Dec. 2, 1969 MICHIO OKAMOTO ET AL 3,482,027

AUTOMATIC RHYTHM INSTRUMENT

Filed April 27, 1966 5 Sheets-Sheet 1

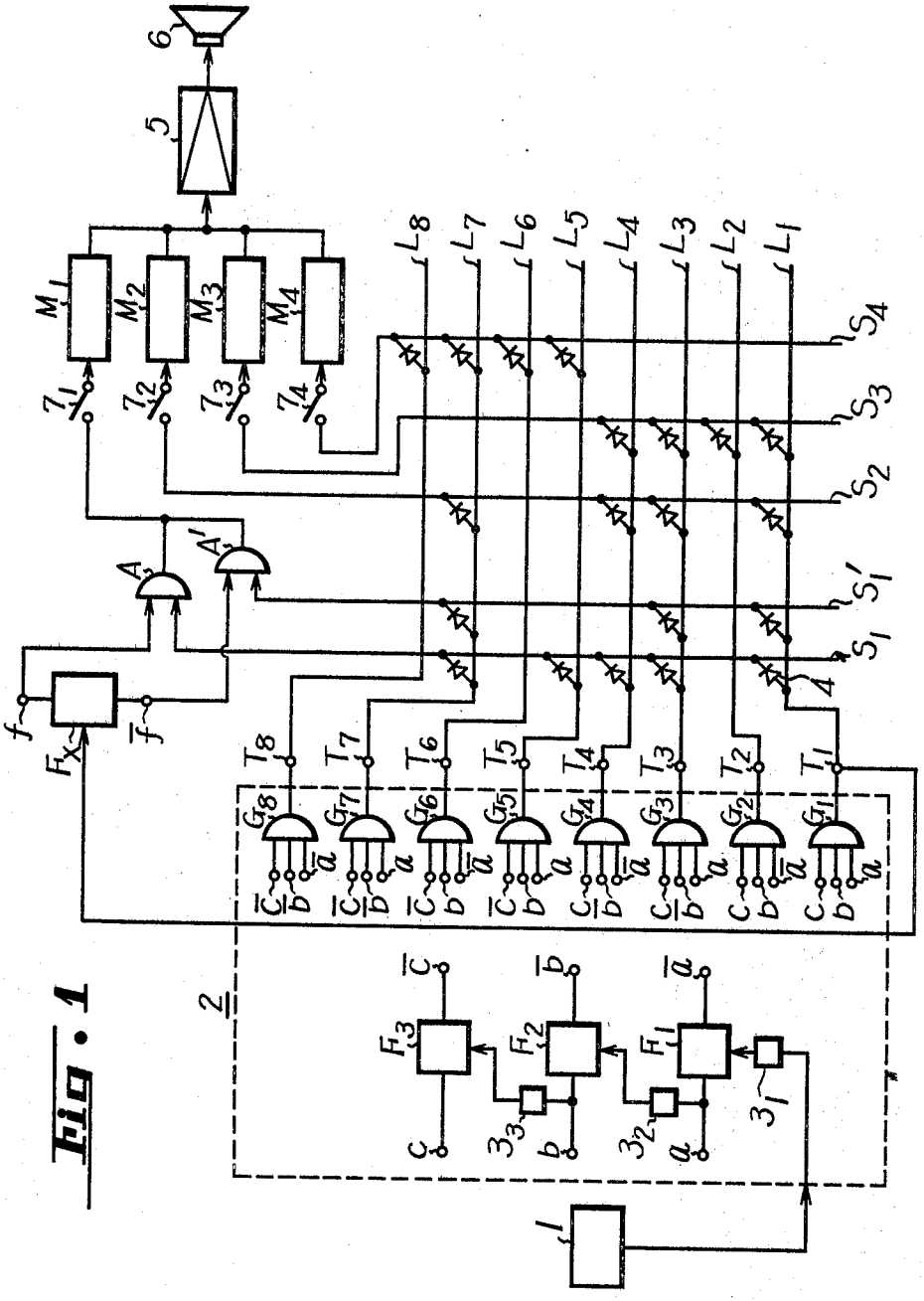

Fig. 1

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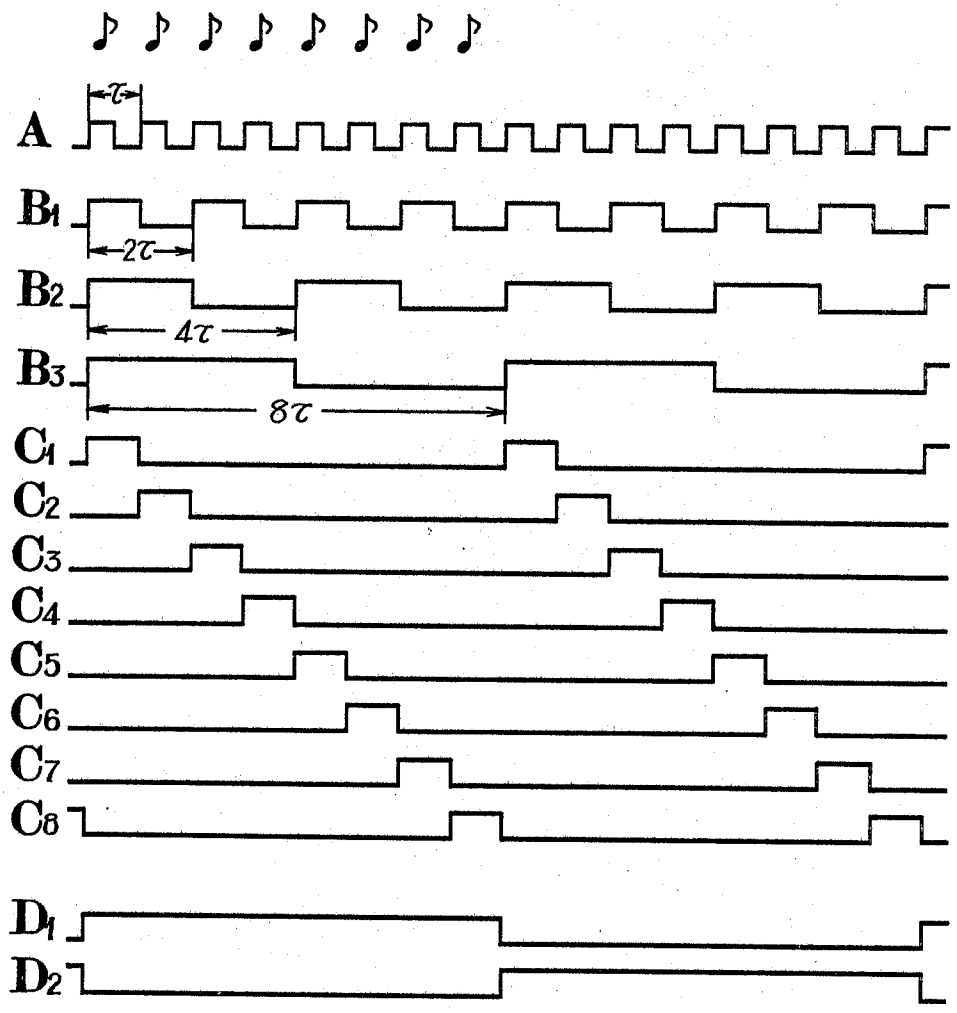
Fig. 2



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AUTOMATIC RHYTHM INSTRUMENT

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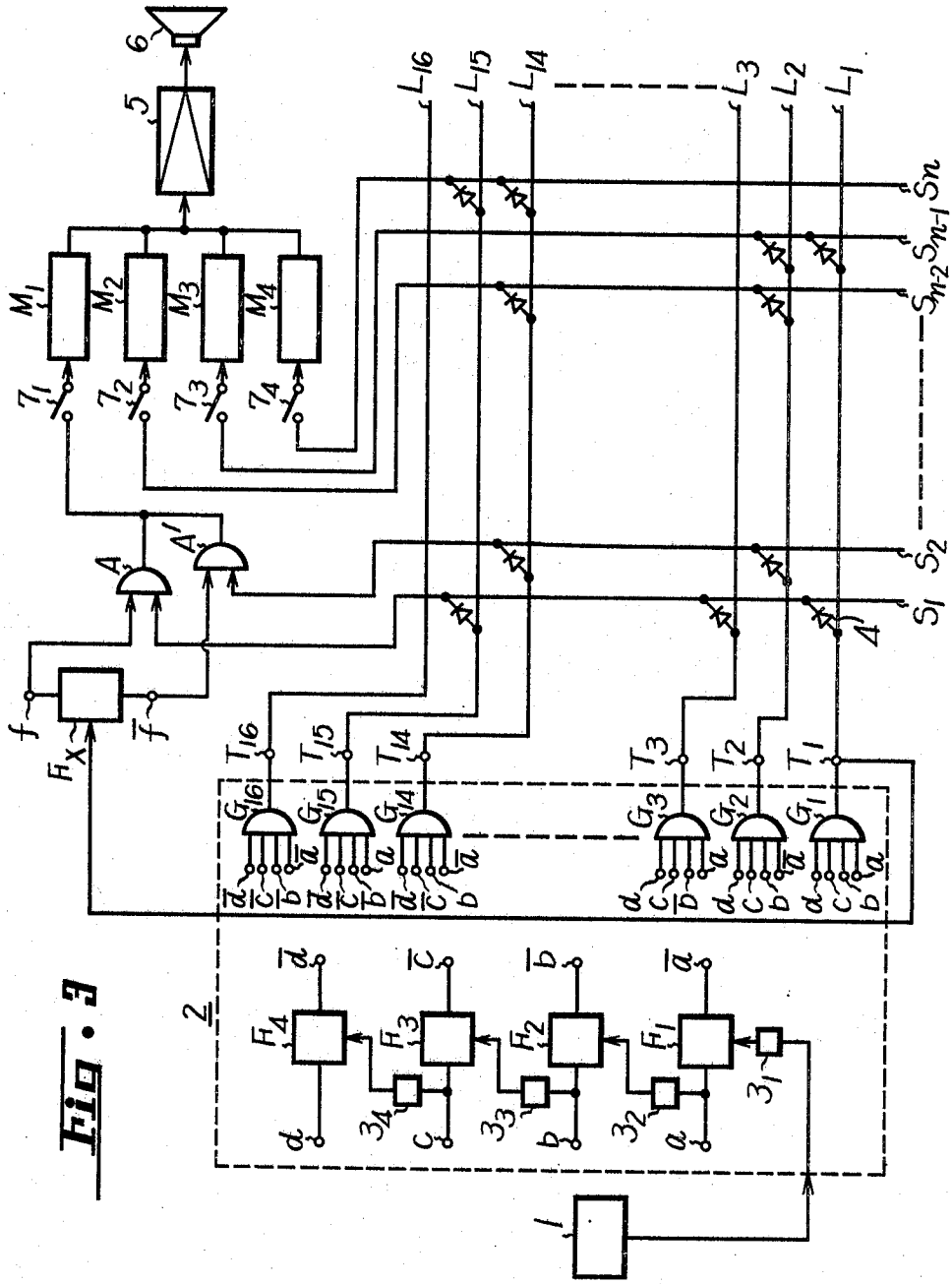

Fig. 3

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Fig. 4

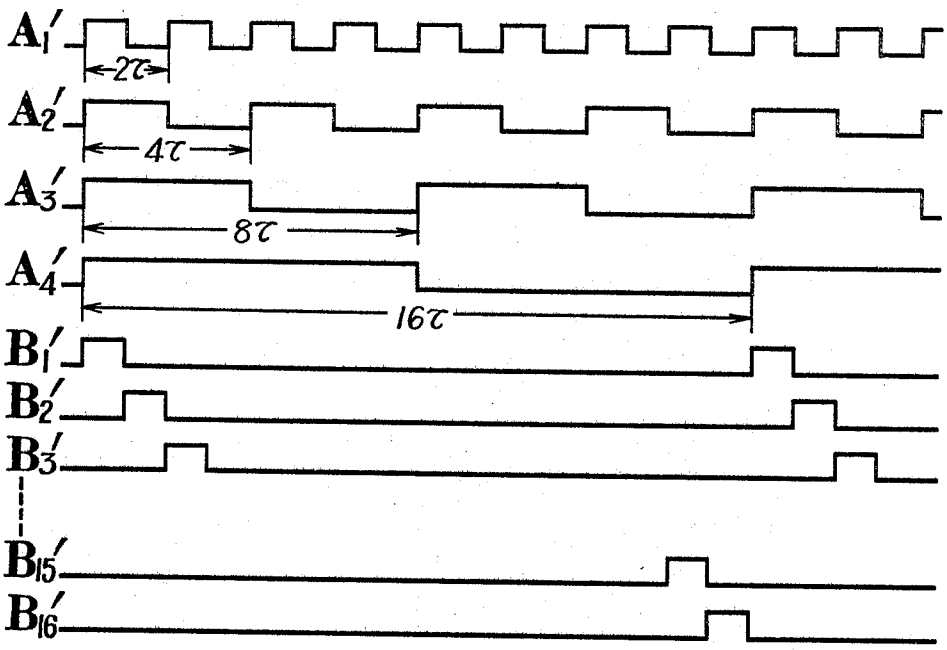
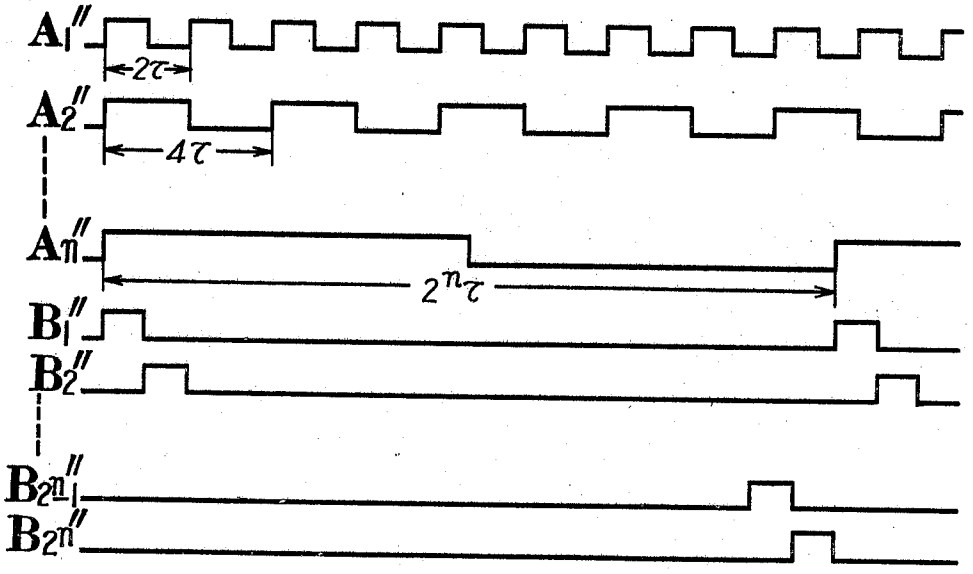


Fig. 6



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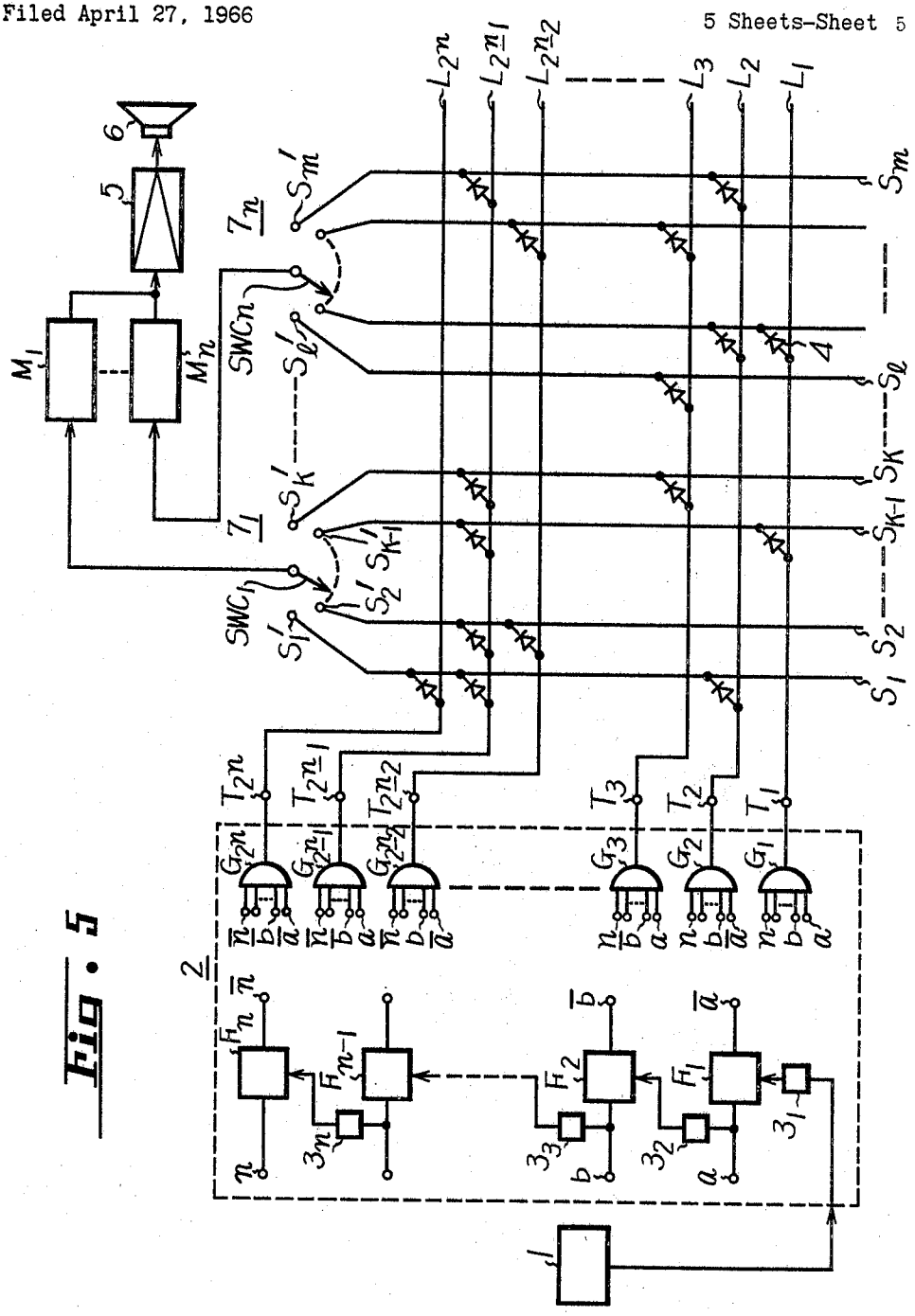

Fig. 5

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United States Patent Office

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AUTOMATIC RHYTHM INSTRUMENT

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Filed Apr. 27, 1966, Ser. No. 545,624
Claims priority, application Japan, Apr. 30, 1965, 40/25,785
Int. Cl. G10f 1/00
U.S. Cl. 84—1.03 8 Claims

ABSTRACT OF THE DISCLOSURE

An electronic musical instrument comprising an automatic rhythm player which is capable of electronically reproducing various rhythms with tones such as a drum, piccolo and other sounds in which complicated rhythm bars are automatically obtained through the use of a multivibrator circuit and and-gates with the multivibrator circuit being driven by the output of a pulse developing circuit and outputs of the pulse developing circuit and the and-gates are combined to produce the desired rhythm.

This invention relates to an electronic musical instrument and more particularly to an automatic rhythm player which is simple but capable of electronically producing various rhythms in the characteristic tones of a drum, a piccolo and so on.

In a prior art electronic musical instrument a rhythm of one bar can easily be produced with a simple circuit structure, while in case of a more complicated rhythm of two or more bars the circuit structure becomes inevitably complicated.

Accordingly, it is one object of this invention to provide an automatic rhythm player for electronic musical instruments which is relatively simple in structure but capable of producing various complicated rhythms electronically.

It is another object of this invention to provide an automatic rhythm player for electronic musical instruments with which complicated rhythms of two or more bars can be produced electronically by the provision of simple circuits in combination with circuits for producing simple rhythms of one bar.

Other objects, features and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a circuit diagram illustrating one example of the automatic rhythm player of this invention;

FIGURE 2 illustrates wave forms for explaining the example shown in FIGURE 1;

FIGURE 3 is a circuit diagram schematically illustrating another example of the automatic rhythm player of this invention;

FIGURE 4 illustrates wave forms for explaining the example shown in FIGURE 3;

FIGURE 5 is a circuit diagram schematically illustrating a further example of the automatic rhythm player of this invention; and

FIGURE 6 illustrates wave forms for explaining the example shown in FIGURE 5.

With reference to the drawings one example of this invention will hereinafter be described in detail.

In FIGURE 1 reference numeral **1** indicates a pulse oscillator having a period which corresponds to a minimum time duration of a certain rhythm or a time duration corresponding to a greatest common measure of minimum time duration of various rhythms. The pulse oscillator **1** produces a pulse output such as illustrated in

FIGURE 2A. Reference numeral **2** identifies a pulse developing circuit which is supplied with the output of the pulse oscillator **1**. This pulse developing circuit **2** comprises, for example, three bistable multivibrator circuits (flip-flop circuits) F_1, F_2 and F_3 and, for instance, eight and-gate circuits G_1, G_2, . . . G_8.

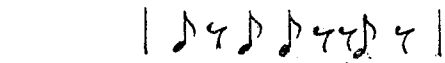
The bistable circuits F_1, F_2 and F_3 are arranged in cascade connection so that each of their output terminals *a*, *b* and *c* is connected to the input terminal of the next. The output of the pulse oscillator **1** is applied to the input terminal of the bistable multivibrator circuit F_1. Reference numerals 3_1 to 3_3 represent polarity discriminator circuits connected to the input side of the bistable multivibrator circuits F_1, F_2 and F_3, and these discriminator circuits are adapted so that the bistable multivibrator circuits F_1, F_2 and F_3 are sequentially switched on and off at, for example, every rising of the pulse output or the rectangular wave output. As a result of this, rectangular wave outputs such as shown in FIGURES $2B_1$, $2B_2$ and $2B_3$ are obtained respectively at the output terminals *a*, *b* and *c* of the bistable multivibrator circuits F_1, F_2 and F_3. At the output terminals $\bar{a}$, $\bar{b}$ and $\bar{c}$ of the circuits F_1, F_2 and F_3, there are obtained outputs which are opposite in sense to those illustrated in FIGURES $2B_1$, $2B_2$ and $2B_3$.

Further, the and-gate circuits G_1 to G_8 have connected thereto selected three terminals from the output terminals *a*, *b*, *c* and $\bar{a}$, $\bar{b}$, $\bar{c}$ in combination with one another. That is, the and-gate circuit G_1 has connected thereto the output terminals *a*, *b* and *c*, the and-gate circuit G_2 has connected thereto the output terminals $\bar{a}$, *b* and *c*, the and-gate circuit G_3 has connected thereto the output terminals *a*, $\bar{b}$ and *c*, the and-gate circuit G_4 has connected thereto the output terminals $\bar{a}$, $\bar{b}$ and *c*, the and-gate circuit G_5 has connected thereto the output terminals *a*, *b* and $\bar{c}$, the and-gate circuit G_6 has connected thereto the output terminals $\bar{a}$, *b* and $\bar{c}$, the and-gate circuit G_7 has connected thereto the output terminals *a*, $\bar{b}$ and $\bar{c}$ and the and-gate circuit G_8 has connected thereto the output terminals $\bar{a}$, $\bar{b}$ and $\bar{c}$ as clearly depicted in FIGURE 1. At the output terminals T_1 to T_8 of the and-gate circuits G_1 to G_8, there are respectively obtained pulse outputs such as illustrated in FIGURES $2C_1$ to $2C_8$, which are phase-shifted from adjacent ones a degree corresponding to the width τ of the rectangular wave output of the pulse oscillator **1** depicted in FIGURE 2A and each of which has a duration τ and a period 8τ.

Then, the output terminals T_1 to T_8 are connected to conductors L_1 to L_8 arranged in rows as illustrated in FIGURE 1. Meanwhile, there are provided, for example, four sound source circuits M_1 to M_4 which are driven by pulses to electronically produce different tones of a drum, a piccolo and the like. The input terminals of the sound source circuits M_1 to M_4 are connected to conductors S_1 to S_4 arranged in columns as shown in the figure. These two groups of the conductors L_1 to L_8 and S_1 to S_4 are selectively connected through diodes **4** in accordance with particular rhythms to be produced. The sound source circuits M_1 to M_4 are connected through a common amplifier **5** to a speaker **6**. Reference numerals 7_1, 7_2, 7_3 and 7_4 identify selector switches incorporated in the systems of the sound source circuits M_1 to M_4.

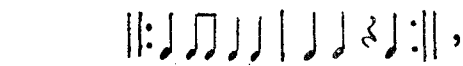
With such an arrangement, there are sequentially produced in the conductors L_1 to L_8 pulses at a time interval corresponding to ⅛ time. In the system of the sound source circuit, for example, M_2 which is connected to the conductor S_2 through the selector switch 7_2, pulses emanating from the output terminals T_1, T_3, T_4 and T_7 are sequentially applied to the conductor S_2 through diodes from the conductors L_1, L_3, L_4 and L_7, the pulses being phase-shifted as clearly depicted in FIGURES $2C_1$, $2C_3$,

$2C_4$ and $2C_7$. That is, no pulses are produced from the other remaining conductors L_2, L_5, L_6 and L_8, so that the pulses are produced in the conductor S_2 in a sequential order "1 0 1 1 0 0 1 0" (1 representing the presence of the pulse and 0 the absence of the pulse). As a result of this, a rhythm



is repeatedly produced from the sound source circuit M_2 in accordance with the pulses.

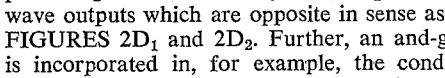
However, in order to produce a more complicated rhythm, for example, rhythm of two bars such as



the pulse developing circuit **2** is required to be provided with sixteen output terminals, so that the circuit **2** becomes inevitably complicated in structure.

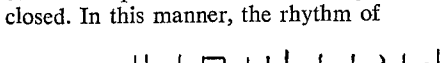
To avoid this, in this invention a bistable circuit F_X is provided in addition to the aforementioned circuits. The input terminal of the bistable circuit F_X is connected to the output terminal T_1 of the pulse developing circuit **2** so that the bistable circuit F_X is switched on and off at every pulse produced at the output terminal T_1, thereby producing at the terminals f and $\overline{f}$ respectively rectangular wave outputs which are opposite in sense as illustrated in FIGURES $2D_1$ and $2D_2$. Further, an and-gate circuit A is incorporated in, for example, the conductor S_1 and the terminal f of the bistable circuit F_X is connected to the circuit A. Another conductor S_1' is arranged along the conductor S_1 and connected through an and-gate circuit A' to the sound source circuit M_1. To this and-gate circuit A' is connected the terminal $\overline{f}$ of the bistable circuit F_X. In this case, the conductors L_1, L_3 and L_7 are connected to the conductor S_1' through diodes **4**.

With such an arrangement, during the first half bar of the aforementioned two-bar rhythm the and-gate circuit A is open and the other and-gate circuit A' remains closed. During the latter half bar of the rhythm the and-gate circuit A' is open and the other and-gate circuit A remains closed. In this manner, the rhythm of



can repeatedly be obtained.

According to this invention, a complicated rhythm can be produced by the provision of a simple circuit without being limited to the number of the output terminals of the pulse developing circuit, as has been described in the foregoing. However, in order to produce a complicated rhythm such as



without the provision of the additional circuits such as A and A', the circuit becomes inevitably complicated and expensive. The present invention avoids such disadvantages.

The time duration mentioned in this specification means a time from the building-up of each pulse to that of the next one, as identified at τ in FIGURE 2A, and this time duration may be referred to as a time interval.

In FIGURE 1 the bistable circuit F_X is connected to the output terminal T_1 of the pulse developing circuit **2**, but different rhythms of two bars can be produced by connecting the bistable circuit F_X to any one of the terminals T_1 to T_8 through a changeover switch.

In the case of using the pulse developing circuit **2** such as shown in FIGURE 1 the minimum time duration in one rhythm corresponds to ⅛ time.

FIGURE 3 illustrates another modified form of this invention in which the minimum time duration is $\frac{1}{16}$ $(1/2^4)$ time. In this example there are employed four flip-flop circuits F_1, F_2, F_3 and F_4, four polarity discriminator circuits 3_1, 3_2, 3_3 and 3_4 related thereto and sixteen and-gate circuits G_1 to G_{16}. These circuits are connected in the same manner as in the example illustrated in FIGURE 1. Four of output terminals a, b, c, d and $\overline{a}$, $\overline{b}$, $\overline{c}$, $\overline{d}$ of each of the flip-flop circuits F_1, F_2, F_3 and F_4 are connected to each of the and-gate circuits G_1 to G_{16}. With such an arrangement rectangular wave outputs such as depicted in FIGURES $4A_1'$, to $4A_4'$ at the output terminals a, b, c and d of the flip-flop circuits F_1, F_2, F_3 and F_4, while at the output terminals $\overline{a}$, $\overline{b}$, $\overline{c}$ and $\overline{d}$ there are produced outputs which are opposite in sense to the aforementioned ones. At the output terminals T_1 to T_{16} of the and-gate circuits G_1 to G_{16}, there are respectively obtained pulse outputs such as illustrated in FIGURES $4B_1'$ to $4B_{16}'$ which are phase-shifted from adjacent ones a degree corresponding to the width τ of the rectangular wave output of the pulse oscillator **1** such as shown in FIGURE 2A and each of which has a duration τ and a period 16τ $(2^4\tau)$. Other circuit elements than the aforementioned ones and their connections are the same as those in the example shown in FIGURE 1. Simliar components to those in FIGURE 1 are identified at similar reference numerals and no further description will be given for the sake of brevity.

FIGURE 5 illustrates a further modification of this invention in which the minimum time duration in one bar is $1/2^n$ time, n being a desired positive integer. In this case sound source circuits of the number of n are provided and changeover switches 7_1 to 7_n are provided so that the sound source circuits may be connected to suitable conductors arranged in column to produce desired rhythms.

In this example, flip-flp circuits F_1 to F_n, polarity discriminator circuits 3_1 to 3_n and and-gate circuits G_1 to G_{2^n} are connected in the same manner as in FIGURES 1 and 3. FIGURES $6A_1''$ to $6A_n''$ illustrate rectangular wave outputs obtained at the output terminals a to n of the flip-flop circuits F_1 to F_n. FIGURES $6B_1''$ to $6B_{2^n}''$ show pulse outputs obtained at the output terminals T_1 to T_{2n} of the and-gate circuits G_1 to G_{2^n}. At the other output terminals $\overline{a}$ to $\overline{n}$ of the flip-flop circuits F_1 to F_n, there are produced outputs which are opposite in sense to the rectangular wave outputs depicted in FIGURES A_1'' to A_n''.

In this example, any desired number of conductors, for example, S_i to S_k among those S_1 to S_m are selectively connected to the sound source circuit, for instance, M_1 through a selector switch 7_1 while some other remaining conductors are also selectively connected to the sound source circuits M_2 to M_n through selector switches 7_2 to 7_n. Swc_1 to Swc_n indicate the movable contacts of the selector switches, and S_1' to S_k' and S_l' to S_m' respectively designate the stationary contacts of the selector switches. In some cases the same group of the conductors can be connected to any of the sound source circuits M_1 to M_n. In this manner, any desired rhythm can selectively be produced.

While the present invention has been described in connection with production of a rhythm of two bars, it is to be understood that this invention is applicable to the production of a rhythm of more than two bars. That is, a plurality of column conductors are provided besides the conductor S_1' and they are connected to any of the row conductors through diodes in accordance with the programing of a desired rhythm and combined with and-gate circuits thereby achieving the desired purpose.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

What we claim is:

1. An automatic rhythm player for electronic musical instruments comprising a pulse oscillator producing

pulse train having a period corresponding to a greatest common measure of minimum time duration of various rhythms; means for sequentially arranging at a plurality of output terminals the pulses from the pulse oscillator as pulse trains that are separated and phase-shifted from adjacent ones; a first group of conductors each being connected to each of the plurality of output terminals respectively, the spatially separated and phase-shifted pulse trains passing through the first group of conductors respectively; a second group of conductors each being arranged to cross the first group of conductors; a plurality of diodes for selectively connecting the conductors of the first group with selected ones of the second group in accordance with rhythms desired, thereby obtaining a pulse train corresponding to the rhythms required at each of said plurality of output terminals of the second group of conductors; a plurality of selector switches, a plurality of sound source circuits of electronically producing different tones actuated by the pulse train obtained from the second group of conductors through said selector switches, each of the selector switches inserted between the input side of each sound source circuit and each of the output terminals of the second group of conductors, an amplifier and a speaker common to the sound source circuits for making the outputs of the sound source circuits audible; and means for producing rhythms having a period several times that of a rhythm produced by the pulse trains from the second group of conductors, the last-mentioned means being actuated by two or more of the pulse trains from the second group of conductors and one of the pulse trains from the output terminal of the first-mentioned means, and the output of the last-mentioned means being supplied to one of the sound source circuits through said selector switches whereby a desired rhythm can be produced.

2. An automatic rhythm player for electronic musical instrument as claimed in claim **1** in which the first-mentioned means comprises a plurality of bistable multivibrator circuits arranged in cascade connection to connect their positive output terminals to the input terminals of the next stage bistable multivibrator circuit, the first stage bistable multivibrator circuit being energized by the output of the pulse oscillator; a plurality of polarity discriminator circuits each connected to the input side of each of the bistable multivibrator circuits to sequentially switch on and switch off the bistable multivibrator circuits upon each pulse rise of the polarity discriminator circuits; and a plurality of and-gate circuits, one of the outputs of each bistable multivibrator circuit being applied to inputs of each and-gate circuit and output terminals of the and-gate circuits being respectively connected to input terminals of the first group of conductors.

3. An automatic rhythm player for electronic musical instruments as claimed in claim **1**, in which the last-mentioned means comprises a plurality of bistable circuits and a plurality of and-gate circuits; one of the bistable circuits being driven by one of the outputs of the first-mentioned means, the other of the bistable circuits being actuated by the bistable circuit driven by the first-mentioned means, the plurality of the and-gate circuits being actuated by the other bistable circuits and the output of the second group of conductors and the outputs of the and-gate circuits connected to a desired one of the sound source circuits through the selector switch.

4. An automatic rhythm player for an electric musical instrument as claimed in claim **1**, in which the last-mentioned means comprises a bistable circuit and two and-gate circuits the bistable circuit being driven by one of the outputs of the first-mentioned means, the two and-gate circuits being alternatively actuated by the outputs of the bistable circuit and the outputs of the and-gate circuits being supplied to a desired one of the sound source circuits through the selector switch.

5. An automatic rhythm player for electronic musical instruments as claimed in claim **1**, in which the period of the pulse from the pulse oscillotor is $\frac{1}{2^n}$ times, where n is a desired positive integer.

6. An automatic rhythm player for electronic musical instruments as claimed in claim **5**, in which n is 3.

7. An automatic rhythm player for electronic musical instruments comprising a pulse oscillator for producing a pulse train having a period corresponding to a greatest common measure of minimum time duration of various rhythms; a plurality of first bistable multivibrator circuits arranged in cascade connection with their output terminals connected to the input terminals of the next stage bistable multivibrator circuit, the first stage bistable multivibrator circuit being driven by the output of the pulse oscillator; a plurality of polarity discriminator circuits connected to the input sides of the bistable multivibrator circuits to sequentially switch on and off the bistable multivibrator circuits upon each rising of pulses of the polarity discriminator circuits; a plurality of and-gate circuits, one of the outputs of each bistable multivibrator circuit being applied to inputs of each and-gate circuit to obtain at its output terminal pulse trains, the pulse trains obtained from the and-gate circuits being separated with one another and sequentially phase-shifted; a first group of conductors each being connected to each of the output terminals of the and-gate circuits, a second group of the and-gate circuits; a second group of conductors each being arranged in crossing relationship with the first group of conductors; a plurality of diodes for selectively connecting the conductors of the first group with those of the second group at their desired crossing points in accordance with rhythms required, thereby obtaining a pulse train corresponding to the rhythms required at each of the plurality of output terminals of the second group of conductors; a plurality of sound source circuits for electronically producing different tones which are actuated by the pulse trains obtained from the second group of conductors through selector switches, each of the selector switches being inserted between the input side of each sound source circuit and each of the output terminals of the second group of conductors; an amplifier and a speaker common to the sound source circuits for making the outputs of the sound source circuits audible; another bistable circuit driven by one of the and-gate circuits; other two and-gate circuits being alternatively actuated by the outputs of the other bistable circuit and the outputs of the second group of conductors; and the outputs of the other two and-gate circuits being supplied to a desired one of the sound source circuits through the selector switch.

8. An automatic rhythm player for electronic musical instruments as claimed in claim **7**, in which the input terminal of the second bistable circuit is selectively connected to one of the output terminals of the first and-gate circuits through a change-over switch.

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U.S. Cl. X.R.

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