United States Patent [19]

Kidd et al.

[11] **3,908,502**

[45] **Sept. 30, 1975**

[54] **ELECTRONIC ORGAN WITH CHORD CONTROL**

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[73] Assignee: **The Wurlitzer Company,** Chicago, Ill.

[22] Filed: **June 12, 1974**

[21] Appl. No.: **478,701**

[52] **U.S. Cl.** **84/1.01;** 84/1.17; 84/DIG. 22

[51] **Int. Cl.**[2] **G10H 1/00;** G10H 5/00

[58] **Field of Search** 84/1.01, 1.03, 1.17, 1.24, 84/DIG. 22

[56] **References Cited**

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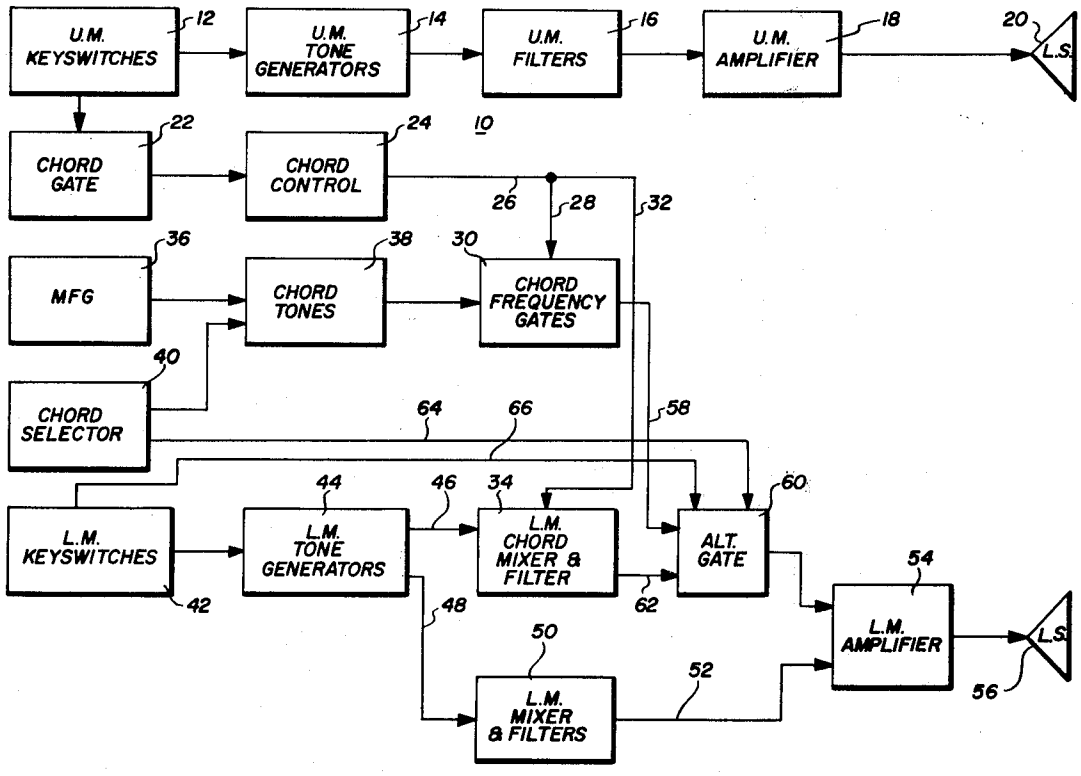
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Assistant Examiner—Stanley J. Witkowski
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[57] **ABSTRACT**

An electronic organ is provided in which chords can be enabled by the left hand on the lower manual or by a chord unit. However, the chord does not sound until a note is played on the upper manual as by the right hand. Thus, the playing of chords is controlled precisely in accordance with the playing of the melody notes.

11 Claims, 3 Drawing Figures



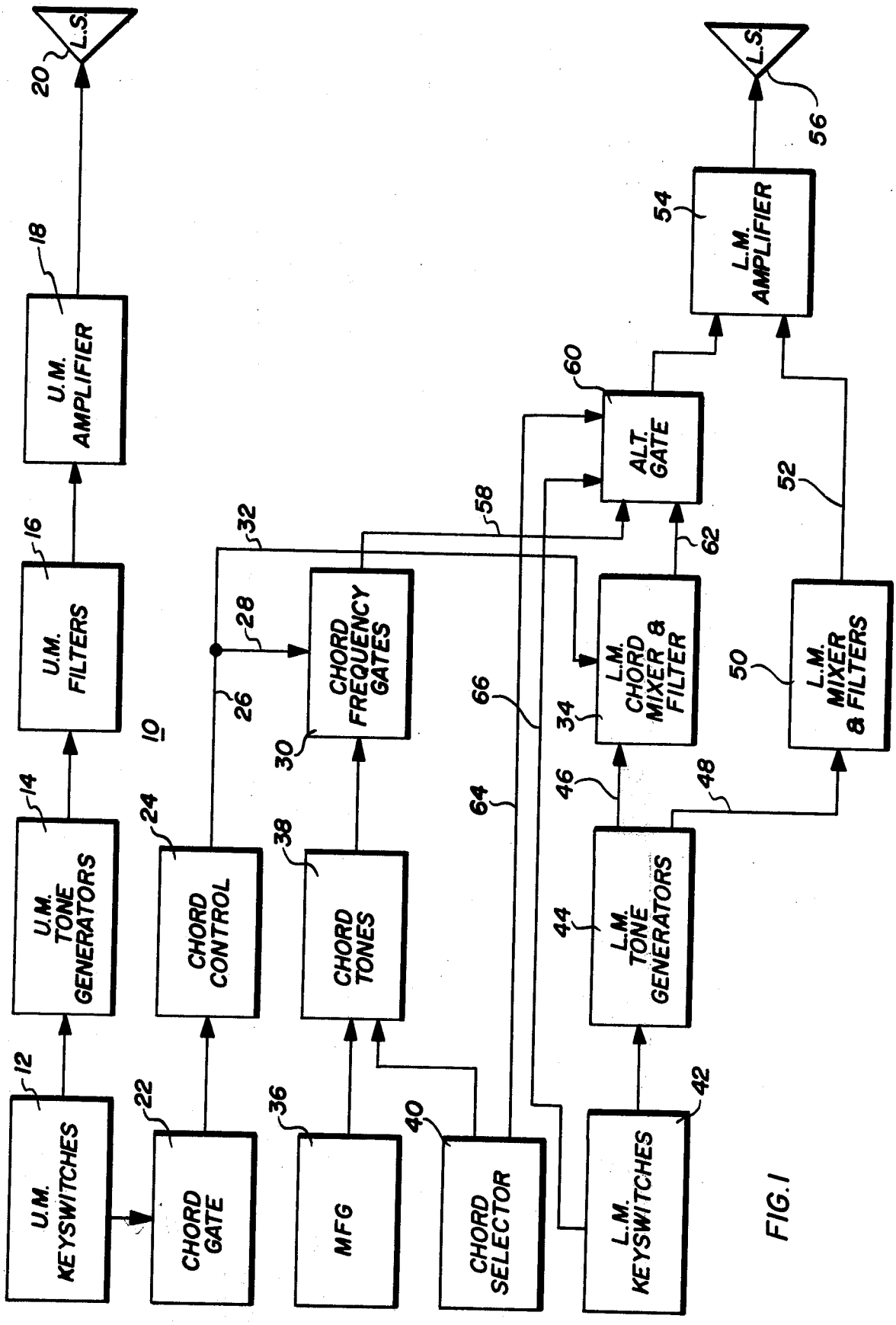

U.M. KEYSWITCHES
12
U.M. TONE GENERATORS
14
U.M. FILTERS
16
U.M. AMPLIFIER
18
L.S.
20
CHORD GATE
22
CHORD CONTROL
24
26
28
CHORD FREQUENCY GATES
30
32
MFG
36
CHORD TONES
38
CHORD SELECTOR
40
L.M. KEYSWITCHES
42
L.M. TONE GENERATORS
44
46
L.M. CHORD MIXER & FILTER
34
ALT. GATE
60
58
62
L.M. AMPLIFIER
54
L.S.
56
L.M. MIXER & FILTERS
50
52
48
64
66
10

FIG. 1

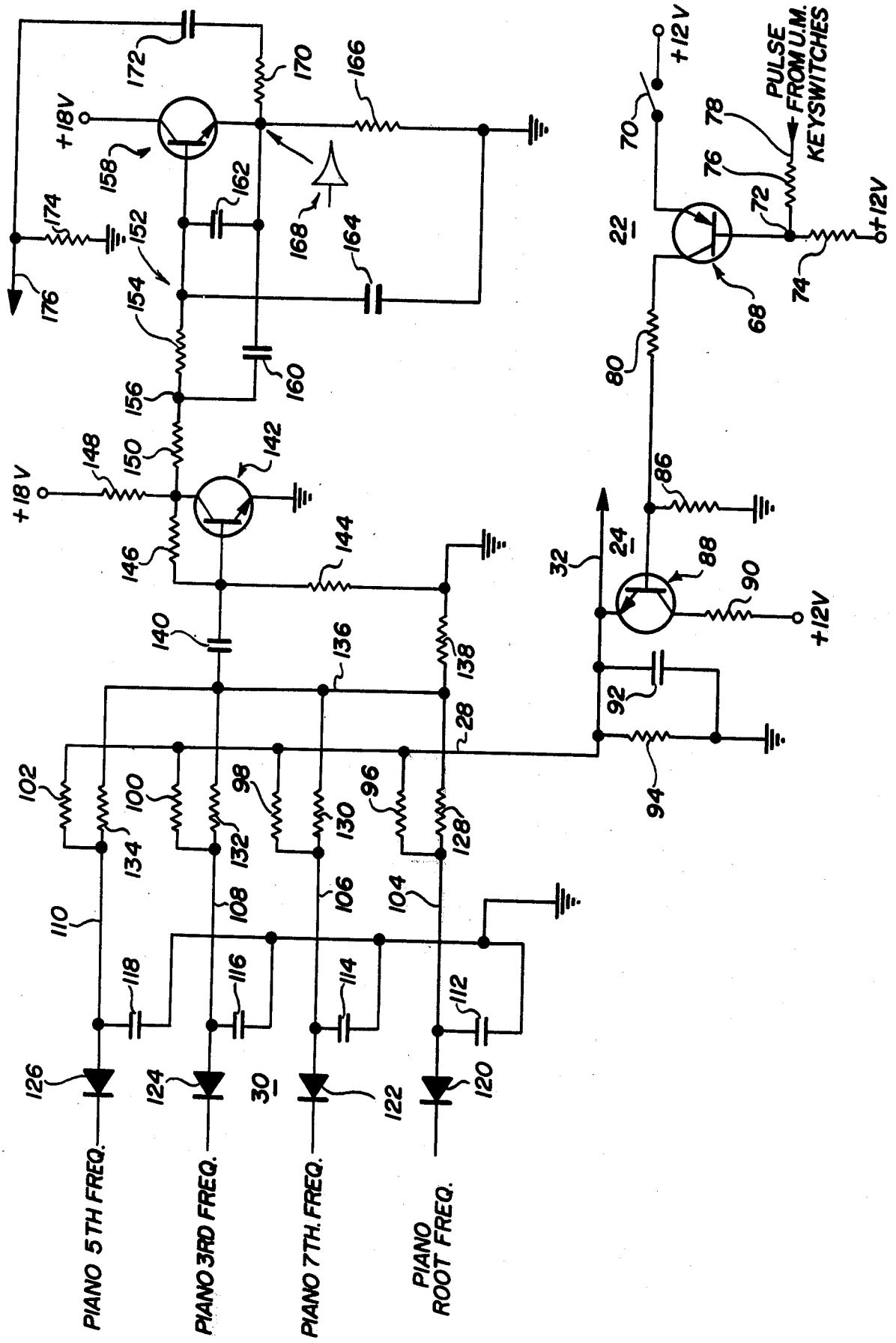

+18V
+18 V
+12 V
+12V
PULSE FROM U.M. KEYSWITCHES
PIANO 5TH FREQ.
PIANO 3RD FREQ.
PIANO 7TH. FREQ.
PIANO ROOT FREQ.

FIG.2

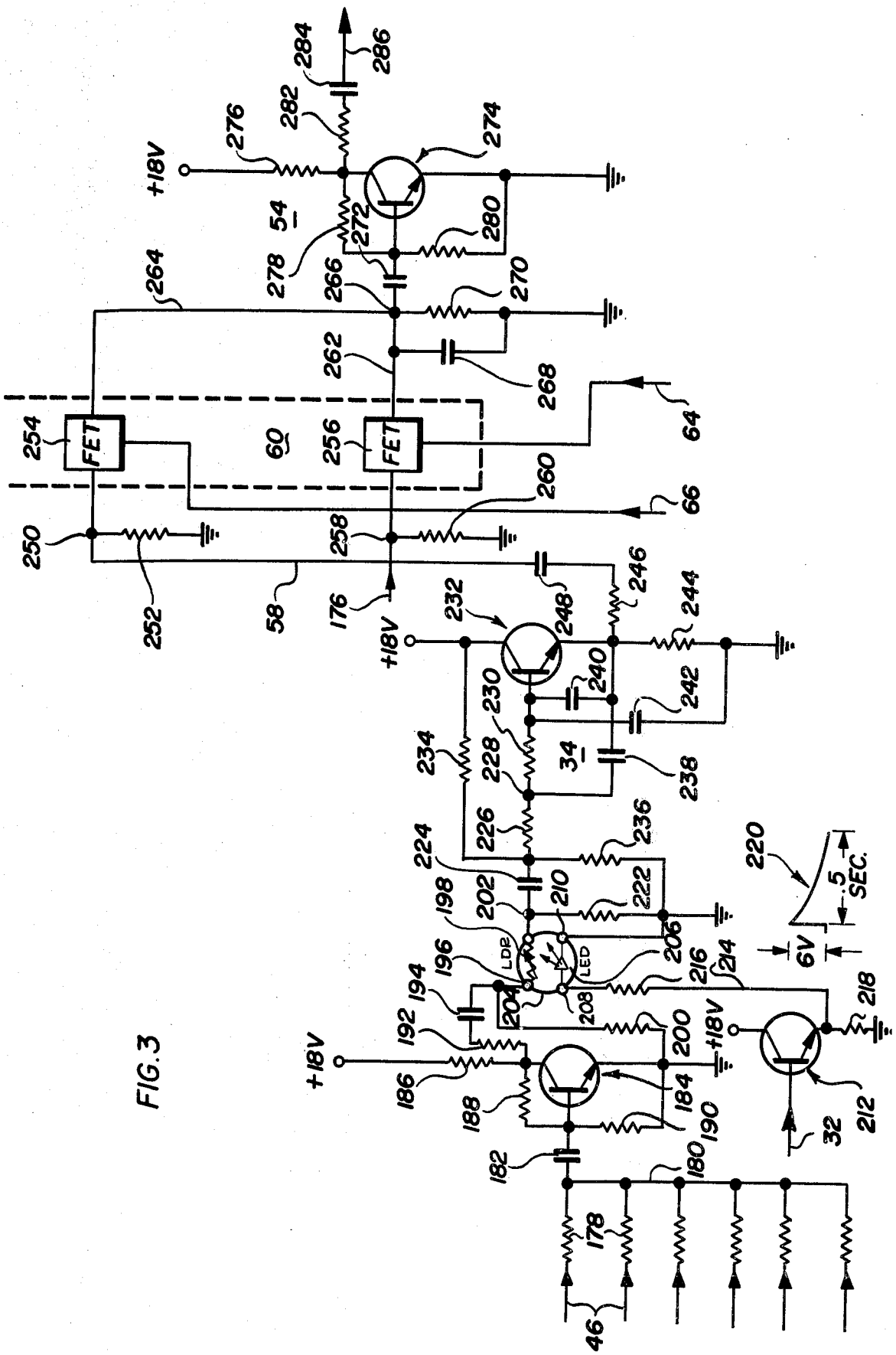

+18V
FET
FET
LDR
LED
.5 SEC.
6V
54
60
32
46
64
66
58
176
252
250
254
256
258
260
262
264
266
268
270
272
274
276
278
280
282
284
286
178
180
182
184
186
188
190
192
194
196
198
200
202
204
206
208
210
212
214
216
218
220
222
224
226
228
230
232
234
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238
240
242
244
246
248

FIG. 3

ELECTRONIC ORGAN WITH CHORD CONTROL

BACKGROUND OF THE INVENTION

In the playing of most keyboard music, specifically organ music, and even more particularly music for the electronic organ, it is common practice to play one or more melody notes with the right hand and to play accompanying chords with the left hand. It is common practice in the playing of organ music to play the melody on the upper manual and to play the accompanying chords on the lower manual, accompanied by the bass or foot pedals.

In electronic organs a choice is often given to the player in the playing of chords by the left hand on the lower manual, or in a chord unit which has buttons labeled for the principal chords, wherein each button is wired to connect the three or more notes for the chord to which it pertains. Many beginning players find it difficult to coordinate the left and right hand so that chords and melody notes are played at the same time. Stated conversely, it is common with beginning players to have the chords either lead or lag the melody notes. This does not sound right, and it is often likely to confuse a novice musician.

In many electronic organs the chords, particularly when played from a chord control button board, are interconnected with a rhythm unit so that once a chord has been selected it plays in a predetermined rhythmic pattern. The player then must play the melody notes in proper time with the chords. Different players respond quite differently to this. For some it is a simple matter, for some it is not too difficult, but for others it is absolutely impossible, and leads to complete confusion.

OBJECTS AND SUMMARY OF THE PRESENT INVENTION

The principle object of the present invention is to simplify chord playing, particularly for the beginning organist.

More specifically, it is an object of the present invention to provide an electronic organ in which the chords are selected by the player, but do not play until a respective melody is played, whereby the chord plays in exact time with a melody note.

In order to effect the foregoing objects, electronic circuitry is provided, whereby a chord is selected by the organist, either by the left hand on the lower manual, or by a chord button array. In either event, the organist depresses the keys or chord button as if to play the chord. This does not actually play the chord, but enables it, or sets up switching so that the chord will play. Subsequently, whenever a melody note is played with the right hand a pulse is produced by closing of the respective key switch, and this pulse causes the enabled chord to play precisely in time with the melody note. The keys or button for a chord can be held down indefinitely, but the chord will only sound for a predetermined time increment immediately upon the closing of the switch of a melody key.

DESCRIPTION OF THE DRAWINGS

The invention will best be understood with reference to the accompanying drawings wherein:

FIG. 1 is a block diagram illustrating the principles of the present invention;

FIG. 2 is a schematic wiring diagram corresponding to part of the block diagram; and

FIG. 3 is a further schematic wiring diagram illustrating outer parts of the block diagram.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention first should be directed to FIG. 1 for a general understanding of the invention. The block diagram represents an electronic organ **10** and includes a plurality of upper manual key switches **12** corresponding to the keys of an upper manual. This manual may be a full 61-note keyboard, or a shortened spinet-type keyboard, such as one having 44 notes. The upper manual key switches are connected to upper manual tone generators **14.** Any tone generators known in the art may be satisfactory for this purpose, including separate generators, or one octave of master oscillators with divider oscillators to provide the tones for lower octaves, or a single very high frequency oscillator with a plurality of parallel divider paths of different ratios to provide the top octave of generators with subsequent divide-by-two circuits to provide the lower octaves. The upper manual tone generators **14** are connected to upper manual filters **16** which will be understood as also including the requisite stop tablet switches for selecting the desired filters. The upper manual filters **16** are connected to an upper manual amplifier **18,** and this in turn is connected to a loud speaker **20** which generally is housed within the organ case or cabinet, but which may be externally disposed. As will be understood, there may be one or more loud speakers for the entire organ, and there may be a single output power amplifier, or different amplifiers for different channels, etc., all as is well known within the state of the art.

The upper manual key switches are arranged so as to provide a pulse each time a key switch is closed, irrespective of whether prior key switches remain closed or not, i.e. whether the playing is staccato or legato. Various means are known in the art for producing such pulses, and one such preferred structure is to be found in Ippolito et al, U.S. Pat. No. 3,808,344 assigned to the same assignee of record and incorporated herein by reference. In any event, the pulses from the key switches **12** are connected to a chord gate **22,** and the output of the chord gate in turn is connected to a chord control **24.** The output of the chord control at **26** splits, and is connected at **28** to chord frequency gates **30,** and is connected at **32** to a lower manual chord mixer and filter **34.**

A multiple frequency generator **36** is provided which simultaneously provides all the notes that might be used in playing chords. This multiple frequency generator preferably is similar to the tone generator disclosed in the aforesaid Ippolito et al. U.S. Pat. No. 3,808,344, comprising a single radio frequency oscillator, a plurality of parallel divider circuits of different ratio to provide a top octave of tones, and subsequent divide-by-two circuits to provide lower octave tones. The output of the multiple frequency generator is connected to provide chord tones **38.** The chord tones at **38** are connected to the chord frequency gates **30.**

There is also provided a chord selector **40** which may be a chord unit or button board array of buttons for the common chords, preferably including the major, minor and seventh.

The organ also is provided with lower manual key switches **42** corresponding respectively to the keys of the lower manual or keyboard. These key switches are

connected to lower manual tone generators 44 which preferably are similar to the upper manual tone generators 14. One output 46 of the lower manual tone generators is connected to the lower manual chord mixer and filter, while an additional output 48 is connected to a lower manual mixer and filters 50, including suitable stop tablets. The latter is for playing of chords in the normal manner rather than through the chord control of the present invention. The output of the lower manual mixer and filters 50 is connected at 52 to a lower manual amplifier 54, and this in turn is connected to a loud speaker 56. As will be understood, the upper manual amplifier 18 and lower manual amplifier could comprise a single power output amplifier, and could be connected to a single speaker or speaker array. However, there are some advantages in handling the upper and lower manual channels separately.

The output of the chord frequency gates 30 is connected at 58 to an alternate gate 60. The output of the lower manual chord mixer and filter 34 similarly is connected at 62 to the alternate gate 60. One control for the alternate gate 60 is provided at 64 from the chord selector 40, while a second control 66 is provided to the alternate gate 60 from the lower manual key switches 42. These controls respectively act through the alternate gate 60 to pass either the output from the lower manual chord mixer and filter or the output from the chord frequency gates, depending upon whether chords are being played by the lower manual key switches, or by the chord selector 40.

Attention now should be directed to FIG. 2, and first to the lower right hand corner thereof where the chord gate 22 will be seen to comprise a PNP transistor 68 having the emitter thereof connected to a normally open chord controlling stop switch 70 operated by a stop tablet on the organ. The other side of the switch is connected to a positive 12-volt source. The base of the transistor 68 is connected to a junction 72 which is connected through a resistor 74 to a positive 12-volt source, whereby normally to hold the transistor 22 off irrespective of whether or not the switch 70 is closed. The junction 72 also is connected through a resistor 76 to the upper manual key switches 12 by a line 78 on which a pulse is supplied from the upper manual key switches whenever a switch is closed. This lowers the potential on the base so that with the switch 70 closed the transistor 68 is turned on.

The collector of the transistor 68 is connected through a resistor 80 to a shunting resistor 86, and hence to the base of an NPN transistor 88. The collector of this transistor is connected through a resistor 90 to a positive 12-volt supply, while the emitter is connected in an emitter follower configuration to a shunting sustain capacitor 92 in parallel with a timing resistor 94, and also to the line 32 previously mentioned, leading to FIG. 3 as hereinafter set forth.

The line 28 leads to the chord frequency gate 30 as aforesaid, and specifically through respective resistors 96, 98, 100 and 102 to lines 104, 106, 108 and 110. These lines are respectively shunted to ground by low value capacitors 112, 114, 116 and 118, and are connected to the anodes of respective diodes 120, 122, 124 and 126. The cathodes of these diodes are respectively provided with chord tones from the chord tones source 38, and these comprise the root frequency, the seventh frequency, the third frequency and the fifth frequency respectively, and specifically of the piano tones. As will be understood, the root frequency, and hence the respective odd harmonics change in accordance with the particular chord played on the chord selector unit 40. Preferably, the frequencies are derived from a chord chip of the type disclosed in William V. Machanian application Ser. No. 475,449 filed June 3, 1974 for Electronic Musical Instrument Using Integrated Circuit Components and assigned to the same assignee of record. The frequencies passed by the respective diodes are rectangular waves. The rectangular waves appearing on the lines 104, 106, 108 and 110 are combined through respective resistors 128, 130, 132 and 134 to a common line 136.

The common line 136 is connected to ground by means of a resistor 138, and it also is connected by means of a capacitor 140 to the base of an NPN transistor 142. The base is biased by means of a shunting resistor 144 to ground, and by means of a resistor 146 connected to the collector, and also connected through a resistor 148 to a positive 18-volt source. The emitter is grounded.

The output of the transistor is taken from the collector through a resistor 150 to a piano filter 152 comprising a series resistor 154 from an input junction 156 to the base of a transistor 158. A capacitor 160 is connected from the junction 156 to the emitter of the transistor, which will be seen to be a NPN transistor, while a capacitor 162 is connected between the base and the emitter. An additional capacitor 164 is connected from the base to ground, while the emitter also is grounded through a resistor 166. The collector is direct connected to a positive 18-volt source. The output appears at the emitter and has an envelope generally as indicated at 168, having a sudden attack and subsequently decay curve, generally simulating the envelope of a piano tone.

This output is connected through a resistor 170 and through a capacitor 172 across a shunting resistor 174 and to an output point 176 leading to the circuitry of FIG. 3, to which attention should now be directed.

Various tonal inputs are connected through resistors 178 (FIG. 3) to a common line 180 to staircase the square wave tonal inputs. The square waves are provided from a lower manual keying circuit through the connection 46, whereby chords can be played from the lower manual key switches 42 rather than from the chord selector 40. Although the lower manual tone signals can be obtained from various sources, it is preferred that they be obtained from a large scale integrated circuit as set forth in considerable detail in the co-pending application of William V. Machanian, Ser. No. 475,448 filed June 3, 1974 for Electronic Musical Instrument For Using Integrated Circuit Components and assigned to the same assignee of record. In any event, square waves appearing on the lines 46 and applied through the resistors 178 are staircased on the common line 180 to provide near sawtooth waves having both odd and even harmonics. The sawtooth waves corresponding to the chord notes played on the lower manual are applied from the common line 180 through a capacitor 182 to the base of an NPN transistor 184. The emitter is grounded, as shown, while the collector is connected through a resistor 186 to a positive 18-volt source. The base is biased from a connection to the collector through voltage divider resistors 188 and 190, the lower end of the last-mentioned resistor being grounded.

The output is taken from the collector of the transistor **184** through a resistor **192** and a series capacitor **194,** and is connected to the input **196** of a light dependent resistor **198.** This input also is grounded through a resistor **200.** The output of the light dependent resistor is connected to a junction point **202.**

The light dependent resistor (LDR) is part of a package **204** with a light emitting diode (LED) **206** having an input at **208,** and a grounded output at **210.**

The line **32** connected to the output of the transistor **88** (FIG. 2) of the chord control **24** is connected in FIG. 3 to the base of an NPN transistor **212** having an emitter follower output at **214** leading through a resistor **216** to the input **208** of the LDR-LED package **204.** The transistor **212** at the collector thereof direct connected to a positive 18-volt source, while the emitter is grounded through a resistor **218.**

The signal or voltage out of the transistor **212** is determined by the piano sustain capacitor **92,** and the wave shape is indicated in FIG. **3** at **220,** having a rapid attack and a typical capacitor discharge decay. As will be apparent, the LDR **198** has a very high resistance in the dark state. However, when the wave shape **220** is applied to the LED the LDR is illuminated, and promptly becomes quite conductive, tapering off to a very high impedance, whereby the chord tones played on the lower manual are percussively reproduced whenever a note on the upper manual is played.

The junction point **202** to which the output of the LDR is connected is grounded through a resistor **222,** and passes through a capacitor **224** to the lower manual chord mixer and filter. The filter is specifically a piano filter, and includes an input series resistor **226** connected to a junction point **228.** A further series resistor **230** leads to the base of an NPN transistor **232,** the collector of which is direct connected to a positive 18-volt source. The top end of a voltage divider resistor **234** is also connected to this source, the lower end being connected through the resistors **226** and **230** to the base, while the voltage divider is completed by a resistor **236** from the bottom of the resistor **234** to ground.

The filter **34** further includes a capacitor **238** connected from the junction point **228** to the emitter of the transistor **232.** A shunting capacitor **240** connects the base to the emitter. The base further is connected to ground by a shunting capacitor **242,** while the emitter is grounded through a resistor **244,** the transistor **232** thus being in an emitter follower connection.

The output is taken through a resistor **246** and a series capacitor **248** to the output line **58** leading to the alternate gates **60,** and specifically an input connection **250** thereof which is shunted to ground by a resistor **252.** The input **250** is connected to a field effect transistor (FET) **254,** having the output thereof connected to the lower manual amplifier **54,** which is shown only in part in FIG. **3.**

An additional field effect transistor **256** is included in the gates **60,** and the input **258** thereof is supplied from the line **176** previously referred to in FIG. **2.** This input is shunted to ground by a resistor **260.** The output of the FET and **256** also is connected to the lower manual amplifier **54.** Neither of the field effect transistors **254,** 256 is normally conductive. However, when the chord selector unit **40** is operated a potential applies on the line **64** which is connected to the gate of the field effect transistor **256,** whereby to turn this field effect transister on in a manner of a switch, whereby an output appears on line **262.** Similarly, when chords are played on the lower manual a control signal applies on the line **66** to turn on the field effect transister **254,** whereby an output appears on line **264.** The two outputs are combined at **266** across an RC filter comprising a capacitor **268** in parallel with a resistor **270** shunting connection **266** to ground to eliminate any undesired noise, switching spikes, or the like appearing at **266.** The output at **266** is connected through a capacitor **272** to an NPN transistor **274** forming a first amplification stage of the lower manual amplifier **54.** The emitter is direct grounded, while the collector is connected through a resistor **276** to a positive 18-volt supply source. The base is biased by a voltage divider resistor pair **278** and **280.** The output is taken from the collector through a series resistor **282** and capacitor **284** to a line **286** for further amplification and application to the loud speaker.

A preferred example of the present invention has now been fully set forth. A chord can be selected by the organ player either by way of the chord selector unit **40** or by way of the lower manual key switches **42** associated with the respective keys of the lower manual, but the chord does not sound until a note is played on the upper manual, whereby to provide an appropriate gating signal, as heretofore set forth to pulse the chord frequencies to the output of the organ. Regardless of whether the upper manual is played legato or staccato the chord output is pulsed in perfect time with the note playing of the upper manual each chord tone plays for a maximum of approximately a half-second, but the latter portion of this half-second is at very low intensity, whereby it will be completely masked by the higher intensity of the new chord tone if the further note is played on the upper manual.

The specific example of the invention as herein shown and described is for illustrative purposes only. Various changes will no doubt occur to those skilled in the art and will be understood as forming 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. In an electronic musical instrument, the combination comprising means for generating electric oscillations corresponding to the notes of a chord, manually operable means for selecting the electric oscillations of a desired chord, gate means to which selected oscillations are supplied, said gate means being normally inoperative to pass said oscillations means for generating oscillations corresponding to melody notes, keyboard means having a plurality of keys for manually playing a melody, and means electrically interconnecting said keys and said gate means to render said gate means effective to conduct manually selected chord oscillations whenever one of said keys is depressed.

2. The combination as set forth in claim **1** wherein the means electrically interconnecting said keys and said gate means comprises means for providing a pulse when any key is depressed to render said gate means conductive.

3. The combination as set forth in claim **1** wherein the manually operable means for selecting electric oscillations of a desired chord selector comprises both a chord unit and a second keyboard.

4. The combination as set forth in claim **3** wherein there are two gate means, one for said chord selector unit, and one for said second keyboard.

5. The combination as set forth in claim 4 wherein both of said gate means are simultaneously turned on upon depression of a melody key, and further including combining circuit means receiving oscillations from said gate means and comprising two secondary gates respectively connected to said chord selector unit and said second keyboard, and additional means interconnecting said chord selector unit and said second keyboard respectively with said secondary gates respectively to change each secondary gate from a non-conducting to a conducting condition.

6. The combination as set forth in claim 4 wherein one of said gate means comprises in combination a light-emitting diode and a light dependent resistor.

7. The combination as set forth in claim 6 wherein said one gate means is interconnected with the second keyboard.

8. The combination as set forth in claim 4 wherein one gate means comprises a plurality of diode gates respectively connected to different electronic oscillation generating means for the respective notes of a chord.

9. The combination as set forth in claim 8 wherein said diode gates are connected to said chord selector unit.

10. The combination as set forth in claim 4 wherein one gate means comprises a light-emitting diode and light dependent resistor combination connected to the second keyboard, and the second gate means comprises a plurality of diode gates respectively connected to the different oscillation generators of said chord selector unit.

11. The combination as set forth in claim 2 and further including a resistance-capacitance filter connected to said gate means for effecting opening of said gate means at a first time interval and closing thereof at a second time interval greater than said first time interval.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,908,502 Dated September 30, 1975

Inventor(s) Dennis E. Kidd and Anthony C. Ippolito

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 6, line 63, cancel "selector"

Col. 6, line 64, after "chord" insert --selector--

Signed and Sealed this

ninth Day of *March 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE

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Col. 6, line 64, after "chord" insert --selector--

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[SEAL]

Attest:

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Attesting Officer

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Commissioner of Patents and Trademarks