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[54] ELECTRONIC MUSICAL INSTRUMENT CIRCUIT

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[51] **Int. Cl.** **G10h 1/02**

[58] **Field of Search** ... 84/1.01, 1.17, 1.24, DIG. 22; 331/143; 307/252 F

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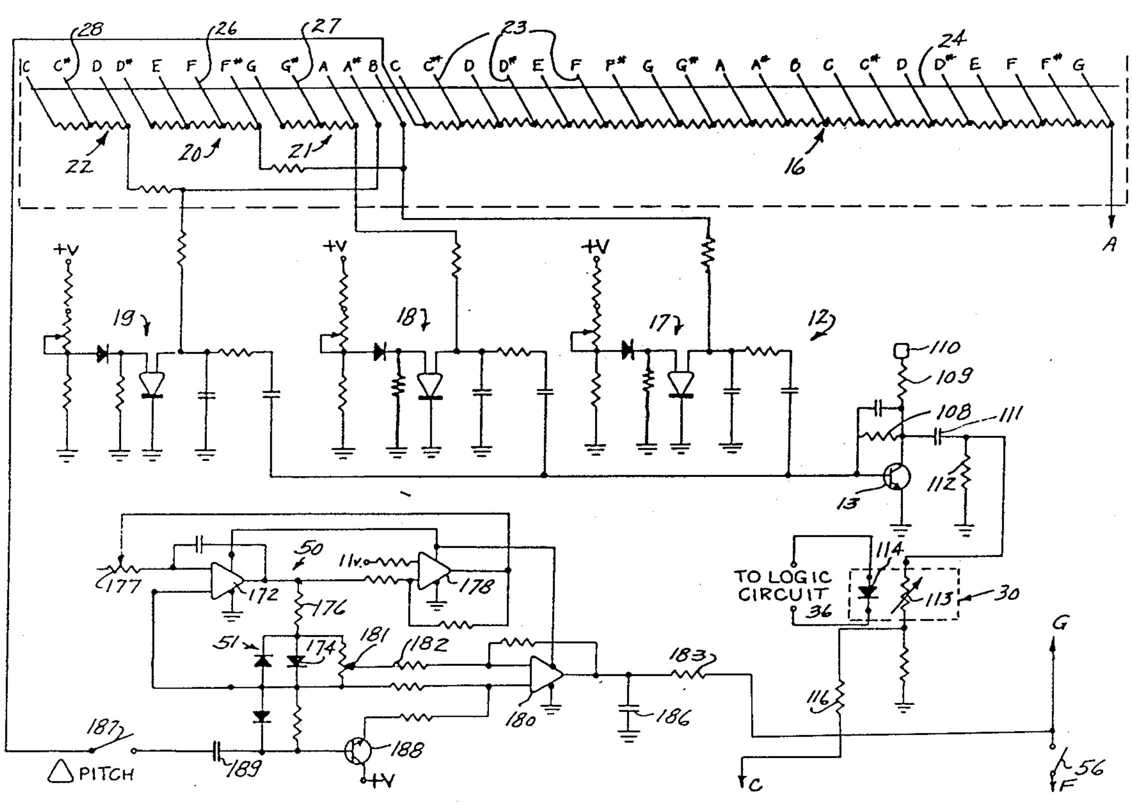
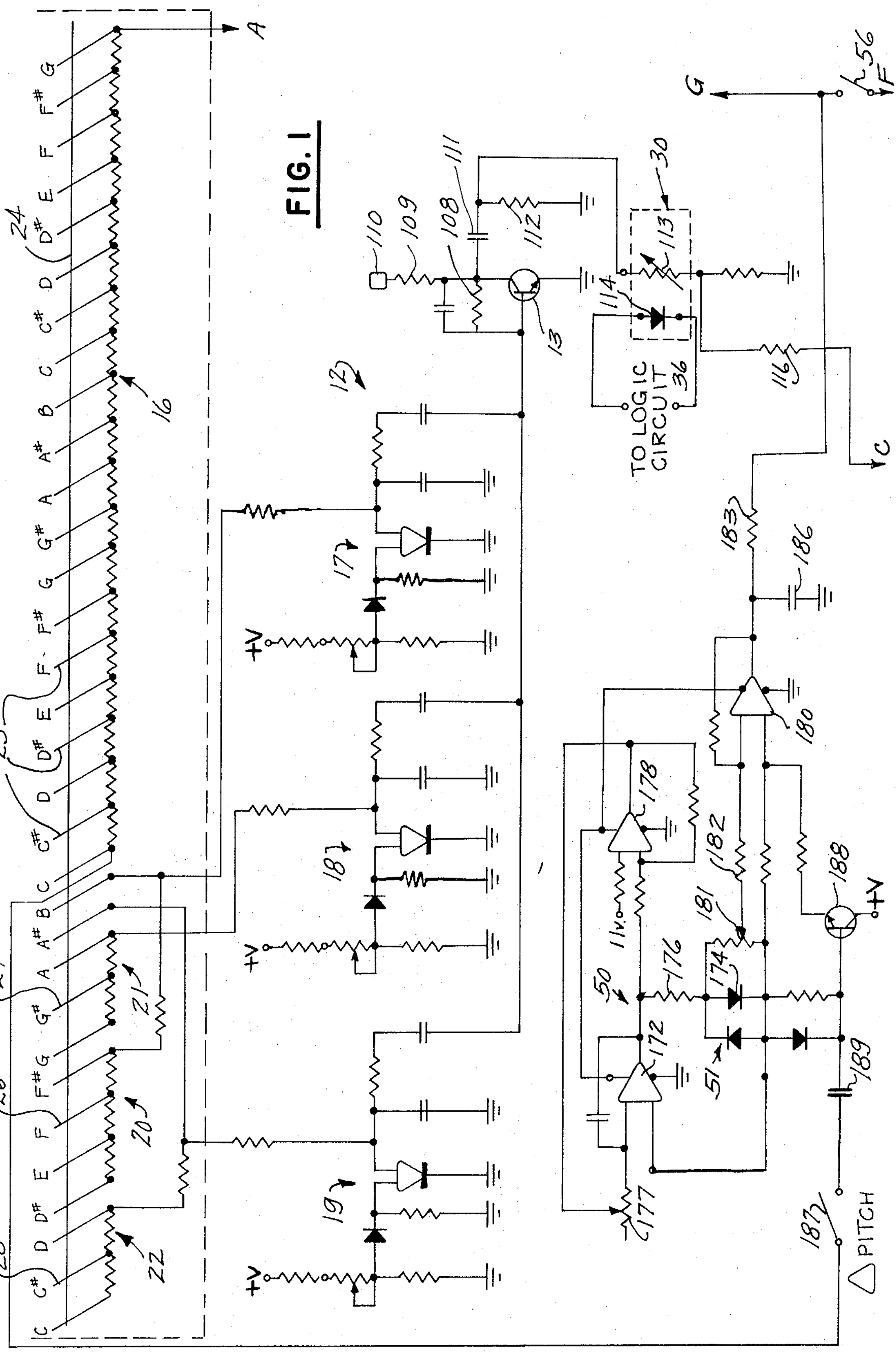
[57] **ABSTRACT**

A key actuated electronic musical instrument of the type suitable for use with piano or organ keyboards, or the like, has a single relaxation oscillator circuit for producing melody tones from selected keys of a keyboard, and three relaxation oscillator circuits for producing chord tones from other selected keys of the keyboard. A delta pitch circuit which produces a sawtooth-like output signal is coupled to one of the inputs of the single oscillator to provide a rapidly changing sound going from a flat tone to a natural tone. The signals for producing melody sounds are delivered through a selective filter circuit which will selectively simulate the sounds of, for example, a saxophone, brass, horn, or a string instrument. The sound signal from the filter circuit is then delivered to an audio amplifier and loud-speaker system. The three oscillator signals for producing chord sounds are mixed together in a transistor buffer stage and then delivered to the audio amplifier through a gate circuit formed by a light-emitting diode and a light-dependent resistor. The gate circuit is responsive to an automatic rhythm generator so that chord sounds may have a selected rhythm. Also connected to the audio amplifier is the automatic rhythm sound generator which can play one of several rhythms utilizing desired percussion sounds. An adjustable vibrato circuit is connected to the melody oscillator to produce a pulsating sound that can be varied in frequency.

6 Claims, 8 Drawing Figures

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C
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20
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12
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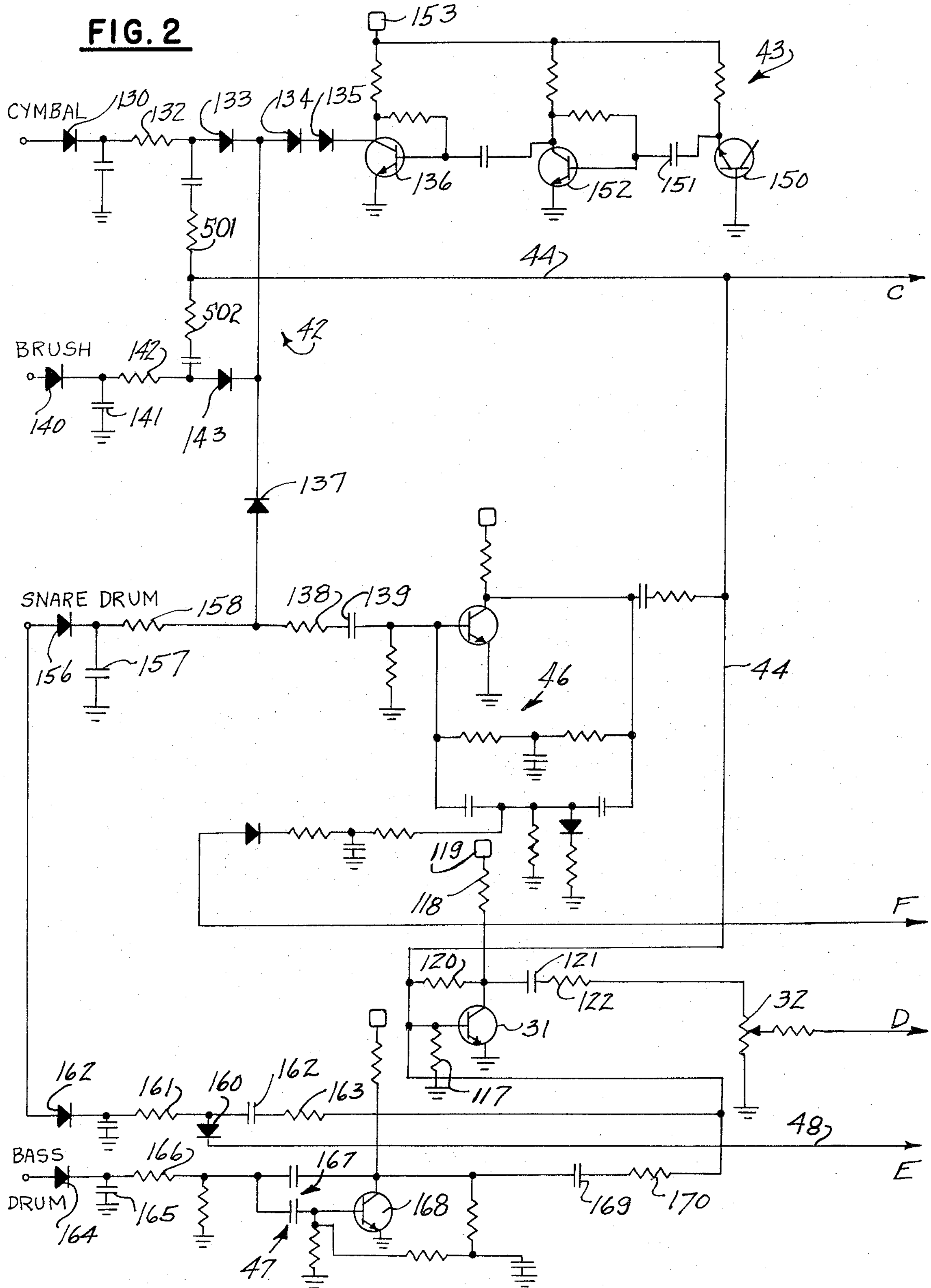
+V
110
109
108
111
112
13
30
113
114
TO LOGIC CIRCUIT 36
116
G
56
F
C
183
186
180
178
182
181
188
174
176
50
172
51
189
177
187
PITCH

FIG. I

FIG. 2


CYMBAL
130
132
133
134
135
153
43
136
152
151
150
501
44
C
502
42
BRUSH
142
140
141
143
137
SNARE DRUM
158
138
139
156
157
46
44
119
118
F
120
121
122
32
31
D
117
162
161
160
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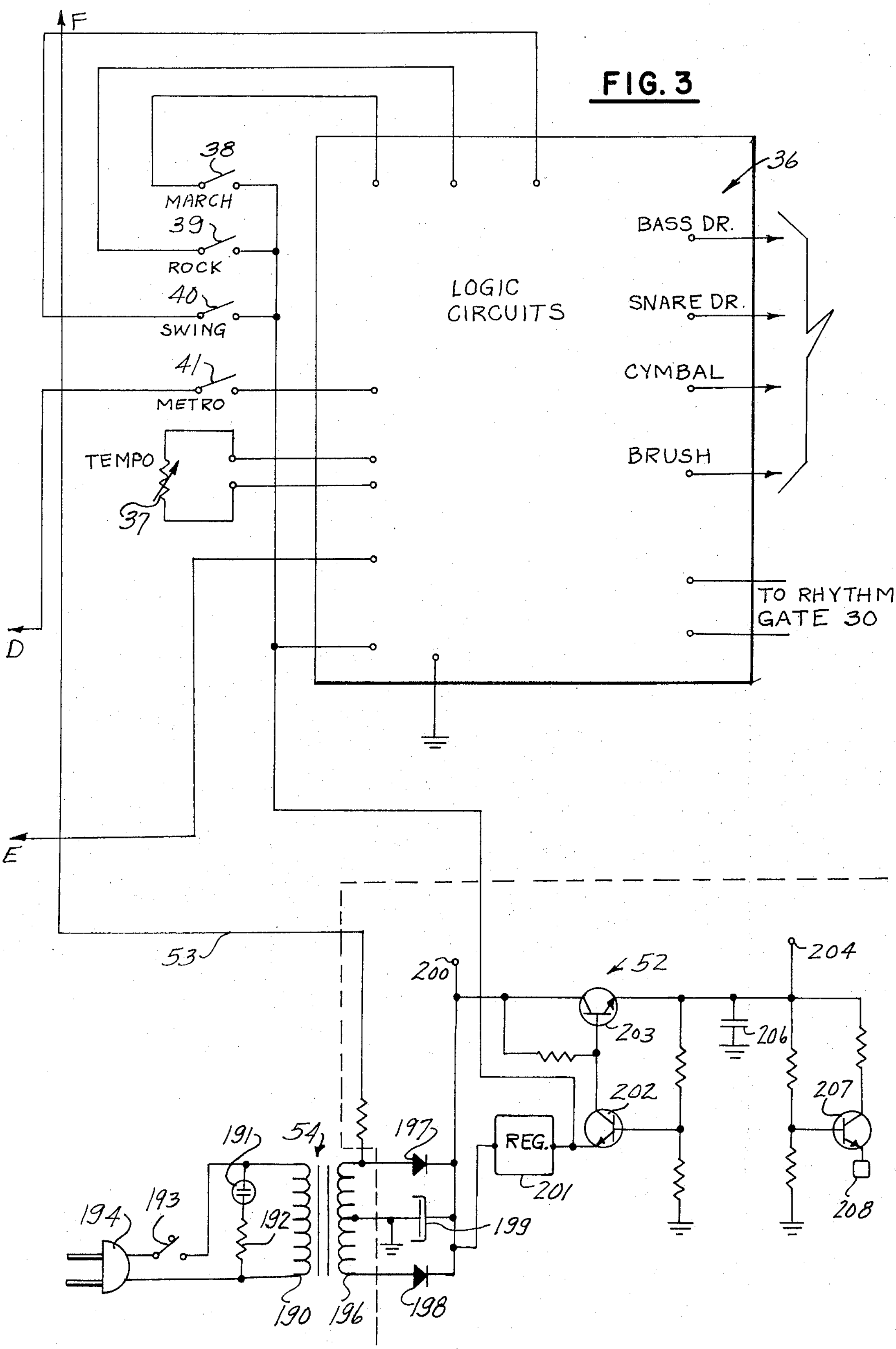
163
48
E
BASS
DRUM
166
167
164
165
168
169
170
47

FIG. 3


F
38
MARCH
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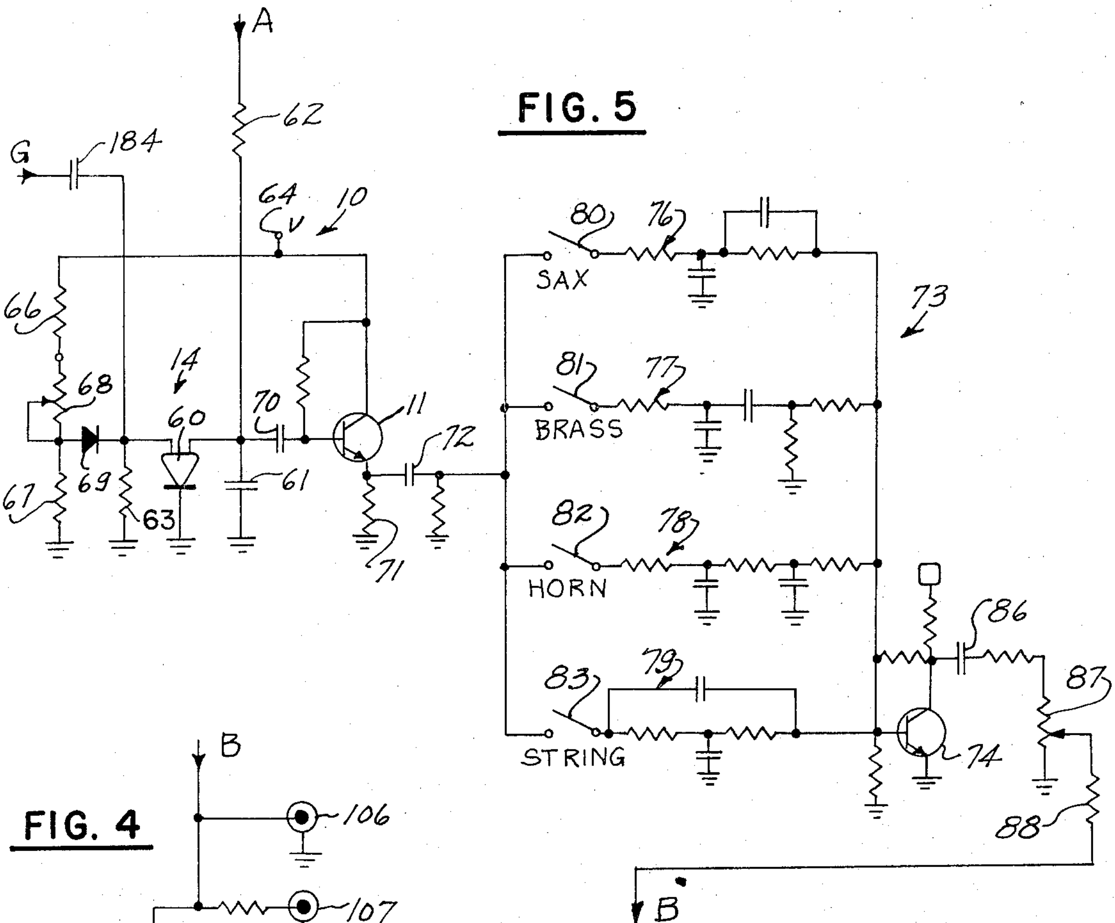
ROCK
40
SWING
41
METRO
TEMPO
37
D
E
36
LOGIC
CIRCUITS
BASS DR.
SNARE DR.
CYMBAL
BRUSH
TO RHYTHM
GATE 30
53
200
52
204
203
206
202
207
191
54
197
REG.
201
193
194
192
199
208
190
196
198

FIG. 5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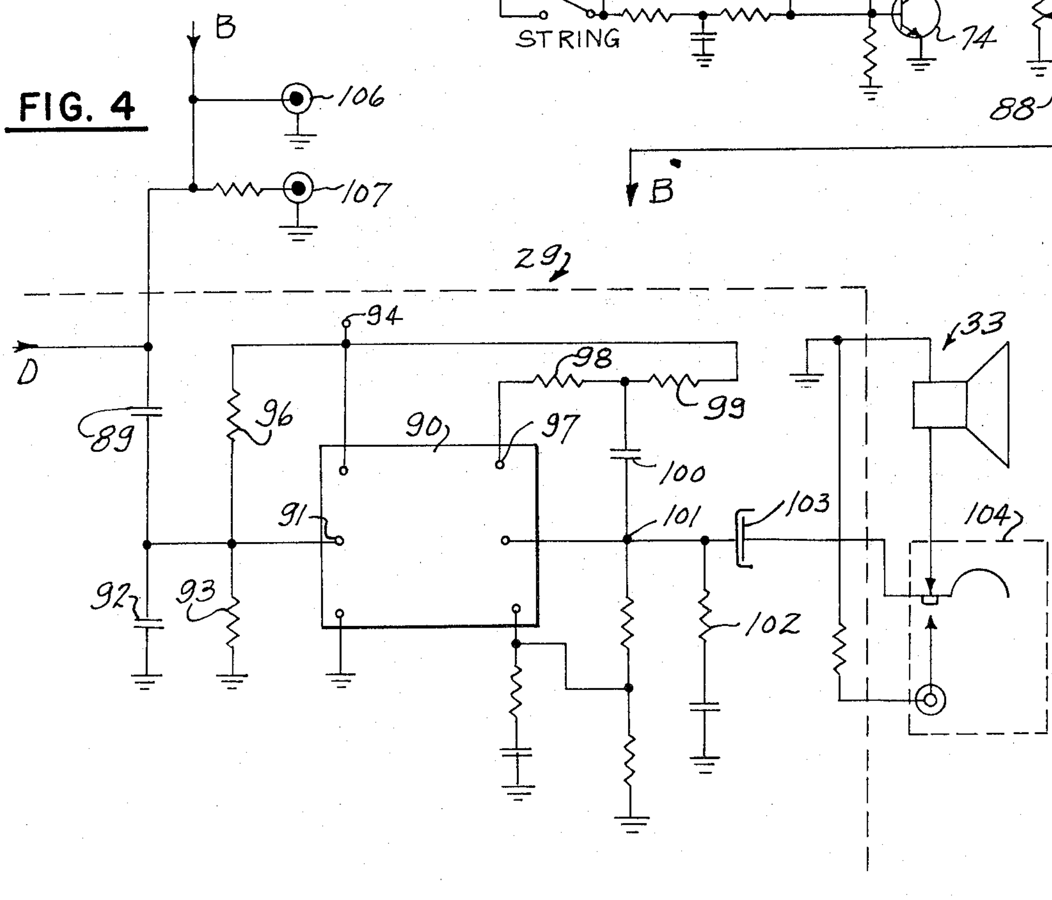
62
G
184
64
V
10
80
76
SAX
73
66
14
81
77
68
60
BRASS
70
11
69
72
67
63
61
82
78
71
HORN
86
79
87
83
STRING
74
88
B

FIG. 4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96
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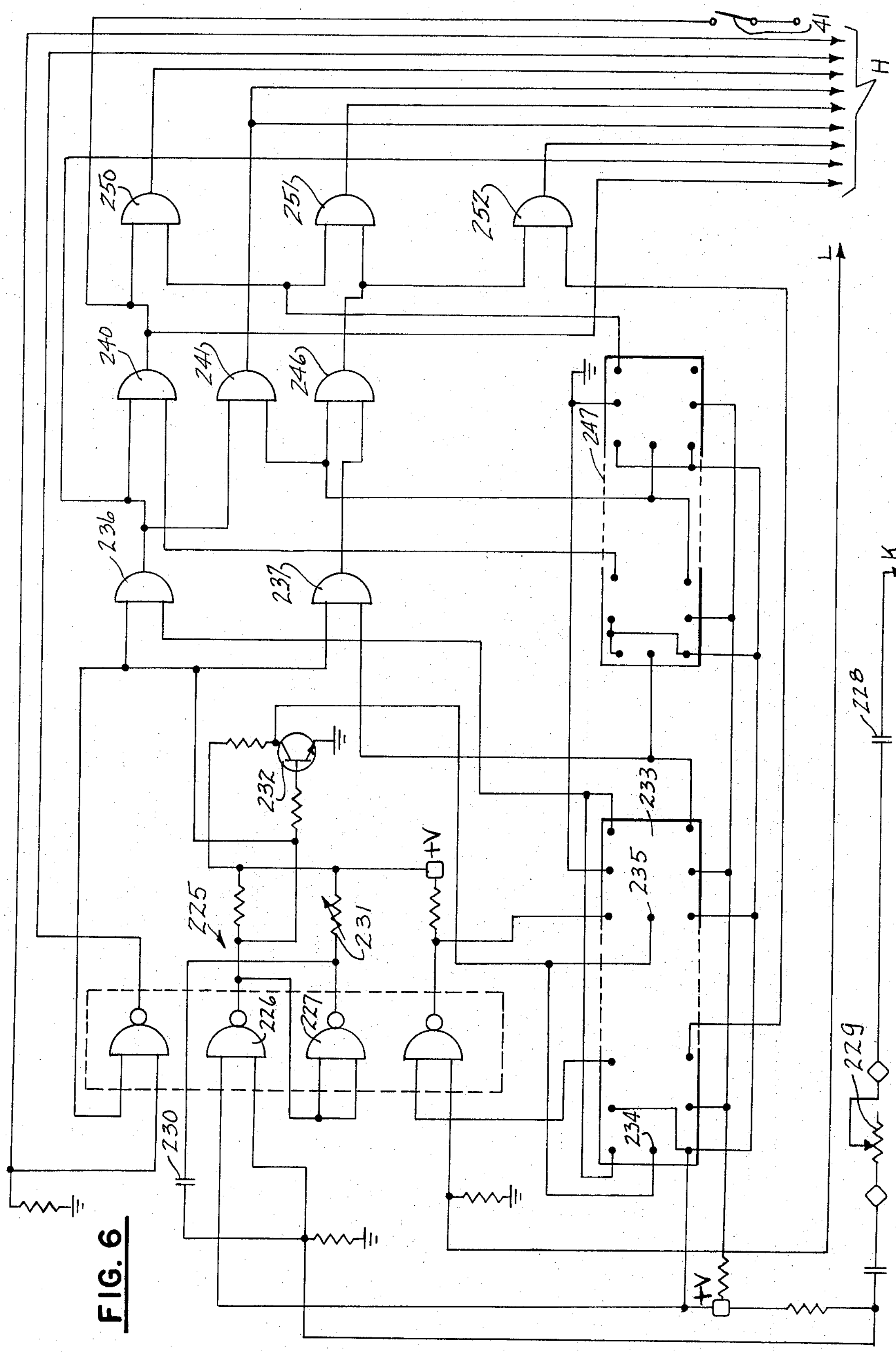
93
102


41
H
L
K
250
251
252
240
241
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236
237
247
233
235
232
+V
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226
227
231
230
234
228
229

FIG. 6

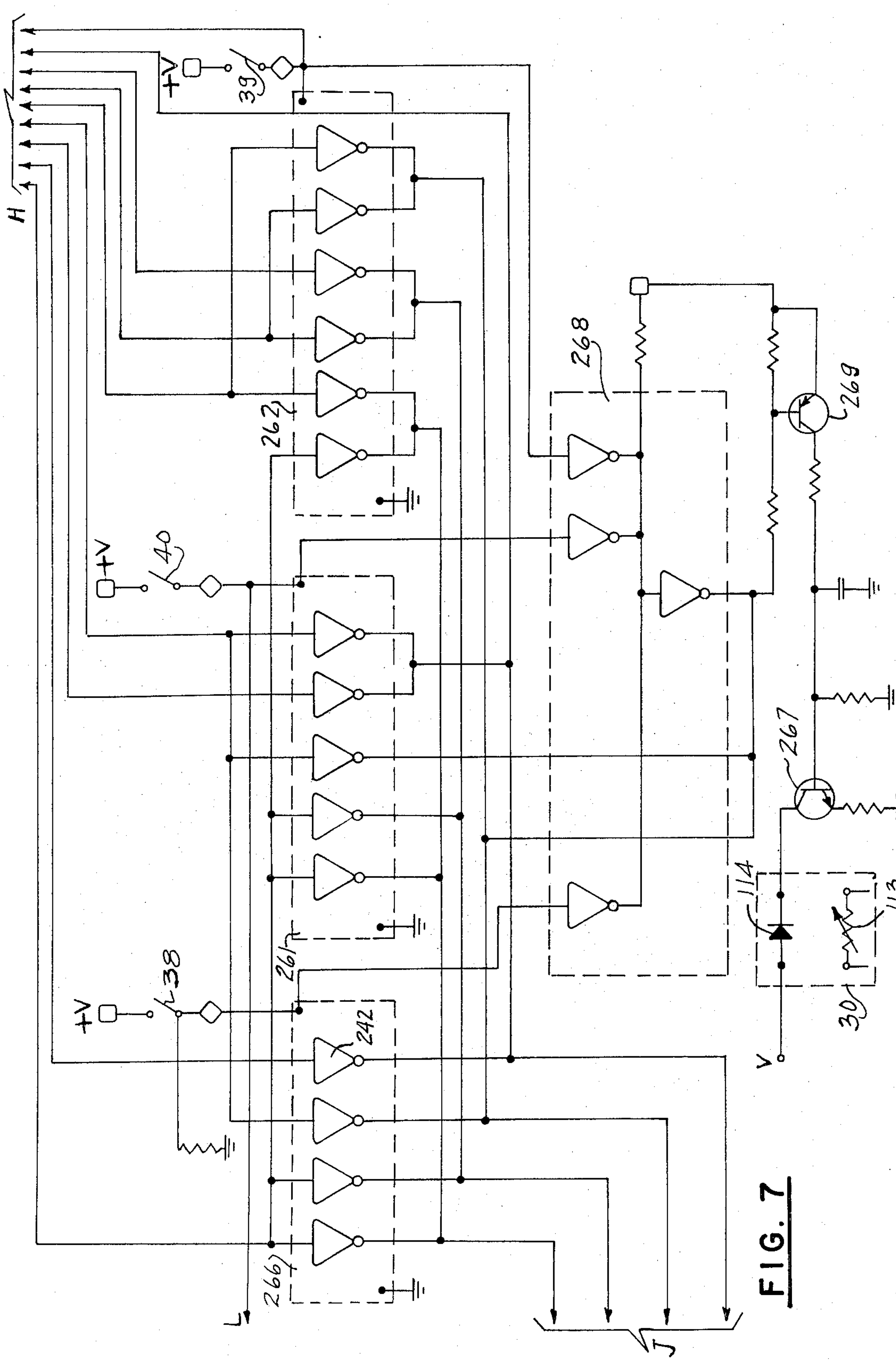

FIG. 7

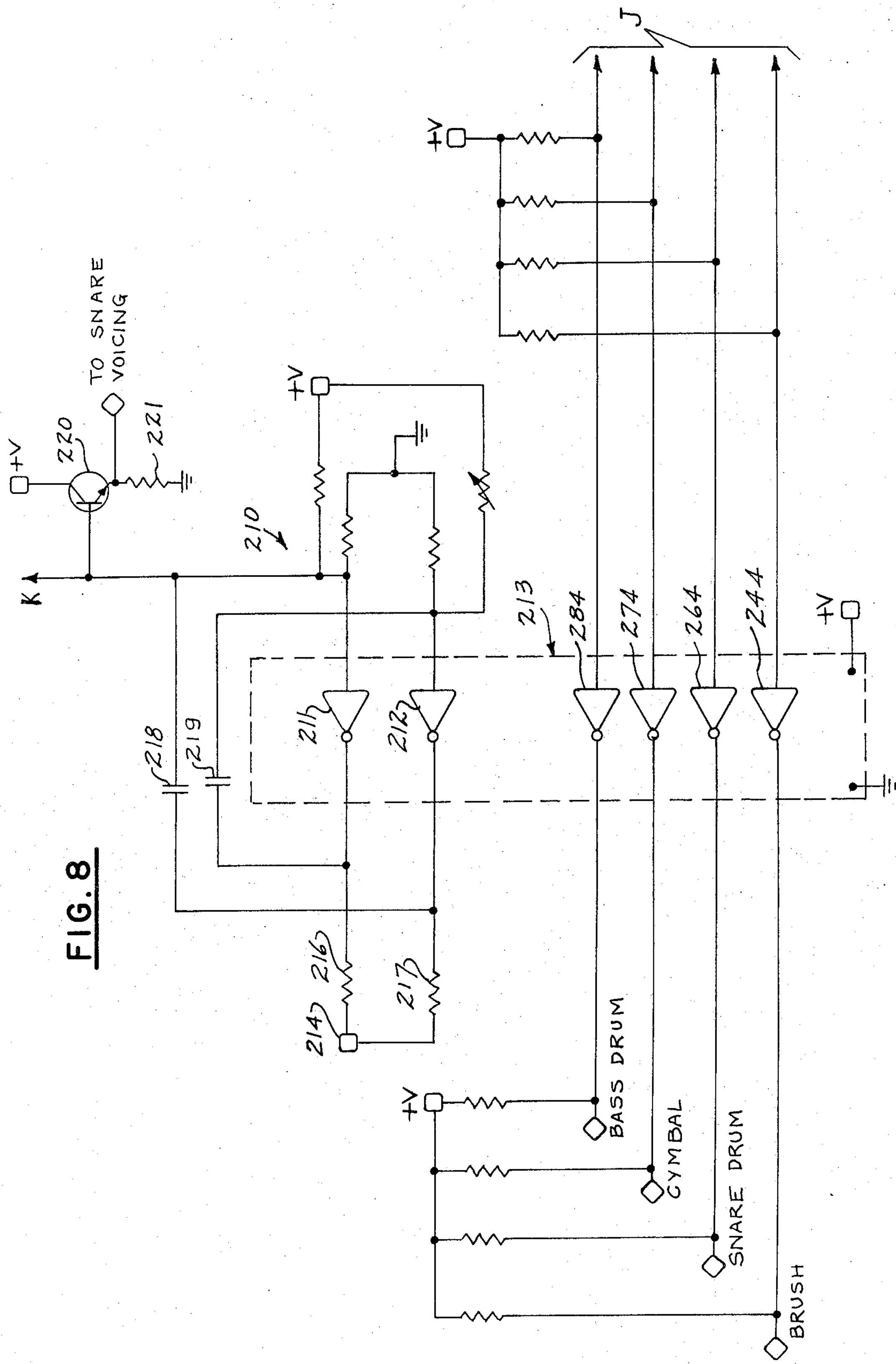
J
+V
TO SNARE VOICING
220
221
210
K
213
284
274
264
244
211
212
218
219
214
216
217
BASS DRUM
CYMBAL
SNARE DRUM
BRUSH

FIG. 8

ELECTRONIC MUSICAL INSTRUMENT CIRCUIT

BACKGROUND OF THE INVENTION

This invention relates to electronic musical instruments of the type which can electronically reproduce melody tones, chord tones, and selected rhythm patterns of percussion instruments. More particularly, this invention relates to electronic organs or the like.

Electronic organs per se are old in the art and this invention is directed to an improved electronic circuit for organs wherein great cost savings and circuit simplicity are obtained. Heretofore, electronic organs have been provided with either built-in or add-on rhythm tone generator systems which provide rhythm patterns of, for example, march music, rock-and-roll music, swing music and the like, and each of these rhythm patterns includes a plurality of different percussive instrument sounds. However, prior art rhythm sound generator systems have been relatively expensive and therefore they have been associated only with the more expensive electronic organs. Also, electronic musical instruments such as organs may include vibrato circuits which cause pulsing of audio signals when a key is sustained in a depressed condition. Here again, the circuitry utilized to generate the vibrato effect has been relatively expensive and incorporated only in more expensive electronic organs. In the more expensive electronic organs there may be provided two or more keyboards for generating melody tones and chord tones. Also, a pitch changing circuit may be included which allows the tone of the sound to change from a flat or sharp tone signal to a natural tone signal when the key on the keyboard is depressed. This will cause a tone signal of either a flat or sharp tone initially to be reproduced when the key is initially depressed, and after a short time interval, and while the key is still depressed, the flat or sharp tone signal will automatically change in frequency to a natural tone signal.

All of these features require complicated circuitry and a multitude of oscillators and mixers incorporated in these electronic musical instruments to achieve the desired result.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an electronic musical instrument circuit arrangement which is simple and inexpensive to manufacture while still being efficient and reliable in operation.

Another object of this invention is to provide an inexpensive electronic musical instrument circuit suitable for use in an electronic organ but which has all of the features of the more expensive electronic organ circuits.

Many other objects, features and advantages of this invention will be more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein like refrence numerals throughout the various views of the drawings are intended to designate similar elements or components.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1, 2, 3, 4** and **5** taken together illustrate a detailed schematic diagram of an electronic musical instrument circuit which can be used in an electronic organ in accordance with the principles of this invention; and

FIGS. **6, 7** and **8,** taken together, is a detailed schematic diagram of the logic circuit utilized in the rhythm sound generator circuit shown in FIG. **3.**

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring first to the FIGS. **1** and **5,** the electronic musical instrument circuit of this invention includes a first sound generator circuit designated generally by reference numeral **10** and which has an output transistor **11** associated therewith. A second sound generator circuit is designated generally by reference numeral **12,** and has a second output transistor **13** associated therewith. The first sound generator circuit **10** has a single oscillator circuit **14** connected to resistor means, here being a plurality of resistors **16** through the leads designated by reference letters A between FIGS. **1** and **5.**

The second sound generator circuit **12** has a plurality of oscillator circuits for generating a plurality of tones of corresponding chord signals. Preferably the second sound generator circuit has three such oscillator circuits **17, 18** and **19.** The oscillator circuits **17, 18** and **19** are connected to corresponding groups of resistor means **20, 21** and **22,** respectively. The plurality of resistors **16** are associated with a corresponding plurality of key switches **23,** which are associated with the keys on a piano-like keyboard used in electronic musical instruments such as organs. The keys are actuated to cause the switches **23** to engage a bus bar **24** when melody tones are played. Upon actuation of each different key of the keyboard, different amounts of resistance are placed in circuit with the single oscillator **14** to change the frequency of oscillation thereof. This change in frequency for each incremental change in resistance will produce the desired melody tones. The chord tones are produced by keys associated with the switches **26, 27** and **28** connected to the groups of resistor means **20, 21** and **22,** respectively. Actuation of one or more of the keys **26, 27** or **28** will produce oscillation within the respective oscillators **17, 18** and **19** and are mixed together within the output transistor **13.**

The audio output signal from the output transistor **11** is delivered to an audio amplifier circuit **29** of FIG. **4** through a line indicated by reference letter B between FIGS. **4** and **5.** On the other hand, the audio signals producing the chord tones are mixed in the output transistor **13** and delivered to the audio amplifier **29** through a rhythm gate circuit **30,** therefrom through terminal C to an audio amplifier and buffer transistor **31** and a variable resistance volume control element **32** which acts as a volume control for both chord and percussion rhythm tone signals. The output from the potentiometer **32** is delivered to the audio amplifier circuit **29** through line D between FIGS. **2** and **4.** The output of the audio amplifier is connected to a loudspeaker system **33** which will reproduce all of the mixed sound, i.e. the melody tones, the chord tones and the rhythm percussion sounds.

The electronic musical circuit of this invention also includes a logic circuit **36**, shown in FIG. 3, for automatically producing rhythm percussion sounds which can be used as accompaniment. The logic circuit 36 has a variable resistance element **37** which functions as a tempo adjustment so that the speed or tempo of the selected rhythm can be adjusted to suit the person using the electronic organ, or the like. The desired rhythm pattern for the percussion sounds can be selected by actuating one of several switches **38**, **39** or **40** which are associated with march music, rock-and-roll music and swing music, respectively. A switch **41** will provide a metronome signal which may be used to aid beginners in learning to maintain a tempo. A plurality of output leads having designations bass drum, snare drum, cymbal and brush receive the percussive sounds in accordance with the rhythm pattern selected, and these percussive sounds are applied to correspondingly marked terminals of FIG. **2** to be gated therefrom to an audio amplifier. The cymbal, brush and snare drum terminals are connected to a gate logic circuit designated generally by reference numeral **42** which also has associated therewith a noise generator circuit **43**. The cymbal and brush signals are applied through the gate circuit and therefrom over a line **44** to the input of the amplifier transistor **31** and therefrom to the volume potentiometer **32**. However, the snare drum signals are applied to a filter circuit **46** which also receives signals from the noise generator **43** to selectively pass a desired band of intermixed noise signals to more accurately reproduce the sound of a snare drum. The output of the filter circuit **46** is also connected to the line **44** and therethrough to the base electrode of transistor **31**. The bass drum circuit **47** does not receive noise signals and is directly connected to the base of the transistor **31**. The snare drum terminal is also connected through a line **48** to terminals E between FIGS. **2** and **3** for connection to a two hundred hertz output signal terminal on the logic circuit **36**.

Also associated with the electronic musical instrument circuit of this invention is a variable frequency vibrator oscillator circuit **50**, FIG. **1**, which produces a triangular wave shape at the output thereof and which triangular wave shape is transformed substantially into a sine wave by a wave shaping circuit **51**. A power supply **51**, FIG. **3**, has an output lead **53** connected to the secondary winding of an input transformer **54** and therefrom through a switch **56** via terminals F and G to the input of the single oscillator of the first sound generator circuit. This will apply a 60 cycle signal to the oscillator for modulating the frequency thereof at a continuous 60 cycle rate. This type of musical effect is selectively switched in and out of the circuit by means of the switch **56**.

For a better understanding of the details of each of the discrete circuit arrangements of the overall electronic musical instrument system, reference is again made to FIG. **5**. Since the first sound generator means includes a single oscillator which is substantially similar to the plurality of oscillators **17**, **18** and **19** of the second sound generator means, only a detailed description of the single oscillator **14** will be given.

The oscillator **14** includes a programmable unijunction transistor **60** connected in shunt current relation with a capacitor **61** which, in turn, is connected in series current relation with a current feed resistor **62** which applies charging current thereto. The current feed resistor **61** is connected through terminals A back to the plurality of resistors **16**, FIG. **1**, and receives an operating voltage from the bus bar **24** when any one of the key switches **23** is actuated. When power is applied across resistor **62** and capacitor **61** the programmable unijunction transistor **60** operates as a relaxation oscillator whose frequency is determined by, among other things, the voltage developed across a resistor **63**. This voltage is applied to resistor **63** from a terminal **64** which, in turn, is connected to a voltage divider network comprising resistors **66**, **67** and potentiometer **68**. The junction between resistor **67** and potentiometer **68** is connected to resistor **63** through a diode **69**. Adjustment of potentiometer **68** will select the firing potential of the programmable unijunction transistor **60** so that the initial frequency of the relaxation oscillator can be adjusted. Frequency changes for different notes are then accomplished by inserting different resistance values into the circuit by actuating the desired key switches **23**.

The output of the single oscillator **14** is delivered to the output transistor **11** through a coupling capacitor **70**. The output transistor **11** operates as an emitter follower circuit having a signal developing resistor **71** connected between the emitter and ground potential and a coupling capacitor **72** for feeding the signal from the oscillator **14** into a selected one of a multiple filter network **73**.

The multiple filter network **73** includes a plurality of discrete filter paths between the output transistor **11** and an amplifier transistor **74**. For example, the filter network may include a path **76** which has a filter configuration to simulate a saxophone sound, a filter path **77** has a filter configuration to simulate a brass sound, a filter path **78** has a filter configuration to simulate a horn sound, and a filter path **79** has a filter configuration to simulate a string sound. The desired filter path or corresponding sound simulation is achieved by actuation of corresponding switches **80**, **81**, **82** and **83** connected in series circuit relation with the associated filter paths **76**, **77**, **78**, **79**, respectively. The modified signal from oscillator **14**, i.e. the signal now having a sound configuration corresponding to one of the sounds of the filter paths, is amplified by transistor **74** and delivered through a coupling capacitor **86** and a potentiometer **87** and series resistor **88** through terminals B, FIGS. **4** and **5**, to the input capacitor **89** of the audio amplifier circuit **29**.

In the illustrated embodiment of this invention the audio amplifier **29** has the active electronic components thereof formed on an integrated circuit element designated generally by reference numeral **90** and can be of any suitable configuration. For example, the audio amplifier circuit **90** may be a five watt amplifier having capabilities of producing an audio output without the use of audio coupling transformers. The audio amplifier circuit **90** can take the form of the transformerless audio amplifier as illustrated in the *GE Transistor Manual* (1964) page 263, which is an 8-watt amplifier, but which may have the output thereof reduced to 5 watts. The input terminal **91** of the integrated circuit element **90** is provided with a filter circuit comprising capacitor **92** and resistor **93** which eliminates extraneous high frequency noise pulses from the desired musical instrument tone signals. Power is applied to the integrated circuit **90** through a power receiving terminal **94** which applies operating bias to the input terminal **91** through a resistor **96** and which applies operating potential to a terminal **97** through a pair of series connected resistors **98** and **99**. A feedback capacitor **100** may be provided to effect regenerative or degenerative feedback as desired, depending on what point in the circuit it is connected. Additional high frequency filtering may be provided at an output line **101** by means of a series resistor and capacitor circuit **102**. A relatively large value capacitor **103** is in series relation with an output jack terminal **104** which, in turn, is connected in series with the speaker system **33**. The large value capacitor **103** is effective as a DC blocking element while passing substantially all audio signals of the entire frequency spectrum being reproduced. The jack switch unit **104** can be used to operate a headphone unit, in which instance the loud-speaker system **33** is completely disconnected from the circuit. Also connected in circuit with the input capacitor **89** of the audio amplifier **29** are a pair of jack plugs **106** and **107** which may correspond to a tape recorder output and a tape recorder input, respectively. Therefore, the melody tones generated by manipulation of the key switches **23** and delivered to the audio amplifier **29** by the filter network **73** can be recorded on a tape recorder. Also, prerecorded tapes can be fed into the audio amplifier **29** to accompany the person playing the electronic musical instrument of this invention.

The output of the plurality of chord tone oscillators **17, 18** and **19** are also delivered to the input capacitor **89** of the audio amplifier **29** for audible reproduction thereof within the loud-speaker system **33**. However, the chord tone signals are delivered thereto through the rhythm gate circuit **30**, amplifier transistor **31** and volume potentiometer **32** via the coupling leads D. The outputs of the chord tone oscillators **17, 18** and **19** are mixed together and amplified within transistor **13** which operates as a class A amplifier biased by means of resistor **108**, and a resistor **109** which is connected to a power terminal **110**. The amplified and mixed signals are delivered through a coupling capacitor **111**, a voltage developing resistor **112** and applied through a variable resistance element **113**. The value of the variable resistance element **113** corresponds to the rhythm pulse pattern produced within the logic circuit **36**, of FIG. **3**, to cause rhythm gating of the chord tones. The variable resistance element **113** preferably is a light-dependent resistor which changes its resistance value between high current passage and low current passage states in accordance with the light intensity impinging thereon. The rhythm gate circuit **30** is responsive to the rhythm pattern of the logic circuit **36** by means of a light-emitting diode **114** which generates light signal pulses in accordance with the pulse pattern of the rhythm circuit. Therefore, the light-dependent resistor **113** will vary between high conductive and low conductive states to vary the amplitude of the chord tone signal from oscillators **17, 18** and **19**. The output of the rhythm gate circuit **30** is then delivered through a fixed resistor **116** through leads C, FIGS. **1** and **2**, and into the amplifier transistor **31**.

The transistor amplifier **31** includes a biasing resistor **117** and a voltage developing resistor **118** connected to a power terminal **119**. A feedback resistor **120** is coupled between the collector and base electrode of transistor **31**. The output of the transistor is delivered to the volume potentiometer **32** through a series coupling capacitor **121** and a resistor **122**. The amplifier transistor **31** also has connected to the base electrode thereof the gating circuit **42** which applies cymbal, brush, snare drum and metronome signals for amplification.

The cymbal sound signals are delivered through a diode **130**, capacitor **131** and resistor **132** to a gating diode circuit comprising diodes **133, 134** and **135** connected in series with one another and in series with the collector of a transistor **136**. The junctions between diodes **133** and **134** are connected to the cathode of a diode **137** which has its anode connected through a coupling network of resistor **138** and capacitor **139** to the filter circuit **46**. Similarly, the brush percussion sounds are delivered through a diode **140**, capacitor **141** and resistor **142** to a diode **143** which also is connected to the cathode of diode **137**. The cymbal and brush percussion sounds are then mixed together through resistors **501** and **502** and connected to amplifier transistor **31**. In each instance, i.e. when cymbal and brush percussion sounds are generated, a noise of suitable frequency and amplitude is mixed therewith by means of the noise generator **43**. When the potential at the cathode of diodes **133** or **134** exceeds the reverse bias condition of diodes **134** and **135**, the noise generator **43** will produce an output to be mixed therewith.

The noise generator **43** comprises a transistor **150** having the base electrode thereof connected to ground potential and the emitter electrode thereof coupled through a capacitor **151** to a transistor **152**. Power is applied to transistors **150, 152** and **136** by means of a voltage terminal **153** and corresponding load dropping resistors connected in series with the respective transistors. The noise generating transistor **150** has the collector electrode thereof free of other electrical component connection so that inherent circuit noise between the base emitter junction of the transistor is generated and amplified through the two transistors **152** and **136**.

Also delivered to the filter circuit **46** is the snare drum percussion sound through a diode **156**, capacitor **157** and resistor **158**. The proper time sequence for the gating of the snare drum percussive sounds is generated within the logic circuit **36** and delivered to the snare drum terminal via the lead marked snare drum, FIG. **3**.

Gating pulses from the logic circuit are applied to the bass drum terminal and therefrom through a diode **164**, capacitor **165** and resistor **166** to a splitter capacitor network **167** at the input of the bass drum percussion sound amplifier **168**. The signal is then applied to the base electrode of transistor **31** through a series coupling capacitor **169** and series resistor **170**. Therefore, all of the signals except the melody signal, i.e. the chord tone signals and the percussion sound signals are mixed together within the amplifier transistor **31** and applied to the volume potentiometer **32**.

The single oscillator circuit **14** of the sound generator means **10** is connected to the variable frequency vibrato oscillator **50** through the lines G between FIGS. **1** and **5**. The vibrato oscillator **50** is always oscillating at some frequency. The output of the operational amplifier **172** is of triangular wave shape and is applied to a pair of parallel connected diodes **173** and **174** through a series resistor **176**. The diodes **173** and **174** will cause clipping of the triangular wave shape signal from the vibrato oscillator **50**. The value of resistor **176** is selected so as to cooperate with the diodes **173** and **174** and produce substantially a sine wave configuration to within 2 per cent of a pure sine wave. This almost pure sine wave configuration is adjustable in frequency from between ½ to 60 hertz by means of a potentiometer **177** which has the movable contact arm thereof connected to the output of a second operational amplifier **178.** The operational amplifiers **172** and **178** are cross-coupled to operate substantially as a multivibrator oscillator with a square wave signal appearing at the output of the operational amplifier **178.** The almost pure sine wave is applied to the input of a third operational amplifier **180** through a potentiometer **181** and a series resistor **182.** This vibrato signal is then delivered through a resistor **183** back to the single oscillator circuit **14** through a capacitor **184,** FIG. **5.** A filter capacitor **186** is connected between the output of the third operational amplifier **180** and ground potential so as to filter extraneous signals therefrom.

The operational amplifier **180** has a second input terminal connected to a delta pitch selector switch **187** through a transistor **188** and a capacitor **189.** Upon closing the delta pitch selector switch **187** a pulse signal is applied through capacitor **189** each time one of the key switches **23** is actuated to come into contact with the power bus bar **24.** This delta pitch signal is then applied through transistor **188** and operational amplifier **180** to provide a rapidly decaying pulse signal at the output thereof which is delivered through the resistor **183** and to the single oscillator **14** through leads G. Upon actuation of each of the key switches **23,** when the delta pitch switch **187** is closed, the tone signal produced at the single oscillator **14** will start out, for example, as a flat tone and then change into a natural tone for the duration of closure of the selected key switch **23.**

To provide still another novel sound effect from the single oscillator **14** a fixed frequency 60 cycle signal from the power supply **52** is delivered through a line **53,** a switch **56** of FIG. **1,** and therefrom into the single oscillator **14** through line G and capacitor **184.** When switch **56** is closed, the oscillator **14** will be modulated at a 60 cycle rate. This feature produces sound effects which are often desired by teenage users.

The power transformer **54** of the power supply **52** has a primary winding **190** shunted by an indicating lamp **191** and a series current limiting resistor **192.** A power on/off switch **193** is in series with one of the power lines leading from a power plug **194.** The transformer **54** has a center tap secondary winding **196** which has the end lead terminals thereof connected to a pair of diodes **197** and **198** which are arranged in a full wave rectifier configuration. The diodes **197** and **198** have their cathodes connected to a relatively large filter capacitor **199** which, in turn, has the other end thereof connected to ground potential. The rectified and filtered voltage developed across capacitor **199** is delivered to a power output terminal **200** for operating various circuit components within the musical instrument circuit of this invention. Also connected to the rectified and filtered DC voltage developed across capacitor **199** is a voltage regulator **201** which has the output thereof connected to the emitter electrode of a transistor **202** which, in turn, is operatively connected to the base electrode of a series regulating transistor **203.** The transistor **203** is rendered conductive to a level corresponding to the amount of power needed within the circuit. Additional filtering is obtained by a capacitor **206** which may be in the order of 10 to 25 microfarads. The output voltage at terminal **204** may be in the order of 22 volts more or less. For additional circuit components requiring a lower output regulated voltage a regulating transistor **207** is connected between the output terminal **204** and an output terminal **208.** This transistor will develop an output in the order of 11 volts to operate circuit components as necessary.

FIG. **3** also shows the logic circuit **36** and the various external switches and potentiometers associated therewith. For a better understanding of the detailed circuit arrangement of the logic circuit **36,** reference is now made to FIGS. **6, 7** and **8** which illustrate the interconnection between the various circuit components.

The logic circuit of FIGS. **6, 7** and **8** includes an oscillator circuit **210,** in FIG. **8,** which oscillates at an output frequency of about 200 hertz. It will be understood that other frequencies can be used as desired. The oscillator circuit **210** is formed of a pair of inverter circuits **211** and **212** of an integrated circuit chip designated generally by reference numeral **213.** The inverter circuit **211** receives power from a terminal **214** through a resistor **216** while the inverter circuit **212** receives power through the resistor **217.** A pair of cross-coupling capacitors **218** and **219** are connected between the output of one inverter circuit to the input of the other. The oscillator circuit **210** operates as a conventional multivibrator producing square wave output along the lines K connected between FIGS. **8** and **6.** A transistor emitter follower **220** has an emitter resistor **221** associated therewith for developing the snare drum voicing which is coupled to the snare drum filter circuit of FIG. **2.**

The output of the oscillator circuit **210** is delivered to a Schmitt trigger circuit designated generally by reference numeral **225** comprising a pair of NAND gates **226** and **227.** This signal is applied to the NAND gates through a 0.1 microfarad capacitor **228** and a variable potentiometer **229** which serves as a tempo adjustment to vary the rate which the percussion rhythm sounds are produced. The operation of the oscillator circuit **210** and Schmitt trigger circuit **225** is such that the repetition rate of the Schmitt trigger is determined by the resistance value of the tempo potentiometer **229.** The pulse width of the Schmitt trigger is determined by a 3.3 microfarad capacitor **230** and a variable resistance element **231.** The pulse width is used to determine the keying on time for all rhythm voices used in the rhythm circuit. When a "Swing" rhythm is used it requires twelve counts or beats per measure, and when a "March" rhythm is used it requires eight counts or beats per measure.

The output of the Schmitt trigger is developed across a transistor **232** and applied therefrom to the input of a multiple flip-flop circuit **233** at the respective input terminals **234** and **235** thereof. The multiple flip-flop circuit comprises a pair of J-K flip-flops of well-known configuration. The output from the Schmitt trigger is also applied to the inputs of a pair of AND gates **236** and **237** which, in turn, have the other inputs thereof coupled to respective different ones of the flip-flops of the multiple flip-flop circuit **233.** Therefore, proper gating of signals is obtained between the AND gates **236** and **237.** The output of AND gate **236** is delivered to one input of each of the AND gates **240** and **241** and to one of the lines of group H, between FIGS. **6** and **7,** to an inverter circuit **242.** The output of the inverter **242** is applied to one of the lines of group J and therefrom to a second inverter 244 to provide a brush percussion sound effect. The output of AND gate 237 is applied to an AND gate 246 together with the output of a second multiple flip-flop circuit 247. Flip-flop circuit 247 is also connected to one of the input leads of the AND gate 240.

The AND gates 240, 241 and 246 are interconnected with AND gates 250, 251 and 252 to provide the appropriate pulse pattern corresponding to the desired rhythm, i.e. swing, march etc. The appropriate rhythm pattern is delivered over the H lines between FIGS. 6 and 7 to be applied to the inputs of a plurality of inverter circuits designated by reference numerals 260, 261 and 262 corresponding to a march rhythm pattern, a swing rhythm pattern, or a rock-and-roll rhythm pattern, respectively. These rhythm patterns are then delivered over the J lines back to FIG. 8, as mentioned above through the appropriate inverter circuits 244, 264, 274 and 284 to produce the snare drum cymbal and bass drum sound effects.

In accordance with the principles of this invention the rhythm gate circuit 30 of FIG. 1 is again shown in FIG. 7 but in this instance the light-emitting diode 114 is shown connected in its appropriate operating circuit while the light-dependent resistor is shown only schematically. The light-emitting diode 114 is connected in series current relation with the transistor 267 which is rendered conductive in accordance with the pulse sequence pattern from an inverter complex designated generally by reference numeral 268. The pulse rhythm pattern is applied through a series connected transistor 269 which, in turn, operates the transistor 267. As mentioned above, the gating of the chord tones produced by the chord key switches 26, 27 and 28, FIG. 1, is accomplished substantially in conformity with the rhythm pattern selected.

What has been described is an overall detailed circuit arrangement for an efficient and inexpensive electronic musical instrument which can be used to function as an electronic organ or the like. The electronic circuit illustrated herein has all of the features of more expensive organ circuits which have automatic rhythm accompaniment, vibrato effect on melody tones, a 60 cycle modulation of the melody tones, when switch 56 is closed, and includes a delta pitch circuit selectively to change the tonality of the melody keys when depressed. Accordingly, it will be understood that variations and modifications of this invention may be effected without departing from the spirit and scope of the novel concepts disclosed and claimed herein.

The invention is claimed as follows:

1. An electronic musical instrument comprising: a first sound generator means having a single oscillator and a first output for producing melody tones, a first group of resistor means connected to said single oscillator, a plurality of switches connected to said first group of resistor means to switch said resistor means into and out of circuit therewith for producing said melody tones at said first output, a second sound generator means having a plurality of oscillators and a second output for producing chord tones, a second group of resistor means forming a plurality of sub-groups of resistor means, a plurality of switches connected to each of said sub-groups, each sub-group of resistor means including discrete resistor elements being connected to a selected one of said plurality of oscillators and each discrete resistor element of each sub-group selectively switched into and out of circuit with its oscillator for energizing the oscillator at different frequencies to produce predetermined chord tones at said second output, audio amplifier means connected to said first and second outputs for simultaneously receiving said melody and said chord tones, and loud-speaker means connected to said audio amplifier means to provide melody and chord sounds therefrom.

2. The electronic musical instrument of claim 1 further including a source of alternating current voltage, and circuit means including a switch connected between said source of alternating current voltage and said single oscillator of said first sound generator means for selectively inserting into said single oscillator a supplemental fix frequency sound.

3. The electronic musical instrument of claim 1 wherein said plurality of oscillators of said second sound generator means is three oscillators, and said second group of resistor means includes three sub-groups of resistor means, one sub-group connected with each respective oscillator.

4. The electronic musical instrument of claim 1 wherein each of said oscillators includes a programmable unijunction transistor operated in a relaxation oscillator circuit mode.

5. The electronic musical instrument of claim 1 wherein said first group of resistor means is formed of a plurality of discrete resistors and connected in series and forming a circuit point between each resistor, said discrete resistors of said first group being switched into and out of circuit with said single oscillator at the circuit points between the resistors of said first group, whereby the total resistance value connected with said single oscillator is the sum of the values of the discrete resistors between said single oscillator and a selected one of said circuit points.

6. The electronic musical instrument of claim 5 wherein each of said sub-group of resistor means is formed of a plurality of discrete resistors connected in series and forming a circuit point between each resistor, said discrete resistors of each of said sub-groups being switched into and out of circuit with its associated oscillator of said second sound generator means at the circuit point between the resistors of said sub-group.

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