

[54] **ELECTRIC ORGAN WITH CHORD PLAYING
AND RHYTHM SYSTEMS**
[75] Inventor: **James S. Southard**, Elkhart, Ind.
[73] Assignee: **C. G. Conn Ltd.**, Elkhart, Ind.
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[58] Field of Search **84/1.01, 1.03, 1.17,
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331/111, 172**

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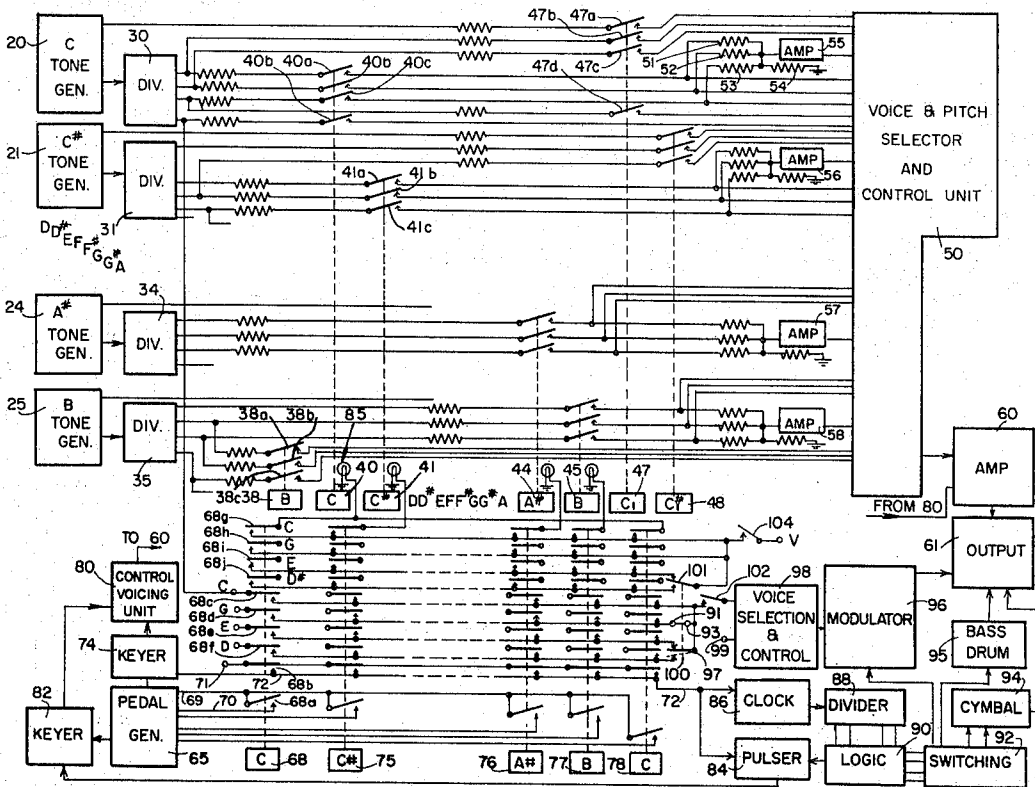
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Primary Examiner—Richard B. Wilkinson
Assistant Examiner—U. Weldon
Attorney—Mueller & Aichele

[57] **ABSTRACT**
The electric organ of the invention includes tone generators and frequency dividers for providing musical tones extending through a number of octaves. Tones in different octaves are combined to provide desired tone characteristics. A pedal board controls a pedal generator which provides bass tones, and selectively couples tones from the dividers to provide major and minor chords associated with the pedal tones played. A rhythm system is provided for chopping or modulating the chords in different rhythm patterns, and to provide percussion sounds and bass sounds in the various rhythm patterns. Logic and switching circuits control the rhythm patterns.

12 Claims, 9 Drawing Figures



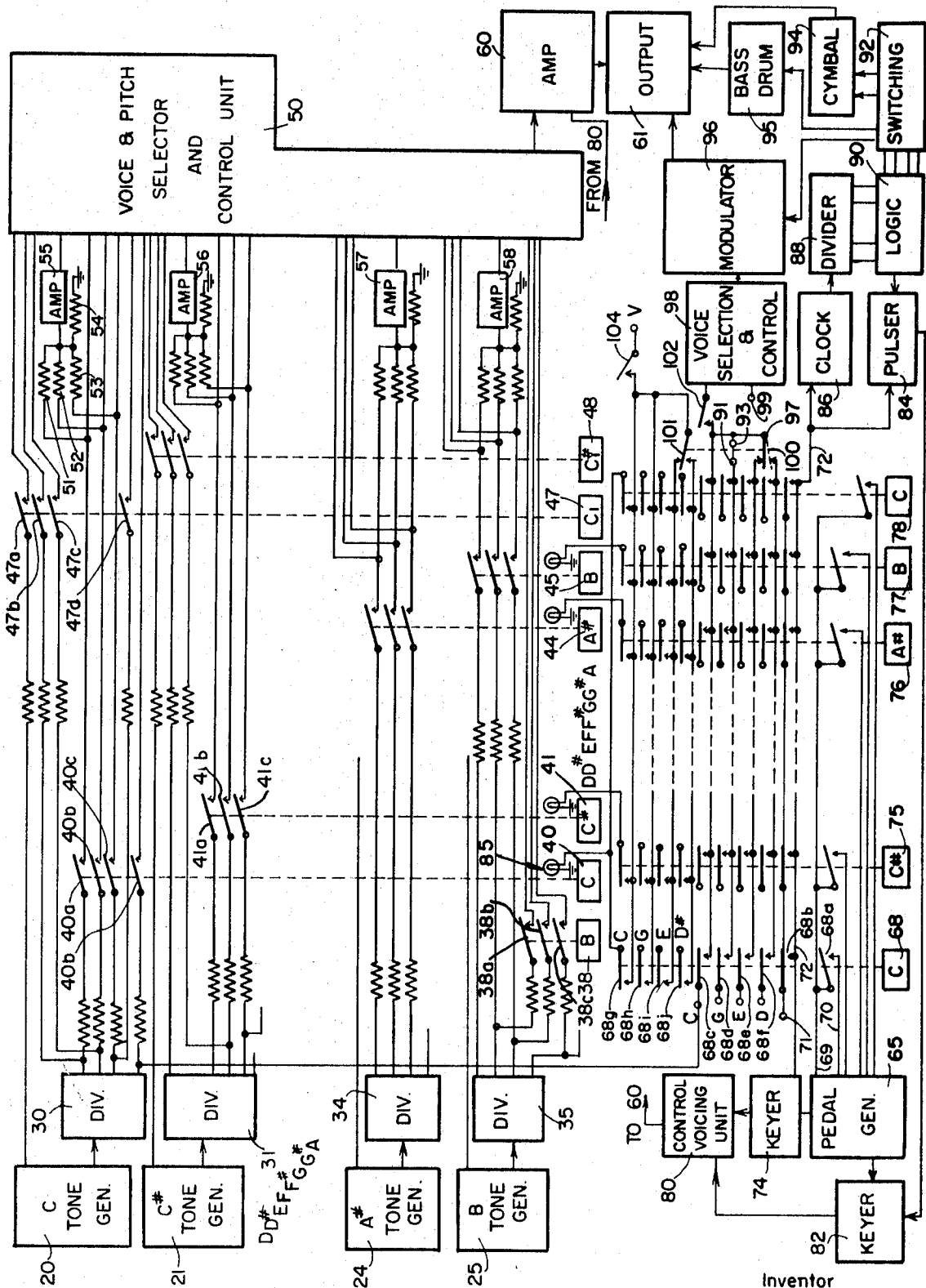


FIG. 1

Inventor
BY JAMES S. SOUTHARD
Mueller & Aichele

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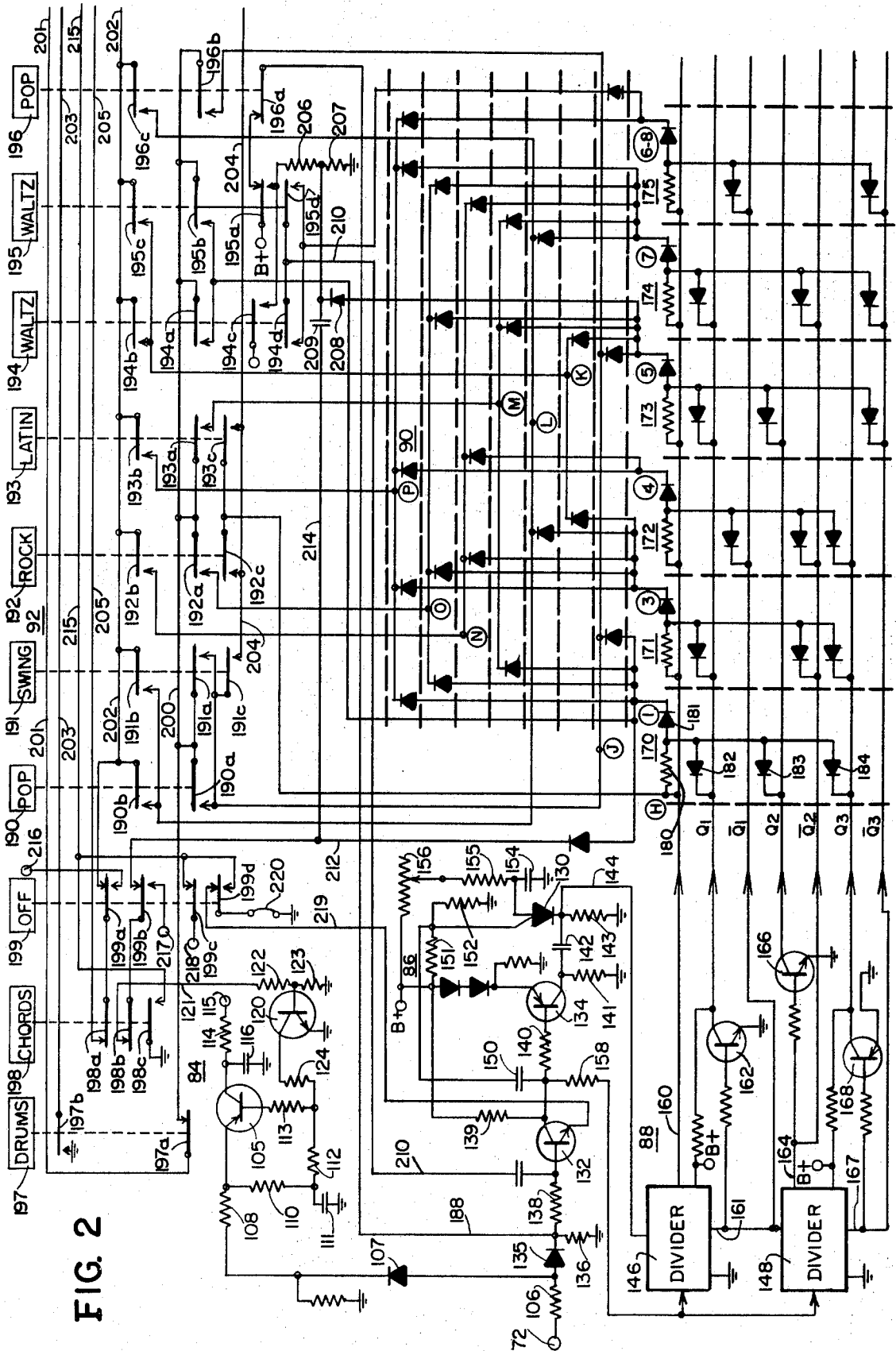


FIG. 4

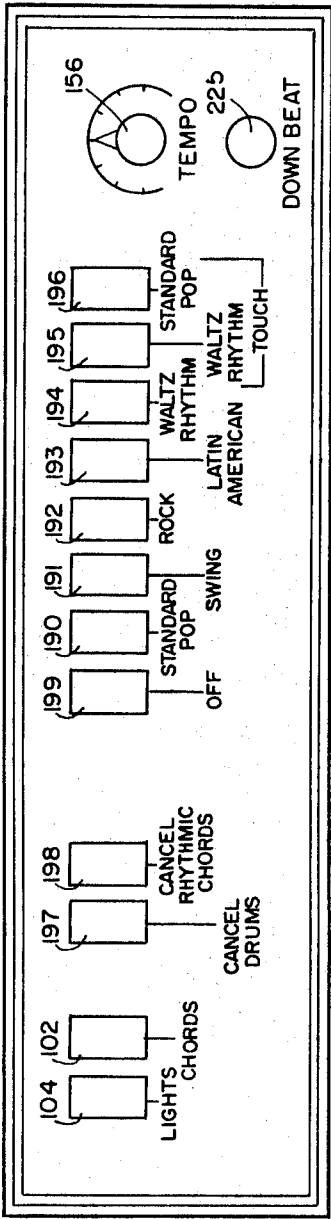


FIG. 3

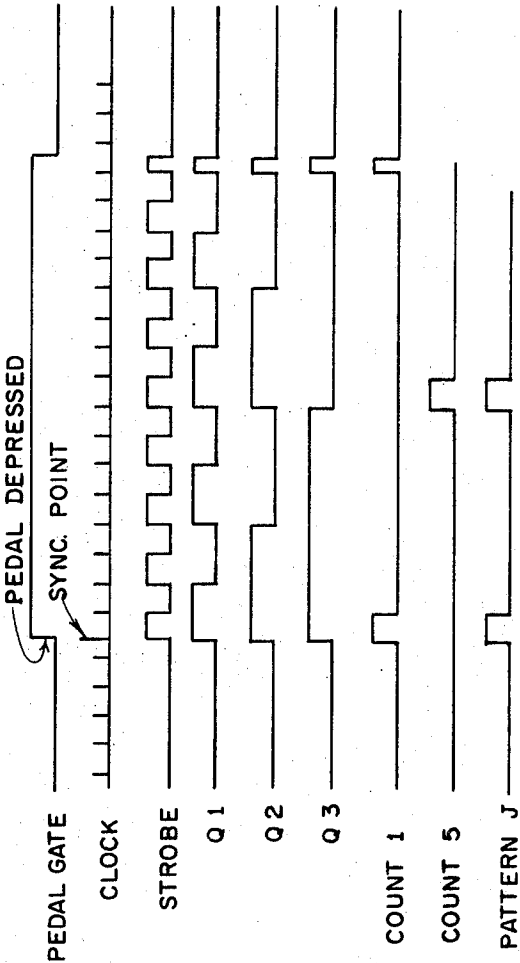
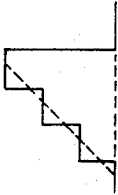
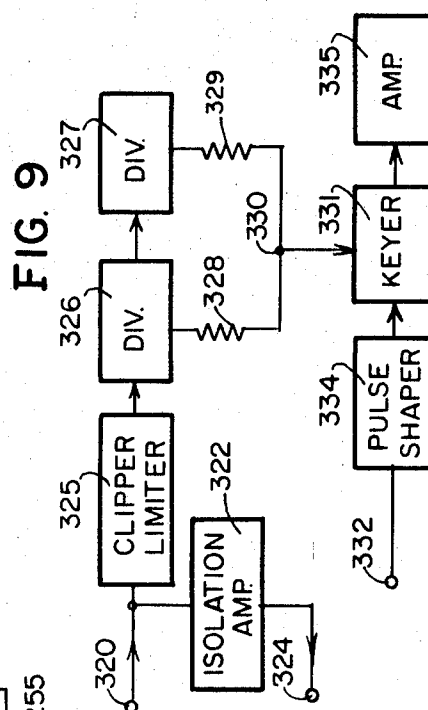
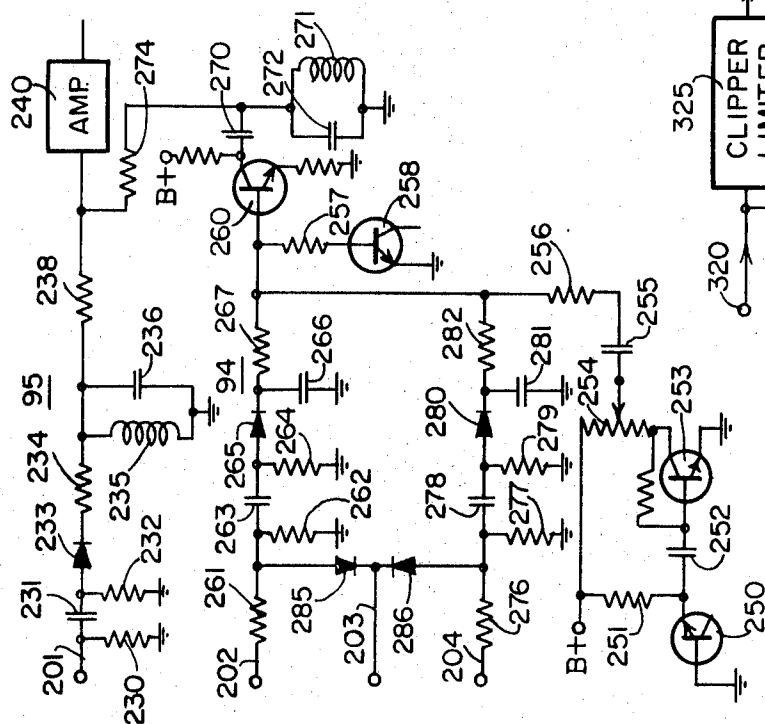
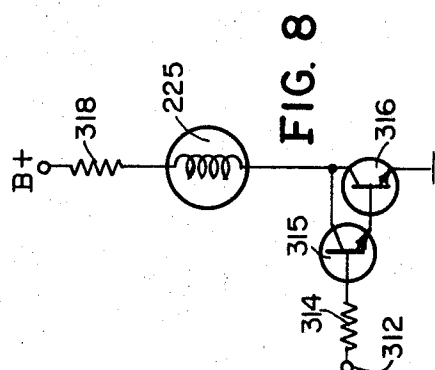
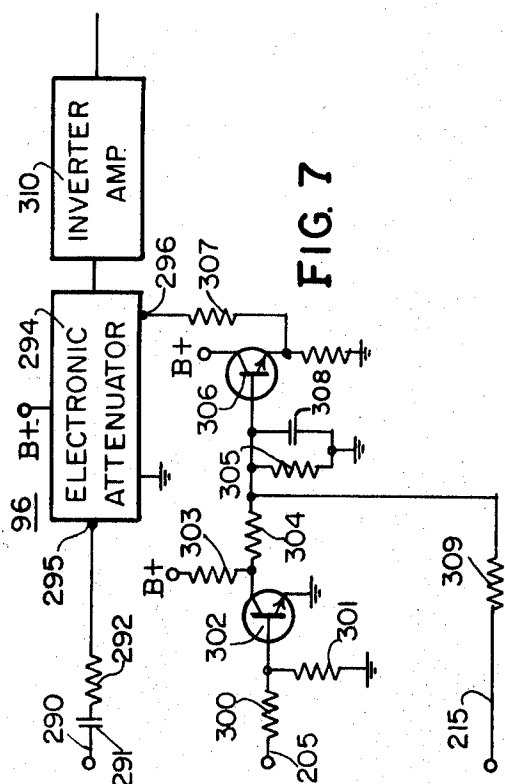


FIG. 5



ELECTRIC ORGAN WITH CHORD PLAYING AND RHYTHM SYSTEMS

BACKGROUND OF THE INVENTION

In electric organs it has been found desirable to provide percussion systems for producing various percussion sounds, such as drums and cymbals, along with the normal organ sounds. In many cases a separate device is used for the percussion sounds, and this presents a problem inasmuch as the organist must divert his attention from the organ to control the percussion device.

Another feature desirable in organs is the ability to play chords without operating keys for the individual notes of the chord, so that the organist's hands are available for operating other keys or controls. Chord organs in which the chords are played by actuation of different buttons are known, but these require a separate playing control for the chords. Organs are also known wherein chords are played automatically by the operation of the foot pedals. However, such organs have had limited numbers of chords available, to thereby limit the use of this facility. Also such organs have not had the facility to provide such chords with a percussion effect to provide the effect of a stringed instrument.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a simple and improved rhythm system for use with electric organs.

Another object of the invention is to provide a rhythm system which chops or modulates chords produced by actuation of the organ pedal.

A further object is to provide a system for playing chords by operation of organ pedals, wherein different chords can be selected for each pedal.

Still another object of the invention is to provide a rhythm system for an organ which is flexible to selectively control percussion instruments, the modulation of tones, and the actuation of string bass tones from the pedal system.

A still further object of the invention is to provide a rhythm system having a logic and switching circuit permitting the selection of various different rhythm patterns.

Another object of the invention is to provide a chord and rhythm system for an organ, wherein one note of the chord is played at a count in the rhythm following the playing of the other notes of the chord.

In practicing the invention, an electric organ is provided including tone generators and frequency dividers for producing the various tone signals required for the notes in a plurality of octaves. The signals are of generally square wave configuration and are modified by voicing networks to provide the waveforms required for producing desired tone characteristics. Tones of different octaves are summed after keying to provide wave shapes for diapason sounds. The organ includes a pedal system with a generator and a pedal board for providing bass tones. The pedals control switches for coupling signals from the frequency dividers for playing chords related to the bass note played. The switches connect tones for both the major and minor chords, and a further switch selects the chord to be played. The organ includes a rhythm system having a clock and dividers for providing 8 counts. A logic system is coupled

to the dividers for selecting particular patterns from the 8 counts. The logic system controls percussion instrument generators for producing the bass drum and cymbal sounds, controls a modulator for the chord tones, and controls a pulser for a string bass keyer for the bass tones. The rhythm system can be operable in a gated mode wherein it is triggered by actuation of a pedal, or in a continuous mode wherein the clock runs continuously to provide the rhythm patterns. A switching system permits selection of the rhythm patterns and controls the application thereof to the percussion generators, modulator and string bass pulser.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the organ of the invention and shows the rhythm system in block diagram form;

FIG. 2 is a circuit diagram of the rhythm system of the invention;

FIG. 3 illustrates the waveform produced by summing of keyed tones of different pitches;

FIG. 4 shows the control panel for the rhythm system;

FIG. 5 is a timing diagram showing the operation of the logic system;

FIG. 6 is a circuit diagram of the percussion instrument generator;

FIG. 7 is a circuit diagram of the modulator;

FIG. 8 is a circuit diagram of the lamp driver; and

FIG. 9 is a circuit diagram of an alternate fifth chord system which can be used in the organ of the invention.

DETAILED DESCRIPTION

In FIG. 1 there is shown schematically the electric organ of the invention. 12 tone generators are provided for the twelve tones in an octave. Four of these are represented by the tone generators 20, 21, 24 and 25. Tone generators 20 and 21 provide the tones for the notes C and C #, respectively, and tone generators 24 and 25 provide the tones for the notes A # and B, respectively. Eight additional tone generators for producing the notes D, D #, E, F, F #, G, G # and A will be provided, but are not illustrated to simplify the drawings. The tone generators provide the tones of highest frequency to be used in the organ, that is, the tones for the highest pitch octave. Lower frequencies are provided by the dividers 30, 31, 34 and 35 which are coupled to the generators 20, 21, 24 and 25, respectively. The dividers may provide as many stages of division as is required for the octaves to be produced by the organ. In the drawing, the dividers are shown each providing four outputs, wherein the generator frequencies are divided by 2, 4, 8 and 16, respectively.

As is common in electric organs, it is possible to sound notes in different octaves by actuation of a single key. The octaves are designated as 2 foot, 4 foot, 8 foot, 16 foot pitches, etc., because of the relation of organ pipes of such lengths. The tones from each generator and its associated divider will be applied to switches operated by the keys associated with the note on one or more manuals (keyboard) of the organ. The higher octaves on the keyboards will cause the higher frequency tones to be produced, and the lower octaves will cause the lower frequency tones to be produced.

In FIG. 1 a section of a keyboard is illustrated, which includes the keys producing notes C, C #, A # and B in one octave, note B in the next lower octave, and notes C₁ and C₁ # in the next higher octave. The key

for note C in the first octave is designated 40 and operates switch sections 40a, 40b, 40c and 40d. These switch sections are closed by action of the key 40 to apply signals from the divider 30 representing the note C. The switch sections apply the 2, 4, 8 and 16 foot pitches of the note C. Similarly, key 41 provides the note C[#] in the first octave and has switch sections 41a, 41b and 41c which apply the 2, 4 and 8 foot pitches of C[#], which are produced by divider 31. Keys for producing the notes D, D[#], E, F, F[#], G, G[#] and A are not shown, but will be included in the keyboard in the normal way. Keys 44 and 45 for the notes A[#] and B of the first octave have contacts for applying the 2, 4 and 8 foot pitches of the notes A[#] and B, respectively, which are produced by the dividers 34 and 35.

The notes C₁ and C₁[#] of the next higher octave are controlled by the keys 47 and 48, which have contacts connected for applying the tones produced by the tone generator 20 and divider 30, and the tone generator 21 and divider 31, respectively. Contact 47a is connected to apply the signal from the tone generator 20, which is the 2 foot pitch for the next higher octave. Contact 47b will apply the highest frequency from the divider, which is the 4 foot pitch for the octave of key 47. This is the same signal which provides the 2 foot pitch for the lower frequency octave of key 40. Similarly, switch section 47c applies the signal from the 8 foot pitch, and switch section 47d is shown providing the 16 foot pitch, which are the same signals providing the 4 and 8 foot pitches in the lower octave.

Key 48 has contacts for applying the tones from the generator 21 and divider 31 in the same manner as has been described for the key 47. The keys may have additional switch contacts for applying lower pitches of the notes provided by the dividers.

Key 38 is the highest note in the octave below the octave first described. This key has switch sections 38a, 38b and 38c, which are the same as switch sections connected to the other keys, previously described. Since this is in a lower octave, the signal applied to the section 38a from the divider 35, will be the second division by two of the signal from the generator 25. That is, this signal which provides the 2 foot pitch from key 38 will be the same signal which produces the 4 foot pitch when key 45 is operated. Contact 38b which provides the 4 foot pitch for key 38 will similarly connect the same signal as for the 8 foot pitch by actuation of key 45. Switch section 38c connects the 8 foot pitch, which is the lowest frequency from divider 35. This signal is not applied to the switch sections connected to key 45, but would be utilized if a 16 foot pitch is provided by that key.

As previously stated, the dividers may include further stages of division to provide still lower frequencies, and these can be used to provide lower pitches of the notes for use in lower octaves on the keyboard. Also, the signals from the tone generators and dividers can be applied to keys in more than one manual. Most organs have at least two manuals, one referred to as the solo manual and the second as the accompaniment manual. The keys shown may be keys of the solo manual, and a second keyboard may have a second set of keys to form an accompaniment manual.

The signals produced by the tone generators and dividers are generally of square wave shape, and these are applied by the switch sections coupled to the keys

to a control unit 50, for the organ which has switching facilities for selecting the desired pitches of the tones which are applied, and for changing the wave shape of the tones to provide different tone characteristics. For example, it is normally desired that the organ will provide flute sounds, reed sounds, such as oboe or clarinets, string sounds, such as violin, horn sounds, such as trumpets and trombone, and diapason sounds, which are typically pipe organ sounds. In order to produce these various sounds, electrical signals of different waveforms are required. Although the waveform or shape of the signal can be changed by filtering, and such filters are included in the section 50, it has been found that certain wave shapes can be more easily provided by combining signals of different pitches.

In FIG. 1 signals corresponding to the C note are applied from the switch sections 40a, 40b, 40c and 40d, and from sections 47a, 47b, 47c and 47d to the voice and pitch selection and control unit 50 to produce tones, such as flute tones. The signals switched by the sections 40a, 40b and 40c are also applied through resistors 51, 52 and 53, respectively, and are summed across resistor 54 and applied to amplifier 55. The combined signals produces a waveform of a stair-step shape as shown in FIG. 3. The signal from the amplifier 55 is applied to the control unit 50 which may include filtering to change the shape to a saw-tooth shape, as shown by the dotted line in FIG. 3. This wave shape can be easily modified to provide diapason, string and horn tones.

Similarly, resistors are connected to the signal lines for the notes C[#], A[#] and B to apply 2 foot, 4 foot and 8 foot tone signals which are summed and amplified in amplifiers 56, 57 and 58. The outputs of these amplifiers are applied to the control unit 50, together with such outputs from the tone generators and dividers for the notes which are not shown. It will be obvious that such combinations of tones can be used for all of the notes on the keyboard.

It may be desired to combine only the 8 foot and 4 foot tones to provide a desired wave shape. It will be obvious that various combinations of tones of different pitches can be used to form waves of different shapes, as may be desired.

The output of the control unit 50 is applied to amplifier 60 for increasing the level of the signals. This amplifier can also control the level of the signal as desired. The amplified signals are applied to an output system 61 which may include loudspeakers for reproducing the musical tones.

In addition to producing notes by actuation of one or more keyboards, electric organs commonly have a pedal board which produces bass tones which are played along with the other tones. The pedal generator 65 illustrated in FIG. 1 produces tones extending through one octave, with one additional tone so that all the notes from C to C₁ are played. Pedal 68 produces the lower C note, and has a plurality of switch sections connected thereto with the section 68a being used to control the frequency of the pedal generator 65 so that a tone of the frequency corresponding to the note C is played. The switch section 68b applies the potential on terminal 71 to line 72 connected to the keyer 74. Similarly, the pedals 75, 76, 77 and 78 have switches for controlling the pedal generator 65 to produce tones corresponding to the notes C[#], A[#], B in the octave and note C₁ in the next higher octave. Each of these

pedals also has a switch section corresponding to the section 68b connected to line 72 for controlling the keyer 74. The output of the keyer 74 is applied to the control and voicing unit 80 which applies signals to the amplifier 60, which has previously been described.

The pedal generator 65 also applies signals to a second keyer 82. This keyer is actuated by pulser 84, which may also be controlled by the potential on line 72. The keyer 74 may apply tones to the control and voicing unit 80 for the normal bass sounds, such as 16 foot major bass and 16 foot sub bass. The keyer 82 may key signals from the pedal generator for a different sound, such as an 8 foot string bass sound. The output of the keyer 82 is also applied to the control and voicing unit 80 which selectively applies signals from keyers 74 and 82 to the amplifier 60, and controls the characteristic of these signals to provide the desired sounds.

The pulser 84 is also controlled by an automatic rhythm system including clock 86 which is actuated by the signal on line 72. Signals from the clock 86 are applied to the divider 88 which has a plurality of outputs producing pulses in fixed time relation to the clock input. The outputs of the divider 88 are applied to logic circuit 90 which applies pulses to the pulser 84 in a particular pattern to thereby actuate the keyer 82 to apply the string bass tones in such pattern. The logic circuit 90 also applies pulses to a switching circuit 92, which can be selectively controlled to apply pulses to a brush cymbal generator 94 and to a bass drum generator 95. Two connections are shown from the switching circuit 92 to the cymbal generator 94 to produce brush cymbal sounds of different characteristics. The switching circuit 92 also applies pulses to the modulator 96 for modulating tone signals applied thereto by the control unit 98. The structure of the clock 86, divider 88, logic circuit 90, switching circuit 92, and pulser 94 are shown in detail in FIG. 2, and will be further described therewith.

As shown in FIG. 1, the pedals 68, 75, 76, 77 and 78 have additional switch contacts associated therewith, including contacts 68c, 68d, 68e and 68f for pedal 68, and similar contacts for the other pedals. Signals are applied to these contacts from the dividers 30, 31, 34 and 35. Signals may also be applied to these contacts from the dividers corresponding to the other notes in the octave, which are not illustrated. The tone connected to contact 68c operated by the C pedal 68 is C, which is the root tone for the C major chord. The tone connected to contact 68d is G, which is the fifth note in the C major chord, and the tone connected to switch contact 68e is E, which is the third note of the C major chord. Accordingly, when the key 68 is operated and the switch contacts 68c, 68d and 68e are closed, these tones will be applied through switch 102 to the voice selection and control unit 98. The tone connected to contact 68f is D#, which is the third note of the C minor chord. As generators which produce the G and E notes are not shown, the notes are indicated by the switch contacts. Switch 100 in its normal position connects the tone signal applied through the switch contact 68e to point 97, where it is combined with the tone signals applied through the contacts 68c and 68d and applied through switch 102 to the control and voicing unit 98. Accordingly, the tones forming the C major chord are applied to the unit 98 when the C pedal 68 is operated, in the event that switch 102 is closed. If the switch 100 is actuated to the dotted position, the D# tone

from contact 68f is substituted for the third tone so that the tones C, G and D#, which form the C minor chord, are applied to the control and voicing unit. The switch 100 may be placed to be easily actuated by a foot of the organist, such as adjacent to the swell pedal.

Switch contacts corresponding to contacts 68c, 68d, 68e and 68f are associated with the pedals 75, 76, 77 and 78 and will be connected to the dividers 30, 31, 34 and 35 to provide the tones for the notes which make up major and minor chords for the associated pedals. These will be applied to the control unit 98 when switch 102 is closed. The tones forming the major chords are normally produced, with the minor chord being substituted when the switch 100 is moved to the dotted position.

The following table shows the notes in the chords played by the foot pedals:

Pedal	Major Chord			Minor Chord		
C	C	E	G	C	D#	G#
C#	C#	F	G#	C#	E	G#
D	D	F#	A	D	F	A
D#	D#	G	A#	D#	F#	A#
E	E	G#	B	E	G	B
F	F	A	C	F	G#	C
F#	F#	A#	C#	F#	A	C#
G	G	B	D	G	A#	D
G#	G#	C	D#	G#	B	D#
A	A	C#	E	A	C	E
A#	A#	D	F	A#	C#	F
B	B	D#	F#	B	D	F#
C	C	E	G	C	D#	G

The control and voicing unit may also receive tone signals, other than the tones forming the chords, which are applied at terminal 99. For example, tones may be applied to terminal 99 from an accompaniment manual of the organ. These tones will be modulated by the modulator when the rhythm system is switched for such operation.

The pedals 68, 75, 76, 77 and 78 each include a further set of 4 switch contacts which energize lamps adjacent the notes in one octave, to indicate the notes which are played in the chords. These contacts for the pedal 68 are indicated as contacts 68g, 68h, 68i and 68j. The contact 68g is connected to lamp 85 adjacent key C, and the contacts 68h, 68i and 68j will be connected to lamps adjacent the G, E and D# keys, respectively, on one octave of the keyboard. The lamp circuit is energized from +V potential through switch 104, with conductors extending therefrom to the fixed contact of the contacts 68g, 68h, 68i and 68j. The conductors extending to contacts 68i and 68j are selectively energized by switch 101, with the conductor connected to contact 68i being energized for major chords, and the conductor extending to contact 68j being energized for minor chords. The switch 101 is ganged with the switch 100 which controls the tones applied for major or minor chords.

Pedals 75, 76, 77 and 78 will also have contacts corresponding to the contacts 68g, 68h, 68i and 68j associated with the pedal 68 for energizing lights for the notes of chords played by these pedals. It is noted that the C chord is played by both pedals 68 and 78, and the same lamp 85 indicates the root tone in both cases. Also the pedals for notes D, D#, E, F, F#, G, G# and A will have contacts associated therewith for energizing lights for the notes of the chord played.

FIG. 2 shows in more detail the circuit of the pulser 84, the clock 86, the divider 88, the logic circuit 90 and the switching circuit 92 of the system of FIG. 1. The

pulser 84 for the string bass keyer is formed by the circuit including transistor 105 (FIG. 2). The voltage from line 72 (FIG. 1), applied by an actuated pedal switch, which is of the order of 18 volts, is applied through resistor 106, diode 107, and resistor 108 to the emitter electrode of transistor 105. This potential also flows through resistor 110 to charge capacitor 111, which is initially at ground potential. The voltage developed across capacitor 111, as it charges, is applied through resistors 112 and 113 to the base of transistor 105 providing a positive emitter to base potential. This causes transistor 105 to turn on so that the potential at the emitter of transistor 105 appears at the collector thereof, and is applied through resistor 114 to output terminal 115. Output terminal 115 is coupled to the keyer 82, (FIG. 1), to operate the string bass keyer. Capacitor 116 connected between the collector of transistor 105 and ground acts to filter out small transit voltage spikes.

As previously stated, pulser 84 is also actuated by the logic circuit 90 and this action takes place through transistor 120. A positive pulse appearing on line 121, in a manner to be explained subsequently, is applied across resistors 122 and 123, the junction of which is connected to the base of transistor 120. The emitter of transistor 120 is connected to ground and the collector is connected through resistor 124 to the junction of resistors 112 and 113. Transistor 120 acts as an inverter to apply a potential to the base of transistor 105 to render the same conductive.

The clock circuit 86 is shown in FIG. 2, together with the control circuit therefor. The clock circuit includes a programmable unijunction transistor 130 connected to provide repeating clock pulses. This circuit is controlled by the circuit including transistors 132 and 134. The emitter of transistor 132 is normally at ground potential, being connected thereto through the switching circuit 92, which will be explained. The potential on line 72 (FIG. 1), from an actuated pedal switch, is coupled through resistor 106 and diode 135 across resistor 136, and through resistor 138 to the base of transistor 132. This potential turns on transistor 132 so that current flows through collector resistor 139, and the voltage at the collector drops, producing a negative pulse. This negative pulse is coupled through resistor 140 to the base of transistor 134, turning on this transistor. When transistor 134 turns on, a positive pulse is developed across resistor 141 connected to its collector, which is applied through capacitor 142 to resistor 143. The voltage across resistor 143 is applied through conductor 144 to the trigger input of divider 146. Divider 146, as well as divider 148 to which it is coupled, may be standard integrated circuit dividers such as Model MFC6050 manufactured by Motorola, Inc., and sold by Motorola Semiconductor Products, Inc., Phoenix, Ariz. Each divider unit is a dual flip-flop with reset, and provides two outputs, the first being delayed with respect to the applied trigger pulse, and the second output having the same delay with respect to the first output.

The negative pulse produced at the collector of transistor 132 is also coupled through capacitor 150 to the junction of resistors 151 and 152, which are connected in series from B+ to ground. This junction is applied to the gate electrode of unijunction transistor 130 and applies a threshold voltage thereto. The negative pulse lowers the voltage applied from the junction of resistors 151 and 152 to the programmable unijunction transis-

tor 130 causing the same to conduct at a lower voltage. Capacitor 154 is normally charged from B+ through resistor 155 and potentiometer 156. When unijunction transistor 130 conducts, the potential across capacitor 154 is applied across resistor 143 and adds to the pulse developed thereacross which is applied to the trigger input of divider 146. This insures that there is sufficient energy to trigger the divider 146.

The negative pulse developed at the collector of transistor 132 is also applied through resistor 158 to the clamp terminals of the dividers 146 and 148 to remove the clamp therefrom. The dividers are normally clamped to an initial condition and when the clamp potential is removed they are in condition to be actuated by a trigger pulse. When the clamp is again applied, the dividers are immediately reset to the initial condition.

The clock circuit 86 will normally operate in a repeating mode, with the unijunction transistor 130 firing to apply the charge on capacitor 154 to resistor 143. The voltage divider including resistors 151 and 152 applies a threshold voltage to the trigger electrode of the unijunction transistor. When the voltage across capacitor 154 reaches this threshold, the transistor 130 will fire. The capacitor 154 will therefore be discharged, and will start to charge again as soon as unijunction transistor 130 ceases conduction. The time required for the capacitor 154 to charge will depend upon the value of B+ and the resistance in series therewith. Potentiometer 156 is variable to control the series resistance to thereby control the charge time and the repetition rate of the clock pulses. Although the clock pulses are continuously applied to the divider 146, the divider cannot produce an output when it is clamped. When the circuit is triggered by the potential applied at terminal 72 to actuate transistor 132, this drops the threshold voltage applied to unijunction transistor 130 so that it will conduct even though the capacitor 154 has not charged to the voltage which will normally trigger the unijunction transistor 130. This insures that the clock pulse train will start at the time the triggering pulse is applied.

After the divider 146 receives a trigger pulse, it will produce a first square wave output on line 160, which is used to strobe the logic. The second output applied on line 161 forms the $\bar{Q}_1$ output, and is inverted by transistor 162 to form the Q_1 output. This second output on line 161 is also applied as the trigger input on divider 148. The first output of divider 148 on line 164 forms the $\bar{Q}_2$ output, and is inverted by transistor 166 to form the Q_2 output. The second output of divider 148 on line 167 forms the $\bar{Q}_3$ output and is inverted by transistor 168 to provide the Q_3 output. The strobe output and the six additional outputs provide 8 count information which is applied to the logic circuit to form the various rhythm patterns.

FIG. 5 shows the action of the clock 86, divider 88, and logic circuit 90. When a pedal is depressed, the voltage which appears on line 72 renders the transistor 132 conducting to provide the pedal gate illustrated in FIG. 5. This acts to synchronize the clock and apply a driving pulse to the divider, as previously described. This action is illustrated in FIG. 5 which shows the clock pulses being synchronized at the Sync Point, with the pedal gate action. This also starts the dividers, and the strobe output therefrom is shown with the Q_1 , Q_2 and Q_3 outputs. The $\bar{Q}_1$, $\bar{Q}_2$ and $\bar{Q}_3$ outputs are not shown, but are the inverse of the Q_1 , Q_2 and Q_3 outputs, respectively. The pedal gate period lasts as long as a

pedal is depressed, and in FIG. 5 the pedal is indicated to be depressed for a time a little longer than the 8 count period provided by the dividers.

The outputs from the divider 88 are applied to the input of the logic circuit 90 which includes six AND gate circuits 170, 171, 172, 173, 174 and 175. This is a positive going logic system with the positive strobe output being selectively applied to the AND gate outputs. Considering circuit 170, the strobe output on line 160 is applied to resistor 180 and will be applied through diode 181 to terminal 1 in the event that the diodes 182, 183 and 184 are not conducting. These diodes are connected to the Q_1 , Q_2 and Q_3 outputs of the divider, and if any of these outputs is in a low state so that the diode connected thereto conducts, the strobe pulse will be absorbed in resistor 180 and not appear at the count 1 output terminal. Accordingly, a voltage will appear at this output terminal of AND gate circuit 170 only for count 1, and this is illustrated in FIG. 5.

The AND gate circuit 171 is generally similar to the AND gate circuit 170, but has diodes connected to the Q_1 , Q_2 and Q_3 outputs. This will produce an output at terminal 3 only for count 3 from the divider. Similarly, AND gate circuit 172 had diodes connected to the Q_1 , Q_2 and Q_3 outputs of the divider, and produces an output at terminal 4 for the count 4 pulse. AND gate circuit 173 has diodes connected to the Q_1 , Q_2 and Q_3 outputs of the divider, providing an output at terminal 5 for count 5. This is shown in FIG. 5. The outputs at terminals 3 and 4 are not shown to simplify the drawing.

AND gate circuit 174 has diodes connected to the Q_1 , Q_2 and Q_3 outputs, providing an output at terminal 7 for count 7. AND gate circuit 175 has diodes connected to the Q_1 and Q_3 outputs providing outputs at counts 6 and 8 at the terminal 6-8. The outputs of the AND gates provide the pulses representing the counts necessary for the rhythm patterns to be provided.

The logic circuit 90 includes a plurality of OR gate circuits coupled to the AND gate circuits for providing rhythm patterns which are utilized in the rhythm system. Each OR gate circuit has an output terminal at which a rhythm pattern appears. The J output terminal is connected to an OR gate circuit having diodes coupled to the outputs of AND gate circuits 170 and 173, which applies pulses to the J terminal at the number 1 and 5 counts. This is illustrated in FIG. 5.

The K output terminal is coupled by OR gate diodes to AND gate circuits 171 and 173 to provide a pattern formed by the number 3 and number 5 counts. The L output terminal is coupled by the OR gate circuit to the outputs of AND gate circuits 171 and 174 to provide the number 3 and number 7 counts. The M output terminal is coupled by OR gate diodes to the outputs of AND gates 170, 173 and 174 to provide the number 1, 5 and 7 counts. The N output is connected by the OR gate circuit to the output of AND gate circuits 171, 172 and 175 to provide counts 3, 4 and 7. The O output is connected through OR gate diodes to the outputs of AND gates 170, 171, 173 and 175 which provides the count 1, 3, 5 and 7 pattern. And the P output of the OR gate logic is connected to the outputs of the AND gate circuits 170, 171, 172, 174 and 175 which provide a pattern including counts 1, 3, 4, 7 and 6-8.

The logic circuit 90 is connected to the switching circuit 92 to provide the different patterns to be selected thereby. In addition to the rhythm patterns provided by

the OR gate outputs J, K, L, M, N, O and P, the strobe output at terminal H, and outputs from the AND gate circuits are also utilized in the circuits established by the switching circuit 92.

The rhythm system has two basic modes of operation. In one mode, which is referred to as the touch or gated mode, the system is initiated by operation of a foot pedal, as has been described. In the second mode of operation, the rhythm pattern system will operate continuously until a clamp or reset voltage is applied to the frequency dividers. The different rhythm patterns which are controlled by the switching circuit 92 (FIG. 2) are STANDARD POP or fox trot, controlled by switch 190, SWING controlled by switch 191, ROCK controlled by switch 192, LATIN AMERICAN controlled by switch 193, and WALTZ controlled by switch 194. These are continuous rhythm patterns. In addition, the gated or touch patterns are WALTZ, controlled by switch 195 and STANDARD POP, controlled by switch 196. FIG. 4 shows the control panel on which the switches are provided.

In addition to the switches for selecting rhythm patterns, switch 197 provides DRUM CANCEL, switch 198 provides CHORD CANCEL and switch 199 is the OFF switch for the rhythm pattern system. The switches are all two position switches, and the contacts are shown in a first or unactuated position. Each of the switches has a plurality of contacts, some of which are double throw contacts and some are single throw contacts.

When either of the switches 195 or 196 for the gated or touch operation is actuated, B+ potential is applied through contact 195a of WALTZ switch 195 and contact 196a of STANDARD POP switch 196 across resistor 136 of the clock control circuit. This holds transistor 132 conducting so that its collector is near ground and the clamp is removed from the dividers 146 and 148. This allows the dividers to operate continuously.

When the STANDARD POP switch 190 is depressed, switch contacts 190a and 190b are closed. Contact 190a connects the J output rhythm pattern to bus 200, which is in a circuit for actuating the bass drum 95 (FIG. 1). Contact 190b connects the OR gate output at terminal L to bus 202, which actuates the brush cymbal circuit 94 (FIG. 1). Bus 202 provides the long brush cymbal operation. It will therefore be seen that the J output, which is a 1, 5 count pattern, is applied to the bass drum, and the L output, which is a 3, 7 count pattern, is applied to the long brush circuit in the STANDARD POP mode of operation.

For the SWING rhythm pattern, switch 191 is actuated to close contacts 191a, 191b and 191c. Contact 191a applies the J pattern to the bass drum bus 200, and contact 191b applies the L rhythm pattern to the long brush bus 202, as in the STANDARD POP mode. However, in the SWING mode of operation, contact 191c also applies the J pattern to the short brush bus 204. Accordingly, the short brush cymbal will be sounded with the base drum on counts 1 and 5, and the long brush will be sounded at the intermediate counts 3 and 7.

For the ROCK pattern, switch 192 is actuated closing contacts 192a, 192b and 192c. Contact 192a applies the O pattern including counts 1, 3, 5 and 7 to the bass drum bus 200. Contact 192b applies the N pattern to the long brush bus, and this includes counts 3, 4 and 7. Contact 192c connects the strobe output at terminal H

to the short brush bus 204, so that short brush is actuated on each of the 8 counts of the rhythm.

For the LATIN pattern, switch 193 is actuated to close contacts 193a, 193b and 193c thereof. Contact 193a applies the M pattern to the bass drum bus 200, so that it is actuated on counts 1, 5 and 7. Contact 193b applies the P pattern to the long brush, so that it is actuated at counts 1, 3, 4, 6, 7 and 8. Contact 193c applies all of the counts from the strobe output H to the short brush so that it is repeatedly operated at a rate determined by the clock.

For a WALTZ rhythm pattern, switch 194 is actuated. Switch 194 includes contacts 194a, 194b, 194c and 194d, all of which are normally open and actuated by the switch. Contact 194a applies the count 1 from the output of AND gate 170 to the bass drum bus 200. Contact 194b applies the K pattern to the long brush bus 202 so that the 3 and 5 counts are sounded by the long brush. Contact 194c applies B+ to the voltage divider including resistors 206 and 207. This acts to bias off diodes 208 so that 5 count is not applied through capacitor 209 during WALTZ action. The operation of this circuit for other modes of operation will be described. Contact 194d connects the 6-8 count output from AND circuit 175 to the waltz reset line 210. This acts to turn off transistor 132 to reset the counter at the 6 count. Although the 8 count will also be applied to this line, it will not be effective because the counters will have been reset on the 6 count.

Considering now the gated or touch WALTZ mode, switch 195 is actuated for this mode of operation. Contact 195b applies count 1 to the bass drum bus 200, and contact 195c applies the K pattern including counts 3 and 5 to the long brush bus 202, as in the continuous WALTZ mode. Contact 195a, when opened, removes the connection of B+ from conductor 188, and thus removes the B+ potential from across resistor 136. This causes transistor 132 to clamp the dividers 146 and 148 so that they are not continuously operable. However, the voltage from the pedal board will cause transistor 132 to conduct to remove the clamp, as has previously been described. The normally open contact is engaged by contact 195a to connect B+ to the divider including resistors 206 and 207, as in the standard WALTZ mode. Also, contact 195d applies the 6-8 count output from AND gate circuit 175 to the waltz reset line, as for the continuous WALTZ operation.

To provide the gated STANDARD POP mode, switch 196 is actuated. This closes contacts 196b and 196c to apply the J pattern to the bass drum bus 200, and the L pattern to the long brush bus 202, as in the non-gated STANDARD POP mode previously described. Actuation of the switch 196 will, in addition, open contact 196a to remove the B+ voltage from conductor 188, which is applied across resistor 136. Transistor 132 thus conducts only when a pedal is operated, as previously described, and the dividers will be clamped except when the pedal voltage is applied.

The DRUM CANCEL switch 197 includes contacts 197a and 197b. Contact 197a is opened by the switch to open the circuit from the bass drum bus 200 to the conductor 201 which is connected to the bass drum circuit. Contact 197b of switch 197 grounds conductor 203, which disables the brush cymbal circuit. Accordingly, actuation of switch 197 prevents both the bass drum and cymbal generators from operating.

CHORUS CANCEL switch 198 has contacts 198a and 198b which are normally closed. Contact 198a is connected to the long brush bus 202 through contact 199a of OFF switch 199. Switch contact 199a is normally closed so that the pulses applied to the long brush bus 202 are applied through contact 198a to bus 205 which is connected to the modulator 96 (FIG. 1). Accordingly, in the normal operation, the same pulse pattern is applied to the modulator 96 as to the brush cymbal generator for long brush operation. The modulator acts to attenuate or chop any signals applied thereto from the control unit 98 and is used in particular to chop the chord signals applied thereto, as has been previously described.

Contact 198b of CHORD CANCEL switch 198 is coupled in series with OFF switch contact 199b and conductor 212 to the output of AND gate 170 to derive the 1 count pulse therefrom. Conductor 214 is connected from the output of AND gate 173 through capacitor 209 and diode 208 to apply the 5 count to conductor 212. Diodes 208 is effective to apply the number 5 count except when the WALTZ switches 194 and 195 are actuated, in which case diode 208 is biased off by the voltage applied from the divider including resistors 206 and 207. The 1 and 5 counts on conductor 212 are applied through the normally closed contacts 199b of the OFF switch, and 198b of the CHORD CANCEL switch to conductor 121 connected to resistors 122 and 123. The junction of these resistors is connected to the base of transistor 120 to render the same conductive. This actuates the string bass pulser by rendering transistor 105 conducting. As previously stated, transistor 105 connects the voltage provided by operation of a pedal applied on conductor 72 to the string bass keyer terminal 115 for actuating keyer 82 (FIG. 1). This causes whatever bass note is generated by actuation of a pedal to be gated to provide a string bass sound at the number 1 and 5 counts of the rhythm pattern. This will occur in all modes except the WALTZ modes, as the number 5 count is blocked in the WALTZ modes and only the number 1 count is applied. This string bass sound can be produced with the other percussion sounds, or alone by actuation of the DRUM CANCEL switch 197.

When the CHORD CANCEL switch 198 is operated, contacts 198a and 198b are open so that the modulating signals are not applied to the modulator 96, and the pulsing signals are not applied to the string bass keyer 82. Contact 198c applies a ground to conductor 215, which is connected to the modulator, to disable the same, as will be described.

The OFF switch contacts 199a and 199b, which have previously been described are double throw contacts and in addition to breaking the circuit to the modulator line 205, and the pulser line 121 establish other circuits when the OFF switch is operated. Contact 199a, when the switch is operated, connects terminal 216 through contact 198a of chord switch 198 to the modulator line 205. This allows operation of the modulator 96 by an external input applied at terminal 216. Similarly, contact 199b, when the switch 199 is operated, connects terminal 217 through contacts 198b of switch 198 to line 121 for actuation of the string bass pulser. Signals can be applied to the inputs 216 and 217 from an external rhythm device to operate the modulator and the string bass keyer. Contact 199c of switch 199 provides a connection from terminal 218 to the modulator dis-

able line 215, which may be required when using the system with an external rhythm device. Switch contact 199b normally connects conductor 219 to ground to thereby provide a ground for the emitter of transistor 132. This connection is made through jumper conductor 220, which can be removed when the system is used with an auxiliary or remote rhythm device. When the OFF switch is operated, contact 199d grounds the modulator disable line 215 through conductor 220. The conductor 220 must be removed if it is desired to actuate the modulator from an external rhythm device with the OFF switch 199 operated.

FIG. 4 shows the control panel used with the rhythm device. The switches 190 through 199 are numbered as in FIG. 2. This panel also includes chord switch 102 for applying the tones for the notes of the chords from the pedal switches to the modulator 96, and switch 104 which controls the lights which indicates the notes of the chord being played. The tempo or speed of the rhythm is controlled by rotary knob 156 which controls the potentiometer 156 controlling the clock 86 (FIG. 2). The downbeat lamp 225 on the control panel is controlled by the circuit shown in FIG. 8.

FIG. 6 shows the circuits of the bass drum generator 95 and the brush cymbal generator 94. A positive going pulse comes in on bass drum line 201 from the switching circuit of FIG. 2, and is applied across resistor 230 and is differentiated by capacitor 231 and resistor 232. The differentiated pulse is coupled through diode 233 and isolating resistor 234 to the tank circuit including coil 235 and capacitor 236. Coil 235 and capacitor 236 form a circuit resonant at a frequency of the order of 50 cycles per second, and the applied pulse shocks the circuit into oscillation. The oscillations are coupled through resistor 238 to amplifier 240, and may then be applied to the organ output circuit 60, in the system of FIG. 1.

The brush cymbal generator includes a white noise generator formed by the base emitter diode of transistor 250, which is connected to B+ through the large resistor 251. The noise is coupled through capacitor 252 to the base of transistor 253 which develops amplified noise across potentiometer 254. The level of noise is selected by the setting of the potentiometer 254, and applied through capacitor 255 and resistor 256 across the circuit including resistor 257 and the base emitter junction of transistor 258. This voltage is applied to the base of transistor 260.

The pulses from the long brush bus 202 of the switching circuit of FIG. 2 are divided by resistors 261 and 262, and the voltage across resistor 262 is differentiated by capacitor 263 and resistor 264. The differentiated pulse is applied through diode 265 across capacitor 266, and through isolating resistor 267 to the base of transistor 260. This gates transistor 260 so that it passes the white noise signal for the desired time duration. The output of transistor 260 is coupled through capacitor 270 to the tuned circuit including inductor 271 and capacitor 272. This tuned circuit is resonant at a frequency of the order of 2000 cycles per second and emphasizes the desired brush cymbal frequency. The output signal is applied through isolating resistor 274 to the amplifier 240.

Similarly, the pulses on the short brush bus 204 are coupled to the divider including resistors 276 and 277. The voltage across resistor 277 is differentiated by capacitor 278 and resistor 279, and the differentiated

pulse is coupled through diode 280 across capacitor 281, and through isolating resistor 282 to the base of transistor 260. This gating circuit is selected to provide a shorter burst of white noise for the short brush cymbal sound. This is amplified by transistor 260 and applied to amplifier 240, with the long brush signals.

The brush cymbal cancel voltage on conductor 203 from the switching circuit is applied in the circuit of FIG. 6 to the diodes 285 and 286. Actually the cymbal cancel voltage is ground potential and this grounds the dividers through which the long and short brush pulses are applied. Accordingly, there is no voltage across resistors 262 and 277 when the brush cancel ground is applied to bus 203, and transistor 270 will not be gated to provide the brush cymbal signal.

The chord modulator 96 which is illustrated as a block in FIG. 1 is shown in detail in FIG. 7. The signal from the control unit 98 is applied to conductor 290, and through capacitor 291 and resistor 292 to the modulating device 294. The modulating device 294 is an electronic attenuator which may be model MFC6040 Electronic Attenuator, manufactured by Motorola, Inc., and sold by Motorola Semiconductor Products Inc., Phoenix, Ariz. This has an input terminal 295 to which the tone signals are applied, and a control terminal 296 to which the modulating voltage is applied.

The modulating voltage from the switching circuit 92 is applied on conductor 205 across the voltage divider including resistors 300 and 301. The voltage from the divider is coupled to the base of transistor 302, the collector of which is connected to resistors 303, 304 and 305. The input impedance of transistor 306 is connected across resistor 305 and cooperates with the resistors to provide the required control voltage for the modulator. Transistor 306 forms an emitter follower and the emitter voltage is applied through resistor 307 to the control terminal of the modulator device 204. The voltage normally applied may have a value of about 5 volts to provide attenuation of the applied tones of around 30db. The logic pulse on line 205 causes transistor 302 to turn on to increase the voltage drop across resistor 303. This drops the voltage across resistor 305, and the voltage applied to control terminal 296 of the attenuator 294 may be about 3.5 volts. This reduces the attenuation and the tones applied to the device 294 are applied therethrough with substantially no attenuation. Capacitor 308 rounds the corners of the square modulating pulse. The duty cycle of the modulator is controlled primarily by the pulse applied on conductor 205.

When the ground is applied to disable line 215 by the switching circuit 92 (FIG. 2), the potential applied to the control terminal 296 of the attenuator 294 is lowered so that this device has substantially no attenuation, and the tone signals on input conductor 290 are applied to the inverting amplifier 310. The inverting amplifier is then coupled to the output amplifier of the organ, indicated as 61 in FIG. 1.

A lamp driver circuit is provided for energizing the down beat lamp shown on the control panel of FIG. 4. This circuit is illustrated in FIG. 8. A pulse is applied to the input terminal 312 from the AND gate circuit 170 which provides the 1 count of the rhythm pattern. This is coupled through resistor 314 to Darlington coupled transistors 315 and 316. The Darlington transistors are connected through the down beat lamp 225 and resistor 318 to the B+ supply. Accordingly, each

time the number 1 count is produced, the light 225 will be energized and illuminated on the control panel.

In FIG. 9 there is illustrated a circuit which can be used in the organ which has been described for playing the fifth note of the chord at a lower pitch, and at a particular count in the rhythm pattern. The input terminal 320 is connected to the terminal 91 (FIG. 1) on the conductor which applies the tone for the fifth note of the chord from the pedal switches, such as switch 68d, to the chord switch 102. When the circuit of FIG. 9 is used, this conductor is broken between terminals 91 and 93, with the tone being applied from terminal 91 to this circuit, and then applied from the circuit to terminal 93. The tone applied at terminal 320 (FIG. 9) is passed through isolation amplifier 322 to output terminal 324. The output terminal 324 is connected to terminal 93 (FIG. 1) to apply the tone for the fifth note in the chord thereto; so that this tone is applied with the other tones for the chord through the switch 102.

The tone representing the fifth note is shaped by clipper limiter 325 and applied in sequence to divider 326 and divider 327. Each of the dividers divides by two, and the outputs are applied through resistors 328 and 329, respectively, and summed at point 330. Each divider output will be essentially a square wave, and the two outputs when summed will provide a saw-tooth wave, generally as shown in FIG. 3, which is applied to gate 331. The pulse from the AND gate circuit 173 (FIG. 2) of the logic circuit, which is the 5 count of the rhythm, is applied at control terminal 332 (FIG. 9), and passed through pulse shaper 334 to control the keyer 331. This will cause the fifth tone to be passed by the keyer at the 5 count in the rhythm. The output of the keyer 331 is applied to amplifier 335, and then to the output system of the organ.

The electric organ which has been described includes unique chord playing and rhythm facilities. Chords can be played by operation of the foot pedals, and either the major or minor chord associated with the note of the pedal can be selected. It will be apparent that other chord patterns, such as diminished chords, can be provided if desired. The rhythm system can be used to chop the chords in various different rhythm patterns, and can also control various percussion generators such as bass drum and cymbal generators. The rhythm system can also be used to control a string bass pulser to provide string bass sounds at various counts in the rhythm. The rhythm system can be operated in a gated mode wherein it is actuated by the pedals of the organ, or in a continuous mode.

I claim:

1. A rhythm system for use with an electric organ including in combination:

clock means for producing a train of clock pulses occurring at a given repetition rate;

divider means connected to said clock means for producing timing voltages at time intervals controlled by said clock pulses, said divider means being adapted to be reset by a potential applied thereto;

logic means connected to said divider and having a plurality of outputs, said logic means producing at each output pulses in a different rhythm pattern under control of said clock pulses;

operating means for the rhythm system;

switch means connecting said outputs to said operating means for selectively applying said pulses for said rhythm patterns thereto; and

clamp means connected to said switch means and responsive to operation thereof, said clamp means including means for applying a clamp potential to said divider means for resetting the same.

2. A rhythm system in accordance with claim 1 wherein said clamp means is connected to said switch means and applies said clamp potential in response to a potential applied to said clamp means by said switch means.

3. A rhythm system in accordance with claim 1 wherein said clamp potential is applied in response to a particular pulse of one rhythm pattern.

4. A rhythm system in accordance with claim 1 wherein said clamp means is coupled to said clock means and controls the same to initiate a pulse train at the time the clamp potential is removed, with said divider means being operative when said clamp potential is removed to produce the timing voltages.

5. A rhythm system in accordance with claim 1 including trigger means coupled to said clamp means for operating the same to remove the clamp potential.

6. A rhythm system in accordance with claim 5 wherein said clamp means is coupled to said clock means and to said divider means, said clamp means being responsive to said trigger means to apply a driving pulse to said divider means and cause said clock means to initiate a pulse train including a first pulse which is coincident with said driving pulse and which is applied to said divider means to supplement said driving pulse.

7. A rhythm system in accordance with claim 1 wherein said operating means includes a modulator for modulating tone signals in accordance with the selected rhythm pattern.

8. A rhythm system in accordance with claim 1 wherein said operating means includes percussion generator means, said percussion generator means producing signals in response to said pulses of the selected rhythm pattern applied thereto by said switch means.

9. A rhythm system in accordance with claim 8 wherein said percussion generator means includes means producing signals for bass drum sounds.

10. A rhythm system in accordance with claim 8 wherein said percussion generator means includes signal means producing signals for brush cymbal sounds, and gating means coupled to said signal means and controlled by said pulses of the selected rhythm pattern applied by said switch means.

11. A rhythm system in accordance with claim 10 wherein said gating means includes a first gate portion for providing short cymbal signals and a second gate portion for producing long cymbal signals, and said switch means includes separate portions for applying pulses to said first and second gate portions for separate rhythm patterns.

12. In an electric organ having tone generator means for producing signals representing musical notes, which are controlled by a keyboard, and which are controlled by a pedal board having pedals for applying tones for bass notes, the combination including,

a plurality of switches coupled to each of the pedals and actuated thereby,

means applying signals from the generator means to said switches for selection thereby, with the signals applied to said switches for each pedal corresponding to notes of chords which include the bass note applied by such pedal and including a first signal of

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the frequency of a note in a first chord and a second signal of the frequency of the corresponding note in a second chord,
switch means connected to said plurality of switches for selecting one of said first or second signals,
a plurality of lights associated with the keys of the keyboard for indicating the notes of the chords played,

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further switches coupled to said pedals for energizing said lights, said further switches being connected between a voltage supply and said lights, and further switch means enabling said further switches to energize the light indicating the note of the said first chord or the said second chord.

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