May 14, 1968 D. M. PARK ET AL 3,383,452

MUSICAL INSTRUMENT

Filed June 26, 1964 5 Sheets-Sheet 1

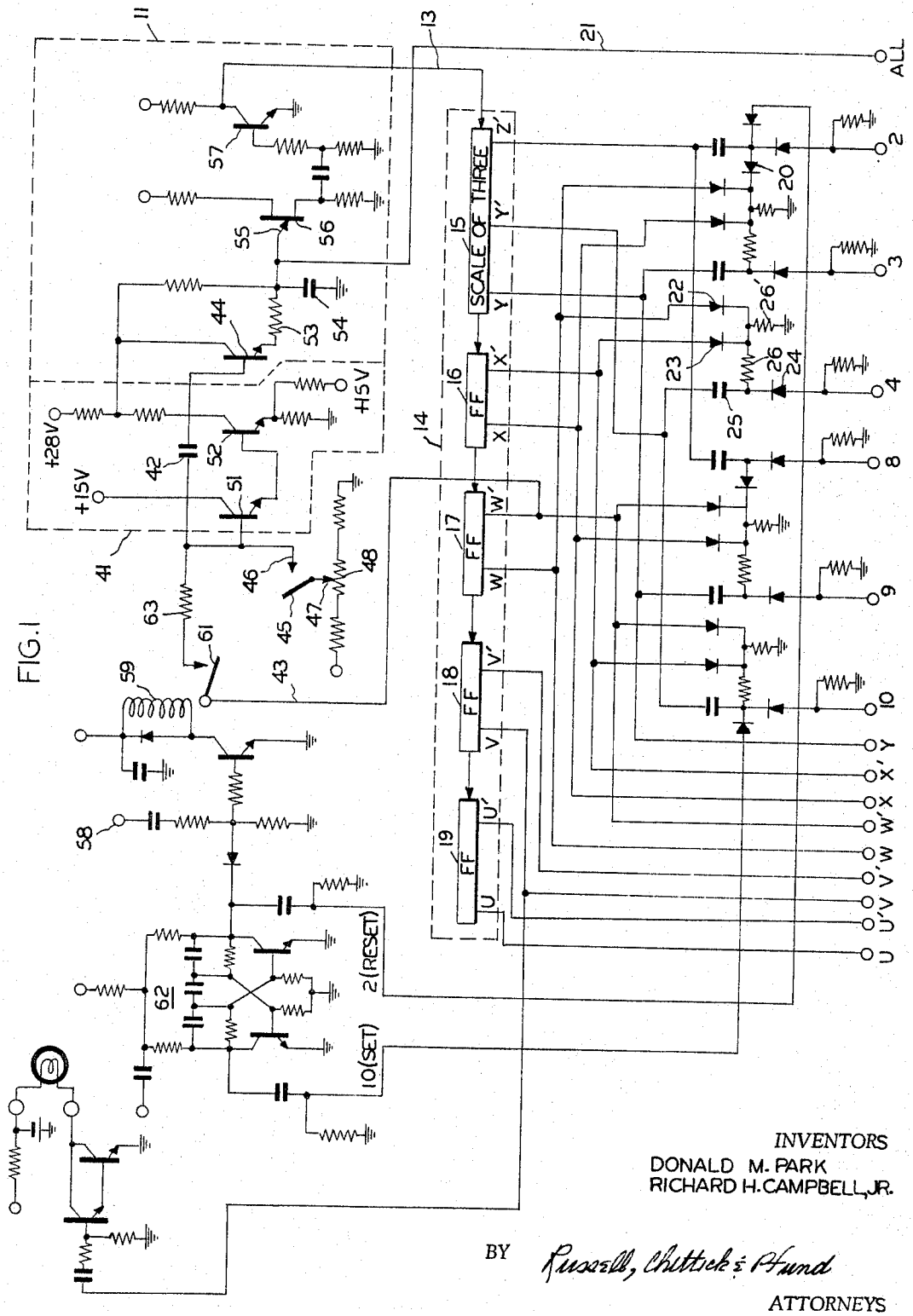



FIG. 1


INVENTORS
DONALD M. PARK
RICHARD H. CAMPBELL, JR.

BY Russell, Chittick & Hund
ATTORNEYS

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MUSICAL INSTRUMENT

Filed June 26, 1964 5 Sheets-Sheet 2

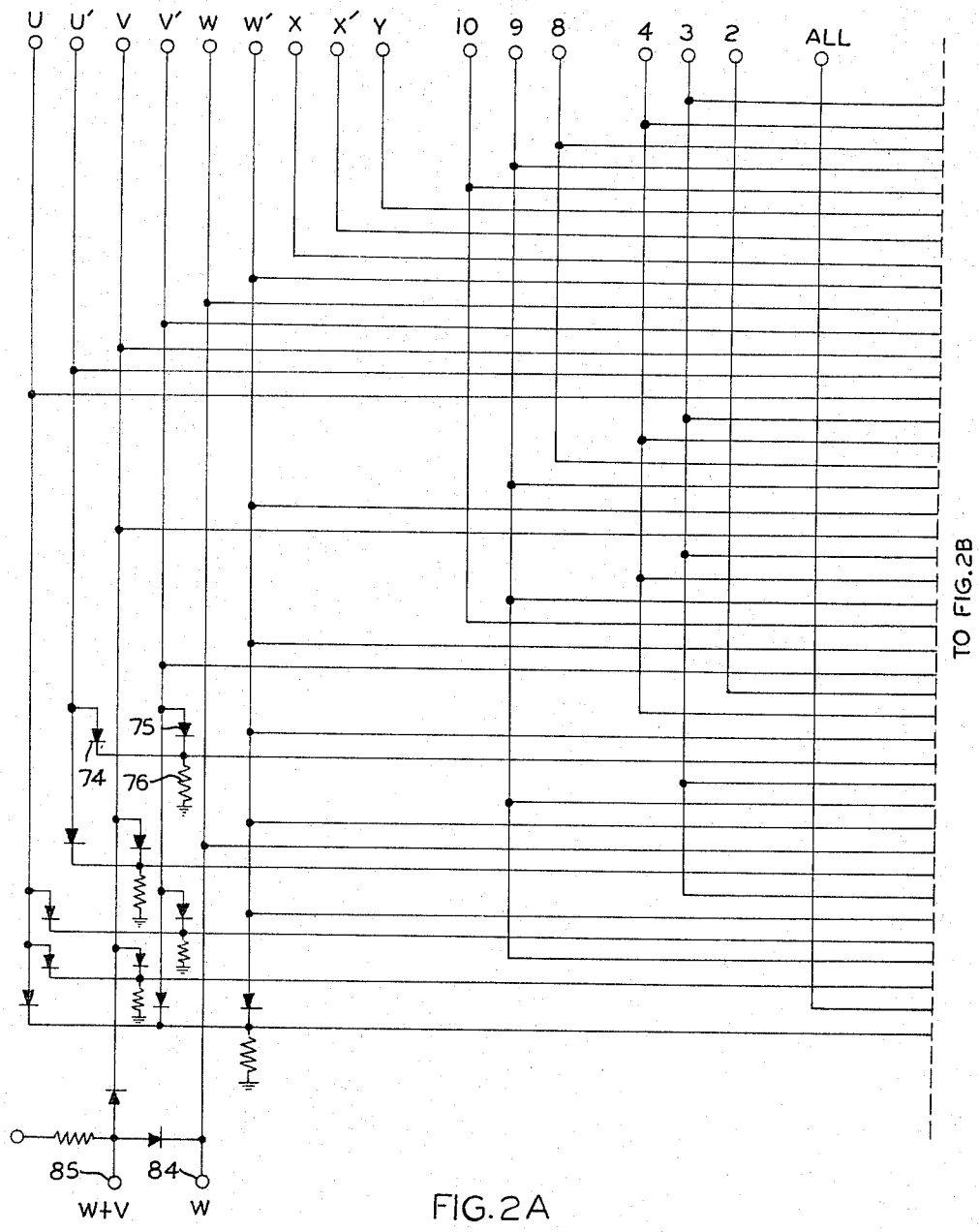



FIG. 2A

INVENTORS
DONALD M. PARK
RICHARD H. CAMPBELL, JR.

BY Russell, Whittick & Pfund
ATTORNEYS

May 14, 1968 D. M. PARK ET AL 3,383,452

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Filed June 26, 1964 5 Sheets-Sheet 5

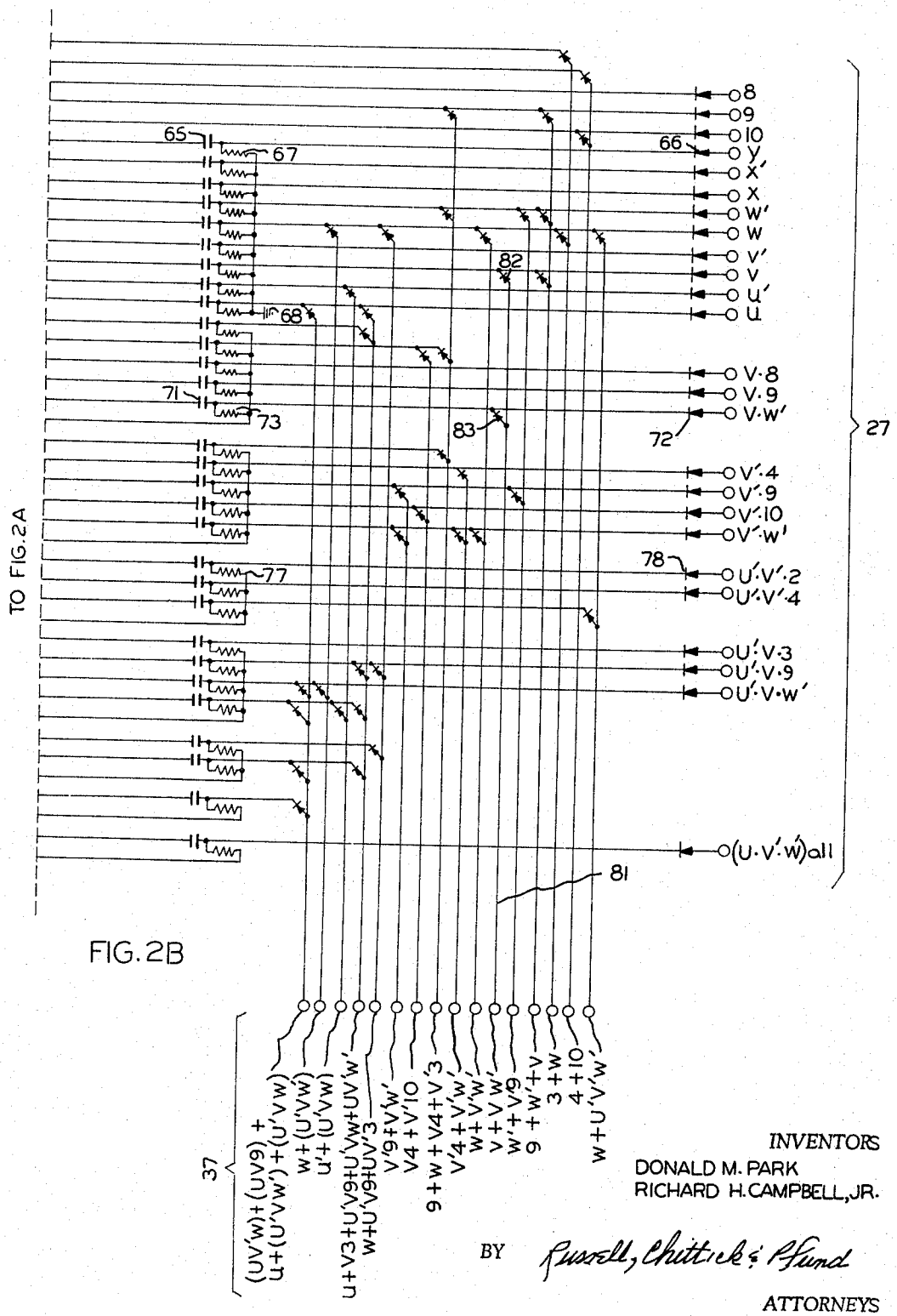



FIG. 2B

INVENTORS
DONALD M. PARK
RICHARD H. CAMPBELL, JR.

BY Russell, Chittick & Pfund

ATTORNEYS

May 14, 1968 D. M. PARK ET AL 3,383,452

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Filed June 26, 1964 5 Sheets-Sheet 4

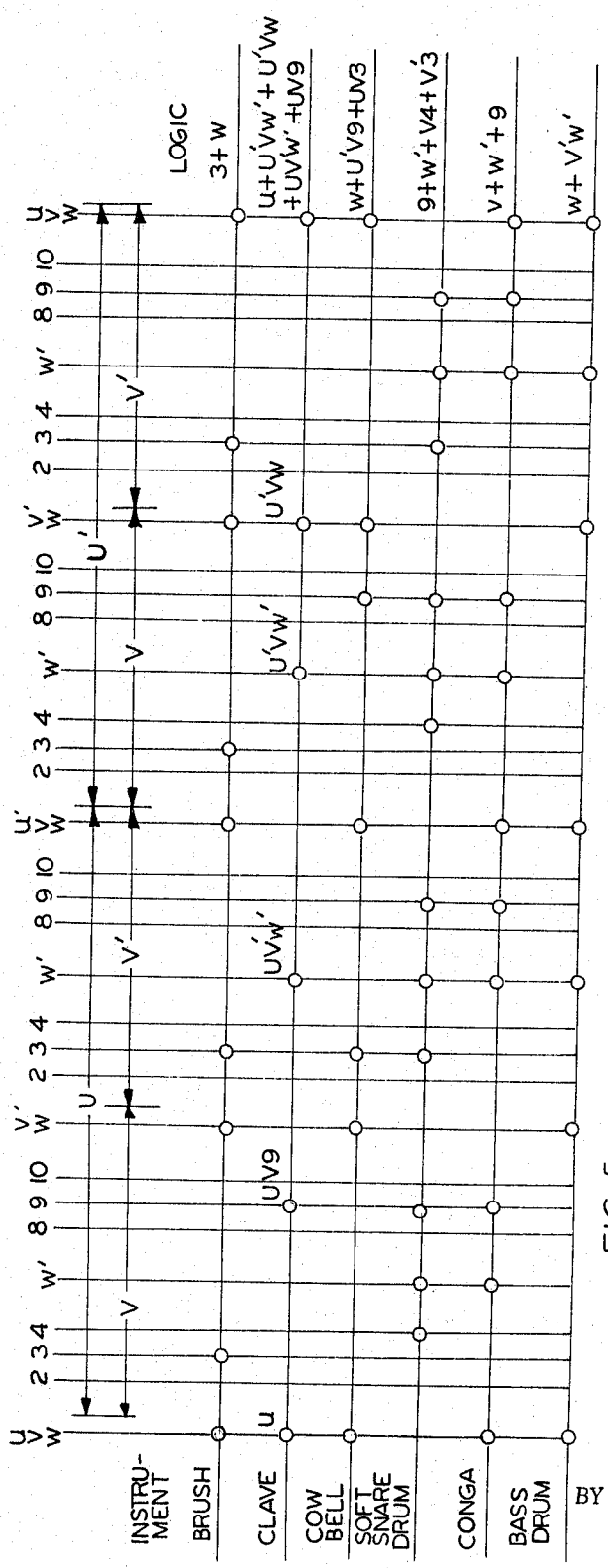
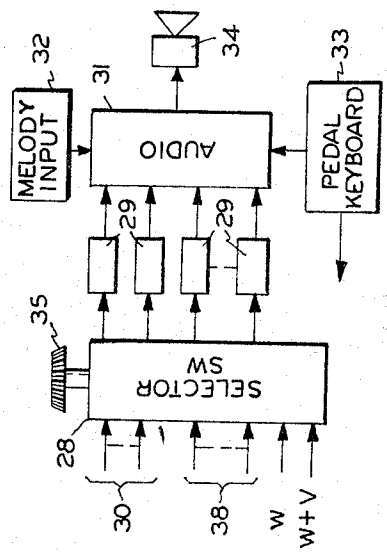



FIG. 5

FIG. 3




INVENTORS
DONALD M. PARK
RICHARD H. CAMPBELL, JR.

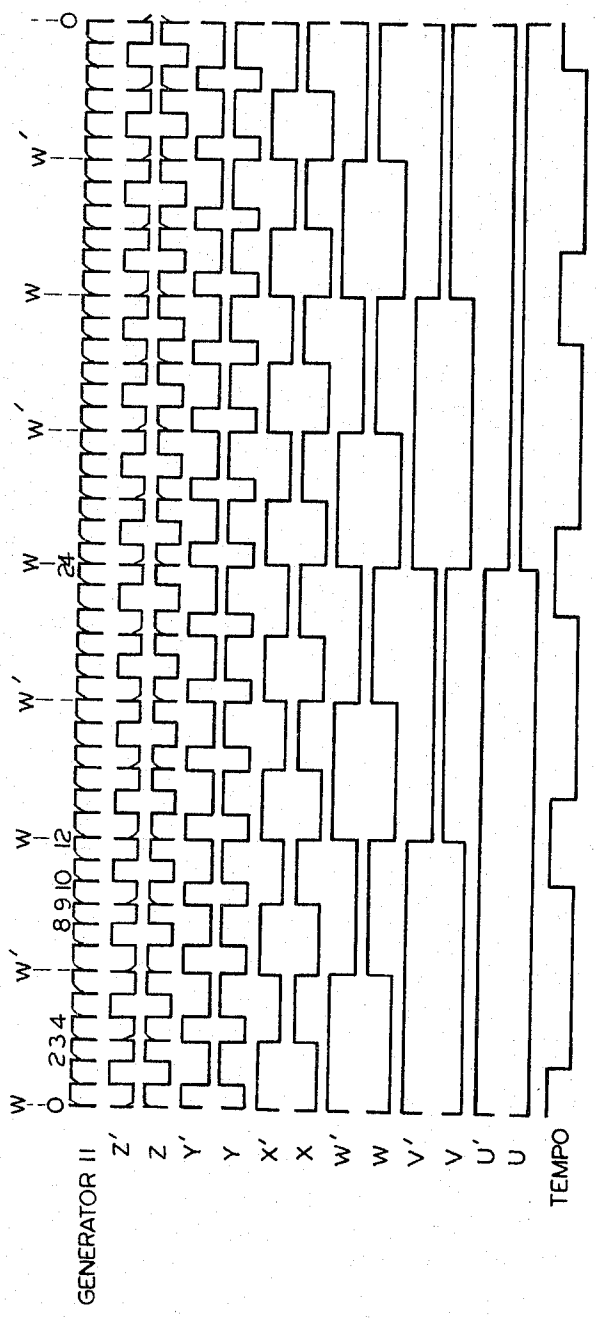
Russell, Chittick & Pfund
ATTORNEYS

May 14, 1968 D. M. PARK ET AL 3,383,452

MUSICAL INSTRUMENT

Filed June 26, 1964 5 Sheets-Sheet 5

FIG. 4




INVENTORS
DONALD M. PARK
RICHARD H. CAMPBELL, JR.

BY Russell, Chittick & Hund
ATTORNEYS

United States Patent Office 3,383,452
Patented May 14, 1968



3,383,452

# MUSICAL INSTRUMENT

Donald M. Park, Raleigh, N.C., and Richard H. Campbell, Jr., Gilford, N.H., assignors to The Seeburg Corporation, Chicago, Ill., a corporation of Delaware

Filed June 26, 1964, Ser. No. 378,364
10 Claims. (Cl. 84—1.03)

## ABSTRACT OF THE DISCLOSURE

A repetitive sequence of pulse combinations for actuating rhythm sound generators of an electronic musical instrument according to the said sequence is provided by an oscillator driving a frequency dividing counter and a matrix having a set of input lines connected to the outputs of the counter stages. The matrix output lines are connected to different ones of the input lines to provide the desired pulse combination sequence generated from the unique combination of states of the counter stages operating to enable a given output line.

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 arrangements disclosed and claimed in "Rhythm Tempo Control System," Ser. No. 217,713, filed Aug. 17, 1962, now Patent No. 3,247,307; and "Automatic Rhythm Instrument," Pat. No. 3,358,068 of Richard H. Campbell, Jr., and "Automatic Repetitive Rhythm Instrument Timing Circuitry," Pat. No. 3,255,292 of Donald M. Park, both filed of even date herewith, the disclosures of which are hereby incorporated by reference for the detailed disclosure of various circuits for achieving rhythm sound patterns.

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 in the preferred embodiment 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 subdivision 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 enable and pulse a plurality of output lines, with the enabling 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 instruments, 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 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.

Another object of the invention is to provide an improved counter and matrix combination for the generation of a wide variety of rhythm pulse combinations with simple and reliable circuits.

Other 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 schematic diagram of the frequency controlled oscillator and frequency control circuit therefor in conjunction with a block diagram of the counter with the logic circuits for deriving specific rhythm beats;

FIGS. 2A and 2B assembled as indicated show a complete schematic for the logic matrix for deriving outputs made up of the various combinations of the inputs obtained from the counter and its associated logic outputs;

FIG. 3 is a block diagram of the selector switch and rhythm instrument portions of a complete player-operated instrument including melody and pedal keyboard inputs to the audio reproducer;

FIG. 4 is a waveform diagram of the various timing waves obtained from the counter and associated circuits; and

FIG. 5 is a representation of the timing and rhythm instrument combinations used for obtaining a particular rhythm effect from the arrangements of the invention.

Referring now to FIGS. 1, 2, and 3, an overall description of the preferred embodiment will first be described. A pulse generator **11** is shown having its frequency controlled as hereinafter described. 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 and for this purpose may include voltage variable relaxation oscillators or signal controlled reactance device oscillators 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 a scale-of-three first stage **15** followed by four binary stages **16**, **17**, **18**, and **19**. The scale-of-three stage **15** consists of two flip-flops with a feedback connection from either side of the second flip-flop to the corresponding side of the first flip-flop, thereby producing a scale-of-three count as indicated by wave-

forms Y, Y', and Z, Z' of FIG. 4 as hereinafter described. Of these waveforms only the Y, Y' and Z' waveforms are utilized as indicated by the correspondingly identified output lines from the scale-of-three stage **15**. Each of the binary stages **16**, **17**, **18**, and **19** has the conventional two output waves indicated respectively as X, X', W, W', V, V' and U, U'.

The outputs from the counter **14** U, U', V, V', W, W', X, X', and Y are all used directly as inputs to the decoding matrix hereinafter described. In addition to the direct outputs, a number of outputs are required which are derived by decoding the stages of the counter **14** to obtain pulse beats timed at positions **2**, **3**, **4**, **8**, **9**, and **10** of a twelve beat half-measure. These output lines are also indicated with the corresponding beat numbers associated therewith in FIG. 1. In addition to these outputs, a line **21** supplies an output of all of the pulses from the pulse generator **11** for particular sound effects such as a drum roll. The derivation of the pulse beats at count times **2**, **3**, **4**, **8**, **9**, and **10** can be understood from a consideration of the details of the generation of the pulse beat output **4**. This pulse beat is derived from the logical AND connection of outputs W and X' in conjunction with the differentiation of the Y' output. In the notation of this application, pulse beat **4** is thus $(W \cdot X')y'$. This AND combination is obtained by a diode **22** connected to output W and a diode **23** connected to output X'. The diodes **22** and **23** are connected in an AND circuit to enable an output diode **24** leading to the output terminal **4**. A capacitor **25** couples the output Y' to the diode **24** and by means of the associated resistors **26** and **26'** acts to differentiate the Y' pulse, thereby producing an impulse for a negative transition of Y' on the output **4** whenever the diode **24** is enabled by the action of signals W and X' through diodes **22** and **23** respectively.

From the foregoing description the derivation of the outputs **2**, **3**, **4**, **8**, **9**, and **10** can be readily understood from the diagram to involve the logic combinations of the following table:

TABLE I

Logic: Capital letters, positive is "zero," negative is "one" Small Letters: Differentiated neg. transitions

| | |
|---|---|
| $2=(W \cdot X)z'$ | $8=(W' \cdot X)z'$ |
| $3=(W \cdot X)y$ | $9=(W' \cdot X)y$ |
| $4=(W \cdot X')y'$ | $10=(W' \cdot X')y'$ |

The only exception to the above-described circuits for obtaining the outputs **2–10** is involved in the circuits for obtaining the output **2** where diode **20** is employed in the differentiating circuit instead of the resistor corresponding to resistor **26**. The reason for this substitution is because the fast repetition rate of the output **2** where the recharging time constant of the unilateral conducting device **20** is useful in obtaining distinct pulses at this fast rate.

The remaining details of FIG. 1 relating to the automatic and manual frequency control of the pulse generator **11** will be described hereinafter.

FIGS. 2A and 2B assembled as indicated show the schematic wiring diagram for the selection matrix which interconnects the counter of FIG. 1 with the selector switch of FIG. 3. Thus the matrix of FIG. 2 has input lines U, U', Z, Z', W, W', X, X' and Y as well as the numbered inputs **10**, **9**, **8**, **4**, **3**, **2**, and the line **21** for ALL-pulses connected to the correspondingly designated output lines of FIG. 1. The outputs of the matrix of FIG. 2 are made up of a plurality of AND combinations **27**, a plurality of OR combinations **37**, and specialized sustained outputs of waveform W and W+V. This matrix is used with FIG. 3 with the AND connections **27** directly connected to the AND inputs **30**, the OR outputs **37** of FIG. 2 directly connected to the OR inputs **38** of FIG. 3, and the continuous outputs W and W+V connected as indicated in FIG. 3. These connections in FIG. 3 supply a selector switch assembly **28** which is wired in any desired manner to interconnect the input pulse combinations and groups thereof to the various rhythm instruments as hereafter described.

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 inputs to an audio section **31**. The audio section **31** may have a melody input **32** and 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, an example of which is shown hereinafter with reference to FIG. 5. These pulse combinations 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**, **37**, W and $V+W$ and selected by the selector switch **28** under the control of the player. Specific detailed arrangements for this selection and generation of the various rhythm sounds, which are merely representative of those which may be produced, are disclosed in detail in the aforementioned application.

Referring again to FIG. 1, for the purpose of developing an automatic rhythm following-up signal, an integrator **41** is provided which has a time controlled input derived directly from pedal keyboard **33**, and a square-wave input on line **43** derived from the W' output of the binary stage **17**. The waveform on line **43** has a transition from negative to positive at the time when a pedal keyboard actuation would ordinarily be imposed by the player on the pedal keyboard **33**. By using this pedal actuation to pass the polarity of the W' output of binary stage **17** to an integration capacitor **42** of integrator **41**, a positive or negative increment can be applied to the integration capacitor **42**, and thus the voltage level of the capacitor **42** can be raised or lowered depending upon whether the actuation of the pedal keyboard **33** occurs during the negative or positive portion of the square-wave input on line **43**. This voltage level on the integration capacitor **42** of integrator **41** is applied by emitter follower **44** to control the frequency pulse 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 W' on line **43** in synchronism with the actuation of the pedal keyboard **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**.

Between pedal actuations, the voltage on integration capacitor **42** is maintained by virtue of the feedback characteristics of the circuit, including transistors **51** and **52**, so that the actual voltage level transferred by emitter follower **44** remains constant between pedal actuations. The voltage on the emitter on the transistor **44** thus is a controlled charging voltage for the time constant circuit consisting of resistor **53** and capacitor **54** thereby providing a variable time for the charging of capacitor **54** to a given voltage level. The capacitor **54** is connected to a control electrode **55** of a unijunction transistor **56**. The unijunction transistor **56** may be the general type designated 2N2646 and has the characteristic of providing switching action at the breakdown voltage applied on electrode **55** characteristic of the particular junction operating characteristics. Thus the transistor **56** will switch and become conducting to discharge capacitor **54** with a variable frequency depending upon the charging voltage to which capacitor **54** charges through resistor **53** as controlled by emitter follower **44**. In this manner the tran-

sistor 56 can operate as a relaxation pulse oscillator of variable frequency, and these pulse outputs are coupled through a pulse amplifier transistor 57, the output of which is the pulse train on line 13.

The time control for the application of the waveform W' by actuation of the pedal keyboard 33 is obtained from the application of the pedal pulse at an input terminal 58. The pedal pulses at terminal 58 which are coincident with the actuation of a key in the pedal keyboard 33 operate to energize a relay 59 to close contacts 61. The contacts 61 are in the line connecting the W' output of flip-flop 17 to the input of the integrator 41, and hence, the W' waveform is applied only when the pedal keyboard is actuated. As a further refinement, the energization of the relay 59 as a result of a pedal pulse on terminal 58 is further controlled by flip-flop 62. The flip-flop 62 is connected to enable the passage of the pedal pulse on terminal 58 to energize the relay 59 only when the flip-flop 62 is set. As indicated in FIG. 1, the flip-flop 62 is set by the pulse output at the count 10 and is reset by the pulse output at count 2, thereby enabling the passage of the pedal keyboard to energize the relay 59 only for the small interval between pulse 10 and pulse 2 which pulses are symmetrically disposed on either side of the pulses at position 12, the normal time position for a pedal occurrence in ordinary compositions. Thus if the pedal is not actuated, or is not actuated within this limited time range when an ordinary pedal actuation should fall for most compositions, no change will be transmitted to the integrator 41, and thus, the frequency of the pulse generator 11 will not be changed. By means of the additional limitation on the time position for the pedal pulse at terminal 58 which is imposed by the use of the flip-flop 62, ambiguous and undesirable operation can be avoided where gross errors in timing of the pedal keyboard or accidental actuation thereof occur.

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 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 presence of resistor 63 prevents the keyboard signal from contacts 61 having any effect when switch 45 is in contact with terminal 46.

Referring now to FIGS. 2A and 2B as assembled, the details of the matrix will be described. The top three lines designated 8, 9, and 10 of the AND outputs 27 are directly connected through diodes to the correspondingly numbered input lines from the counter of FIG. 1. These pulses at time positions 8, 9 and 10 are derived in the same manner as the pulse at position 4 which was described in detail with reference to FIG. 1.

The next sequence of output lines 27 is the group designated *y*, *x'*, *x*, *w'*, *w*, *v'*, *v*, *u'*, *u*. These are the pulse outputs obtained from the correspondingly lettered input lines U, U', V, V', W, W', X, X' and Y. The conversion of a negative transition on any one of these inputs to the corresponding pulse output at the transition time will now be described. The flip-flops of the counter 14 in FIG. 1 utilize transistors connected to switch the particular lettered output lines from ground to a positive voltage whenever the transistor becomes non-conductive and, conversely, when the transistor becomes conductive, the lettered output line is connected directly through the transistor to ground, thus being grounded through a very low impedance path. Examining the line in FIG. 2 from Y input to *y* output 27, we find that the line passes through a series capacitor 65 and series diode 66 poled to be conductive when the signal applied at the input is negative relative to the output. The second factor influencing the conductivity of the diode 66 is the voltage applied thereto through a resistor 67 which is connected to ground 68. For a negative transition of the waveform Y, the junction of capacitor 65 and resistor 67 suddenly becomes negative and renders the diode 66 conductive, thereby passing a pulse to the output *y* terminal which has a brief duration according to the time constant of the capacitor 65 and resistor 67. For a positive transition of the waveform Y, the diode 66 is blocked and no signal appears at the *y* terminal.

If instead of connecting resistor 67 to ground 68, it is connected to an enabling input voltage, the conductivity of the diode 66 could be controlled by the polarity of the enabling voltage so applied. This control is illustrated, for example, in the output terminal V*w'*. Here the input terminal W' is connected through a capacitor 71 to a series diode 72 which is connected to output terminal V*w'* and poled to pass negative signals. A resistor 73 is connected from the junction of capacitor 71 and diode 72 to the input line V. If the signal V input is at ground level, the operation is the same as just described for the signal path from Y input to Y output. However, if the input signal V is positive, this positive voltage applied by resistor 73 to the diode 72 maintains the diode non-conductive even in the presence of a negative transition signal coupled to the capacitor 71. Thus, both input V and input W' must be negative if an output is to appear at output terminal V*w'*, and again, due to the differentiating action of the capacitor 71 and resistor 73, the output signal will be a short pulse at the negative transition time of the input signal W'.

As indicated, additional outputs are obtained with the enabling signal V, namely, V8 and V9. Four further outputs are obtained from the AND combinations of V' with the input lines 4, 9, 10 and *w'*. Enabling combinations of two or more input lines may be employed to derive further unique signal combination. For example, input lines U' and V' are AND connected to diodes 74, 75, and resistor 76 to place the lower end of resistor 77 at ground potential only when both U' and V' are at ground potential. Thus, the outputs controlled thereby through resistor 77 is that of the input from pulse position 2 and the output through diode 78 is a negative pulse only when U' and V' are at ground potential and waveform 2 goes through its negative transition to ground potential. The remaining circuit combinations necessary for obtaining all of the output lines 27 of FIG. 2 will be obvious from the foregoing description.

The OR output lines 37 are obtained by diode connections to the desired pulse patterns, consisting of individual pulses occurring on any one of the input lines connected by means of diodes to one of the output lines 37. For example, the output line 37 having the output $v+Vw'$ indicated at vertical line 81 is achieved by means of a diode 82 connected to output line *v* with a polarity to pass the negative pulse signals transmitted to output terminal *v* to line 81 also and a similar diode connection 83 to the output line connected to diode 72, thus producing the logical OR output desired on line 81. The remaining OR connected lines 37 are obvious from this description.

For specialized effects the undifferentiated waveform W is used as an output at terminal 84 and is OR connected with the input wave V to produce at output terminal 85 the OR connections of waves $V+W$. The output at terminal 85 is thus ground whenever either wave V or wave W is at ground potential.

Obviously, many other combinations of pulses could be synthesized by means of the techniques shown in FIG. 2 and other basic logic could be utilized to derive positive pulses or pulses which occur on different transitions of the waveforms as desired. Also, greatly simplified versions of the general arrangement of the matrix for producing desired rhythm pulses and combinations thereof can be employed using the technique of differentiating the lowest order counter stage output wave applied in combination with enabling waves to any given output

terminal to obtain a short duration pulse at the transition time for the lowest order stage used.

Referring now to FIG. 4, the various waveforms existing in the counter and control circuit of the FIG. 1 can be identified. The top line designated generator **11** shows forty-eight equally spaced pulses produced by the generator **11** covering the time interval corresponding to two measures of a composition played at a given rhythm tempo. As previously described, this actual time lapse for these two measures can be set by means of the control **47** or can be determined by the player-operated instrument follow-up system so the rhythm tempo corresponds to that imposed by the player. The next twelve lines of FIG. 4 show the waveforms for the various points on the outputs of the stages of the counter **14**, including for completeness the waveform Z which is not used as an actual output line. As indicated, the waveforms Z' and Z are the result of two flip-flops with a feed-back connection to obtain a scale-of-three stage operation for the first stage **15**. The remaining lettered waveforms are the conventional binary counter sequence.

The lower waveform in FIG. 4 designated "TEMPO" shows the enabling period between pulses **10** and **2** of the generator pulse sequence of the top waveform, thereby providing an enabling interval which starts just before the pulse positions **12** and **24** and ends just after these positions. Thus at the beginning and end of each measure and in the middle of each measure the follow-up tempo control system is enabled by the TEMPO wave to permit the pulse generator **11** to receive control impulses and adjust the rhythm tempo to that imposed by the player-operated instrument. Obviously, the enabled interval could be made any desired length using other logic combinations controlling the flip-flop **62**.

It will be noted that the counter arrangement derives from the generator **11** two successive measures subdivided into twenty-four equal intervals, and thus successive measures can have slight variations in their particular rhythm patterns as desired for certain compositions. The generator **11** is thus operating as a multiple of the basic rhythm frequency of the instrument, and also a multiple of the rhythm beat which may be imposed at the beginning and ending of the measure and also midway through the measure, if desired.

Referring now to FIG. 5, the combination of various rhythm pulses through various rhythm instruments to produce a particular rhumba combination will be described.

The rhumba position of selector switch **28** actuates a six-contact switch. The first contact connects a logic output combination which bears the logic pulse pattern $3+w$ to the Brush input on the instrument generator **29**. Thus the Brush sounds each time the pulse **3** or the pulse $w$ occurs.

The second selector switch contact connects the logic output combination which bears the more complex pulse pattern $u+(UV)9+(UV')w'+(U'V)w'+(U'V)w$ to the Clave input on the instrument generator **29** so that the Clave sounds on these five pulses over the full two-measure interval.

Similarly the remaining lines in FIG. 5 show logic combinations connected to the Cow Bell input, logic output $9+w'+V4+V'3$ (through a 47 kilohm resistor to reduce its amplitude) to the Snare Drum input, logic output $v+w'+9$ to the Conga input, and the logic output $w+V'w'$ to the bass drum input.

The combination of these six instruments, each sounding in its own beat pattern over the two-measure interval as indicated by the small circles at the intersections of the horizontal and vertical lines, creates the characteristic rhythm of the rhumba.

From considering the foregoing, 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 rhythm sequences into the various rhythm instruments in the combinations which achieved the desired artistic pattern. Obviously, the specific example given does 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 a particular instrument built in accordance with the invention.

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.

We 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 having a plurality of cascaded counter stages with an input stage coupled to said generator for counting down submultiples of the frequency of said generator, said submultiples being the transition frequencies of said counter stages respectively; a matrix connected to said frequency divider for decoding the unique combination states of said counter stages to provide a plurality of successively enabled output lines, each line being enabled by a different predetermined combination of the states of said stages; means for transmitting pulses on each said output line, when enabled, in response to transitions of the lowest order stage enabling the respective line; and means for selectively coupling different ones of said output lines to energize rhythm circuits with the combination of pulses produced by said transitions on the selected output lines as the are successively enabled.

**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 corresponding to a multiple of the basic rhythm frequency for said instrument; a multistage frequency divider having a plurality of cascaded counter stages with an input stage coupled to said generator for counting down submultiples of the frequency of said generator, said submultiples being the transition frequencies of said counter stages, respectively; a matrix connected to said frequency divider for decoding the unique combination states of said counter stages to provide a plurality of successively enabled output lines, each line being enabled by a different predetermined combination of the states of said stages; means for transmitting pulses on each said output line, when enabled, in response to transitions of the lowest order stage enabling the respective line; means for selectively coupling different ones of said output lines to energize rhythm circuits with the combination of pulses produced by said transitions on the selected output lines as they are successively enabled; and means for applying a variable frequency control signal to said repetitive pulse generator.

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

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

**6.** Apparatus according to claim **3** and including means for coupling from said counter a wave having potential transitions at the rhythm beat for said basic rhythm frequency; a control-signal circuit; means for transferring said wave to said 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 potential of said wave at the

time of transfer for producing said variable frequency control signal to confrom the rhythm beat of said generator to the rhythm beat imposed by said player.

7. An electronic musical instrument for generating continuous repetitive rhythm patterns comprising a petitive pulse generator having a signal controlled frequency corresponding to a multiple of the basic rhythm frequency for said instrument; a multistage frequency divider having a plurality of cascaded counter stages with an input stage coupled to said generator for counting down submultiples of the frequency of said generator, said submultiples being the transition frequencies of said counter stages, respectively; a matrix connected to said frequency divider for decoding the unique combination states of said counter stages to provide a plurality of successively enabled output lines, each line being enabled by a different predetermined combination of the states of said stages; means for transmitting pulses on each said output line, when enabled, in response to transitions of the lowest order stage enabling the respective line; means for selectively coupling different ones of said output lines to energize rhythm circuits with the combination of pulses produced by said transitions on the selected output lines as they are successively enabled; means coupled to different stages of said frequency divider for determining a timing interval extending a short time before and after the rhythm beat for said basic rhythm frequency; means for coupling from said counter a wave having potential transitions at the rhythm beat for said basic rhythm frequency; a control signal circuit; means for transferring said wave to said control signal circuit in tempo with the rhythm beat imposed by a player-operated instrument only if the rhythm beat imposed by said player is within said timing interval; and storage means associated with said control signal circuit and responsive to the potential 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 7 having solid-state active components including a unijunction transistor relaxation oscillator for said generator; and a capacitor-feedback integrator circuit for said storage means operative to establish a controlled charging voltage for said relaxation oscillator.

9. Apparatus according to claim 7 in which said means for determining a timing interval comprises a bistable flip-flop; a circuit coupling said flip-flop to said counter to be set by a count occurring just prior to the rhythm beat for said basic rhythm frequency; and a circuit coupling said flip-flop to said counter to be reset by a count occurring just after the rhythm beat for said basic rhythm frequency.

10. An electronic musical instrument for generating continuous repetitive rhythm patterns comprising a repetitive pulse generator having a signal-controlled frequency corresponding to a multiple of the basic rhythm frequency for said instrument; a counter having a scale-of-three first stage coupled to said generator and a plurality of cascaded binary stages coupled to said first stage; a matrix having a plurality of input lines coupled to the respective count terminals of the stages of said counter and a plurality of successively enabled output lines, each output line being enabled by a different predetermined combination of the states of said stages and including a resistor-capacitor-diode gate network coupling each said output line to the lowest order stage input line enabling that particular output line; means for selectively coupling different ones of said output lines to energize rhythm circuits with the combination of pulses produced by said transitions on the selected output lines as they are successively enabled; and means for applying a variable frequency control signal to said repetitive pulse generator.

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JOHN S. HEYMAN, *Primary Examiner.*