# United States Patent [19]

**Obayashi**

[11] **3,794,747**

[45] ***Feb. 26, 1974**


[54] **ELECTRONIC MUSICAL INSTRUMENT**


[75] Inventor: **Nobuharu Obayashi,** Shizuoku-ken, Japan

[73] Assignee: **Kabushiki Kaisha Kawai Gakki Seisakusho,** Hamatsu-shi, Shizuoka-ken, Japan



[ * ] Notice: The portion of the term of this patent subsequent to Oct. 24, 1989, has been disclaimed.

[22] Filed: **May 9, 1972**

[21] Appl. No.: **251,796**

[30] **Foreign Application Priority Data**

May 11, 1971 Japan ..... 46-30858

[52] **U.S. Cl.** ..... **84/1.01,** 84/1.08

[51] **Int. Cl.** ..... **G10h 1/00**

[58] **Field of Search** ..... 84/1.01, 1.03, 1.17, 1.24, 84/1.26



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,610,799 | 10/1971 | Watson | 84/1.26 X |
| 3,617,602 | 11/1971 | Kniepkamp | 84/1.17 |
| 3,696,301 | 10/1972 | Arsem et al. | 84/1.01 |



*Primary Examiner*—Richard B. Wilkinson
*Assistant Examiner*—U. Weldon
*Attorney, Agent, or Firm*—Eric H. Waters



[57] **ABSTRACT**

An electronic musical instrument comprising an oscillator, first and second multiplex counter circuits synchronously driven in common by said oscillator, first and second matrix circuits coupled respectively to said counter circuits for producing respective sequences of pulses, a common conductor, said matrix circuits including a plurality of output terminals, switches connecting the output terminals of said first matrix circuit to said conductor, a pulse selective circuit coupled to said conductor and to the output terminals of said second matrix circuit, sound means, and gating means controlled by said pulse selective circuit to control the output of said sound means.


**9 Claims, 6 Drawing Figures**

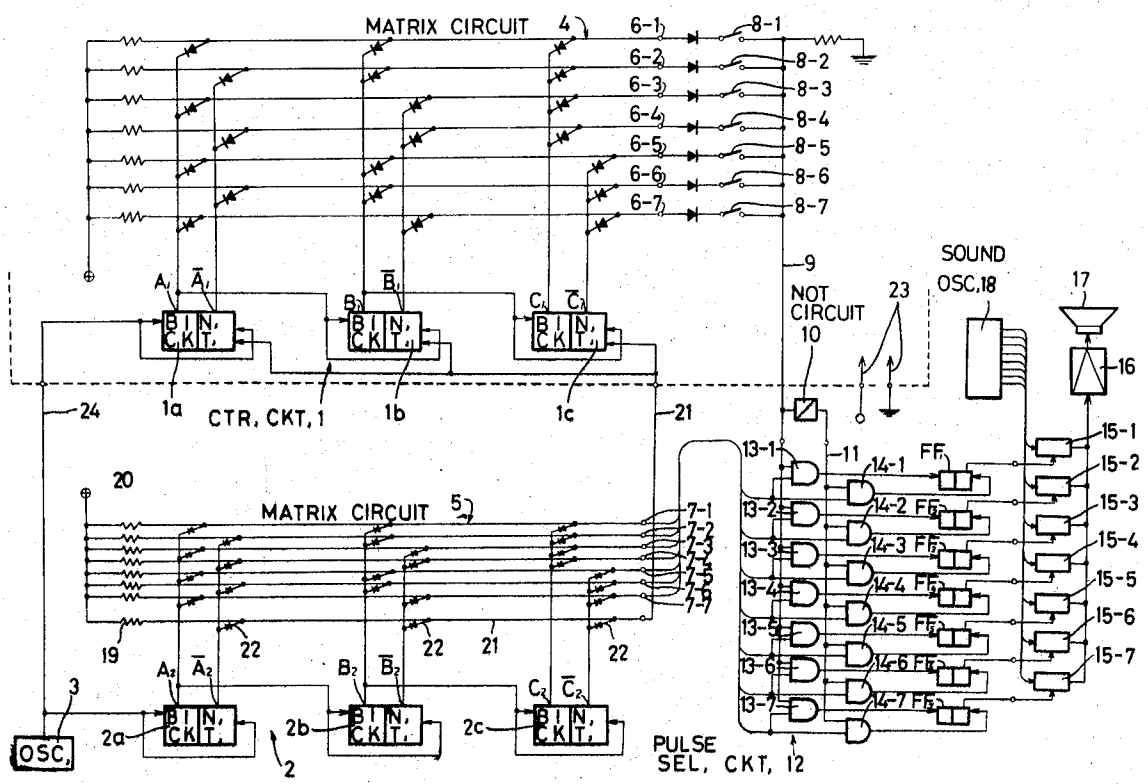
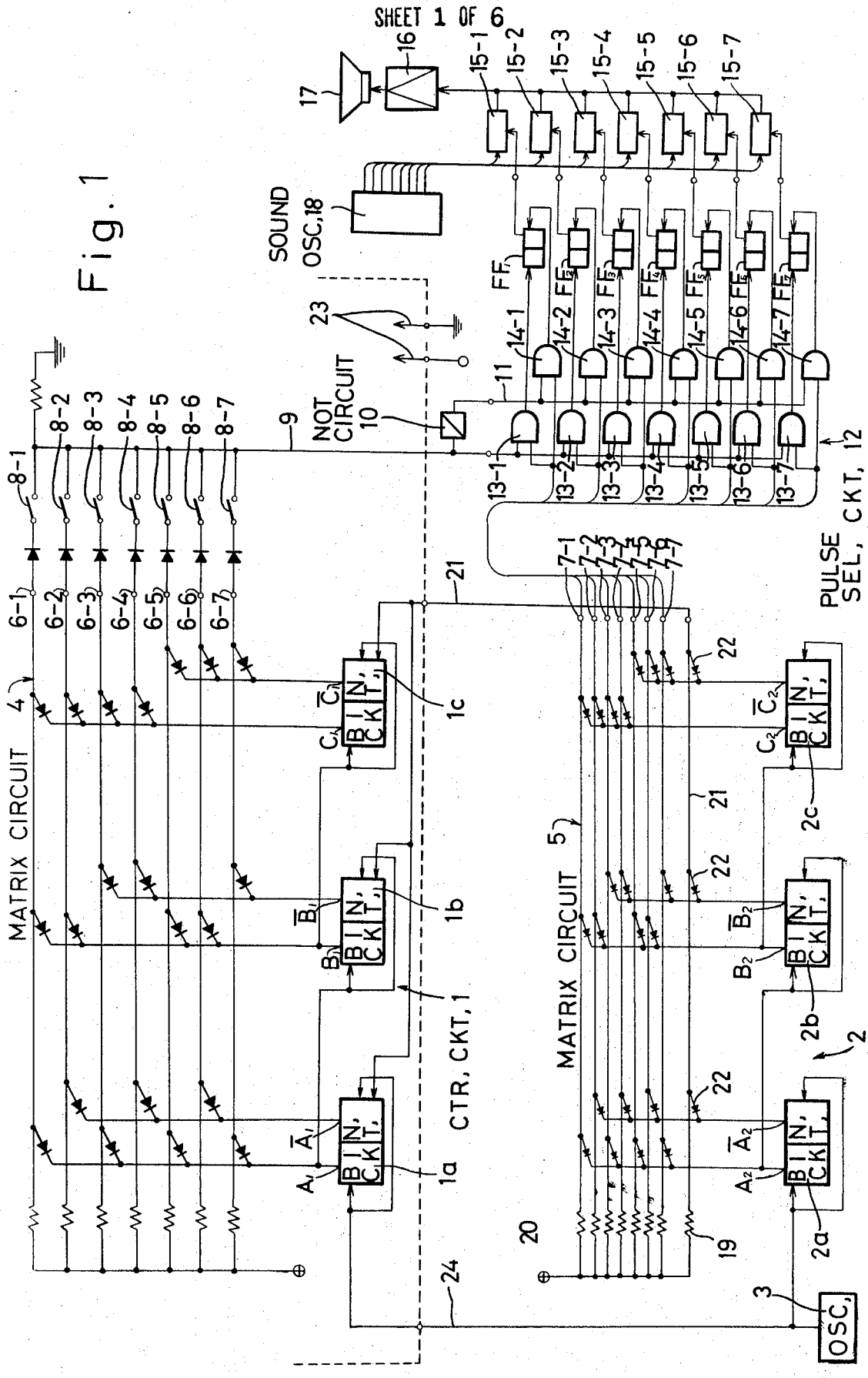


Fig. 1


SOUND OSC, 18
NOT CIRCUIT 10
PULSE SEL, CKT, 12
MATRIX CIRCUIT 4
MATRIX CIRCUIT 5
CTR, CKT, 1
OSC, 3
BIN, CKT,
FF1
FF2
FF3
FF4
FF5
FF6
FF7

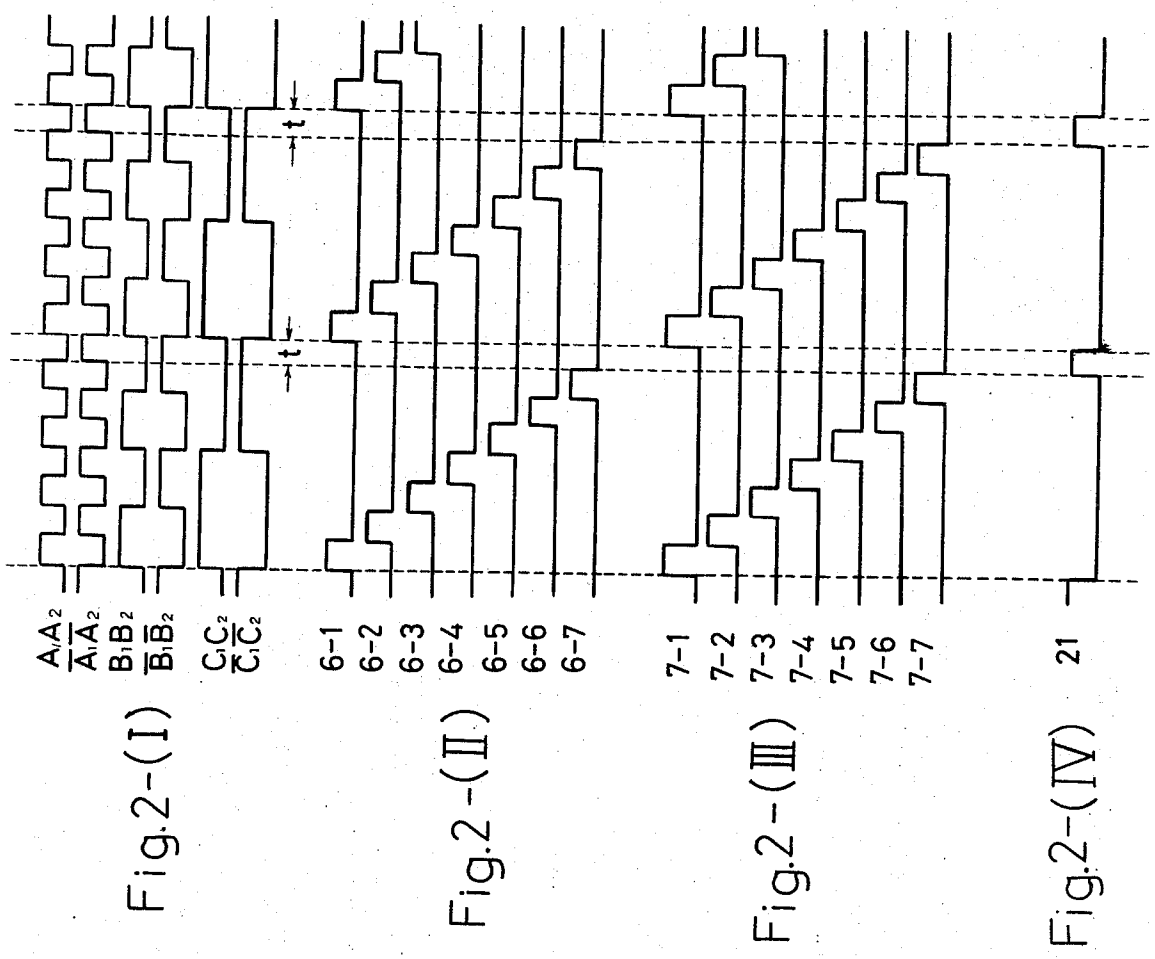



Fig.2-(I) Fig.2-(II) Fig.2-(III) Fig.2-(IV)

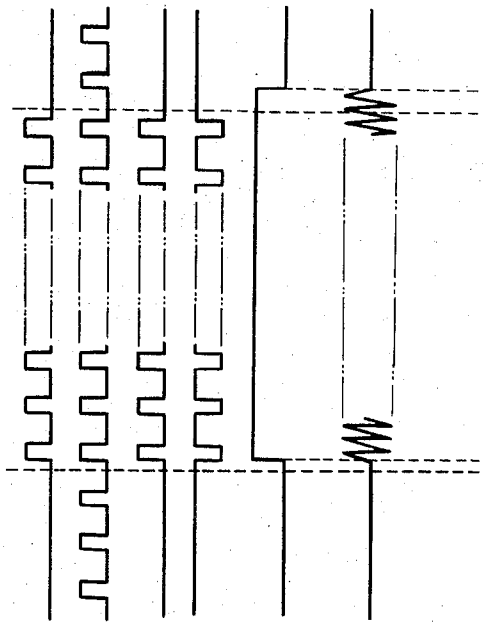


Fig. 3a Fig. 3b Fig. 3c Fig. 3d Fig. 3e Fig. 3f

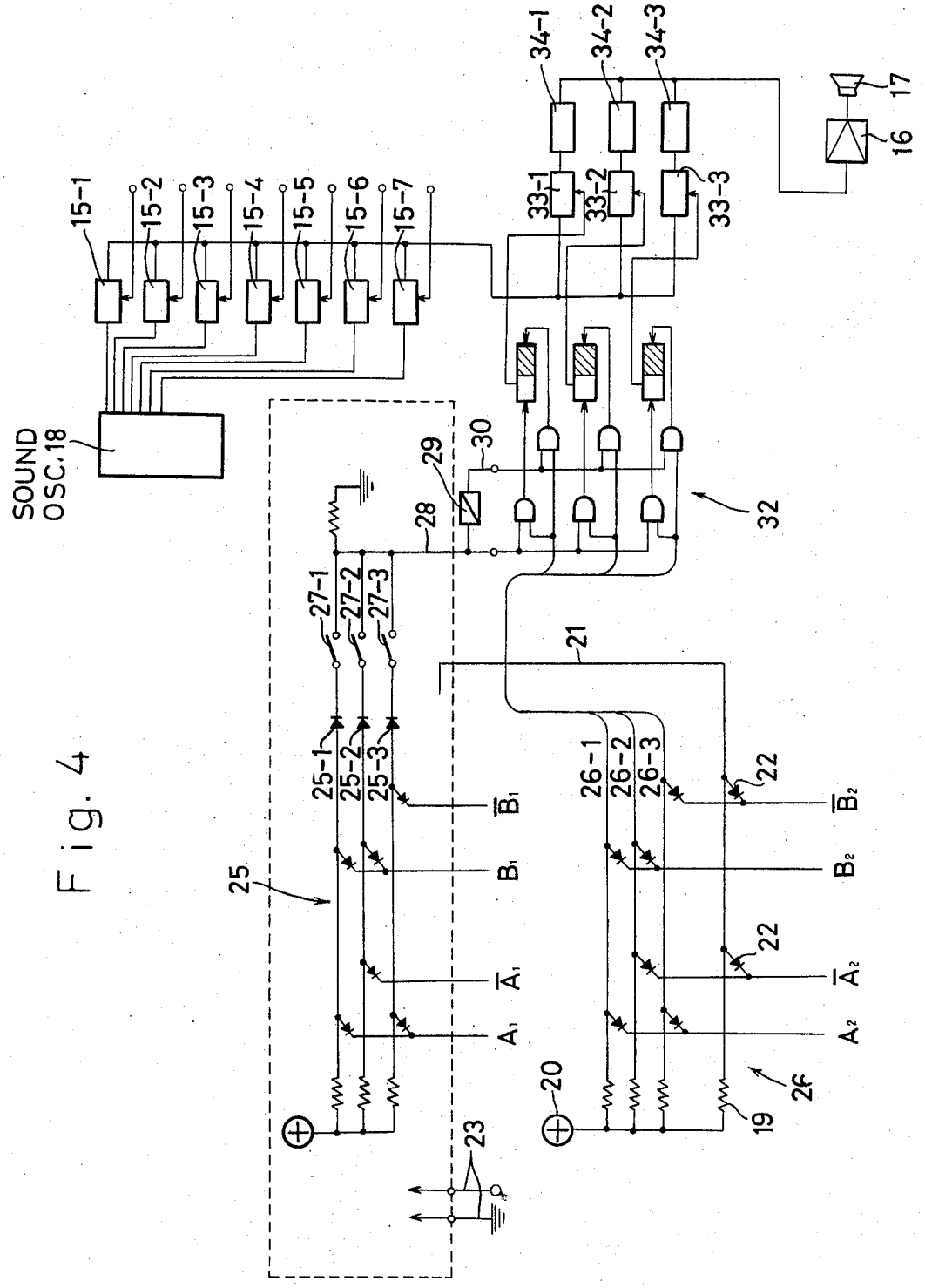

SOUND OSC. 18
15-1
15-2
15-3
15-4
15-5
15-6
15-7
34-1
34-2
34-3
33-1
33-2
33-3
17
16
29
30
28
32
27-1
27-2
27-3
21
25-1
25-2
25-3
26-1
26-2
26-3
22
25
26
$\bar{B}_1$
$B_1$
$\bar{A}_1$
$A_1$
$\bar{B}_2$
$B_2$
$\bar{A}_2$
$A_2$
20
23
19

Fig. 4

Fig. 5

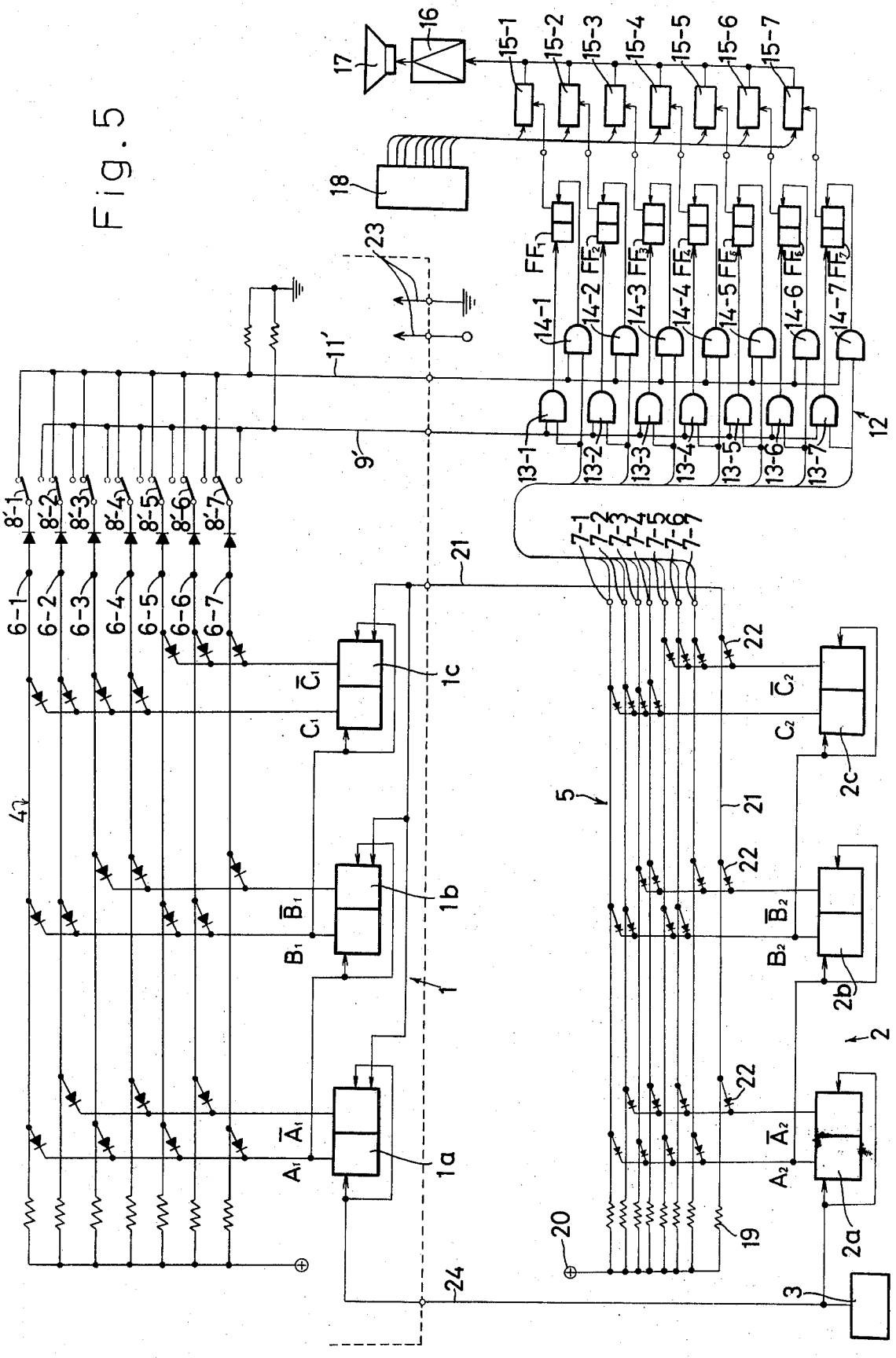
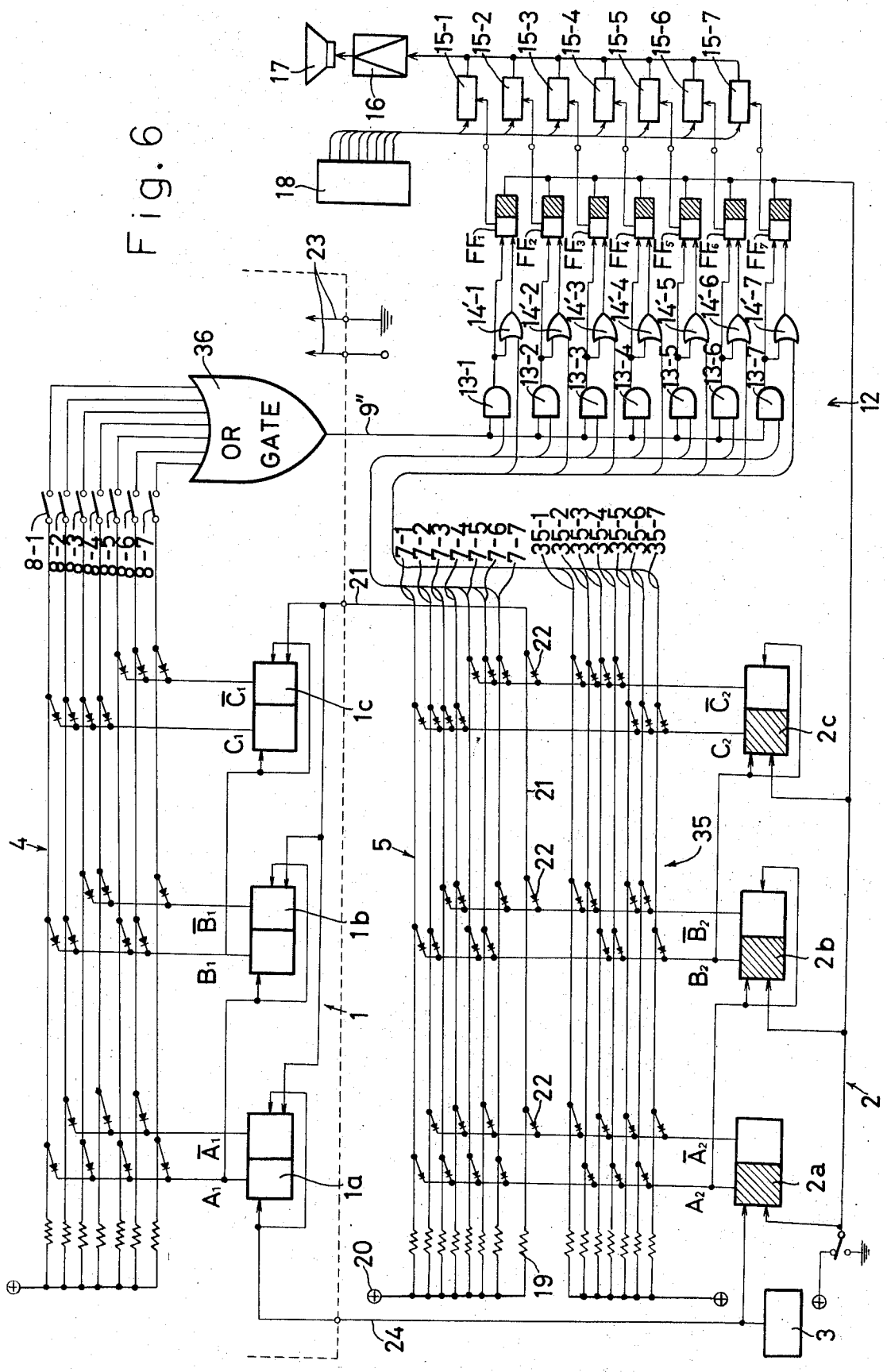

16
17
15-1
15-2
15-3
15-4
15-5
15-6
15-7
18
23
FF1
FF2
14-1
14-2
14-3
14-4
14-5
14-6
14-7
11'
9'
13-1
13-2
13-3
13-4
13-5
13-6
13-7
12
8'-1
8'-2
8'-3
8'-4
8'-5
8'-6
8'-7
6-1
6-2
6-3
6-4
6-5
6-6
6-7
7-1
7-2
7-3
7-4
7-5
7-6
7-7
21
22
4
5
1
2
3
1a
1b
1c
2a
2b
2c
A1
B1
C1
A2
B2
C2
19
20
24

Fig. 6


OR GATE
36
9"
12
23
17
16
18
15-1
15-2
15-3
15-4
15-5
15-6
15-7
FF1
FF2
FF3
FF4
FF5
FF6
FF7
14'-1
14'-2
14'-3
14'-4
14'-5
14'-6
14'-7
13-1
13-2
13-3
13-4
13-5
13-6
13-7
8-1
8-2
8-3
8-4
8-5
8-6
8-7
7-1
7-2
7-3
7-4
7-5
7-6
7-7
35-1
35-2
35-3
35-4
35-5
35-6
35-7
21
22
1
1a
1b
1c
2
2a
2b
2c
3
4
5
35
19
20
24
A1
Ā1
B1
B̄1
C1
C̄1
A2
Ā2
B2
B̄2
C2
C̄2

# ELECTRONIC MUSICAL INSTRUMENT

## DETAILED EXPLANATION OF INVENTION

1. Field of Invention

This invention relates to an electronic musical instruments and, more particularly, to instruments including key switches and tablet switch relation circuits and the like.

2. Background

The Applicant has previously proposed an electronic musical instrument in which a multiplex counter circuit is provided at its output side with a preset circuit comprising, for example, an AND matrix circuit, a reset circuit comprising, for example, an OR matrix circuit and a key or tablet switch circuit comprising, for example, an AND matrix circuit, the output terminals of these circuits being connected to a pulse selective circuit comprising, for example, a combination of an AND circuit, an OR circuit and other related circuits a plurality of gate circuits being provided on the output side of the pulse selective circuit, so that by closing any of the key or tablet switches, a corresponding one of the gate circuits is opened for allowing a sound signal to pass therethrough and, by means of a pulse signal from the aforementioned reset circuit caused by opening of said switch, the gate circuit is closed for preventing the sound signal from passing therethrough. For further details, reference may be made to U.S. Pat. application No. 215,055 filed Jan. 3, 1972.

## SUMMARY OF INVENTION

An object of the present invention is to simplify the wiring of the key or tablet switch relation circuit in the above-described kind of electronic musical instrument.

The invention is characterized in that first and second multiplex counter circuits arranged to be driven synchronously by a single common oscillator are provided on their output sides with first and second matrix circuits having a plurality of output terminals for taking out pulse signals in successively delayed relationship. The output terminals of the first matrix circuit are connected to a single common output terminal through a key switch or tablet switch or other like switch circuit. This common output terminal and the output terminals of the second matrix circuit are connected to a pulse selective circuit, and there are provided on the output side thereof a plurality of gate circuits corresponding to the key switch or tablet switch and interposed in a circuit connected between the output terminals of a sound source oscillator and a speaker through an amplifier.

Embodiments of this invention will next be explained with reference to the accompanying drawings in which:

## BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a circuit diagram showing one embodiment of this invention;

FIG. **2** is a diagram showing wave forms at different portions of the circuit of FIG. **1**;

FIG. **3** is a diagram showing wave forms for explaining the operation of the circuit of FIG. **1**;

FIGS. **4** to **6** are respective circuit diagrams showing different embodiments.

## DETAILED DESCRIPTION

FIG. **1** shows an embodiment in which the invention



is applied to a key circuit. In FIG. **1**, sections **1** and **2** are first and second multiplex counter circuits driven by an oscillator **3**. Circuits **1** and **2** respectively comprise three binary circuits **1***a*, **1***b* and **1***c* and **2***a*, **2***b* and **2***c*. It is arranged that the pulse signals shown in FIG. **2** (I) may be obtained at their output terminals $A_1$, $\overline{A}_1$, $B_1$ $\overline{B}_1$, $C_1$ $\overline{C}_1$, and $A_2$ $\overline{A}_2$, $B_2$ $\overline{B}_2$, $C_2$ $\overline{C}_2$.

Circuits **4** and **5** are first and second matrix circuits each comprising AND circuits consisting of the various diodes and resistors. These matrix circuits **4** and **5** are respectively connected to the output terminals $A_1$ $\overline{A}_1$, $B_1$ $\overline{B}_1$, $C_1$ $\overline{C}_1$, and $A_2$ $\overline{A}_2$, $B_2$ $\overline{B}_2$, $C_2$ $\overline{C}_2$, of the first and second multiplex counter circuits **1** and **2**. It is thus arranged that pulse signals delayed successively as shown in FIG. **2** (II) and FIG. **2** (III may be obtained at respective terminals **6-1 . . . 6-7** and **7-1 . . . 7-7**.

Elements **8-1 . . . 8-7** are key switches arranged to be closed by the pushing of keys and are connected to the output terminals **6-1 . . . 6-7**. The output-terminals of these switches are connected to a common conductor **9**. This conductor **9**, a conductor **11** branching therefrom through a NOT circuit **10**, and the output terminals **7-1 . . . 7-7** are connected to a pulse selective circuit **12**.

The pulse selective circuit **12** comprises flip-flop circuits $FF_1$ . . . $FF_7$ provided on its output side. AND gate circuits **13-1 . . . 13-7** are connected to the setting terminals of these flip-flops. AND gate circuits **14-1 . . . 14-7** are connected to the resetting terminals thereof.

The output terminals **7-1 . . . 7-7** of the second matrix circuit **5** are connected to input terminals of the corresponding AND gate circuits **13-1 . . . 13-7** and **14-1 . . . 14-7**, respectively. The conductor **9** is connected to input terminals of the AND gate circuits **13-1 . . . 13-7**. The conductor **11** is connected to input terminals of the AND gate circuits **14-1 . . . 14-7**.

Gate circuits **15-1 . . . 15-7** are connected to the output terminals of the flip-flop circuits $FF_1$ . . . $FF_7$. Upon opening of any of the gate circuits **15-1 . . . 15-7**, a sound signal generated by a sound source signal oscillator **18** is allowed to pass and is sent to a speaker **17** through an amplifier **16**.

Erroneous operation in the pulse selective circuit **12** may be caused if the binary circuits **1***a*, **1***b* and **1***c* and **2***a*, **2***b* and **2***c* constituting the first and second multiplex counter circuits **1** and **2** do not perform a completely synchronous operation. Accordingly, it is arranged that the output terminals $\overline{A}_2$, $\overline{B}_2$ and $\overline{C}_2$ of the binary circuits **2***a*, **2***b* and **2***c* constituting the second multiplex counter circuit **2** are connected to a conductor **21**, one end of which is connected to a voltage source **20** for the second matrix circuit **5** through a resistance **19** and through respective diodes **22** so as to form an AND circuit. The other end of the conductor **21** is connected to the input sides of the binary circuits **1***a*, **1***b* and **1***c* constituting the first multiplex counter circuit **1** so that a a reset signal can be sent thereto. Thus, a pulse signal which is the eighth output of the second matrix circuit **5** as shown in FIG. **2** (IV) is obtained on the conductor **21**, and the first multiplex counter circuit **1** is reset at the time t in FIG. **2** (II) and is thus prepared for the next arriving first pulse. It serves as a reset signal for synchronizing the first and second multiplex counter circuits when they are not synchronized as may occur expecially when the electric source is put on.

Elements 23 are electric source terminals for the first multiplex counter circuit 1 and the first matrix circuit 4. If the first multiplex counter circuit 1 and the first matrix circuit 4 are provided in a music organ body and the remaining sections are separately provided, the organ body section and the remaining sections are interconnected by only five conductors. These include a conductor 24 connected between the oscillator 3 and the first multiplex counter circuit 1, the conductor 21 for the resetting signal, the conductor 9 connecting the output sides of the key switches 8-1 . . . 8-7 in common, and the conductors 23 for the voltage source.

The operation of the above circuits will next be explained as follows:

If any one of the keys is pushed and, for example, the second one 8-2 of the key switches 8-1 . . . 8-7 is closed, the second order pulse signal in FIG. 2(II) (see also FIG. 3 (*a*)) is supplied to the AND gate circuits 13-1 . . . 13-7 through the conductor 9 and at the same time the second order AND gate circuit 13-2 is supplied with the second order pulse signal in FIG. 2(III) (see also FIG. 3(*b*)) from the second terminal 7-2 of the second matrix circuit 5. Thus, an output signal as shown in FIG. 3(*c*) is obtained on the output side of the second order AND gate circuit 13-2, and the second order flip-flop circuit $FF_2$ on the output side thereof is set for generating an output signal as shown in FIG. 3(*e*). The gate circuit 15-2 is opened and a sound signal from the sound source signal oscillator 18 as shown in FIG. 3(*f*) is allowed to pass therethrough. The speaker 17 is driven thereby through the amplifier 16.

If the key is released the switch 8-2 is opened, and thus by a "1" signal obtained on the output side of the NOT circuit 10 and a pulse signal (FIG. 3(*b*)) obtained on the second output terminal 7-2 side of the second matrix circuit 5, a signal "1" is obtained on the output terminal side of the AND gate circuit 14-2. The second order flip-flop circuit $FF_2$ is thus reset and the gate circuit 15-2 is closed whereby the sound signal as shown in FIG. 3(*f*) is blocked from passing therethrough.

The above is the case where the number of the keys is seven. If, in this case, it is considered that the time interval between two sounds which cannot be recognized by hearing is 8 msec., it is required that eight or more pulses be generated during the 8 msec. Accordingly, the frequency generated in the oscillator 3 may be enough if above 500 Hz. As for the oscillator 3, the sound source signal oscillator 18 (8186 Hz) including a frequency divider circuit can be utilized.

FIG. 4 shows an embodiment in which the invention is applied to a tone forming circuit. The first and second multiplex counter circuits 1 and 2 of FIG. 1 or other first and second multiplex counter circuits (not shown) are provided at their output terminals $A_1$ $\overline{A}_1$, $B_1$ $\overline{B}_1$, and $A_2$ $\overline{A}_2$, $B_2$ $\overline{B}_2$ with first and second matrix circuits 25 and 26 connected thereto. Output terminals 25-1 . . . 25-3 of the first matrix circuit 25 are provided with tone selective switches 27-1 . . . 27-3, instead of the key switches in FIG. 1. A branches conductor 28 connects the switches in common and a conductor 30 branches therefrom through a NOT circuit 29. Output terminals 26-1 . . . 26-3 of the second matrix circuit 26 are connected to a pulse selective circuit 32. Gate circuits 33-1 . . . 33-3 corresponding to the tone selective switches 27-1 . . . 27-3 are provided on the output side thereof. These gate circuits 33-1 . . . 33-3 and tone forming circuits 34-1 . . . 34-3 connected in series thereto are interposed in the circuit connecting the sound source signal oscillator 18 and the speaker 17 through the gate circuits 15 . . . 15-7 and the amplifier 16.

The first and second multiplex counter circuits connected to the input sides of the first and second matrix circuits 25 and 26, respectively, are arranged to be operated synchronously in the same manner as in the case of FIG. 1, so that synchronized pulse signals are generated in successively delayed relationsip at the output terminals 25-1 . . . 25-3 and 26-1 . . . 26-3 of the first and second matrix circuits 25 and 26.

If any of the tone selective switches 27-1 . . . 27-3 is closed, in almost the same manner as in the case of FIG. 1, the corresponding one of the gate circuits 33-1 . . . 33-3 is opened and a sound signal passed through any of the key switches 8-1 . . . 8-7 is allowed to pass through the opened one of the gate circuits 33-1 . . . 33-2 and the corresponding one of the tone forming circuits 34-1 . . . 34-3, whereby the signal is formed into a desired tone wave form. Thus a sound having a desired quality of tone is heard from the speaker 17.

If the closed one of the tone selective switches 27-1 . . . 27-3 is then opened, in almost the same manner as in the case of FIG. 1, the corresponding one of the gate circuits 33-1 . . . 33-3 is closed and the tone signal is blocked from passing therethrough.

FIG. 1 shows the case where the conductor 11 is branched from the conductor 9 through the NOT circuit 10, so that there may be obtained a signal for closing of the gate circuits 15-1 . . . 15-7, that is by the generation of a reset signal.

FIG. 5 shown an embodiment where the NOT circuit 10 of FIG. 1 is removed, and key switches 8'-1 . . . 8'-7 each is formed as a changeover switch having an ordinarily closed contact and an ordinarily opened contact. All the ordinarily closed contacts and all the ordinarily opened contacts are connected in common with the respective conductors 9' and 11' so that a signal for setting is obtained on the conductor 9' and a signal for resetting is obtained on the conductor 11'. Except for this, the embodiment of FIG. 5 is the same as that of FIG. 1.

FIG. 6 shows an embodiment in which the second matrix circuit 5 on the output side of the second multiplex counter circuit 2 is provided with a third matrix circuit 35 arranged to generate negative pulse signals in successively delayed relationship on its output terminals 35-1 . . . 35-7. The output sides of the key switches 8-1 . . . 8-7 are connected to an OR circuit 36 leading out a signal common conductor 9'' for set signals, and the output terminals 35-1 . . . 35-7 and the AND circuits 13-1 . . . 13-7, to which the conductor 9'' and the output terminals 7-1 . . . 7-7 of the second matrix circuit 5 are connected to OR circuits 14'-1 . . . 14'-7 connected to the terminals for the resetting of the flip-flop circuits $FF_1$ . . . $FF_7$ of the pulse selective circuit 12, so that the flip-flop circuits $FF_1$ . . . $FF_7$ are not reset by a positive signal supplied thereto through the key switches 8-1 . . . 8-7 but the same are reset by being given a negative pulse from the output terminals 35-1 . . . 35-7 of the third matrix circuits 35 and thereby the gate circuits 15-1 . . . 15-7 are closed.

Thus, according to this invention, first and second multiplex counter circuits are provided on the input sides of the first and second matrix circuits, and those counter circuits are arranged to be driven synchro-

nously by a single common oscillator, so that when the first matrix circuit including the key switches or the tone selective switches and the first multiplex counter circuit are provided in a musical organ body and the remaining sections, that is, the second multiplex counter circuit, the second matrix circuit, the pulse selective circuit and others are provided separately therefrom, the number of the conductors interconnecting those sections and the organ body is small and the wiring thereof becomes extremely simple. Because a sound signal does not pass through these conductors but rather only a control signal passes therethrough, the signal-noise ratio becomes small.

What is claimed is:

**1.** An electronic musical instrument comprising an oscillator, first and second multiplex counter circuits synchronously driven in common by said oscillator, first and second matrix circuits coupled respectively to said counter circuits for producing respective sequences of pulses, a common conductor, said matrix circuits including a plurality of output terminals, switches connecting the output terminals of said first matrix circuit to said conductor for selectively transferring signals from said first matrix circuit to said conductor, a pulse selective circuit coupled to said conductor and to the output terminals of said second matrix circuit, sound means, a speaker and gating means coupled between said sound means and speaker and being coupled to and controlled by said pulse selective circuit, said pulse selective circuit responding to signals on said conductor and from said second matrix circuit to control said gating means.

**2.** An instrument as claimed in claim **1** wherein said sound means produces outputs of different frequencies.

**3.** An instrument as claimed in claim **1** wherein said sound means produces outputs for generating different tones.

**4.** An instrument as claimed in claim **2** wherein said sound means produces outputs for generating different tones.

**5.** An instrument as claimed in claim **1,** said pulse selective circuit includes flip flops including set and reset terminals and wherein said instrument further comprises a NOT circuit connected between the said conductor and reset terminals of the flip flops of the pulse selective circuit to reset the said flip flops.

**6.** An instrument as claimed in claim **1** comprising an OR gate connecting the switches to said common conductor and via the common conductor to said pulse selective circuit.

**7.** An instrument as claimed in claim **1** comprising a third matrix associated with the second matrix and coupled to the pulse selective circuit to reset the latter.

**8.** An instrument as claimed in claim **1,** said pulse selective circuit including flip flops including set and reset terminals and wherein said instrument further comprises a third matrix associated with the second matrix and coupled to said counter circuits and coupled to the reset terminals of the flip flops of the pulse selective circuit to reset said flip flops.

**9.** An electronic musical instrument comprising an oscillator, first and second multiplex counter circuits synchronously driven in common by said oscillator, first and second matrix circuits coupled respectively to said counter circuits for producing respective sequences of pulses, first and second common conductors, said matrix circuits including a plurality of output terminals, switches connecting the output terminals of said first matrix circuit to said conductors for selectively transferring signals from said first matrix circuit to said conductors, a pulse selective circuit coupled to said conductors and to the output terminals of said second matrix circuit, sound means, a speaker and gating means coupled between said sound means and speaker and being coupled to and controlled by said pulse selective circuit, said pulse selective circuit responding to signals on said conductors and from said second matrix circuit to control said gating means, said pulse selective circuit including flip flops including set and reset terminals and said switches including first output terminals connected to said first conductor, second output terminals, and switch blades selectively connecting said first or second output terminals to said first matrix circuit, said second conductor being connected between said second output terminals and the reset terminals of the flip flops of the pulse selective circuit to reset the said flip flops.

* * * * *