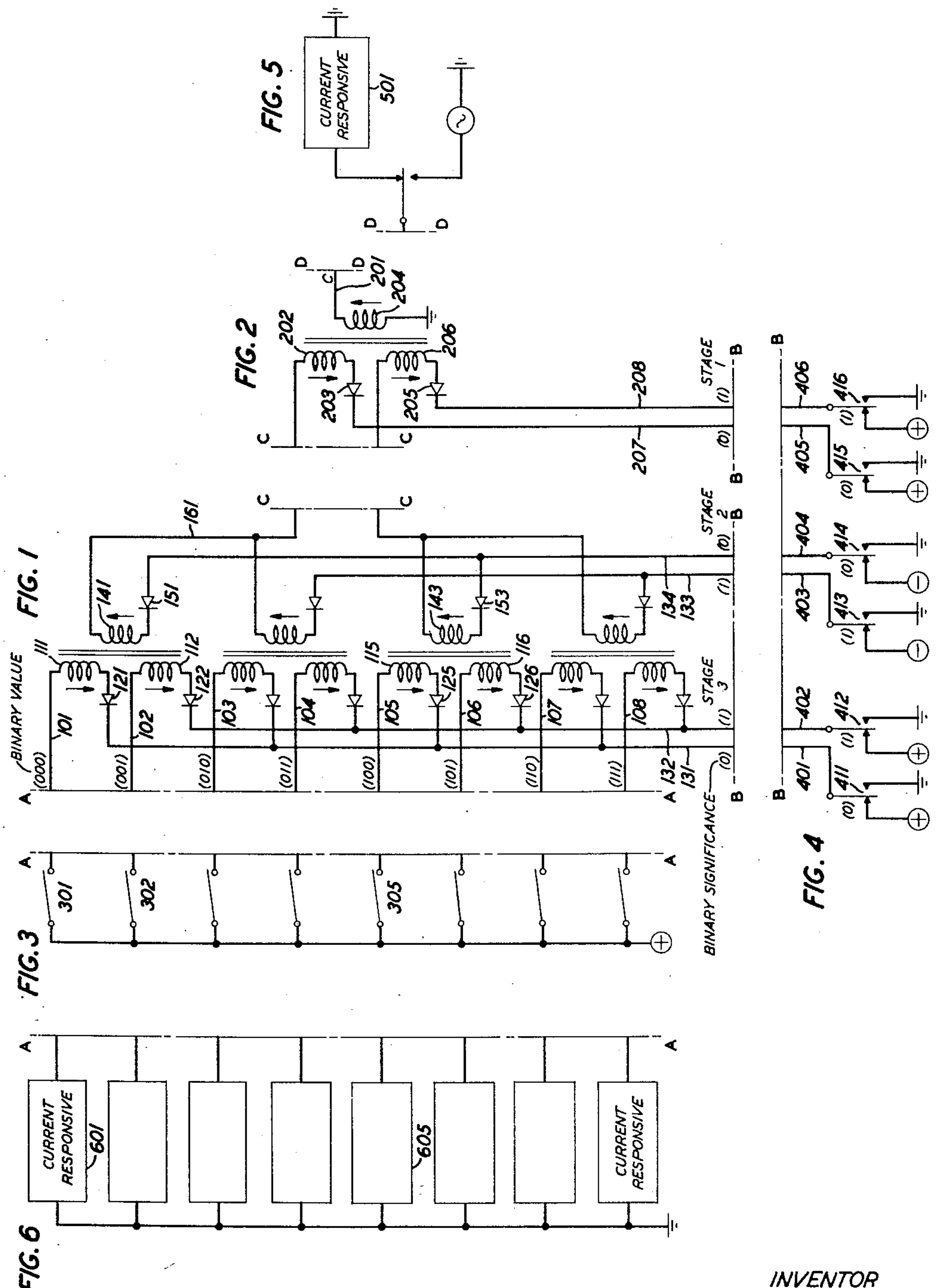
Dec. 17, 1957 W. R. YOUNG, JR 2,817,079

SWITCHING NETWORK USING DIODES AND TRANSFORMERS

Filed May 22, 1956 2 Sheets-Sheet 1



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Filed May 22, 1956 2 Sheets-Sheet 2

FIG. 7

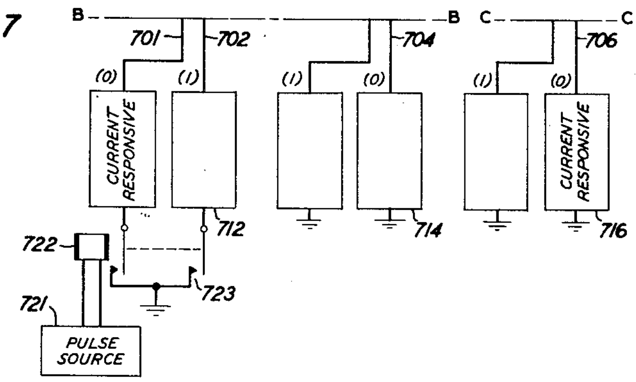


FIG. 8

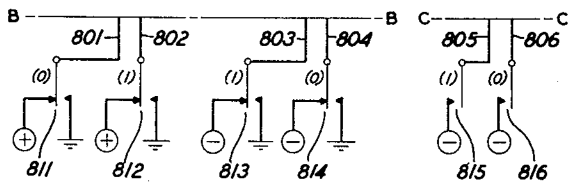


FIG. 9

SCANNING

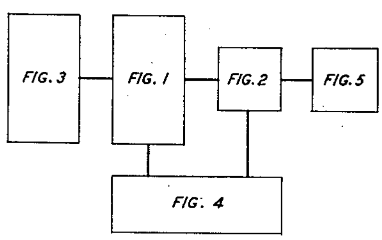


FIG. 10

MARKING

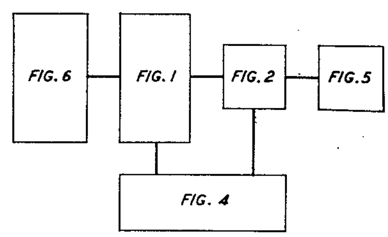


FIG. 11

TRANSLATING

ONE OUT OF EIGHT INPUTS TO BINARY CODE ON THREE OUT OF SIX LEADS

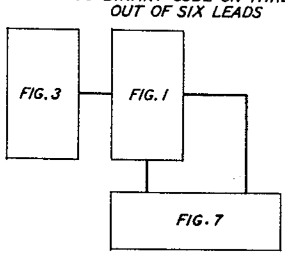
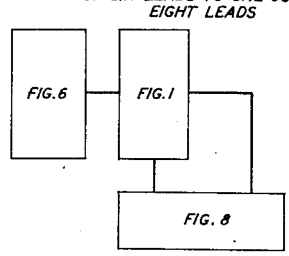


FIG. 12

TRANSLATING

BINARY CODE ON THREE OUT OF SIX LEADS TO ONE OUT OF EIGHT LEADS



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SWITCHING NETWORK USING DIODES AND TRANSFORMERS

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20 Claims. (Cl. 340—367)

This invention relates to a switching network which employs transformers and asymmetrical circuit elements to provide selectively conductive low impedance electrical paths between input, output and control conductors.

In most multifunctional telephone switching circuits there is a need for "signaling circuits" to associate input, output and control conductors for short periods of time. Exemplary of the type of functions required in a multifunctional telephone switching circuit are scanning, marking and translating. Heretofore, such circuits have utilized relays, stepping switches, or diode and resistance networks either solely or in combination.

Relays and stepping switches are generally expensive and bulky and they require considerable operating power. Diode and resistance networks, which perform some of the requisite functions, are less bulky and consume less power than their electromechanical counterpart; however, the power consumed is still considerable.

It is an object of this invention to provide a single space-saving structure to provide the scanning, marking and translating functions required in a modern telephone switching system.

Another object of this invention is to provide a structure which can be operated at speeds commensurate with modern switching concepts.

Another object of this invention is to minimize the number of circuit elements required in a multifunctional switching circuit.

A further object of this invention is to advantageously minimize the power required to perform the requisite functions and to minimize the number of synchronized voltages required to energize the structure.

In accordance with one feature of this invention linear transformers and diodes are interconnected to selectively provide combinations of low impedance electrical paths between input, output and control conductors. These combinations of paths are selectively rendered conductive by the application of significant combinations of potentials to the various conductors. Advantageously, current, other than minor inductive charging currents, is present only in the selected combination of paths. The particular arrangement of transformers and diodes adopted in the exemplary embodiment of this invention provides a high degree of flexibility in that one structure may be used to implement scanning, marking and translating circuits.

The invention and the features thereof will be understood more fully and clearly from the following detailed description with reference to the accompanying drawings in which:

Figs. 1 and 2 comprise an exemplary embodiment of this invention having eight selectable conductors with three stages of binary control conductors;

Fig. 3 is means for selectively applying a significant potential to the selectable conductors;

Fig. 4 is means for selectively applying significant potentials to the binary conductors;

Fig. 5 is means responsive to activation of the common conductor C and means for applying significant potentials to the common conductor C;

Fig. 6 is means for applying a significant potential to the selectable conductors through means responsive to the activation of the selectable conductors;

Fig. 7 is means for applying significant potentials to the binary conductors through means responsive to activation of the binary conductors;

Fig. 8 is means for applying other significant potentials to the binary conductors;

Fig. 9 is the arrangement of the foregoing figures to provide a scanning circuit having eight selectable inputs;

Fig. 10 is the arrangement of the foregoing figures to provide a marking circuit having eight selectable outputs;

Fig. 11 is the arrangement of the foregoing figures to provide a circuit to translate a signal from one-out-of-eight input conductors to a signal on three-out-of-six binary output conductors; and

Fig. 12 is the arrangement of the foregoing figures to provide a circuit to translate a signal from three-out-of-six binary conductors to a signal on one-out-of-eight outputs.

The exemplary embodiment of the invention herein disclosed has eight selectable conductors and three stages of control conductors which have binary significance. The invention, however, is not limited to these codes but rather is very flexible and lends itself to many other input and output code arrangements. For example, the number of stages can be varied and the control conductors may have decimal or other significance.

General description

A scanning or selecting circuit chooses one conductor from a plurality of similar conductors by the application of predetermined electrical information to the control conductors of the scanning circuit. An example of such a circuit is shown in Fig. 9. A circuit which interrogates a plurality of telephone lines to determine which one of the lines is requesting service is an example which is commonly known as a line scanner. In Figs. 1 and 2, the application of information in binary code form to the control conductors shown at cut-line B—B serves to scan the eight conductors shown at cut-line A—A. Application of a significant potential on any one of the eight lines co-incident with application of the code information discrete to that line on the control conductors produces an output pulse at the common conductor C which is shown at cut-line D—D.

A marking circuit places a significant marking potential on one conductor chosen from a plurality of similar conductors by the application of predetermined electrical code information to the control conductors of the marking circuit. An example is shown in Fig. 10. This is another type of selecting circuit. In Figs. 1 and 2 simultaneous application of the source of potentials shown in Fig. 5 to the common conductor C and the application of electrical code information to the control conductors shown on cut-line B—B serves to produce an output current in the conductor shown at cut-line A—A which is represented by the applied code input.

Translation comprises the conversion of information in one electrical code form to information in another electrical code form. Examples of such a circuit are shown in Figs. 11 and 12. In the example shown in Fig. 11 an input code consisting of information on one of the eight conductors shown in Fig. 1 at cut-line A—A produces an output on three of the six conductors shown at line B—B. This is a reversible translator, therefore, code information on three out of the six conductors shown at cut-line B—B will produce an output on the one of the eight conductors represented by the three-out-of-six code input.

Scanning

The arrangement of Figs. 1, 2, 3, 4, and 5, as shown in Fig. 9 comprises a circuit which is capable of scanning the input conductors 101 to 108 and producing an output at conductor **201**. For the purposes of explanation it is assumed that conductors **101** to **108** represent telephone lines and that closure of the switches shown in Fig. 3 indicates that the line associated with the closed switch is requesting service from the switching equipment. Assume that lines **101**, **102** and **105** are requesting service as indicated by the closure of switches **301**, **302** and **305**. The switches of Fig. 4 can be positioned to interrogate any of the lines **101** to **108**. Positioning switches **411** through **416** to simultaneously apply ground on conductor **401**, positive battery on conductor **402**, negative battery on conductor **403**, ground on conductor **404**, ground on conductor **405**, and positive battery on conductor **406** serves to interrogate line **101**. A current pulse will be produced from positive battery through switch **301**, transformer winding **111**, diode **121**, conductor **131**, conductor **401** and switch **411** to ground. This will induce a voltage in transformer winding **141** and current will flow from ground through switch **414**, conductor **404**, conductor **134**, diode **151**, transformer winding **141**, conductor **161**, transformer winding **202**, diode **203**, conductor **207**, conductor **405** and switch **415** to ground. Current flowing in transformer winding **202** induces a voltage in transformer winding **204** which causes a current to flow from ground through transformer winding **204**, conductor **201**, and the current responsive device **501** to ground. Although there is a positive voltage applied to conductor **102** through switch **302** current will flow in conductor **102** as diode **122** is back biased by the application of positive battery to conductor **402** through switch **412**. Positive battery applied to conductor **105** will tend to cause current to flow in transformer winding **115**, diode **125**, conductor **131**, conductor **401** and switch **411** to ground. However, the application of positive battery through switch **416** to conductor **406** back biases diode **205** and therefore the electrical path from ground through switch **414**, conductor **404**, diode **153**, transformer winding **143**, transformer winding **206**, diode **205**, conductor **208**, conductor **406** and switch **416** to positive battery is of high impedance. This high impedance is reflected from transformer winding **143** to transformer winding **115** and the current which flows through transformer winding **115** and diode **126** is limited to the transformer magnetizing current. Therefore, with the application of potentials to conductors **401** through **406**, where such potentials are discrete to conductor **101**, an output pulse will be received at conductor **201** only if switch **301** is closed and the operation will not be effected by the presence or absence of potentials on other lines. It should be noted that a mere change of potential on the selectable lines is adequate and there need not be an accompanying change in impedance.

Marking

The arrangement of Figs. 1, 2, 4, 5, and 6, as shown in Fig. 10, comprises a circuit for applying a marking potential to any desired one of lines **101** to **108** by application of discrete control potentials to conductors **401** to **406**. In this case, lines **101** to **108** are all terminated with current responsive devices connected to ground. A marking potential may be applied to conductor **105** by operating switches **411** to **416** to place ground on conductor **401**, positive battery on conductor **402**, negative battery on conductor **403**, ground on conductor **404**, positive battery on conductor **405**, and ground on conductor **406**. These control potentials effect a low impedance path from ground through conductor **404**, conductor **134**, diode **153**, transformer winding **143**, transformer winding **206**, diode **205**, conductor **208**, conductor **406**, and switch **416** to ground. The application of an alternating-current signal or a voltage pulse to conductor C, as would be applied by the generator of Fig. 5, causes current in transformer winding **204**. This current, in turn, causes current in the foregoing low impedance circuit. It should be noted that positive battery through switch **415** applied to conductor **405** back biases diode **203** and causes transformer winding **202** to be in a high impedance path in which there will be little or no current. Current flow in transformer winding **143** induces voltages into transformer windings **115** and **116**. Transformer winding **116** is in a high impedance path because of the positive potential applied to conductor **402** through switch **412**. This back biases diode **126** and therefore only limited current will flow in transformer winding **116**. The path which includes current responsive device **605**, line **105**, transformer winding **115**, diode **125**, conductor **131**, conductor **401**, and switch **411** to ground, however, provides a low impedance path for currents which tend to flow because of the voltage induced in transformer winding **115**. Therefore, a current pulse is selectively provided in current responsive device **605** without activation of the other current responsive devices connected to lines **101** to **108**.

Translating

The arrangement of Figs. 1, 3 and 7, as shown in Fig. 11, comprises a circuit which will accept code information on one-out-of-eight input conductors and translate this to code information on three-out-of-six output conductors. Input information comprising the placement of a positive potential on conductor **102** by the closure of switch **302** will provide output pulses in three of the conductors **401** to **406**. The binary designations applicable to conductors **101** to **108** are shown in parenthesis above the respective lines. The binary significance of each of conductors **131** to **134**, **207** and **208** is also designated on the drawings. Therefore, an input on conductor **102** which has a binary value of "001" will produce current pulses in conductors **706**, **704**, and **702**. The pulse source **721** causes relay **722** to apply ground pulses simultaneously to conductors **701** and **702**. An input may be tolerated on only one of the eight conductors at any time. A current pulse flows from positive battery through switch **302**, conductor **102**, transformer winding **112**, diode **122**, conductor **132**, conductor **702**, current responsive device **712**, and contact **723** to ground. This current pulse induces a voltage in transformer winding **141** which causes current to flow in current responsive device **714**, conductor **704**, conductor **134**, diode **151**, transformer winding **141**, conductor **161**, conductor **706** and current responsive device **716** to ground. Therefore, an input on conductor **102** which has the binary value of "001" causes current to flow in the "0" conductor of stage one, the "0" conductor of stage two, and the "1" conductor of stage three.

The translation process can be reversed by arranging Figs. 1, 6, and 8 as shown in Fig. 12. This arrangement provides a circuit which translates coded electrical input information on three-out-of-six conductors to coded electrical information on one-out-of-eight output conductors. Input information having binary significance of "000" provided by the positioning of switches **811** through **816** to provide negative battery on conductor **806**, ground on conductor **804**, negative battery on conductor **803**, positive battery on conductor **802**, and ground on conductor **801** will produce a current pulse in current responsive device **601**. This device is connected to conductor **101** which has a binary value of "000." These input potentials cause current to flow in a low impedance path which includes switch **816**, conductor **806**, conductor **161**, transformer winding **141**, diode **151**, conductor **134**, conductor **804** and switch **814**. The current through transformer winding **141** will induce a voltage in transformer windings **111** and **112**, however, the application of positive battery to conductor **802** through switch **812** will back bias diode **122** and prevent the flow of current through this path. Current, however, will flow in the path which includes current responsive device **601**, transformer winding **111**, diode **121**, conductor **131**, conductor **801** and switch **811** to ground. Therefore, electrical information on three input conductors having binary significance of "000," respectively, provides an output pulse on one-out-of-eight conductors having a binary value of "000."

What is claimed is:

1. A signaling network comprising a pularity of first conductors, means to apply any one of a plurality of discrete combinations of potentials to said first conductors, a plurality of transformers, a plurality of second conductors, means to apply any one of a plurality of discrete combinations of potentials to said second conductors, a third conductor, means to apply significant potentials to said third conductor, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to selectively provide any one of a plurality of discrete combinations of low impedance electrical paths between said first, second and third conductors.

2. A signaling network comprising a plurality of first conductors, means to apply any one of a plurality of discrete combinations of potentials to said first conductors, a plurality of transformers connected to said first conductors, a plurality of second conductors, means to apply any one of a plurality of discrete combinations of potentials to said second conductors, wherein each discrete potential combination is distinctive to one of said first conductors, a third conductor, means to apply significant potentials to said third conductor, a plurality of asymmetrical circuit elements, said transformers and said asymmetrical circuit elements arranged to selectively provide any one of a plurality of discrete combinations of low impedance electrical paths between said first, second and third conductors, said low impedance paths selectively rendered conductive by the application of the voltage combination, distinctive to said first conductor, to said plurality of second conductors.

3. A signaling network comprising a plurality of first conductors, means to apply any one of a plurality of discrete combinations of potentials to said first conductors, a plurality of transformers, a plurality of second conductors, means to apply any one of a plurality of discrete combinations of potentials to said second conductors, wherein each discrete potential combination is distinctive to one of said first conductors, a third conductor, means to apply significant potentials to said third conductor, a plurality of asymmetrical circuit elements connecting said second conductors and said transformers, said transformers and said asymmetrical circuit elements arranged to selectively provide any one of a plurality of discrete combinations of low impedance electrical paths between said first, second and third conductors, said low impedance paths selectively rendered conductive by the application of the voltage combination, distinctive to said first conductor, to said plurality of second conductors.

4. A signaling network comprising a plurality of first conductors, means to apply any one of a plurality of discrete combinations of potentials to said first conductors, a plurality of transformers connected to said first conductors, a plurality of second conductors, means to apply any one of a plurality of discrete combinations of potentials to said second conductors, wherein each discrete potential combination is distinctive to one of said first conductors, a third conductor, means to apply significant potentials to said third conductor, a plurality of asymmetrical circuit elements connecting said second conductors and said transformers, said transformers and said asymmetrical circuit elements arranged to selectively provide any one of a plurality of discrete combinations of low impedance electrical paths between said first, second and third conductors, said low impedance paths selectively rendered conductive by the application of the voltage combination, distinctive to said first conductor, to said plurality of second conductors.

5. A scanning network comprising a plurality of input conductors, means to apply a significant potential to any one of said input conductors, a plurality of transformers, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, an output conductor, a current responsive device connected to said output conductor, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to selectively provide low impedance electrical paths between any one of said input conductors and said output conductor, said low impedance electrical path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said input conductor.

6. A scanning network comprising a plurality of input conductors, means to apply a significant potential to any one of said input conductors, a plurality of transformers connected to said input conductors, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, wherein each discrete potential combination is distinctive to one of said input conductors, an output conductor, a current responsive device connected to said output conductor, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to selectively provide low impedance electrical paths between any one of said input conductors and said output conductor, said low impedance electrical path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said input conductor.

7. A scanning network comprising a plurality of input conductors, means to apply a significant potential to any one of said input conductors, a plurality of transformers, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, wherein each discrete potential combination is distinctive to one of said input conductors, an output conductor, a current responsive device connected to said output conductor, a plurality of asymmetrical circuit elements connecting said control conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to selectively provide low impedance electrical paths between any one of said input conductors and said output conductor, said low impedance electrical path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said input conductor.

8. A scanning network comprising a plurality of input conductors, means to apply a significant potential to any one of said input conductors, a plurality of transformers connected to said input conductors, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, wherein each discrete potential combination is distinctive to one of said input conductors, an output conductor, a current responsive device connected to said output conductor, a plurality of asymmetrical circuit elements connecting said control conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to selectively provide low impedance electrical paths between any one of said input conductors and said output conductor, said low impedance electrical path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said input conductor.

9. A marking network comprising an input conductor, means to apply significant potentials to said input conductor, a plurality of output conductors, each of said output conductors connected to a significant potential, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, each discrete potential combination distinctive to one of said output conductors, a plurality of transformers, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to selectively provide a low im-

pedance electrical path between said input conductor and any one of said output conductors, said low impedance path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said output conductor.

10. A marking network comprising an input conductor, means to apply significant potentials to said input conductor, a plurality of output conductors, a plurality of current responsive means connected between each of said output conductors and a significant potential, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, each discrete potential combination distinctive to one of said output conductors, a plurality of transformers connected to said output conductors, a plurality of asymmetrical circuit elements and said transformers, said asymmetrical circuit elements and said transformers arranged to selectively provide a low impedance electrical path between said input conductor and any one of said output conductors, said low impedance path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said output conductor.

11. A marking network comprising an input conductor, means to apply significant potentials to said input conductor, a plurality of output conductors, a plurality of current responsive means connected between each of said output conductors and a significant potential, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, each discrete potential combination distinctive to one of said output conductors, a plurality of transformers, a plurality of asymmetrical circuit elements connecting said control conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to selectively provide a low impedance electrical path between said input conductor and any one of said output conductors, said low impedance path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said output conductor.

12. A marking network comprising an input conductor, means to apply significant potentials to said input conductor, a plurality of output conductors, a plurality of current responsive means connected between each of said output conductors and a significant potential, a plurality of control conductors, means to apply any one of a plurality of discrete combinations of potentials to said control conductors, each discrete potential combination distinctive to one of said output conductors, a plurality of transformers connected to said output conductors, a plurality of asymmetrical circuit elements connecting said control conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to selectively provide a low impedance electrical path between said input conductor and any one of said output conductors, said low impedance path selectively rendered conductive by the application of the discrete control conductor voltage combination which is distinctive to said output conductor.

13. A translating network comprising a plurality of input conductors, means to connect a significant potential to any one of said input conductors, a plurality of transformers, a plurality of output conductors, means to apply significant combinations of potentials to said output conductors, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between any one of said input conductors and said output conductors.

14. A translating network comprising a plurality of input conductors, means to connect a significant potential to any one of said input conductors, a plurality of transformers connected to said input conductors, a plurality of output conductors, means to apply significant combinations of potentials to said output conductors, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between any one of said input conductors and said output conductors.

15. A translating network comprising a plurality of input conductors, means to connect a significant potential to any one of said input conductors, a plurality of transformers, a plurality of output conductors, means to apply significant combinations of potentials to said output conductors, a plurality of asymmetrical circuit elements connecting said output conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between any one of said input conductors and said output conductors.

16. A translating network comprising a plurality of input conductors, means to connect a significant potential to any one of said input conductors, a plurality of transformers connected to said input conductors, a plurality of output conductors, a plurality of current responsive means connected between said output conductors and a significant potential, a plurality of asymmetrical circuit elements connecting said output conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between any one of said input conductors and said output conductors.

17. A translating network comprising a plurality of input conductors, means to apply any one of a plurality of combinations of potentials to said input conductors, a plurality of output conductors, a plurality of current responsive means, a plurality of transformers, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between said input conductors and any one of said output conductors.

18. A translating network comprising a plurality of input conductors, means to apply any one of a plurality of combinations of potentials to said input conductors, a plurality of output conductors, a plurality of current responsive means connected between said output conductors and a significant potential, a plurality of transformers connected to said output conductors, a plurality of asymmetrical circuit elements, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between said input conductors and any one of said output conductors.

19. A translating network comprising a plurality of input conductors, means to apply any one of a plurality of combinations of potentials to said input conductors, a plurality of output conductors, a plurality of current responsive means connected between said output conductors and a significant potential, a plurality of transformers, a plurality of asymmetrical circuit elements connected between said input conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between said input conductors and any one of said output conductors.

20. A translating network comprising a plurality of input conductors, means to apply any one of a plurality of combinations of potentials to said input conductors, a plurality of output conductors, a plurality of current responsive means connected between said output conductors and a significant potential, a plurality of transformers connected to said output conductors, a plurality of asymmetrical circuit elements connected between said input conductors and said transformers, said asymmetrical circuit elements and said transformers arranged to provide unique low impedance electrical paths between said input conductors and any one of said output conductors.

No references cited.