference character 76, to be sampled includes a plurality of first coordinate lines X₁ through X₄ and a plurality of second coordinate lines Y₁ through Y₄. I connect a plurality of matrix impedances 78 between the respective lines X₁ to X₄ and each of the lines Y₁ through Y₄. These elements may take many forms. For example, they may merely be impedances, the value of which is to be selectively measured when the coordinate lines between which an impedance is connected are coupled in the circuit. They may also be elements which have a resistance which is a function of some type of external radiation to be measured. Alternatively, external circuitry (not shown) may be employed to control the impedance of the elements 78 to provide an output yielding an amplitude as well as a pulse code signal where an analogue voltage is placed across common input terminals to be described hereinafter. The value of an impedance 78 at any point in the matrix could be made to indicate the third dimension of a three-dimensional cam. Whatever the nature of the individual impedance elements 78, it will be appreciated that when any element is to be sampled, the corresponding coordinate lines must be coupled into the circuit. For example, where the line X₂ and the line Y₃ are connected into the circuit in a manner to be described, an output signal is produced which affords a measure of the impedance 78 connected between these lines.

I provide the form of my matrix sampling system shown in FIGURE 4 with a plurality of logic circuit elements 46a to 46d, each of which is indicated by a broken line block in the figure. Each of these elements 46 includes the back-to-back diodes 10 and 12, a resistor 36 connected between the common terminal of the diodes and a common conductor 80 connected to a terminal 82 to which the relatively high potential V_S is applied. An inductor 42 connected between the input terminal 44 and the output terminal of the diode 12 is adapted to

apply one of the two control potentials to the diode 12. I connect each of the input terminals 38 to a common conductor 84 to which the sampling input potential V₁ is applied by an inductor 86 connected between the conductor 84 and one input terminal 88 of the pair of sampling voltage input terminals 88 and 90. I connect respective capacitors 92 and 94 in parallel with the inductors 42 and 86. Each of these circuits is resonant at the frequency of the radio frequency input signal to provide a high impedance to the radio frequency voltage. An oscillator 96 which puts out a radio frequency signal is connected in series with a buffer amplifier 98 and a capacitor 100 between ground and the common input conductor 84 to apply a radio frequency input signal to each of the elements 46a to 46d.

I connect a plurality of resistors 102 in series across the terminals of a suitable source of direct current potential such as a battery 104. I connect various points along the voltage divider to the input terminals 44 to provide the reference control voltages V₂₁ to V₂₄ with which the sampling input voltage at terminals 88 and 90 is compared to render one of the elements 46a to 46d conductive. A plurality of respective capacitors 106 couple the output terminals of the elements 46a to 46b to the matrix lines Y₁ to Y₄.

I provide a plurality of respective elements 46e to 46h associated with the matrix lines X₁ to X₄. The elements 46e to 46h are substantially the same in construction as are the elements 46a to 46d and for this reason will not be described in detail. A common conductor 108 is adapted to apply the relatively high potential V_S at a terminal 110 to the elements 46e to 46h. It will readily be appreciated that if desired the conductor 110 may be connected to the terminal 82. A voltage divider made up of a plurality of resistors 112 connected in series across a source such as a battery 114 provides reference potentials V₂₁' to V₂₄' against which the second sampling voltage V₁' which is coupled by an inductor 116 from a pair of input terminals 118 and 120 to a common input conductor 122 is compared. Capacitors 123 couple the respective output terminals of the elements 46e to 46h to the lines X₁ to X₄ of the matrix. From the structure just described it will be apparent that when the potential at terminals 118 and 120 is equal to the voltage divider potential applied to an input terminal 44 of any one of the elements 46e to 46h, then the corresponding element is in its low impedance condition and the associated one of the lines X₁ to X₄ is connected in the circuit. Assuming, for example, that both elements 46b and 46g are in their low impedance states then the impedance 78 connected between lines X₂ and Y₃ is connected in the circuit and an RF voltage affording a measure of this impedance appears across a load resistor 124 connected between conductor 122 and ground.

A capacitor 126 couples the voltage across resistor 124 to the base 128 of an emitter-follower unity gain transistor amplifier, indicated generally by the reference character 130. A resistor 132 connected between collector 134 and base 128 provides a bias for the transistor. A resistor 136 connects the collector to a terminal 138 of a suitable source of potential. I connect a capacitor 140 between the collector 136 and ground and I connect a parallel circuit including an inductor 142 and a capacitor 144 resonant at the radio frequency between emitter 146 and ground. An amplifier 148 amplifies the output signal at the emitter 146 and applies it to a detector including a diode 150 and a parallel circuit made up of a resistor 152 connected in parallel between the output terminal of diode 150 and ground. The output potential appearing at a terminal 156 is a measure of the matrix impedance 78 being interrogated.

I provide my matrix sampling system with means for controlling the effects of multiple impedance paths through the matrix. I accomplish this result by bringing all the lines X₁ to X₄ and Y₁ to Y₄ to the radio frequency level

of the output of the emitter follower 130. A conductor 158 connects the output terminal of the emitter follower 130 to a plurality of resistors 160 connected to the respective matrix lines X_1 to X_4 . A second plurality of resistors 162 connect the line 158 to the lines Y_1 to Y_4 of the matrix. With this arrangement the loading effect of the impedances 78 on the matrix lines to which the impedance under interrogation is connected is small because of the feedback. On all matrix lines other than those to which the element under interrogation is connected low impedance equipotentials exist which nullify the multiple path currents. In theory the attenuation and unwanted multiple signals can be eliminated by this arrangement. While these effects cannot in practice be entirely eliminated, they can be reduced to a point at which they are negligible. The possible preciseness of the gain control and phase in the high input impedance in low output impedance amplifier 130 determines the minimum size to which the impedances may go before the transmission of the matrix is decreased.

It will readily be appreciated that while I have shown a matrix including only four lines for each coordinate I may readily provide as many lines as desired within the practical limitations of the system. Further, in a system in which the value of the respective impedances 78 is under the control of external circuitry my matrix in effect is a three-dimensional matrix.

In operation of the switching element shown in FIGURE 1 with a voltage V_S applied to the terminal 34 and with the voltage V_1 at terminal 38 being within a small range centered about the voltage V_2 at terminal 44 both the diodes 10 and 12 will be in their low impedance condition and the signal from source 20 will be passed from the amplifier 22 to cause an output to appear at the terminal 28.

In the impedance measuring circuit shown in FIGURE 3 where it is desired to connect one of the impedances Z_a to Z_b in the circuit, there is applied to terminal 60 a potential equal to that at the terminal 64a to 64d corresponding to the impedances to be measured. For example, where it is desired to connect the impedance Z_b in the circuit, there is applied to the terminal 60 a potential equal to that existing at terminal 64b to cause element 46b to conduct to complete a circuit from line 62 through element 46b through the impedance Z_b and through the conductor 72 to terminal 74. The voltage appearing at terminal 74 is a measure of the impedance Z_b .

In the form of my matrix sampling system shown in FIGURE 4 where it is desired to interrogate an element 78 connected between a pair of coordinate lines signals corresponding to the reference potentials of the elements 46 corresponding to these lines are applied respectively to the pair of terminals 88 and 90 and to the pair of terminals 118 and 120. For example, where I desire to interrogate the element 78 connected between the coordinate lines X_2 and Y_3 I apply to the terminals 118 and 120 a potential substantially equal to the reference potential applied to the device 46f to connect line X_2 into the circuit. Similarly, I apply to the terminals 88 and 90 a potential equal to the reference potential applied to the element 46c to render this element conductive to connect the line Y_3 into the circuit. When this has been done, a circuit is completed from oscillator 96, amplifier 98 and capacitor 100; through element 46c to line Y_3 ; through the element 78 connected between line Y_3 and line X_2 ; through the element 46f; through the amplifier 130, the amplifier 148 and diode 150 to the output terminal 156 with the result that the signal at terminal 156 is a measure of the impedance of the element 78 connected between coordinate lines X_2 and Y_3 . It will readily be appreciated that the impedances of the various elements may be controlled from an external source of radiation or from an external circuit.

It will be seen that I have accomplished the objects of my invention. I have provided a matrix sampling system

which permits high speed random access to the information stored in the matrix. My matrix sampling system is externally versatile in application. It may be employed as an encoder or it may be used to transform an analogue voltage into a pulse code. I may use my matrix sampling system as a transducer for converting external radiation focused on the elements of the matrix and the electrical signals.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be understood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, what I claim is:

1. Apparatus for selectively coupling a first conductor to one of a second conductor and a third conductor including in combination first and second bilateral switching devices, each having a first terminal and a second terminal, each of said devices comprising means providing a biasing voltage of a given magnitude normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response to the presence of substantially equal direct current potentials at its first and second terminals, means including a capacitor for coupling said first conductor to the first terminal of each device, means providing a first direct-current reference voltage and a different second direct-current reference voltage, each of said reference voltages being of a magnitude appreciably less than said biasing voltage, means coupling the first reference voltage to the second terminal of the first device and to the second conductor, means coupling the second reference voltage to the second terminal of the second device and to the third conductor, a direct-current source producing an output substantially equal to one of said reference voltages, means coupling said source to the first terminal of each device and a circuit completing connection between said reference voltage providing means and said biasing voltage producing means and said source.

2. Apparatus for selectively coupling a first conductor to one of a second conductor and a third conductor including in combination first and second bilateral switching devices each having a first terminal and a second terminal, each of said switching devices comprising a pair of diodes connected back-to-back between said first terminal and said second terminal and comprising means providing a biasing voltage of a given magnitude applied to the common connection of said diodes normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response to the presence of substantially equal direct-current potentials at its first and second terminals, means including a capacitor for coupling said first conductor to the first terminal of each device, means providing a first direct-current reference voltage and a different second direct-current reference voltage, each of said reference voltages being of a magnitude appreciably less than said biasing voltage, means coupling the first reference voltage to the second terminal of the first device and to the second conductor, means coupling the second reference voltage to the second terminal of the second device and to the third conductor, a direct-current source producing an output substantially equal to one of said reference voltages, means coupling said source to the first terminal of each device and a circuit completing connection between said reference voltage providing means and said biasing voltage producing means and said source.

3. Apparatus for selectively coupling a first conductor to one of a second conductor and a third conductor in-

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cluding in combination first and second bilateral switching devices each having a first terminal and a second terminal, each of said devices comprising means providing a biasing voltage of a given magnitude normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response to the presence of substantially equal direct-current potentials at its first and second terminals, means including a capacitor for coupling said first conductor to the first terminal of each device, means providing a first direct-current reference voltage and a different second direct-current reference voltage, each of said reference voltages being of a magnitude appreciably less than said biasing voltage, means comprising a first tuned circuit coupling said first reference voltage to the second terminal of the first device and to the second conductor, means comprising a second tuned circuit for coupling the second reference voltage to the second terminal of the second device and to the third conductor, a direct-current source producing an output substantially equal to one of said reference voltages, means coupling said source to the first terminal of each device and a circuit completing connection between said tuned circuits and said biasing voltage producing means and said source.

4. Apparatus for sampling impedances including in combination first and second bilateral switching devices each having a first terminal and a second terminal, each of said devices comprising means producing a biasing voltage of a given magnitude normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response of the presence of equal direct-current potentials at its first and second terminals, respective first and second impedances to be sampled, an output terminal, means connecting said impedances respectively between said second terminals and said output terminal, a source of alternating-current voltage, means including a capacitor for coupling said alternating-current source to the first terminal of each device, means providing a first direct-current reference voltage and a different second direct-current reference voltage, each of said reference voltages being of a magnitude appreciably less than said biasing voltage, means coupling the first reference voltage to the second terminal of the first device, means coupling the second reference voltage to the second terminal of the second device, a direct-current source producing an output substantially equal to one of said reference voltages, means coupling said source to the first terminal of each device and a circuit completing connection between said reference voltage providing means and said biasing voltage producing means and said source.

5. A matrix sampling system including in combination a plurality of first coordinate lines, a plurality of second coordinate lines, a plurality of impedances to be sampled, means connecting each impedance between a first coordinate line and a second coordinate line, a plurality of first bilateral switching devices each having a first terminal

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and a second terminal, each of said switching devices comprising means producing a biasing voltage of a given magnitude normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response to the presence of equal direct-current potentials at its first and second terminals, means coupling the second terminals of said first devices respectively to said first coordinate lines, a source of alternating-current voltage, means including a capacitor for coupling said alternating-current source to the first terminals of said first devices, means producing respective first direct-current reference voltages, each of said first reference voltages being distinctly different and of a magnitude appreciably less than said biasing voltage, means coupling the first reference voltages respectively to the second terminals of the first devices, a first direct-current source providing an output substantially equal to one of said first reference voltages, means coupling said first source to the first terminals of said first devices, an output terminal, a plurality of second bilateral switching devices each having a first terminal and a second terminal, each of said second devices comprising means producing a biasing voltage of a given magnitude normally to render said device nonconductive in the presence of unequal direct-current potentials at its first and second terminals and to render said device conductive in response to the presence of equal direct-current potentials at its first and second terminals, means coupling said first terminals of said second devices respectively to said second coordinate lines, means coupling the second terminals of the second devices to said output terminal, means producing respective second direct-current reference voltages, said second reference voltages being distinctly different and of a magnitude appreciably less than said second device biasing voltage, means for coupling said second reference voltages respectively to the second terminals of the second devices, a second direct-current source providing an output substantially equal to one of said second reference voltages, means coupling said second source to the first terminal of each of said second devices and a circuit completing connection for said sources and said reference voltage producing means and said biasing voltage producing means.

6. A system as in claim 5 in which said output terminal carries an output signal and means for applying said output signal to said first and second coordinate lines.

References Cited by the Examiner

UNITED STATES PATENTS

2,781,968	2/1957	Chenus	340—166
2,859,428	11/1958	Young	340—166 X
2,877,451	3/1959	Williams	340—176 X
3,005,111	10/1961	Kinsey	340—166
3,050,713	8/1962	Harmon	340—172
3,109,161	10/1963	Boback	340—166

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