Dec. 12, 1967 R. H. CAMPBELL, JR 3,358,068

AUTOMATIC RHYTHM DEVICE

Filed June 26, 1964 2 Sheets-Sheet 1

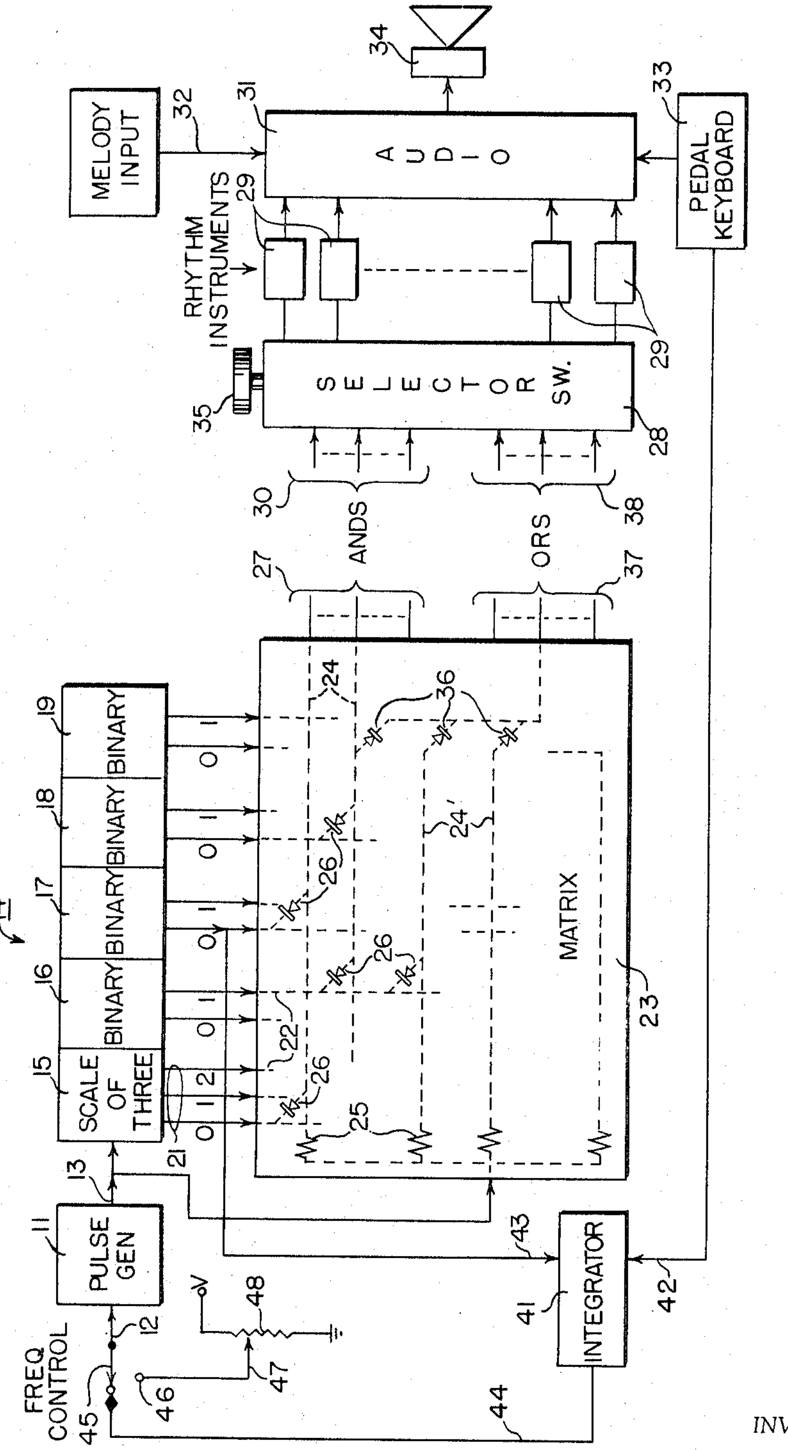


FIG. 1

INVENTOR.
RICHARD H. CAMPBELL, JR.

BY Russell, Chittick & Pfund

Dec. 12, 1967 R. H. CAMPBELL, JR 3,358,068

AUTOMATIC RHYTHM DEVICE

Filed June 26, 1964 2 Sheets-Sheet 2

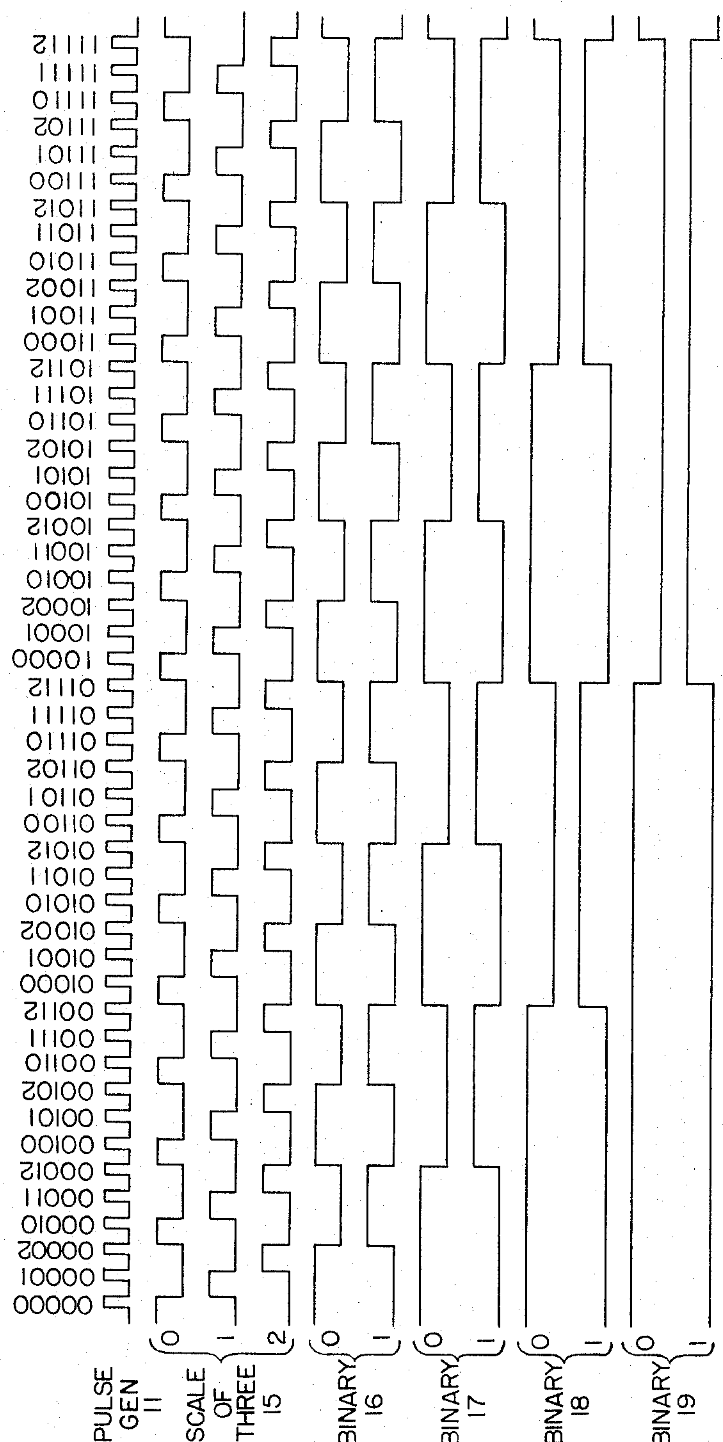


FIG. 2

INVENTOR.
RICHARD H. CAMPBELL, JR.
BY
Russell, Chittick & Pfund

United States Patent Office 3,358,068
Patented Dec. 12, 1967



# 3,358,068
# AUTOMATIC RHYTHM DEVICE

Richard H. Campbell, Jr., Gilford, N.H., assignor to The Seeburg Corporation, Chicago, Ill., a corporation of Delaware

Filed June 26, 1964, Ser. No. 378,365
11 Claims. (Cl. 84—1.01)


## ABSTRACT OF THE DISCLOSURE

A pulse generator drives a frequency dividing counter chain and the outputs of both are connected as inputs to a diode matrix such that the pulse outputs of the various counter stages appear on the output lines of the matrix. These output lines are AND and OR connected to produce a pulse train having any desired sequence combination of the pulse outputs of the counter stages to drive the rhythm instruments of an electronic organ. The frequency of the pulse generator is either manually or automatically controlled to set the tempo of the rhythm sounds produced by the organ.


This invention relates generally to an automatic repetitive rhythm instrument for use in association with a musical instrument in which various selectable rhythm sound combinations may be obtained with the sounds produced in tempo with the musical instrument and the selection being played.

This invention is an improvement over the arrangement disclosed and claimed in "Rhythm Tempo Control System," Serial No. 217,713, and now Patent No. 3,247,307, the disclosure of which is hereby incorporated by reference for the detailed disclosure of various circuits for achieving rhythm sound patterns. Further details of the circuits herein disclosed are shown in applicant's copending application, as co-inventor with Park, for Musical Instrument, Serial No. 378,364, filed June 26, 1964.

The present invention provides an all-electronic arrangement for achieving repetitive rhythm sound patterns, thereby providing economies of manufacture and greater versatility in formulating desired rhythm pulse combinations, and permitting a wide selection of rhythms and rhythm instrument sounds to be made available to the player of the instrument with a minimum of circuit cost and complexity.

In accordance with the present invention, an electronic pulse generator is provided which generates a pulse train which is a multiple of the basic rhythm frequency of the instrument. This pulse frequency is variable over a range which corresponds to the range over which the basic rhythm tempo varies for various types of musical compositions, and the variation in the frequency of the pulse generator is controlled by a frequency control input signal. The output of the pulse generator is applied to a counter to provide sub-division of the pulse generator frequency down to the basic rhythm frequency of the instrument, and the outputs from the various stages of the counter are applied to a matrix to gate the output of the pulse generator to a plurality of output lines, with the gating provided by the matrix being such that each output line has a predetermined combination of pulses thereon. These output lines may be combined in various arrangements through OR circuits or various AND circuit combinations to provide the more complex rhythm patterns which are required, and these output lines are then selectively connected to the various rhythm instruments so



that the pulse pattern is translated into a sound pattern providing the combination pulses reproduced as the various rhythm instruments.

When the rhythm instrument is used with or incorporated in an automatic or player-operated instrument such as an electronic organ, the output of the counter is also utilized to develop a polarized signal representative of the timing of the rhythm beat. By combining this polarized signal with the signal from the pedal keyboard of an electronic organ or similar signal from other player-operated instrument an error signal is developed which can be utilized as the frequency control input to the pulse generator. Thus the repetitive rhythm patterns are generated in tempo with the tempo of the composition being played on the complete instrument. As an alternative, the frequency control of the pulse generator can be manually selected at any desired frequency for the purposes of producing novelty effects or where the player of the player-operated instrument desires to follow a preset rhythm rather than have the rhythm instrument follow the tempo which the player imposes upon the instrument by manipulating the pedal keyboard.

Accordingly, the object of the present invention is to provide an improved all-electronic repetitive rhythm instrument for use with various musical instruments such as an electronic organ and capable of supplying a wide variety of rhythm sound combinations and tempos for accompanying such an instrument, either automatically or selectively adjustable.

The features and objects of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram of the system in accordance with the invention, and

FIG. 2 is a waveform diagram showing the relation of the pulse generator output and the outputs of the various stages of the counter.

Referring now to FIG. 1, a pulse generator **11** is shown having a frequency control input **12**. The pulse generator **11** may be any form of free-running oscillator circuit which provides a pulse output on line **13** within the range generally corresponding, for example, to twenty-four times the basic beat tempo that is imposed on the instrument by a player. The generator **11** is also adapted to be frequency controlled by an electrical input signal on line **12** and for this purpose may include voltage variable capacitors or variable reactance devices for producing the electrical frequency control in any manner known to the art.

The output pulse train on line **13** is applied to the input of a counter **14** which has as a first stage **15** a scale-of-three stage followed by four binary stages **16**, **17**, **18**, and **19**. The output of the scale-of-three stage **15** has three states, and three output lines **21** from the scale-of-three counter **15** are energized in succession. These outputs **21** are designated 0, 1, and 2 to represent the three states of the scale-of-three counter **15**. Each of the binary stages **16–19** has two outputs designated 0 and 1 in conventional fashion.

The outputs **21** of the scale-of-three stage **15** and the 0 and 1 outputs of the binary stages **16–19** supply and are connected to input lines **22** of an interconnection matrix **23** which may be wired in any desired interconnection combination of inputs and outputs hereinafter referred to as a matrix. The matrix **23** has a plurality of horizontal lines **24** and **24'**. The output **13** of pulse generator **11** is also connected as an AND input to all of the output lines **24** and **24'** by means of AND resistors **25** with the AND circuit completed by a pattern of diode connections between any input line **22** and any output line **24** or **24'** as indicated by diodes **26**. Thus an output line **24** or **24'** will receive a pulse from pulse generator **11** only when that pulse is the one which occurs when the diodes connected thereto are enabled by the appropriate voltage level on the outputs of the various stages of the counter **14** to which the particular output line **24** or **24'** is connected by means of diodes **26**. In the example shown, positive voltage logic is employed as indicated by the polarity of the AND and OR diodes. In this manner, various combinations of pulses can be obtained on the output lines **24** and **24'**. The output lines **24** are connected by means of conductors **27** to various points on a selector switch assembly **28** by corresponding conductors **30**.

The selector switch **28** can be any desired type such as that disclosed in the application Ser. No. 217,713. The output of the selector switch **28** supplies a plurality of rhythm instruments **29** which are, in turn, connected as input to an audio section **31**. The audio section **31** may have a melody input **32** and an input from pedal keyboard **33** with all signals being combined to produce a composite output in the audio transducer system **34** where the complete melody and rhythm composition is rendered audible.

The selector switch **28** has an operative control **35** which permits the operator to select any desired rhythm sequence combination as shown hereinafter with reference to Table I. These pulse combination inputs are channeled by the selector switch **28** into the various rhythm instrument devices **29**, which produce, for example, the sound of the snare drum, cymbal, blocks and any other desired rhythm sound in the cadence of the selector pulse combination derived from the lines **27** and selected by the selector switch **28** under the control of the player. The detailed arrangements for this selection and generation of the various rhythm sounds which are merely representative of those which may be produced are all disclosed in detail in the aforementioned application.

The matrix **23** includes OR circuits in which various ones of the output lines **24** and **24'** are OR connected by diodes **36** to produce, on OR output lines **37**, the OR combination of one or more output lines **24** and **24'**. As indicated in matrix **23**, certain additional combinations are achieved by AND connection of various input lines **22** to the auxiliary output lines **24'** where the AND combinations of lines **24'** used in making up some of the OR configurations are not used individually in the AND outputs **27**. Thus the combinations on OUTPUT lines **24** and those on auxiliary output lines **24'** may be OR connected to produce further versatility in the total available output combinations while at the same time minimizing the requirements for additional circuit components and connections. The OR outputs **37** are connected to corresponding inputs **38** on the selector switch **28**.

For the purpose of developing an automatic rhythm follow-up signal, an integrator **41** is provided which has two inputs; one, a pulse input **42** derived directly from pedal manual **33**, and a square-wave input **43** derived from the ZERO output of the binary stage **17**. The waveform on lead **43** has a transition from negative to positive at the time when a pedal manual actuation would ordinarily be imposed by the player on the pedal keyboard **43**. By using this pedal actuation to pass the polarity of the ZERO output of binary stage **17** to the integration capacitor of integrator **41**, a positive or negative increment can be applied to the integration capacitor, and thus the voltage level of the capacitor can be raised or lowered depending upon whether the actuation of the pedal manual **33** occurs during the negative or positive portion of the square-wave input on line **43**.



This voltage level on the integration capacitor of integrator **41** is applied on line **44** to the frequency control input **12** of phase generator **11** when switch **45** is in the position shown. Thus, the frequency of pulse generator **11** will be controlled to maintain the square-wave transition of the wave on line **43** in synchronism with the actuation of the pedal manual **33** by the player as he plays the composition, and the automatic rhythm generation will, in fact, follow the tempo imposed by the player as he actuates the pedal keyboard **33**.

In order to provide a predetermined and fixed tempo for the repetitive rhythm generated by the instrument, switch **45** may be actuated to terminal **46** which supplies a fixed but adjustable voltage to the frequency control input **12** by means of adjustment of slider **47** on potentiometer **48**. The potentiometer **48** is connected to a suitable DC voltage to provide the desired range of frequency control for the pulse generator **11**.

The operation of the arrangement of FIG. 1 will now be described with reference to FIG. 2 which shows the waveforms available from the counter chain **14** and Table I which shows the various counter-combinations which are used to generate various outputs for different rhythms and the associated rhythm sound producer which may be used. In Table I the simplest rhythm output is indicated as being on line 1 where a pulse occurs for each ZERO count on the scale-of-three counter **15**. As indicated in Table I, this pulse for the cha-cha-cha and rhumba would be passed through the brush rhythm instrument to simulate the sound of a brush on a snare drum for each ZERO count of the counter **15**. Similarly, for example, output line 10 indicated in Table I produces an output pulse for the simultaneous occurrence the ONES output of counters **17** and **18** and ZEROS output on the counters **16** and **15**. The pulse which occurs for this combination of inputs is useful in the tango to actuate the rhythm instrument that simulates the sound of the cymbal as indicated for output 10 in Table I. It can be seen for the particular instrument of Table I, thirteen separate output lines are provided for generating the rhythm sequences indicated. These outputs numbered 1–13 in Table I are the lines represented by numeral **27** in FIG. 1. It should be understood that the numbered outputs 1–13 in Table I have no relation to the corresponding numbers appearing on the drawing of FIG. 1.

Table II shows the derivation of the combinations numbered 14–30 in Table II. These combinations appear on lines 24' and are generated upon the coincidence of the signals for the various counter stages as indicated. These AND gate patterns of Table II are used only to generate the more complex rhythms, consisting of one or more AND gate patterns combined in the OR circuits which have their outputs in FIG. 1 on line **37**. Here again the numerals 14 through 30 in Table II represent the number of distinct AND gate patterns utilized in a particular instrument and these numerals do not relate to the same numerals as used in the drawing FIG. 1.

Table III shows a set of OR gate patterns achieved on the output lines A–R and appearing on the lines indicated 37 in FIG. 1. The various pulse patterns are achieved by the OR circuits combining the particular AND gate pattern indicated. For example, pattern A in Table III is achieved by combining in an OR circuit AND gate pattern **11** with AND gate pattern **8** both from Table I. Similarly, for example, OR gate pattern F is obtained by OR circuits which combine AND gate pattern **7** from Table I and AND gate pattern **19** from Table II.

From the foregoing considerations of Tables I, II, and III, it will be apparent that extremely complex and sophisticated rhythm sequences can be generated and the desired musical effects produced by selecting portions of these rhylthm sequences into the various rhythm instruments in the combinations which achieve the desired artistic effect. Obviously, the specific examples given do not begin to exhaust the possibilities which an artist can achieve and which the manufacturer can provide by suitable switch selections and matrix connections, depending upon the degree of complexity which is desired for any particular instrument built in accordance with the invention.

FIG. 2 shows the timing waveforms generated by pulse generator **11** with the corresponding code designation for each pulse for two measures consisting of a total of 48 pulses. This is a frequency which is an integral multiple of the basic rhythm frequency of the instrument which may be set or imposed by the player, and, thus, two successive measures of the composition to be played are subdivided into 24 intervals each equally spaced. In this manner, successive measures can have slight variations in the rhythm sequence, as required for certain compositions. The scale-of-three counter **15** has the three outputs, 0, 1, and 2, shown in FIG. 2. The binaries **16**, **17**, **18**, and **19** have the 0 and 1 outputs shown in the remaining waveforms of FIG. 2. By comparing the AND and OR combinations specified in Tables I, II, and III with the waveforms shown in FIG. 2, it can readily be determined which pulses are passed to the rhythm instruments **29** under any given conditions.

For achieving the automatic rhythm control provided by the loop which includes integrator **41**, it can be seen in FIG. 2 that the ZERO output of binary stage **17** provides negative polarity just prior to the basic beat and the midway between the basic beat represented by pulses **24** and **48** and provides a positive waveform just after the occurrence of pulses **1**, **12**, **24**, **36** and **48**. This waveform is used to provide the proper polarities for increasing or decreasing the frequency of pulse generator **11** depending upon whether the pedal beat falls in the negative or positive portion of the ZERO output of binary waveform **17**. If desired, further gating can be provided to make unambiguous the fact that the integrator error signal is derived only from the particular transitions of the ZERO waveform of binary **17**.

TABLE I

| Lines 24 | Counter Stage | | | | | AND gate patterns, used in rhythms |
|---|---|---|---|---|---|---|
| | 19 | 18 | 17 | 16 | 15 | |
| 1 | – | – | – | – | 0 | Cha-Cha-Cha & Rhumba (Brush). |
| 2 | – | – | – | 0 | 0 | Fox Trots II & IV & Shuffle (Drum), Tango (Brush). |
| 3 | – | – | – | 1 | 0 | Beguine (Woodblock I & II & Brush). |
| 4 | – | – | 0 | 0 | 0 | Marches, Fox Trots I & III, Tango, Samba, Rhumba (Drum), Cha-Cha (Tom Tom I), Metronome (WB II), Fox Trot I & II (Brush), Fox Trot III & IV (Cymbal). |
| 5 | – | – | 1 | 0 | 0 | Fox Trot I & II (Cymbal). |
| 6 | – | – | 1 | 0 | 2 | Western (Woodblock II). |
| 7 | – | 0 | 0 | 0 | 0 | Western, Waltzes, Beguine (Drum), Marches, Waltzes, Tango, Samba (Tom Tom II), Western (Woodblock I). |
| 8 | – | 0 | 1 | 0 | 2 | Waltz I (Cymbal). |
| 9 | – | 1 | 0 | 1 | 1 | Waltz I (Brush), Waltz II (Cymbal). |
| 10 | – | 1 | 1 | 0 | 0 | Tango (Cymbal). |
| 11 | – | 0 | 1 | 0 | 0 | Cha-Cha-Cha (Tom Tom II). |
| 12 | – | 1 | 0 | 0 | 0 | Western (Woodblock III). |
| 13 | 1 | 0 | 1 | 1 | 0 | Rhumba (Woodblock II). |

TABLE II

[AND gate patterns used only with OR gates]

| Lines 24′ | Counter Stage | | | | | Lines 24′ | Counter Stage | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19 | 18 | 17 | 16 | 15 | | 19 | 18 | 17 | 16 | 15 |
| 14 | – | – | 1 | 1 | 1 | 22 | 1 | 0 | 0 | 1 | 0 |
| 15 | – | – | 1 | 1 | 0 | 23 | 1 | 1 | 0 | 1 | 1 |
| 16 | – | 1 | 1 | 1 | 0 | 24 | 1 | 1 | 0 | 0 | 2 |
| 17 | – | 0 | 1 | 1 | 0 | 25 | 0 | 1 | 0 | 0 | 0 |
| 18 | – | 1 | 0 | 1 | 0 | 26 | 0 | 0 | 0 | 0 | 0 |
| 19 | – | 0 | 0 | 1 | 0 | 27 | 0 | 0 | 1 | 1 | 0 |
| 20 | – | – | 0 | 1 | 1 | 28 | 0 | 1 | 1 | 0 | 0 |
| 21 | 1 | 1 | 1 | 0 | 0 | 29 | 1 | 0 | 1 | 0 | 0 |
| | | | | | | 30 | 1 | 1 | 0 | 0 | 0 |



TABLE III

| Lines 37 | Outputs 1-30 From Tables I and II | OR gate patterns |
|---|---|---|
| A | 11+8 | Waltz II (Brush). |
| B | 5+14 | Fox Trots III & IV (Brush). |
| C | 12+10 | Tango (Tom Tom II), Beguine (Tom Tom I). |
| D | 4+21 | Bolero (Drum). |
| E | 2+18 | Cha-Cha-Cha (Woodblocks I & II). |
| F | 7+19 | Rhumba (Tom Tom I). |
| G | 10+16 | Rhumba (Tom Tom II). |
| H | 4+6 | 6/8 March (Tom Tom II & Brush). |
| I | 11+18+12 | Rhumba (Woodblock I). |
| J | 2+20+14 | Shuffle (Brush). |
| K | 11+17+12 | Samba (Tom Tom II). |
| L | 7+10+16 | Samba (Woodblock I). |
| M | 2+15 | Samba (Brush). |
| N | 26+27+28+29+30 | Rhumba & Samba (Clave). |
| O | 2+6+14+23+24 | Bolero (Tom Tom II). |
| P | 10+18+21+25 | Cha-Cha-Cha (Clave). |
| Q | 4+10+17+22 | Tango (Woodblock I & Clave). |
| R | 4+13+30 | 2/4 March (Tom Tom II & Brush). |

Obviously, many modifications can be made by those skilled in the art in practicing the invention herein disclosed, and the invention is accordingly to be limited only by the scope of the appended claims.

I claim:

**1.** An electronic musical instrument for generating continuous repetitive rhythm patterns comprising a repetitive pulse generator having a frequency corresponding to a multiple of the basic rhythm frequency for said instrument, a multistage frequency divider coupled to said generator for couting down submultiples of the frequency of said generator, a matrix connected to the stages of said frequency divider and to said pulse generator for producing a plurality of outputs each consisting of a different predetermined combination of pulses from said generator, and means for selectively coupling different ones of said outputs to energize rhythm circuits with the combinations of pulses on the selected outputs.

**2.** Apparatus according to claim **1** and including means for adjusting the frequency of said pulse generator.

**3.** An electronic musical instrument for generating continuous repetitive rhythm patterns comprising a repetitive pulse generator having a signal controlled frequency range corresponding to a multiple of the basic rhythm frequency range for said instrument, a multistage frequency divider coupled to said generator for counting down submultiples of the frequency of said generator, a matrix connected to the stages of said frequency divider and to said pulse generator for producing a plurality of outputs each consisting of a different predetermined combination of pulses from said generator, and means for selectively coupling different ones of said outputs to energize rhythm circuits with the combinations of pulses on the selected outputs, and means for applying a variable frequency control signal to said repetitive pulse generator.

**4.** Apparatus according to claim **3** and including means for manually adjusting the frequency of said pulse generator.

**5.** Apparatus according to claim **3** and including associated instrument tempo signal input means and means for automatically controlling said frequency control signal in accordance with the tempo of said associated instrument.

**6.** Apparatus according to claim **3** and including associated instrument tempo signal input means and means for selectively manually adjusting or automatically controlling said frequency control signal in accordance with the tempo of said associated instrument.

**7.** Apparatus according to claim **3** and including means for coupling from said divider a wave having polarity transitions at the rhythm beat for said basic rhythm frequency, means for transferring said wave to a control signal circuit in tempo with the rhythm beat imposed by a player-operated instrument, and storage means associated with said control signal circuit and responsive to the polarity of said wave at the time of transfer for producing said variable frequency control signal to conform the rhythm beat of said generator to the rhythm beat imposed by said player.

8. Apparatus according to claim 3 in which said frequency divider comprises a scale-of-three counter coupled to said generator and a plural stage binary counter coupled to said scale-of-three counter.

9. Apparatus according to claim 3 in which said divider has count terminals respectively providing said submultiples and said matrix comprises a plurality of separate input lines coupled respectively to said count terminals of said divider, a plurality of separate output lines for supplying said outputs, first means for providing AND connections from said pulse generator to each of said output lines, and second means providing AND connections from different combinations of said input lines to each of said output lines for energizing said output lines with only predetermined combinations of pulses from said pulse generator.



10. Apparatus according to claim 9 in which said second means providing AND connections between said input and output lines comprises a diode for each connection.

11. Apparatus according to claim 9 in which said output lines include auxiliary output lines and means providing OR connections from auxiliary output lines to other output lines thereby providing on said auxiliary output lines combinations of pulses on said other output lines.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,006,299 | 10/1961 | Hadden et al. | 84—1.24 |
| 3,207,835 | 9/1965 | Holman et al. | 84—1.03 |


ARTHUR GAUSS, *Primary Examiner.*

Z. ZAZWORSKY, *Assistant Examiner.*