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Arsem et al.

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[54] **AUTOMATIC RHYTHMIC CHORDING UNIT**

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[52] **U.S. Cl.** **84/1.03**, 84/1.13, 84/1.17, 84/1.24, 84/1.26

[51] **Int. Cl.**.....**G10f 1/00**

[58] **Field of Search**.....84/1.01, 1.03, 1.24, 1.26, 84/DIG. 22, DIG. 23

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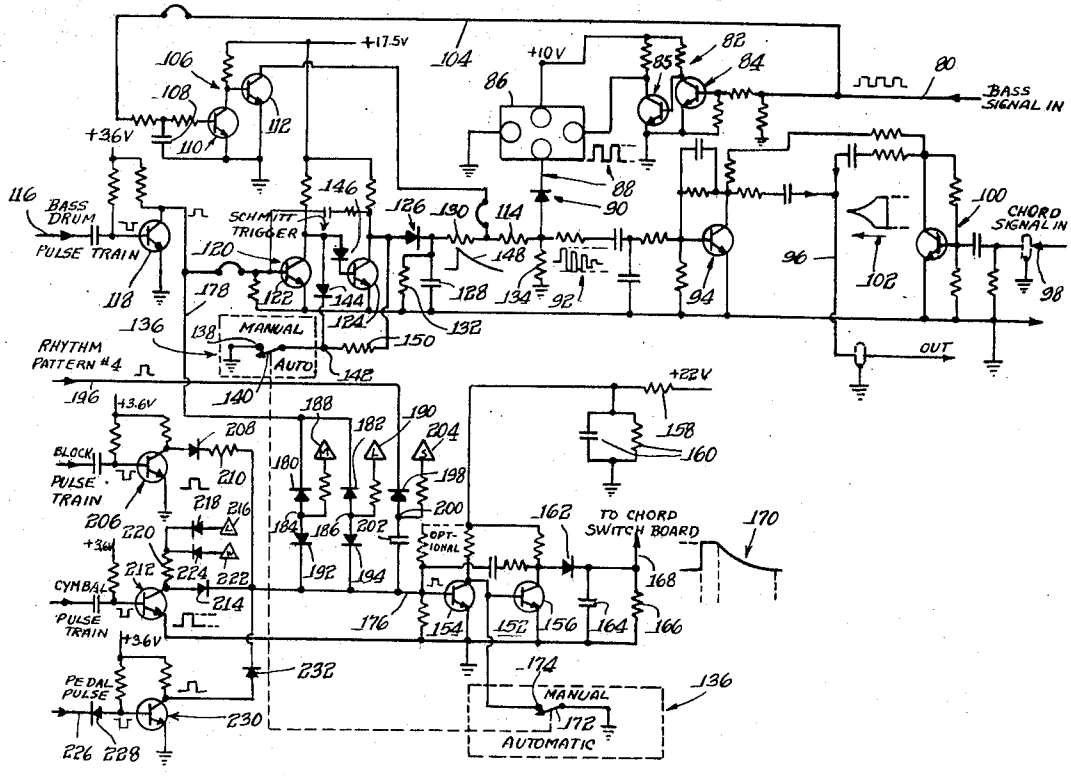
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[57] **ABSTRACT**

A keyboard musical instrument is provided having a keyboard for playing solo or lead. Automatic switching also is provided for producing predetermined percussive-type rhythm patterns and sounds, and is operable with a plurality of chord buttons to play predetermined chords and also a related bass note. The chords and bass note may be alternated, the bass note being the root of the chord or its fifth preferably alternating.

4 Claims, 5 Drawing Figures

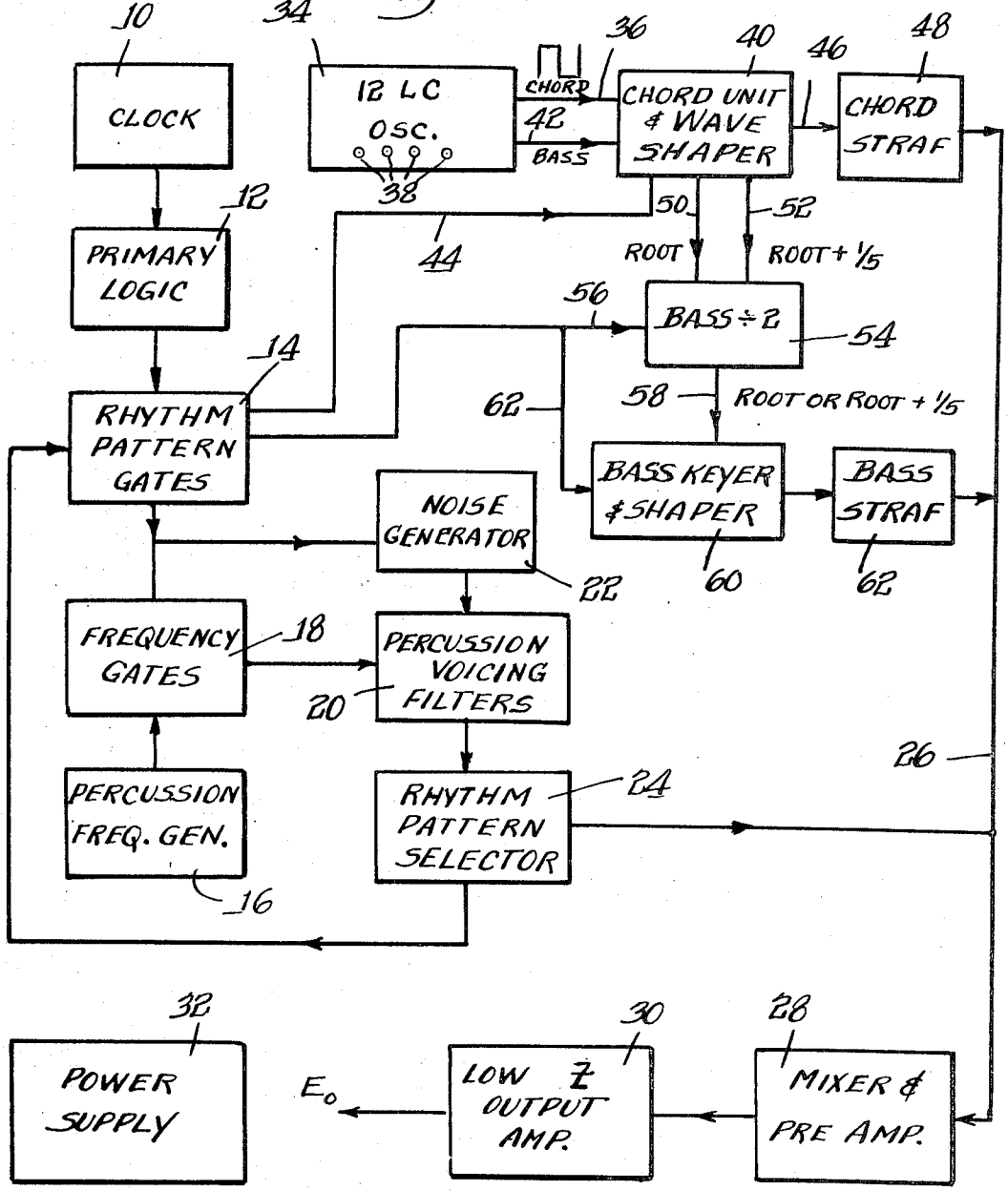


PATENTED DEC 19 1972

3,706,837

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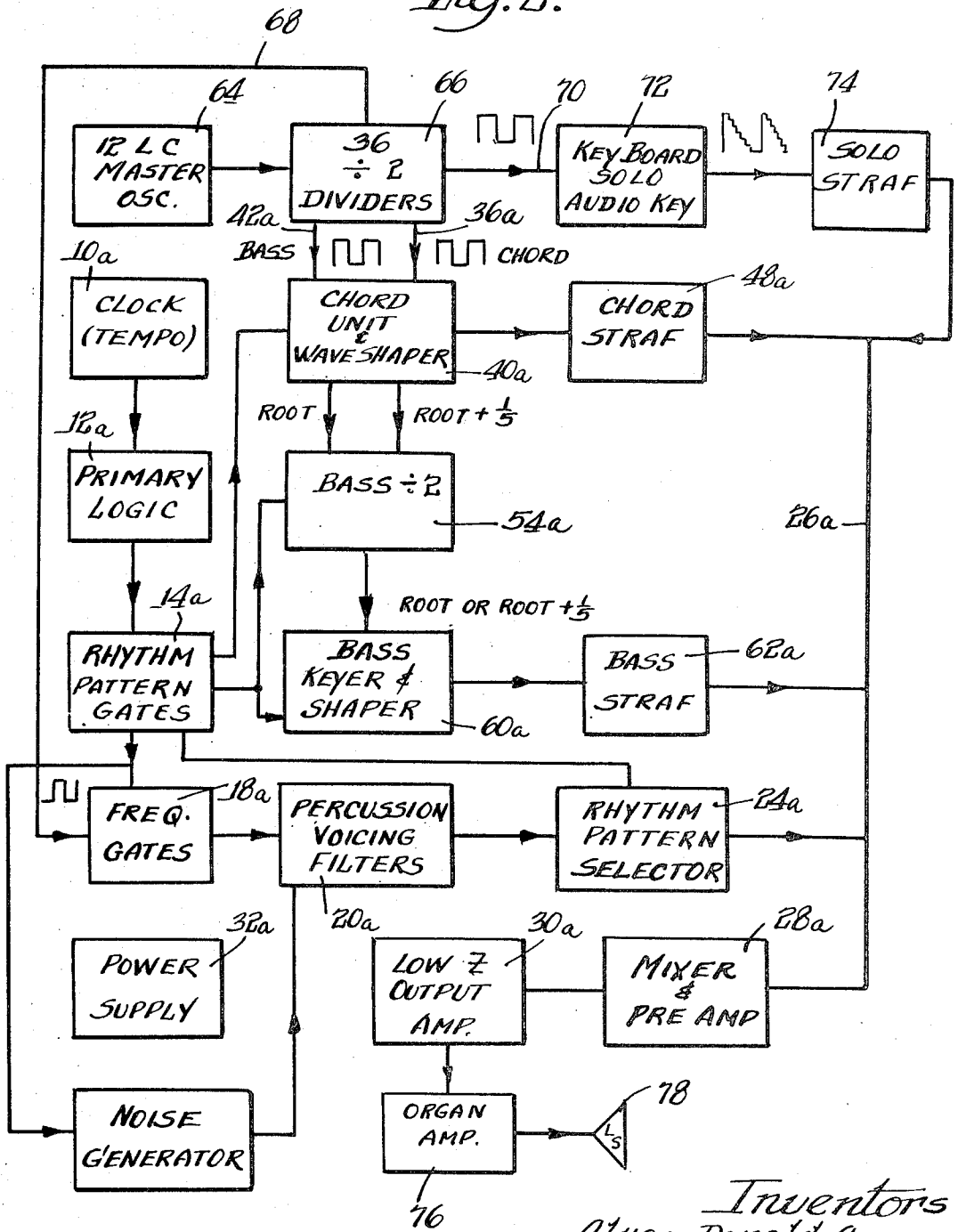
Fig. 1.



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Fig. 2.



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PATENTED DEC 19 1972

3,706,837

SHEET 3 OF 5

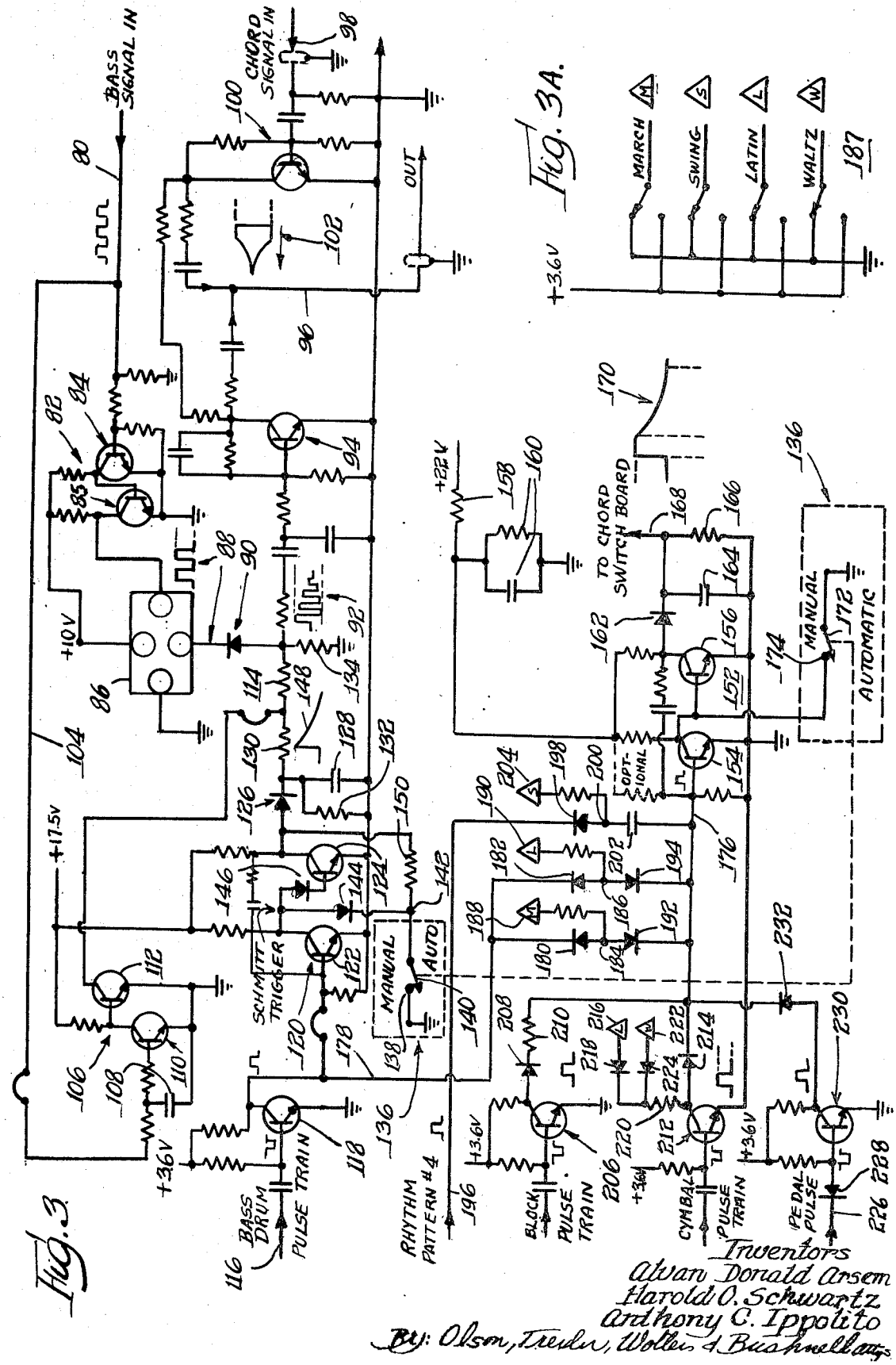


Fig. 3

Fig. 3A.

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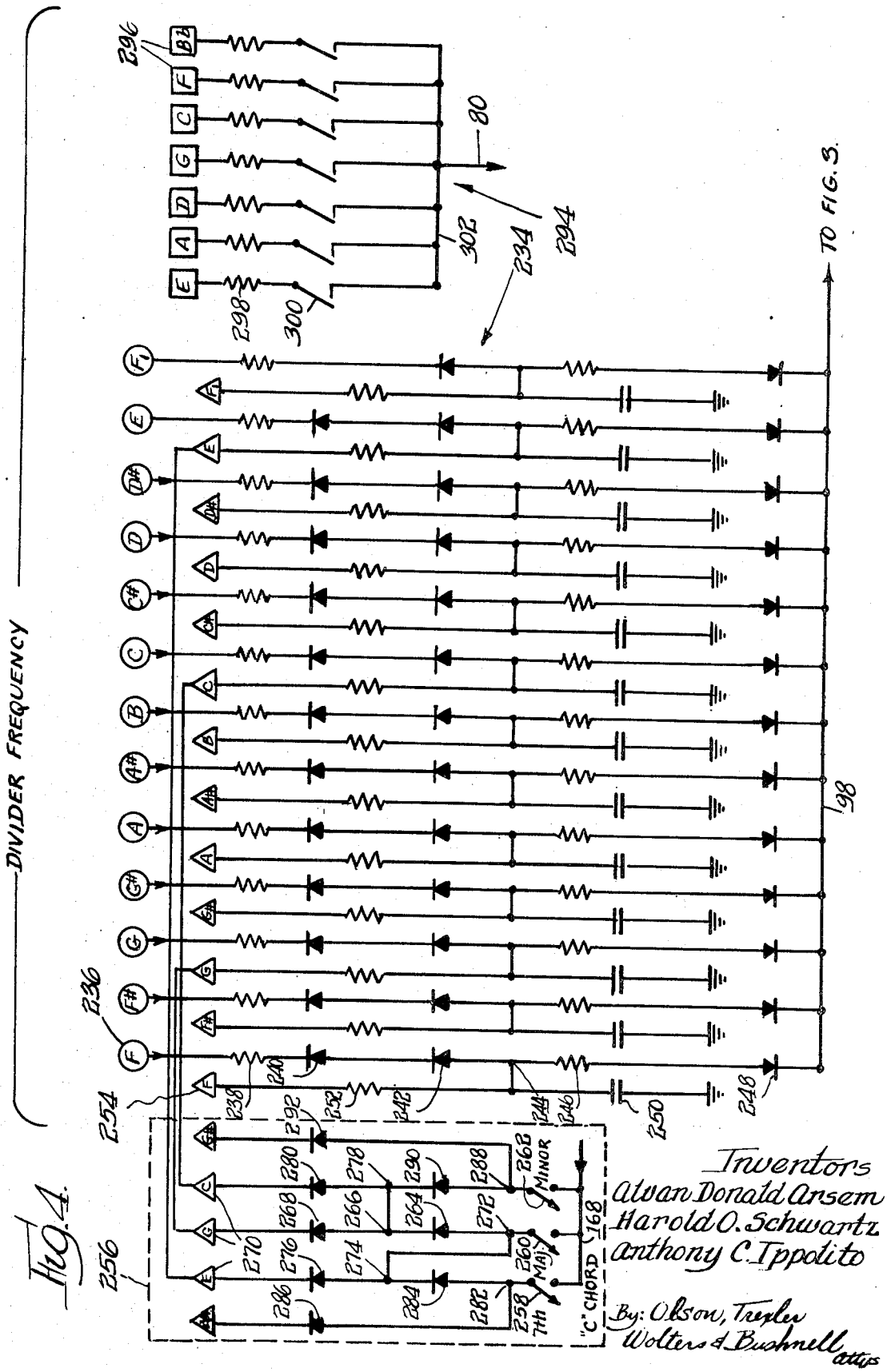


Fig. 4.

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3,706,837

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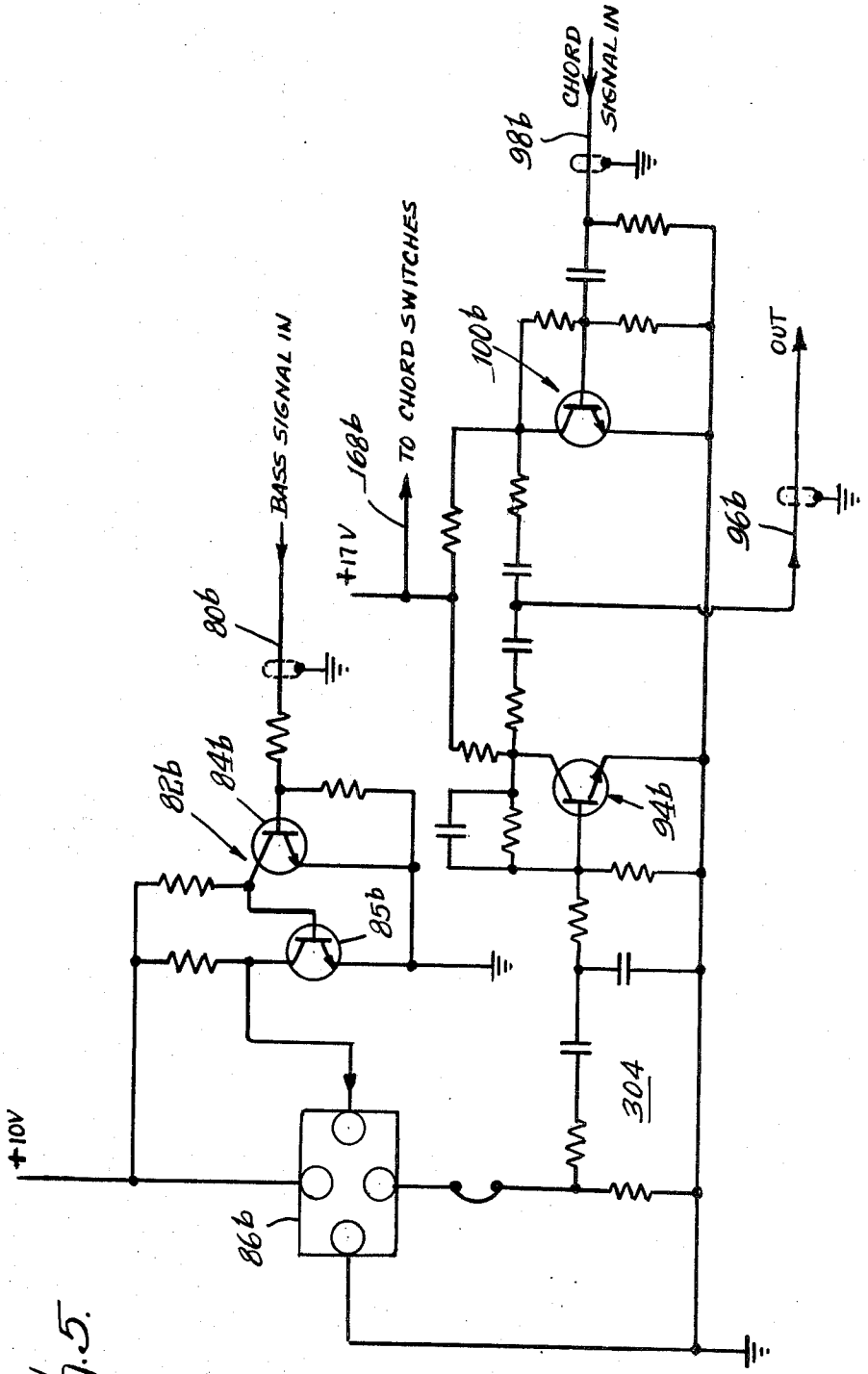


Fig. 5.

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AUTOMATIC RHYTHMIC CHORDING UNIT

Electronic organs have enjoyed considerable commercial success and popularity in recent years. Although it is not particularly difficult to learn to play an electronic organ, there are those who do not have the time or the inclination to learn to play, using the left hand as well as the right and one or both feet in conventional manner, as for playing chords and bass notes. Heretofore, there have been electronic chord organs developed wherein a plurality of buttons is provided, each of which is pushed to play a preset chord. Conventionally, each chord is held on until the chord changes, and the player then pushes another chord button. This is remarkably easy to master, but in relatively short order becomes rather monotonous. Accordingly, chord organs of the aforesaid type have fallen out of favor.

Electronic switching techniques have now been advanced to a point where rhythm devices are well known in the patent art and in the market place. A master clock, a series of dividers, and a matrix or other combining network or devices provide substantially any desired rhythm pattern. Electronic waves corresponding to various percussive tones such as drums, cymbals, etc. are keyed or gated in accordance with the foregoing combination to provide the desired tones.

In accordance with the present invention, such electronic switching is utilized to provide not only percussive rhythm tones, but to play selective chords and related bass notes alternatively.

In accordance with the present invention, a plurality of oscillators is provided to produce the notes necessary for chords in at least three or four basic musical keys. A timer or clock and logic devices of known construction are used to key the selected chords on and off in accordance with pre-set rhythm patterns. The logic devices further may alternate the chord played with the root and/or fifth of the chord. At the same time, the clock and logic devices control the playing of rhythm sounds such as bass drum, snare, block, cymbal, and brush, along with the playing of the chords and bass notes.

The invention will be best understood with reference to the following description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a block diagram showing a simplified form of the invention;

FIG. 2 is a block diagram showing a somewhat more complex form of the invention as incorporated in an electronic organ and using the generators thereof;

FIG. 3 is an electrical wiring diagram showing certain details of FIG. 2;

FIG. 4 is another electrical wiring diagram showing additional details; and,

FIG. 5 is yet another electrical wiring diagram showing a system for the playing of chords without automatic rhythm.

Turning now to FIG. 1, there will be seen a basic timer or clock **10**. This clock and the ensuing parts now to be described are generally similar to those disclosed in Harold O. Schwartz, Peter E. Maher and John E. Holt application for U. S. Pat., Ser. No. 827,234, filed May 23, 1969 for "An Electronic Ryhthm Generator Particularly Suitable for Integrated Circuitry" (prosecution on the merits having been closed by a communication from the Examiner Nov. 2, 1970) to

which reference may be made if it is desired to ascertain the circuits accompanying the block diagrams shown herein. The clock **10** is connected to a primary logic unit **12** which in turn is connected to rhythm pattern gates **14**.

A plurality of percussion frequency generators **16** is provided, such, for example, as for bass drum, snares, etc., and these percussion frequency generators are connected to frequency gates **18** which are controlled by the rhythm pattern gates **14** as indicated. The outputs from the frequency gates **18** are connected to percussion voice filters **20**. In addition, a white noise generator **22** is provided which is controlled by the rhythm pattern gates to simulate the sizzle sound of a cymbal. The output of the noise generator **22** is likewise connected to the percussion voice filters. The output of the percussion voice filters is connected to a rhythm pattern selector **24**, which is connected back to the rhythm pattern gates **14** to control the operation of these gates, all in accordance with the previously identified application Ser. No. 827,234. The output of the rhythm pattern selector is connected to a collector bus **26** which is in turn connected to a mixer and preamplifier **28** leading to an amplifier **30** having a low impedance output whereby the output of this amplifier can be connected to any suitable power amplifier and loudspeaker connection.

A power supply **32** is indicated at the lower left corner of the drawing, and this is suitably connected to the parts heretofore enumerated, and those to be set forth hereinafter.

In addition to the production of rhythm sounds in accordance with the block diagram as heretofore outlined, and which corresponds to application Ser. No. 827,234, as noted heretofore, means is provided for the automatic playing of chords and accompanying bass notes. Thus, there is provided a series of stable oscillators **34**. By way of illustration, there are 12 such oscillators, and these are LC (inductance-capacitance) oscillators producing a square wave output. Suitable means is provided for connecting pre-selected ones of the oscillators to a chord output **36**, and in a simple case this may be push buttons **38** and accompanying switches. Alternatively, and for more skilled instrumentalists, there could be provided 12 push buttons or keys, one for each of the oscillators, with the player to depress desired ones of the push buttons or keys to select the chord himself. In any event, the output of the oscillators is in the form of square waves, as indicated above the output line **36**, which are rich in harmonics, and which can thereafter be filtered as desired to produce proper instrumental tones. The chord output **36** is connected to a chord unit and wave shaper **40** about which more will be said shortly.

In addition to the plurality of outputs corresponding to a chord, the oscillators **34** are provided with a single bass output **42** which corresponds to the frequency of the root note of the chord being played, and also to the musical fifth related to this root note. The output **42** is likewise connected to the chord units and wave shaper **40**.

The chord unit and wave shaper includes electronic switches, such as diodes or transistors, and these are controlled by means of suitable connections indicated at **44** from the rhythm pattern gates **14**, whereby to

produce a chord output 46 leading to a chord straf unit 48, the chord output 46 being pulsed in accordance with the timing and pattern in which the rhythm pattern gates 14 are controlled by the primary logic unit 12 and the rhythm pattern selector 24. As will be apparent, this is in timed relation to the rhythm sounds, including the percussive tones of the frequency generators 16 and the sizzle or cymbal-like tones from the noise generator 22.

In addition, the chord unit and wave shaper produces a pulsed output of the root note at 50 and of the musical fifth related thereto at 52. Both of these are connected to a bass divider 54, which divides the root and fifth tones by two.

A control arm 56 leads from the rhythm pattern gates 14 to the bass divider circuit 54 to control the output thereof, consisting of the root and the fifth note alternating, and applied at 58 to a bass keyer and shaper 60. The bass keyer and shaper 60 is controlled at 62 from the line 56 so that properly shaped oscillations corresponding to the root or fifth note are applied to a bass straf unit 62. Both straf units 48 and 62, which may include such preamplification as may be necessary, further voicing, switching, etc., are connected to the collector bus 26 for amplification to the mixer and preamp along with the rhythm tones supplied thereto.

Thus, in accordance with the invention as disclosed to this point, rhythm tones are produced in any desired pattern, such as waltz, swing, Latin, etc., while chords and bass notes are played in timed relation thereto. Preferably, the control from the rhythm pattern gates 14 is such that the bass and the chords alternate, as is common in musical playing, as for example, in playing an electronic organ. Furthermore, preferably the root and fifth notes are played alternately, although this is not an essential. The melody accompaniment may be played on an entirely separate instrument, or the invention as heretofore shown and described may be packaged with any satisfactory instrument, such as a conventional electronic organ.

The concepts as heretofore shown and described are combined with an electronic organ with a more efficient use of tone generators as is shown in FIG. 2, to which reference should now be made. Much of the disclosure in FIG. 2, is the same as in FIG. 1, and like numerals are utilized with the addition of the suffix *a* to identify similar parts. What distinguishes the disclosure of FIG. 2, from that of FIG. 1, is that it utilizes certain of the existing parts of an electronic organ. More specifically, there will be seen at the upper left hand corner a block representation of 12 LC (inductance-capacitance) oscillators 64 corresponding to the top octave of the organ tones. As is common practice in electronic organs, the master oscillators are connected to strings of divider oscillators 66. Typically, there are 12 parallel strings of three divide-by-two dividers, thus providing four octaves of organ tones. Square waves are provided in each instance to be filtered as is needed. Since square waves are available of a great many frequencies, it is not necessary to provide specific percussion frequency generators such as was done in FIG. 1. Instead, selected outputs are taken at 68 which are supplied to the frequency gates 18*a*. Likewise, bass 42*a* and chord 36*a* outputs are taken from the dividers 66 to the chord unit and wave shaper 40*a*. As will be apparent far more frequencies are available than the 12 of FIG. 1. Accordingly, the chord unit and wave shaper 40*a* preferably is provided with a chord button board providing all of the common chords in major, minor, and seventh, with separate buttons for the bass. In playing, the thumb may press a bass button corresponding to a particular bass note of a chord, while a finger of the left hand engages the corresponding chord button. The bass note, either root or fifth, preferably alternating, is provided alternating with the chord as discussed with regard to FIG. 1.

In addition to the foregoing, the dividers 66 (and also the 12 master oscillators 64) have an output at 70 controlled by an organ keyboard 72 for playing of a solo or melody, the keying conveniently being audio keying. According to the manner in which the switching is produced, controlled in part by a solo straf unit 74 to which the keyboard solo audio keys 72 are connected, the square waves may pass through for filtering to produce one type of tone, or the square waves may be combined with one another in staircase fashion to simulate sawtooth waves which produce a characteristic type of tone.

The solo straf unit 74 is connected to the collector bus 26a along with the bass straf and the rhythm pattern selector as heretofore. The output amplifier 30*a* is connected to an organ amplifier 76 which in turn is connected to a loudspeaker system 78, whereby the organ solo notes and also the rhythm effects, chords, and bass notes are played simultaneously. Although not specifically shown it will be understood that the organ may retain the lower or accompaniment manual and the pedal clavier, and the tonal outputs therefrom may be connected through the same organ amplifier 76 and loudspeaker system 78, or through a different amplifier and loudspeaker system.

Details of certain of the parts referred to in FIG. 2, will be seen with reference to FIG. 3. Thus, the bass input from the chord unit, of which more will be set forth later with regard to FIG. 4, is identified at 80 in the upper right corner of FIG. 3. When a bass signal is applied to a driver circuit 82 comprising a transistor buffer amplifier and a direct coupled transistor amplifier stage 85, the output of which is applied to a divide-by-two divider 86. The divider is provided with DC potential, as indicated, on one terminal, and is grounded in another terminal. The output from the amplifier 85 is connected to a third terminal, while the output is taken at a fourth terminal, the output being a square wave as indicated at 88. The square wave is positive going, and is normally blocked by a diode 90, except when the diode is forward biased, as will be brought out hereinafter.

When the diode 90 is open it is on a decaying basis, the bass square wave oscillations conducted thereby being shown at 92. The decaying square wave 92 is applied to a transistor amplifier stage 94, and the output thereof is taken on a line 96 leading to the bass straf unit 62*a*.

The chord signal from the chord switchboard, about which more will be said later in connection with FIG. 4, is applied to the circuit of FIG. 3, at 98 which leads to a transistor amplifier and mixer stage 100. The signal from this stage 100, the envelope of which is indicated 102, is applied to the output lines 96, and it will be ap-

preciated that in the particular example of FIG. 3, the chord straf and bass straf units are combined.

The bass input line **80** is provided with a branch line **104** leading to the upper left corner of FIG. 3, to the input of a two transistor switching circuit **106**. The input of the switching circuit **106** includes a shunt capacitor **108** connected to the base of a first switching transistor **110**. The output of the switching transistor **110** is connected to the base of a second switching transistor **112**, and the output of the second switching transistor **112** is connected through a resistor **114** to the anode of the diode **90**. In the absence of a bass signal from the line **80** and from the branch line **104**, there is no charge on the capacitor **108** and the transistor **110** is biased off, the transistor **112** thereby being biased on. With the transistor **112** biased on, the collector thereof is substantially at ground potential, the anode of the diode **90** therefore likewise being substantially grounded, and the diode being non-conductive of the positive divided bass pulses applied to the cathode thereof.

On the other hand, when the bass signal does appear on the line **80** and the branch line **104**, the bass signal comprising positive going pulses, the capacitor **108** charges positive and turns on the transistor **110**. This, in turn, turns off the transistor **112**, whereupon the anode of the diode **90** is no longer at ground potential, and is at least momentarily at positive potential as will be brought out hereinafter, whereupon the divided bass signal **88** is transmitted by the diode **90** and passes to the transistor amplifier stage **94**.

The brass drum pulse train from the rhythm pattern gate **14a** is applied to the circuit of FIG. 3, at **116**. The bass drum pulse train comprises a succession of negative going pulses, and these are applied to a transistor amplifier **118**. The transistor amplifier **118** inverts the negative going pulse train and applies it to a Schmitt trigger circuit **120** comprising transistors **122** and **124**. The Schmitt trigger circuit assures the production of pulses of constant amplitude and pulse length which are applied through a diode **126** to a rather large capacitor **128** to charge this capacitor. The capacitor is connected through a resistor **130** to the resistor **114**, and hence, to the anode of the diode **90**. The capacitor **128** charges rapidly through the diode **126** from the Schmitt trigger circuit stage, but discharges more slowly, partly through a resistor **132** in parallel with the capacitor **128**, but mainly through the resistor **130** and **114**, and a shunting resistor **134**. The diode **126** prevents back discharge of the capacitor **128**.

Immediately below the Schmitt trigger **120** as shown in FIG. 3, there is a manual-automatic switch **136**. The switch **136** comprises a double pole, single throw switch only half of which is shown immediately below the Schmitt trigger, this half including a grounded fixed contact **138** and a moveable contact arm **140** engageable therewith. When the moveable contact arm **140** is grounded by engagement with the fixed contact **138**, the setting is for manual operation, and the chords and bass notes are played manually on the organ rather than with the automatic rhythm pattern. The moveable switch contact **140** is connected to a junction point **142** which is in turn connected to the cathode of a diode **144** having its anode connected to the collector of the first Schmitt transistor **122**. The anode of the diode **144** is also connected to the anode of the diode **146** which connects the collector of the Schmitt transistor **122** to the base of the Schmitt transistor **124**. When the switch **136** is in the manual position shown, the base of the Schmitt transistor **124** is grounded, and there is no output from the Schmitt trigger circuit **120**, whereby the capacitor **128** is not charged by the Schmitt trigger circuit.

A resistor **150** parallels the capacitor **128** and provides a discharge path therefor to produce the decay on the wave shape **148** shown to the right of the capacitor. The diode **126** provides for rapid charging of the capacitor **128**, while preventing back-discharge.

A Schmitt trigger circuit **152** is provided at the lower central portion of FIG. 3, and comprises a pair of transistors **154** and **156** provided with positive potential through a series resistor **158** over a smoothing capacitor comprising a shunt connected capacitor and resistor **160**, the capacitor being of relatively large size. The output of the Schmitt trigger is connected through a diode **162** to a shunt capacitor **164** of relatively large size paralleled by a resistor **166**. The diode has its anode connected to the Schmitt trigger circuit and hence is poled to pass positive signals to the capacitor **164**. The diode and the top of the capacitor are connected to an output line **168** leading to the chord switchboard to be described hereinafter in connection with FIG. 4. The output wave shape appearing on the line **168** is shown immediately to the right thereof at **170**. This output wave shape comprises a plateau at approximately 17 volts positive potential, the length of the plateau being determined by the pulse width of the Schmitt trigger circuit. The wave shape then tapers down on a decaying exponential, it being appreciated that the capacitor **164** will charge very quickly through the diode **162**, but cannot back-discharge through the diode, the decay time thus being determined by the resistor **166** in combination with the capacitor **164**.

The second pole of the manual-automatic switch **136** is connected to the base of the second transistor **156** of the Schmitt trigger circuit **152**. The switch arm **172** is ganged with the switch arm **140**, as is indicated, and in the manual position engages a fixed switch contact **174** connected to the base of the transistor **156**. Thus, in the manual position the transistor **156** is held off, and no potential is supplied to the switchboard over the line **168**. In the automatic position the switch arm **172** does not engage anything, and the Schmitt trigger circuit **152** therefore is free to operate upon application of a positive pulse to the base of the first transistor **154** on a line **176**. The pulse, or rather series of pulses, depends upon the selection and keying of signals through a circuit now to be set forth.

The bass drum pulse train after inversion in the transistor inverter or amplifier stage **118**, besides being applied to the Schmitt trigger circuit **120**, is applied by means of a line **178** to the cathodes of two diodes **180** and **182**, the anodes of which are respectively connected to junction points **184** and **186**. Since the pulses at this time are positive, they are normally blocked by the respective diodes **180** and **182**. However, a connection is made at **188** to the march rhythm switch of a selector **187** (FIG. 3A) so that positive potential is selectively applied to the junction point **184** with the march switch closed, and thus to open the diode gate

180. With the march switch open, ground is applied, and the diode blocks the signal. Similarly, the Latin switch when closed applies positive potential at 190 to the junction point 186, thereby to open the diode gate 182 when the Latin rhythm is selected, it being appreciated that the selector 187 is ganged with a control for the gates 14*a*. The junction points 184 and 186 are respectively connected through diodes 192 and 194 to the input line 176 to the Schmitt trigger circuit 152, the anodes being connected to the junction points 184 and 186 so as to conduct signals therefrom to the line 176, thereby providing isolation and preventing a signal at junction 184 from turning on diode 182, and likewise preventing a signal at 186 from turning on diode 180.

Rhythm pattern No. 4 from the rhythm pattern gate 14*a* is applied to a line 196 (see the aforesaid Schwartz et al. application Ser. No. 827,234). The rhythm pattern No. 4 comprises a train of positive pulses and is connected by means of the line 196 to the cathode of a diode 198, the anode of which is connected to a junction 200. The junction 200 is connected through a coupling capacitor 202 to the input line 176, and further is connected through a resistor to the swing switch of the selector 187, whereby the diode 198, comprising a gate, is selectively opened to allow rhythm pattern No. 4 to come through to the line 176.

The block pulse train from the rhythm pattern gates 14a, comprising a train of negative pulses, is applied to a transistor inverter 206 and the resulting positive pulse train is connected through a diode 208 and a resistor 210 to the line 176, previously noted, whereby the inverted block pulse train is applied to the Schmitt trigger 152.

The cymbal pulse train from the rhythm pattern gates 14a also comprising a train of negative pulses, is applied to a transistor inverter stage 212, and the resulting positive pulse train is applied through a diode 214 to the line 176. As will be apparent, the diodes 208 and 214 provide isolation so that the block pulse train and cymbal pulse train do not have a reaction on one another.

In addition, a positive voltage is applied at 216 when the Latin switch of selector 187 is closed and is connected through an isolating diode 218 and a resistor 220 to the anode of the diode 214 previously mentioned. Similarly, a positive potential is applied at 222 through a diode 224 and the resistor 220 previously mentioned to the diode 124 when the waltz switch of selector 187 is closed.

Finally, a pedal pulse is applied at 226, consisting of a negative pulse whenever any pedal of the organ is depressed, through a diode 228 to a transistor inverter 230. The resulting series of positive pulses is applied to an isolating diode 232 to the line 176.

The diode 214 is only biased on when one of the diodes 218 or 224 is biased on to prevent undesired interaction at such times as the transistor 212 is conducting (and hence has a low collector-to-base impedance).

Attention now is directed to FIG. 4, wherein there is shown a diode matrix 234 for the chord switching. Frequencies are taken from the frequency divider of an organ and are applied at inputs indicated by the circles 236 through one octave plus one of notes, indicated as F through F¹ an octave higher. The matrix 234 comprises a plurality of like parts, and attention should be directed to the left side where the circuit for the note F is described as illustrative.

The input for the F tone as indicated at the circle 236, is connected through a resistor 238 to the cathode of a diode 240. The frequency oscillations applied are positive going square waves, and hence will not be transmitted through the diode 240 unless the diode is biased on. To prevent leakage a second diode 242 is provided in series with the diode 240, the polarity being in the same direction as previously indicated. The anode of the second diode 242 is connected to a junction 244. The junction 244 is connected through a resistor 246 to the anode of the diode 248, the cathode of which is connected to a collector line identified at 98, being the same as the input line 98 indicated at the upper right portion of FIG. 3.

The junction point 244 further is grounded through a capacitor 250, and is also connected through a resistor 252 to a connection or tie point 254 indicated as a triangle.

As will be brought out subsequently, a positive voltage is applied selectively to the tie point F to turn on the diodes 240 and 242, whereby a signal from the input connection 236 may pass through these two diodes, through the resistor 246, and through the resistor 248 to the collector line 98.

As will be understood with reference to FIG. 4, the circuit just described is repeated for each of the octave of notes having the inputs at 236. If it is desired to provide chord inversions, it is possible to supply more than one octave plus one of frequencies to the matrix, in which case the circuit specifically described would be further duplicated.

Immediately to the left of the diode matrix 234 as shown in FIG. 4, there is a representation of a chord switching network for a C chord. There are seven such networks for the seven common chords, these, in addition to the C chord, comprising B♭, F, C, G, D, A and E. Since the remaining chord switching networks are similar, only the chord switching network 256 for the C chord is shown. An input line 168 is provided at the bottom of the chord switching circuit which is directly connected to the line 168 from FIG. 3. This line is connected to the fixed contacts of three single-pole single-throw switches 258, 260 and 262, respectively corresponding to a C 7th chord, a C major chord and a C minor chord.

The moveable switch contact 260 for the C major chord is connected to the anode of the diode 264 leading to a junction 266 and the anode of a series connected diode 268. The cathode of the diode 268 is connected to a tie point 270, indicated as a triangle and having the musical note G therein. The triangle 270, labeled as G, is directly connected to the G triangle tie point 254 of the diode matrix. Thus, whenever a positive potential is applied to the line 168 with the switch 260 closed, the diodes 264 and 268 are open to supply a positive potential through the tie points to open the diodes 242 and 240 of the G tone to pass it through to the line 98.

In addition, the switch 260 is connected from a junction 272 to a junction 274 which is connected to the anode of a diode 276 having its cathode connected to a tie point 270 labeled as E and directly connected to the E tie point 254. Furthermore, the junction 266 is con-

nected to a junction **278** which is connected to the anode of a diode **280** having its cathode connected to the C tie point **270**. Thus, when positive potential is applied by means of the line **168** and switch **260**, positive potential is applied simultaneously to the C, E and G tie points, whereby to play a C major chord. The C 7th switch **258** is connected to a junction **282** and from thence to the anode of a diode **284** having its cathode connected to the junction **274**. In addition, the junction **282** is connected to the anode of a diode **286** leading to the A# tie point **270**. Thus, when the C 7th switch **258** is closed and a positive potential appears on the line **168** the A# circuit will be open as well as the C, E and G circuits, whereby a C 7th chord will be played.

The C minor switch **262** is connected to a junction **288** leading to the anode of the diode **290** having its cathode connected to the junction **278**. Likewise, the junction **288** is connected to the anode of the diode **292** leading to the G# tie point **270**.

Accordingly, when the C minor switch **262** is closed, and positive potential appears on the line **168**, the circuits for C, G and G# will be turned on, whereby to play a C minor chord.

As will be appreciated, the reference to appearance of positive potential on the line **168** is with regard to the circuit previously discussed in FIG. **3**, whereby the positive potential comprises a series of pulses appearing in selected rhythm pattern.

A bass switching unit **294** is provided at the right side of FIG. **4**. The bass switching circuit is provided with note oscillations as indicated at the squares **296** from the respective notes indicated therein, namely: E, A, D, G, C, F and B♭. As will be observed, these are the same notes as the chords that are to be played by the various chord switching networks **256**. Each of the note input squares **296** is connected through a resistor **298** to a bass switch **300** which is in turn connected to a collector line **302**. The collector line is connected to the line **80** comprising the bass input line **80** of FIG. **3**, as previously described.

The physical arrangement of the bass switches and chord switches is not shown, since such physical arrangements are known in the art. However, it will be understood that the bass switches (which are normally open single-pole single-throw switches) are directly closable by manual actuators such as push buttons, with the push buttons preferably arranged in a horizontal row. The various chord switches (also normally open single-pole single throw switches) likewise are preferably operated by push buttons, and these push buttons are arranged in more or less vertical columns above the horizontal row of bass push buttons. For example, the push buttons for the C chord, which would comprise three buttons, respectively for the C major, C minor and C 7th chords would be in alignment with the C bass button. Thus, it is a simple matter to depress a desired bass button with the left thumb and the corresponding desired chord button with one of the left fingers, such as the index finger.

The chord and bass switching circuits of FIG. **4**, are useful independently of the circuit of FIG. **3**, to play the bass and chords in non-automatic fashion, as will be apparent with reference to FIG. **5**. Much of FIG. **5** is similar to parts of FIG. **3**, being a simplification thereof, and similar parts are identified by like numerals with the addition of the suffix *b*. Thus, the bass signal input is applied to a line **80***b* leading to two transistor amplifier stages **84***b* and **85***b* comprising a driver circuit **82***b*, the output of which leads to a divider **86***b*.

The output of the divider **86***b* goes to a resistance-capacitance network **304** leading to a transistor amplifier stage **94***b* with the output thereof applied to a line **96***b* leading out to the straf units, amplifiers and loudspeaker system.

Similarly, the chord signal input from the chord switchboard is applied to a line **98***b* leading to a transistor amplifier stage **100***b* which has the output applied to the line **96***b*, just mentioned. As will be apparent, when the non-automatic circuit of FIG. **5**, is to be used with FIG. **4**, direct current would be applied continuously to the line **168** of FIG. **4**. Thus, whenever a chord button is depressed, the chord is played as long as the button is held depressed. Similarly, since there is nothing to effect switching of the bass signal in the circuit of FIG. **5**, as long as a bass push button is held down, the corresponding bass note will sound.

OPERATION

When the apparatus as herein shown and described is set with the switch **136** in automatic position, the bass drum pulse train will produce a pulse from the rhythm primary logic **12***a* and rhythm pattern gates **14***a* on the first beat for 3/4 time, or on the first and third beat for 4/4 time. This will cause the Schmitt trigger circuit **120** to charge the capacitor **128** rapidly, discharge being through the resistor **132**, and also through resistors **130**, **114** and **134**, to produce the wave shape or envelope **148**. This wave shape in turn controls the opening of the diode gate **90** whereby to produce the bass signal as a decaying basis at beat 1, or beats 1 and 3, as just noted, the signal being divided by the divider **86** to lower the bass tone an octave, and subsequently being amplified by the transistor amplifier stage **94** and applied to the output line at **96**.

At the same time, if either the march or Latin rhythm is turned on, the bass drum pulse train will also pass through the diodes **180**, **192** or **182**, **194**, respectively, to charge the capacitor **164** through the diode **162** by way of the Schmitt trigger circuit **152** to produce the envelope **170**, which is applied to the chord switchboard to produce the chord simultaneously with the bass note on the first beat or on the first and third beats, as aforesaid.

Furthermore, depending upon how the switching is set as for march, swing, Latin or waltz, pulses will appear from the rhythm pattern No. 4, or from the block pulse train or from the cymbal pulse train, or some combination thereof, to supply pulses to the Schmitt trigger circuit **152** on the second and third beat of waltz time, or on the second and fourth beat for march time, and on other beats for swing and Latin. Obviously, a switch can be provided in the line **178** so that the bass drum pulse train will not pulse the chords.

Accordingly, the bass may alternate with the chords or the chords may play at pulsed times along with the bass, and also independently of the bass. On the other hand, when the switch **136** is switched to manual, or if the circuit of FIG. **5** is used, the bass and the chords will play whenever an appropriate button is depressed, which may be continuously, or on an alternating basis if the player is sufficiently dextrous.

It is recognized that an on-off signal of the same intensity as a continuous signal sounds of lower intensity to the ear. Thus, when the apparatus is set for automatic operation, the level of the pulse delivered through the diode **126** to charge the capacitor **128** is very nearly at the 17.5 volt supply potential, since the collector resistor of the transistor **124** is of a much lower value than is the resistor **132**, the two forming a voltage divider through the diode **126**. On the other hand, when the apparatus is set for manual operation, the voltage divider includes the resistor **150** which is of a much lower value than the resistor **132**, and not a great deal larger than the collector resistor of the transistor **124**. Thus, the potential applied through the diode **126** is much lower for the non-automatic or manual operation.

In addition to the automatic operation of the bass and chords, if a stop switch to the pedal assembly of the organ is closed, a negative pulse will appear on the line **226** whenever a pedal is depressed, thus, providing a manually controllable production of the chord in addition to the automatic timed playing of the chord.

As has been noted heretofore, when the apparatus is set for automatic operation, and there is no bass signal in, the operation of the circuit **106** is such that the transistor **112** is conducting, whereby the junction between the resistors **130** and **148** is held substantially at ground potential, thereby to prevent any spurious signals from opening or partially opening the diode gate **90**.

The specific examples of the invention as herein shown and described will be understood as being illustrative only. Various changes in the structure will no doubt occur to those skilled in the art, and will be understood as forming a part of the present invention insofar as they fall within the spirit and scope of the appended claims.

The invention is claimed as follows:

1. Automatic rhythmic chord playing apparatus in an electronic organ, said organ having a plurality of keys and pedals and a plurality of means for generating tone oscillations corresponding to said keys and to said pedals and interconnected therewith, the means for producing tone oscillations corresponding to pedals comprising divider means connected to the generators for the tone oscillations corresponding to the keys comprising electronic gate means connected to the output of said divider means, means for rendering said electronic gate means conductive suddenly and for subsequently rendering said electronic gate means gradually non-conductive, pulse producing means, means connecting said pulse producing means to said means for rendering said gate means conductive and non-conductive to pass oscillations corresponding to pedal tones in accordance with a predetermined pattern, means connected to predetermined groups of said gate means and to said pulse producing means to pass oscillations corresponding to chords musically related to said pedal tones in accordance with the pattern of said pulses, said last named means comprising a plurality of normally non-conducting gates respectively receiving pulses from said pulse producing means and having a common output line, means for respectively rendering said non-conducting gates conductive to transmit pulses to said common output line, and pulse shaping means connecting said common output line to said predetermined groups of gate means and output means connected to said gates and to said gate means and receiving the tone oscillations therefrom.

2. Automatic rhythmic chord playing apparatus in an electronic organ, said organ having a plurality of keys and pedals and a plurality of means for generating tone oscillations corresponding to said keys and to said pedals and interconnected therewith, comprising a plurality of electronic gates, means connecting said gates to said tone generators, means for producing pulses corresponding to musical beats, means connecting said pulse producing means to certain of said gates to pass oscillations corresponding to pedal tones in accordance with a predetermined pattern including at least on the first musical beat of a measure, means connecting said pulse producing means to groups of said gates to pass oscillations corresponding to chords musically related to said pedal tones on certain of said beats other than the first beat of a measure, means connected to the organ pedals and to said chord gates for rendering said chord gates conductive upon depression of any pedal, and output means connected to said gates and receiving the tone oscillations therefrom.

3. Apparatus as set forth in claim **1** including means for playing chords and pedal tones manually instead of automatically and including means for limiting the conductivity of the gate means to a lower level for manual than automatic operation to produce pedal tones at a lower intensity on manual operation than on automatic operation.

4. Apparatus as set forth in claim **1** wherein the means for respectively rendering the non-conducting gates conductive comprises DC.

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