

[54] ELECTRONIC MUSICAL INSTRUMENT

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[51] Int. Cl..... G10h 1/00
[58] Field of Search..... 84/1.01, 1.03, 1.17,
84/1.24, 1.26

[56] References Cited

UNITED STATES PATENTS			
3,610,799	10/1971	Watson	84/1.26
3,617,602	11/1971	Kniepkamp.....	84/1.17
3,696,201	10/1972	Arsem et al.	84/1.01

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[57] ABSTRACT

An electronic musical instrument having a simplified circuit arrangement intermediate the instrument key circuit and a control signal circuit, and including a pair of matrix circuits for connection through an array of switching and gate means of a speaker and amplifier.

4 Claims, 8 Drawing Figures

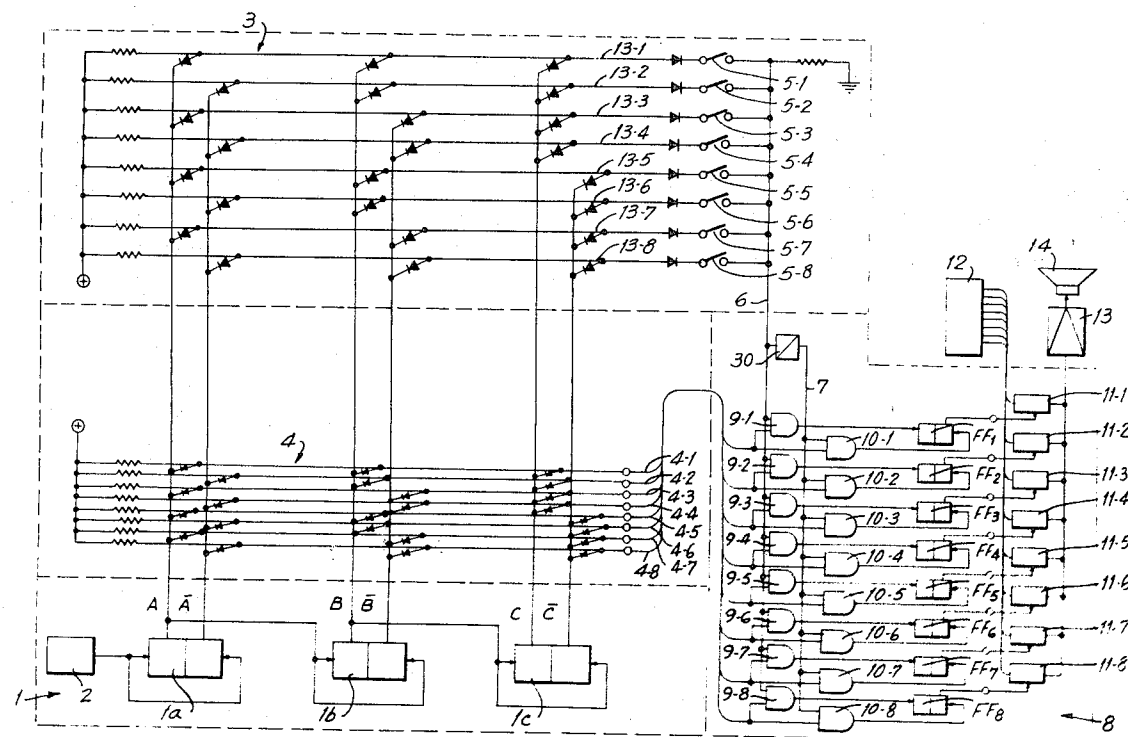


FIG. 1

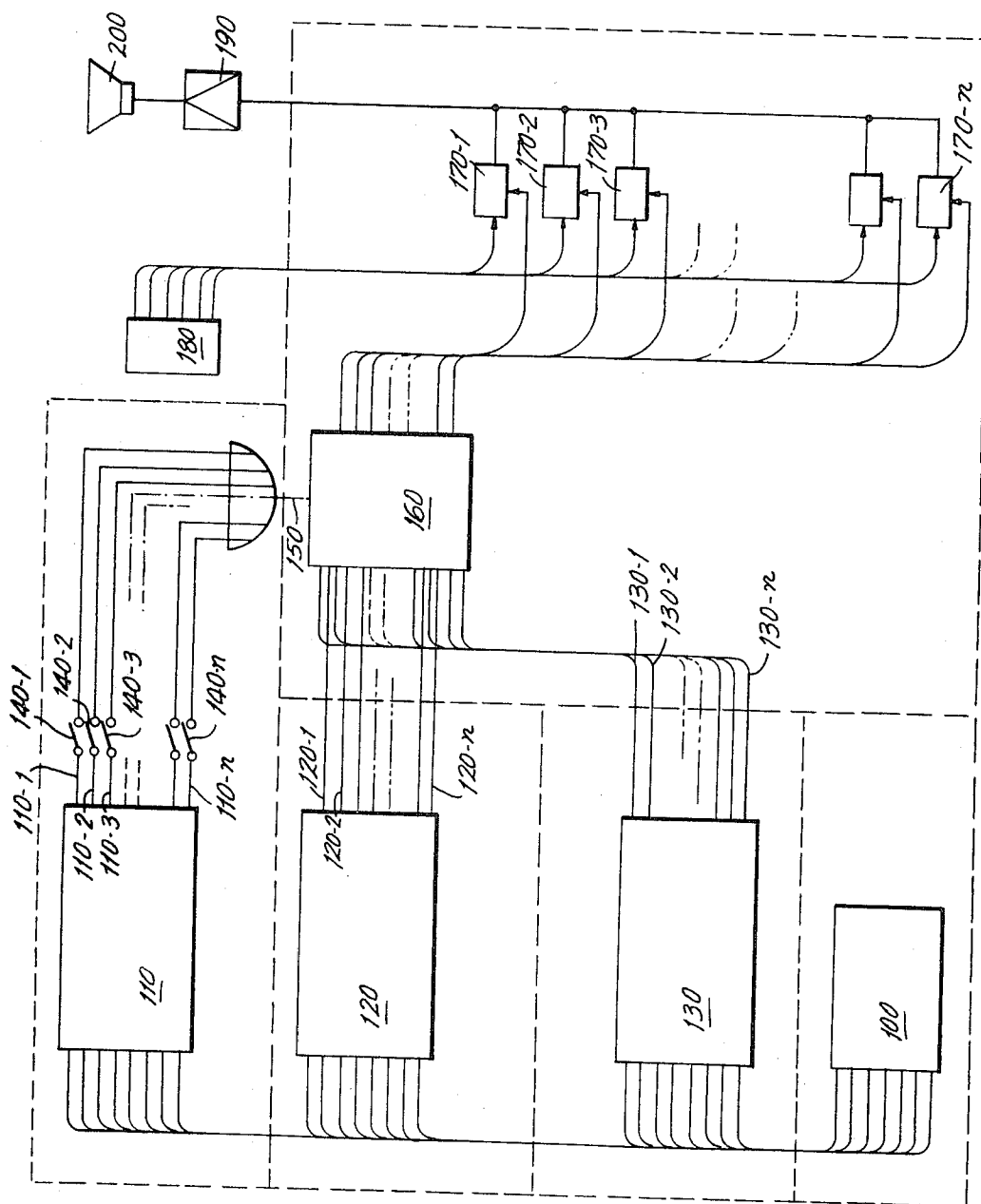


FIG. 2

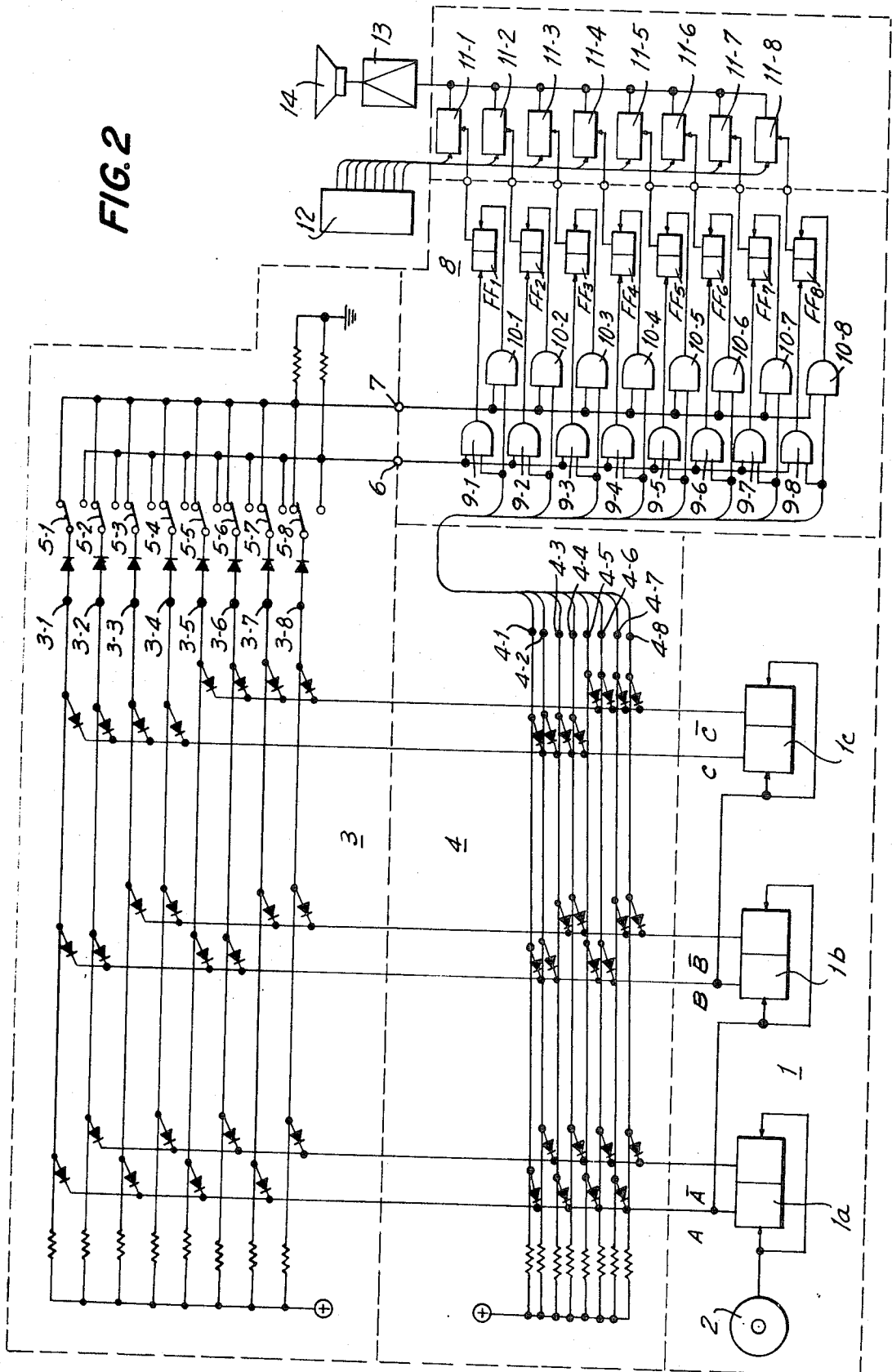


FIG. 3-I

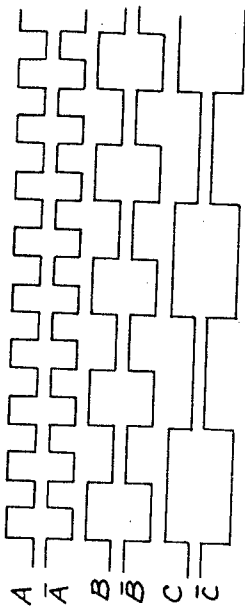


FIG. 3-II

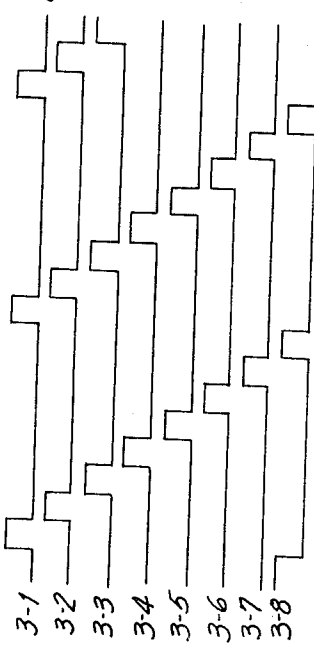


FIG. 3-III

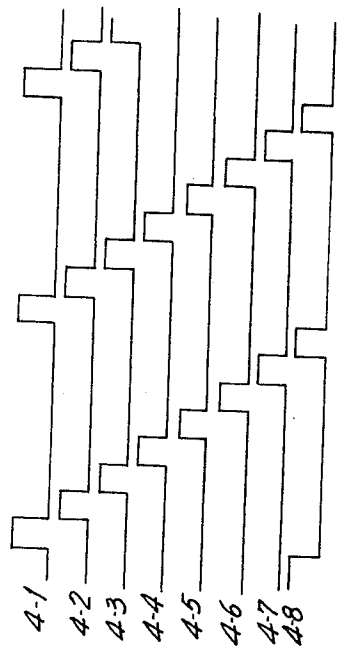


FIG. 4(a)

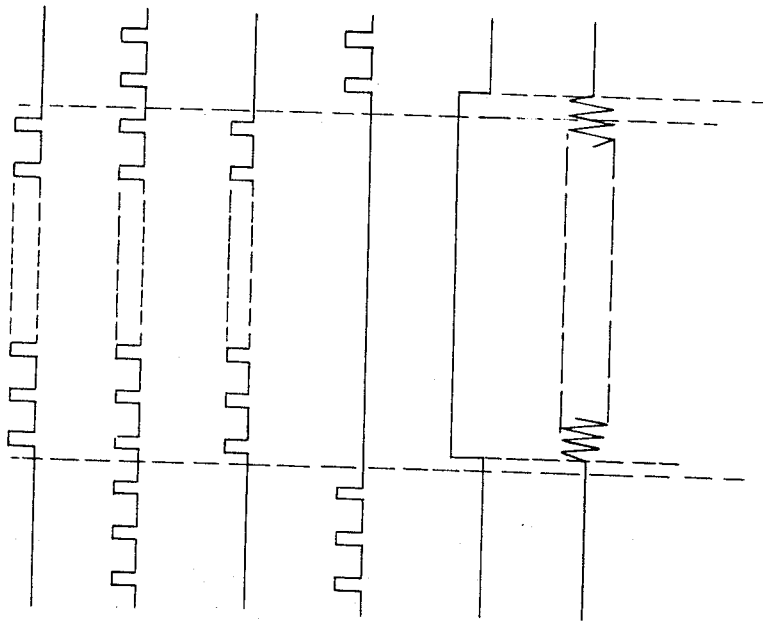
FIG. 4(b)

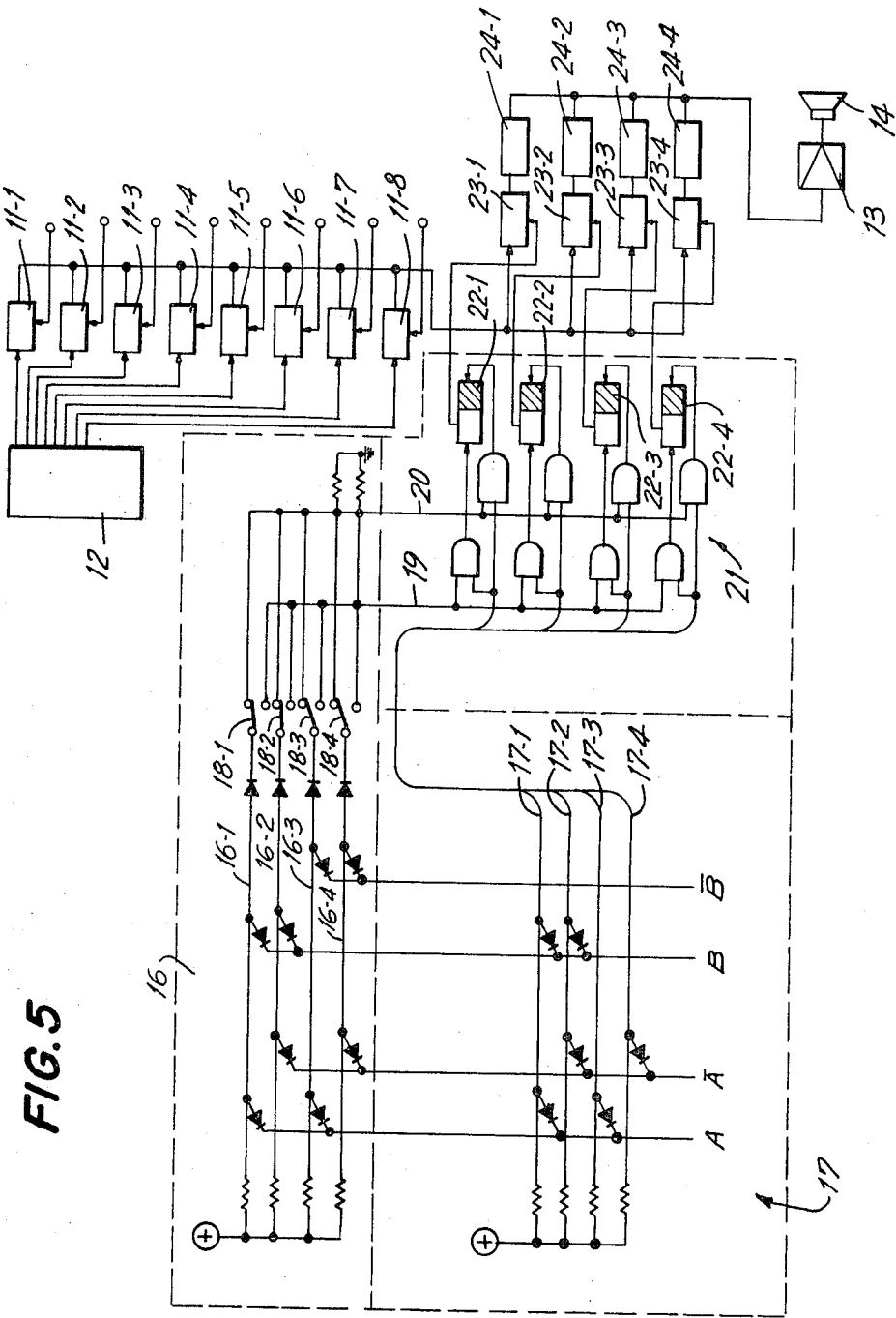
FIG. 4(c)

FIG. 4(d)

FIG. 4(e)

FIG. 4(f)





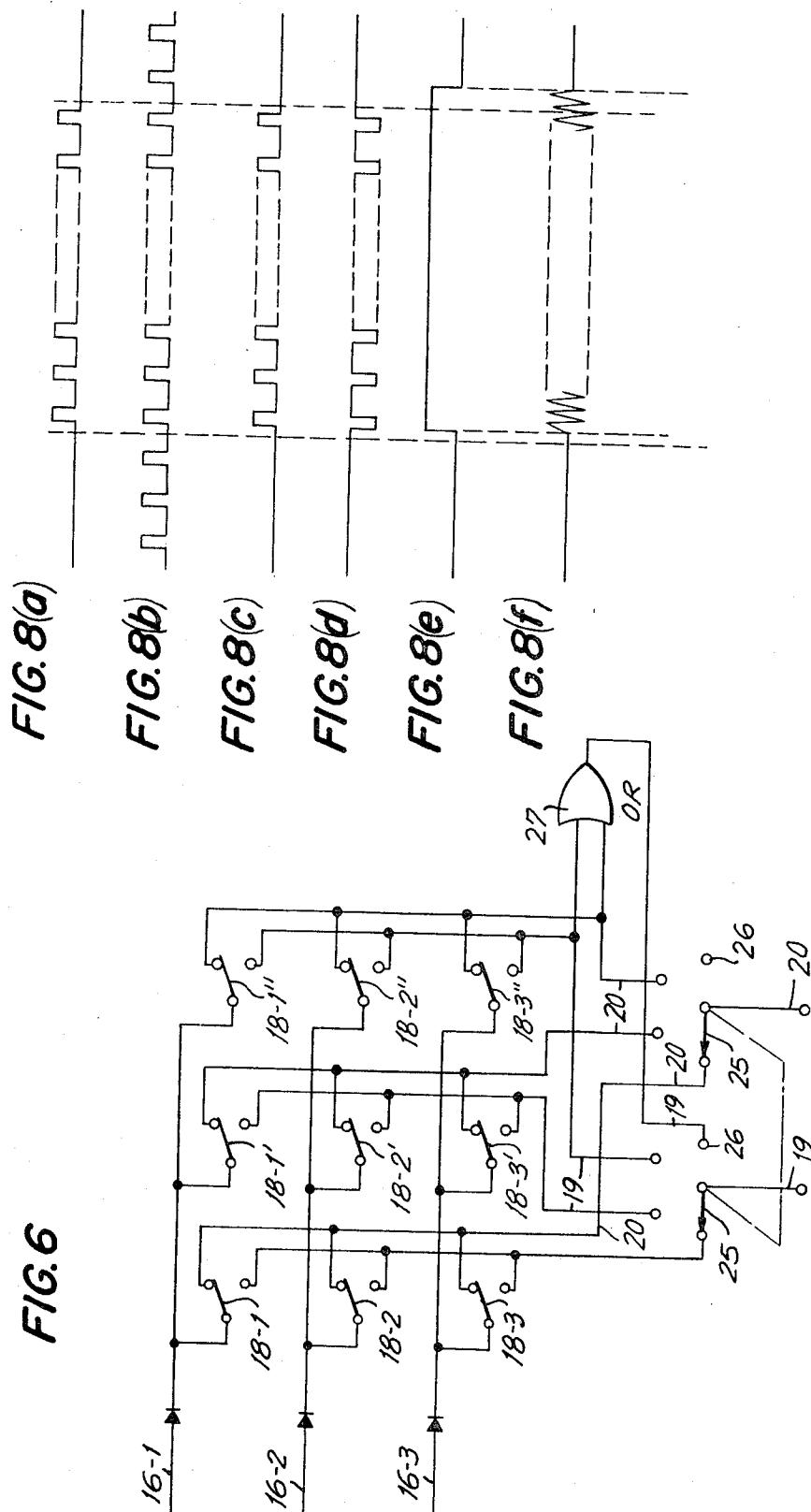
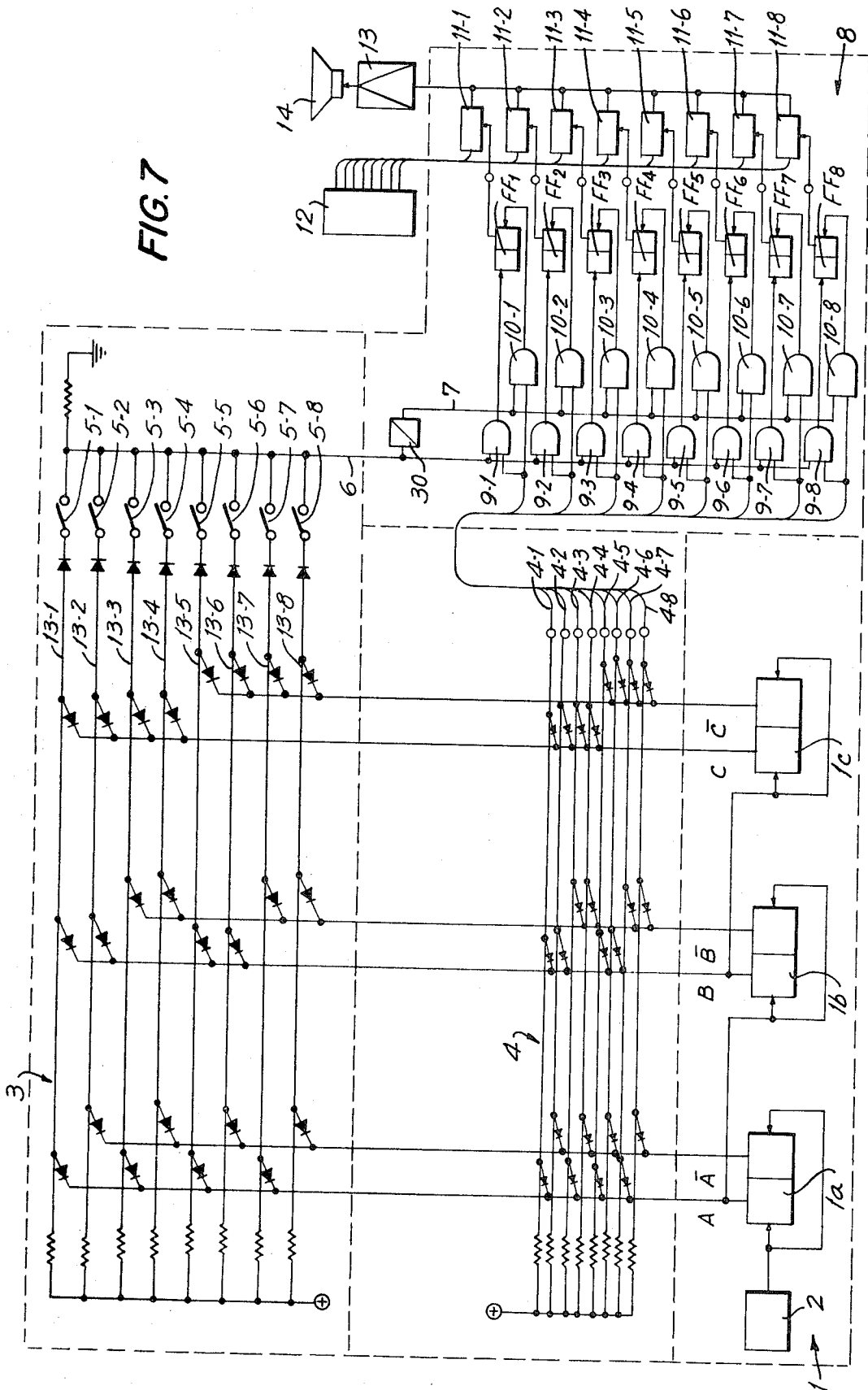


FIG. 7



ELECTRONIC MUSICAL INSTRUMENT

FIELD OF THE INVENTION

This invention relates to an electronic musical instrument and, more particularly, to an instrument providing for a simplified mutual connection between a key switch or tablet switch relation circuit and a control signal circuit, and a simplified signal selection circuit, providing for the ready wiring of its connections, and having a very small SN ratio.

DISCUSSION OF THE PRIOR ART

Electronic musical instruments of the general type disclosed herein have been heretofore proposed. In particular, a similar electronic musical instrument is shown in applicant's earlier copending U.S. Patent Application No. 215,055, filed Jan. 3, 1972.

The prior electronic musical instrument incorporates a multiplex counter circuit comprising three matrix circuits on its output side, and an array of output terminals, key switches, pulse selective and gate circuits connected to an amplifier and speaker through an extensive connecting network, described in greater detail hereinbelow. In essence, although the prior electronic musical instrument is generally satisfactory, it requires an unduly complex electronic circuitry and connection rendering it expensive and cumbersome to manufacture, service and maintain. Furthermore, the extremely large number of circuit components involved in the prior art electronic musical instrument increases the possibility of operative failure of the instrument because of malfunctioning of one or more of the multitudinous components.

SUMMARY OF THE INVENTION

The electronic musical instrument according to the present invention, in order to ameliorate and obviate the drawbacks encountered by the complex structure of the prior art instrument, greatly simplifies the circuitry of the instrument while concurrently providing an electronic musical instrument having a very small desirable SN ratio. In this connection, the inventive electronic musical instrument has the following essential and preferred features:

A first feature of the present instrument consist of in that a multiplex counter circuit is provided on its output side with first and second matrix circuits, whereby pulse signals which are time-delayed may be successively taken out from plural output terminals of these two matrix circuits, and in which the output terminals of the first matrix circuit are connected to respective changeover switches each having a normally closed contact and a normally open contact. The normally closed contacts and the normally open contacts are each connected to respective common conductors, and these conductors and the output terminals of the second matrix circuit are connected to a pulse selective circuit. Consequently, upon closing of the normally open contact of any predetermined selected changeover switch, a corresponding one of plural gate circuits connected to the output side of the selective circuit is closed to permit a sound or audio signal to pass therethrough; while through closing of the normally closed contact the gate circuit is opened so as to prevent the sound signal from passing therethrough.

In a second embodiment of the present invention, the aforescribed normally closed contacts are omitted

and the conductor which was normally connected to those contacts is now connected through a NOT circuit to the conductor on the normally open contacts' side, so that, upon any switch being opened from its closed position, it causes the NOT circuit to generate a signal to open the gate circuit.

As indicated hereinabove, in comparison with the earlier instrument, in the present invention the matrix circuits required may consist of only two, in effect, first and second matrix circuits, and in which output terminals of the first matrix circuit are provided with respective changeover switches each having a normally closed contact and a normally open contact whereby, upon closing of the normally open contact of any desired switch, the corresponding gate circuit is opened, and whereby, upon opening of the normally closed contact, the gate circuit is closed; or it is arranged that, when the switch is opened from its closed position, the NOT circuit is energized to convey a signal for opening to the gate circuit. Thus, in an advantageous manner, the third matrix circuit of the earlier musical instrument may be readily omitted, permitting the wiring to be extremely reduced and simplified, providing an economical instrument construction, and permitting the SN ratio to become extremely small since the sound signal now does not pass through the first and second matrix circuits, the pulse selective circuit and the like.

Accordingly, it is an object of the present invention to provide an improved and novel electronic musical instrument of the type described, having an extremely simple circuitry and the desired operative and audio characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference may now be had to the illustrative embodiments of the electronic musical instrument taken in conjunction with the drawings, in which:

FIG. 1 is a schematic block diagram showing a prior art electronic musical instrument operative circuit;

FIG. 2 is a circuit diagram illustrating a first embodiment of an electronic musical instrument according to the present invention;

FIG. 3 is a chart showing output wave forms at each section of the circuit of FIG. 2;

FIG. 4 is a diagram showing output wave forms at each section of FIG. 2 elucidating the operation thereof;

FIG. 5 is a circuit diagram illustrative of a second embodiment of this invention;

FIG. 6 is a circuit diagram showing a modification of a portion of the circuit of FIG. 5;

FIG. 7 is a circuit diagram showing another embodiment of this invention; and

FIG. 8 is a diagram showing output wave forms at each section of the circuit of FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

Referring now in detail to the drawings, FIG. 1 shows the prior art circuit of the electronic musical instrument disclosed in Ser. No. 215,055.

As shown in FIG. 1, a multiplex counter circuit 100 is provided on its output side with first, second and third matrix circuits 110 120 130, and output terminals 110-1.....110-n of the first matrix circuit 110 are connected through respective key switches 140-1.....140-n to a single common conductor 150, and this conductor 150 and output terminals 120-1.....120-n of the second

matrix circuit 120 are connected to a pulse selective circuit 60, and output terminals of the circuit 160 are connected to gate circuits 170-..... 170-n provided correspondingly with the abovementioned switches 140-.....140-n, whereby, upon closing any desired switch 140-k, the corresponding gate circuit 170-k is closed and thereby a sound signal generated at a sound signal generating source 180 is permitted to pass therethrough so as to drive a speaker 200 through an amplifier 190. Additionally, output terminals 130-1.....130-n of the third matrix circuit 130 are similarly connected to the pulse selective circuit 160, whereby, upon opening of the aforementioned switch 140-k, an output signal from the third matrix circuit 130 closes the gate circuit 170-KO so as to stop the sound signal from passing therethrough.

As becomes readily apparent, this requires at least three matrix circuits and a complex array of ancillary circuitry.

In comparison, the present electronic musical instrument incorporates the following components and circuitry:

FIG. 2 illustrates an instance in which the invention is applied to a key switch circuit. Numeral 1 denotes a multiplex counter circuit driven by an oscillator 2, and this circuit 1 comprises three binary circuits 1a, 1b and 1c so that pulses, as are shown in FIG. 3-I, may be obtained at their output terminals A $\bar{A}$, B $\bar{B}$, C $\bar{C}$. The pulses as shown in FIG. 3 II and III are taken out in successively time-delayed relationship at their output terminals 3-1.....3-8 and 4-1.....4-8. Numerals 5-1.....5-8 designate changeover switches provided on the output terminals of the first matrix circuit 3, and wherein each of these switches has a normally open contact and a normally closed contact. The normally opened contacts and the ordinarily closed contacts are respectively connected in common to form two conductors 6, 7. Hereinafter, the conductor 6 is designated as a set terminal and the conductor 7 is designated as a reset terminal. Numeral 8 denotes a pulse selective circuit which comprises AND gate circuits 9-1.....9-8 connected to terminals for setting of flip-flop circuits FF₁, ...FF₈ provided on its output side and AND gate circuits 10-1.....10-8 connected to terminals for resetting of the same. The AND gate circuits 9-1.....9-8 and 10-1.....10-8 are connected at their input terminals to the second matrix circuits 4-1.....4-8, the set terminal 6 is connected to the AND gate circuits 9-1.....9-8, whereas the reset terminal 7 is connected to the AND gate circuits 10-1.....10-8. Gate circuits 11-1.....11-8 are connected to the output terminals of the flip-flop circuits FF₁, ...FF₈ and the closing and opening of those gate circuits serve to control passing of a sound or audio signal from a sound signal oscillator 12. These gate circuits 11-1.....11-8 are connected at their input terminals to output terminals of the corresponding frequencies of the oscillator 12 and are connected at their output terminals to a speaker 14 through an amplifier 13.

If any desired key is pushed and the corresponding one, for example, 5-2 of the changeover switches 5-1.....5-8 is changed to close the normally open contact thereof, the pulse signal at the second order in FIG. 3-II extends through the set terminal 6 as shown in FIG. 4a and is applied to the AND gate circuits 9-1.....9-8. At the same time, the pulse signal at the second order in FIG. 3-III (FIG. 4b) is applied to the second gate cir-

cuit 9-2 through the second order output terminal 4-2 of the second matrix circuit 4, so that the second order AND gate circuit 9-2 is opened and the signal "1" is applied to the flip-flop circuit FF₂, whereby the flip-flop circuit FF₂ is given the setting shown in (FIG. 4e). Thus, through the output thereof, the second gate circuit 11-2 is opened and the output signal from the oscillator 12 is allowed to pass therethrough (FIG. 4f) so as to operate the speaker 14 through the amplifier 13. If, thereafter, the depression of the key is continued, during that time the plural number of signal "1" is conveyed through the gate circuit 9-2 to the flip-flop circuit FF₂ as shown in FIG. 4c, but the flip-flop circuit FF₂ is not reset and the open position of the gate circuit 11-2 is maintained. Subsequently, if the depression of the key is released, the normally open contact is again opened and the normally closed contact is closed, so that the pulse of the output terminal 3-2 is conveyed to the AND gate circuit 10-2 through the reset terminal 7 (FIG. 4d), and whereby, through this pulse and the pulse signal from the second output terminal 4-2 of the second matrix circuit 4 (FIG. 4b), the AND gate circuit 10-2 is opened so as to cause the flip-flop circuit FF₂ to reset. Consequently, the gate circuit 11-2 is closed and the operation of the speaker 14 ceases. The above is an illustration in which the number of the keys is six.

If it is assumed that the time difference between two sounds which cannot be distinguished through hearing is about 8 msec., it is necessary that more than eight pulses are generated within 8 msec. Accordingly, the oscillation frequency of the oscillator 2 is sufficient at above 500 Hz. For the oscillator 2, for example, a portion of the sound signal source oscillator 12 can be used. The above is illustrated with respect to an embodiment in which the number of the keys is eight.

If, however, for example, the number of keys is 61, it is required that the number of the binary circuits constituting the multiplex counter circuit 1 is 6, and the first and the second matrix circuits each has 61 output terminals. In this instance, the number of the conductors connecting between the multiplex counter circuit 1 and the first matrix circuit 3 becomes 12, that of the output conductor becomes 1 and that of the electric source relation becomes 3 and thus the number of the conductors leading out from the key switch relation circuit, including the first matrix circuit 3, is sufficient with only a total of 16. In this instance, it is necessary that the oscillation frequency of the oscillator 2 constituting a part of the multiplex counter circuit 1 is about 4,000 Hz.

FIG. 5 shows an embodiment in which the invention is applied to a tone color circuit. First and second matrix circuits 16, 17 are connected to the A $\bar{A}$, B $\bar{B}$, of multiplex counter circuit 1 as shown in FIG. 2, and tone color selective changeover switches 18-1.....18-4 are provided on output terminals 16-1.....16-4 of the first matrix circuit 16. Set and reset terminals 19, 20 connecting normally closed contacts and normally open contacts of these switches and output terminals 17-1.....17-4 of the second matrix circuit 17 are connected to a pulse selective circuit 21, and output terminals of flip-flop circuits 22-1.....22-4 provided on the output side thereof, are connected to gate circuits 23-1.....23-4 interposed in parallel one with another in a circuit connecting between the sound source oscillator 12 and the speaker 14. Additionally, tone color forming circuits 24-1.....24-4 are provided on the out-

put sides of the gate circuits 23-1.....23-4. Numeral 11-1.....11-8 denotes gate circuits analogous to those in FIG. 2, and these gate circuits are arranged so as to be opened by depressing of any of the keys so as to allow a signal from the sound source oscillator 12 to pass therethrough. Consequently, if any desired one of the tone color selective changeover switches 18-1.....18-4 is switched so as to close the ordinarily open contact, in almost the same manner as in the case of key switch operation in FIG. 2, the corresponding one of the flip-flop circuits 22-1.....22-4 is set and the corresponding one of the gate circuits 23-1.....23-4 connected thereto is opened. A sound signal passed through any of the foregoing gate circuits 11-1.....11-8 is allowed to pass through this opened one of the gate circuits 23-1.....23-4 and the corresponding one of the tone color forming circuits 24-1.....24-4 is operated so as to produce a tone color forming and to drive the speaker 14 through the amplifier 13.

FIG. 6 shows a tone color selective combination circuit, and in which tone color selective changeover switches as shown in FIG. 5 are positioned to form three stages, that is, a first stage of 18-1.....18-3, a second stage of 28-1'.....18-3', and a third stage of 18-1''.....18-3'', and in which the set terminal 19 and the reset terminal 20 are connected to a gang-type changeover switch 25, so that by the changeover operation of the switch 25 any desired tone color may be obtained. The fourth order contact 26 of the switch 25 is for a full organ. If the third row of the set terminals 19 and that of the reset terminals 20 are connected thereto through an OR circuit 27, the entire tone color forming circuit may be rendered operable if the same is selectively connected.

FIG. 7 shows an embodiment in which the normally closed contacts in FIG. 2 are omitted and the conductor 7 which was connected thereto is now connected to the conductor 6 through a NOT circuit 30. In comparison with the embodiment of FIG. 2, the plural normally closed contacts and the output conductor thereof are omitted and therefore the number of the conductor led out from the key switch relation circuit including the first matrix circuit 3 becomes only one. Each reference numeral in FIG. 7 corresponds to that in FIG. 2. The operation thereof is substantially similar to that of FIG. 1, except for the following:

In effect, as shown in FIG. 8d, a negative pulse signal is generated on the output side of the NOT circuit 30 when the key switch 5-k is closed. This negative pulse does not provide a special effect. When the AND gate 10-k becomes "ON" by a signal "1" caused by the opening of the foregoing key switch 5-k and a pulse signal supplied from the second matrix circuit 4, the flip-flop circuit FF_k is provided with a reset signal and accordingly the gate circuit 11-k is closed. It is quite obvious that the circuit shown in FIG. 7 is not limited to the key switch relation circuit but may also be used as a tone color circuit.

While there has been shown what is considered to be the preferred embodiment of the invention, it will be obvious that modifications may be made which come within the scope of the disclosure of the specification.

What is claimed is:

1. A circuit for an electronic musical instrument comprising a multiplex counter circuit, first and second matrix circuits, a plurality of conductors interconnecting said matrix circuits, said second matrix circuit being connected to the output side of said multiplex counter circuit, said two matrix circuits having plural output terminals issuing pulse signals in a successively delayed relationship, changeover switches each having a normally closed contact and a normally open contact being connected to the output terminals of said first matrix circuit, said normally closed contacts and said normally open contacts being connected to respective common conductors, a pulse selective circuit connected to said common conductors and to the output terminals of said second matrix circuit, and plural gate circuits connected to the output side of the selective circuits whereby, upon closing of the normally open contact of any predetermined one of the changeover switches, the corresponding one of said plural gate circuits connected to the output side of the selective circuit is opened to allow a signal to pass therethrough, and upon closing of the normally closed contact, said gate circuit is closed so as to prevent the signal from passing therethrough.

2. A circuit for an electronic musical instrument comprising a multiplex counter circuit, first and second matrix circuits, a plurality of conductors interconnecting said matrix circuits, said second matrix circuit being connected to the output side of said multiplex counter circuit, said first and second matrix circuits having a plurality of output terminals, the output terminals of said first matrix circuit being connected through a plurality of respective switches to a single common conductor, said conductor having a second conductor diverging therefrom, a NOT circuit interposed in said second conductor, a pulse selective circuit connected to the output terminals of said second matrix, and a plurality of gate circuits corresponding in number to said plurality of switches being provided on the output said (gate) selective circuit (circuits) being connected to said NOT circuit by said second conductor and to said plurality of switches by said common conductor whereby, upon closing of any predetermined one of said switches, a corresponding gate circuit is opened to allow a signal to pass therethrough, and wherein opening of the switch closes the gate circuit so as to prevent the signal from passing therethrough.

3. A circuit as claimed in claim 1, wherein said pulse selective circuit comprises plural flip-flop circuits connected to the input terminals of the plural gate circuits, plural AND gates connected to input terminals for setting of the flip-flop circuits, and plural AND gates connected to input terminals for resetting of the plural flip-flop circuits.

4. A circuit as claimed in claim 2, wherein said pulse selective circuit comprises plural flip-flop circuits connected to the input terminals of the plural gate circuits, plural AND gates connected to input terminals for setting of the flip-flop circuits, and plural AND gates connected to input terminals for resetting of the plural flip-flop circuits.

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