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Freeman

[11] **3,839,592**

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[54] **PLURAL MODE AUTOMATIC BASS SYSTEM WITH PEDAL SUSTAIN**

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[51] **Int. Cl.** **G10h 1/00**

[58] **Field of Search** ..... 84/1.01, 1.03, 1.13, 1.17, 84/1.24, 1.26, DIG. 2, DIG. 12, DIG. 22

[56] **References Cited**

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3,546,355	12/1970	Maynard	84/1.03
3,548,066	12/1970	Freeman	84/1.03
3,549,774	12/1970	Bunger	84/1.03
3,567,838	3/1971	Tennes et al.	84/1.01
3,610,799	10/1971	Watson	84/1.01
3,707,594	12/1972	Ichikawa	84/1.03
3,708,602	1/1973	Hiyama	84/1.03

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D. O. Pederson et al., Introduction to Electronic Systems, Circuits, and Devices, Copyright 1966 by McGraw-Hill, Inc., pp. 191–193.

Primary Examiner—Richard B. Wilkinson
Assistant Examiner—Stanley J. Witkowski

[57] **ABSTRACT**

A system is provided for automatically playing bass notes from accompaniment chords in a plurality of modes and also for playing bass notes with sustain in response to pedals. A scanner is provided to scan a selected one of two sets of playing controls and to stop and cause a bass note to sound when it encounters an actuated control. An automatic rhythm device is provided to restart the scanner for rhythmic modes. In non-rhythmic modes, the scanner is restarted when any control is actuated after the control which stopped it is released. The system also includes a controllable ratio frequency divider to minimize the number of pins required for an integrated circuit pack to implement the system for an electronic organ. Controls are further provided to select any of the following playing modes:

a. All chord notes sounded in bass in ascending pitch order.

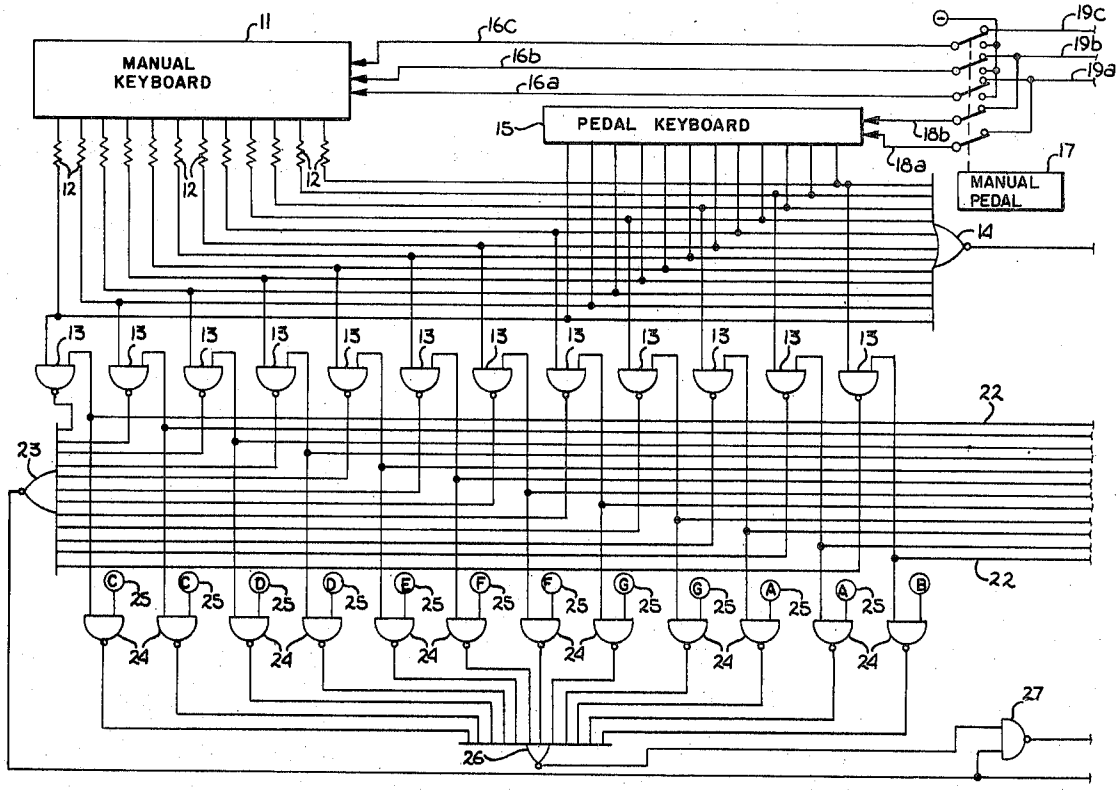
b. All chord notes sounded in bass in ascending and in descending pitch order without repeating highest and lowest pitch notes in succession.

c. Highest and lowest pitch notes of chord sounded alternately in the bass.

d. Bass notes sound with or without sustain in normal response to operation of pedals.

e. Lowest pitch note of chord sounds in the bass.

9 Claims, 3 Drawing Figures



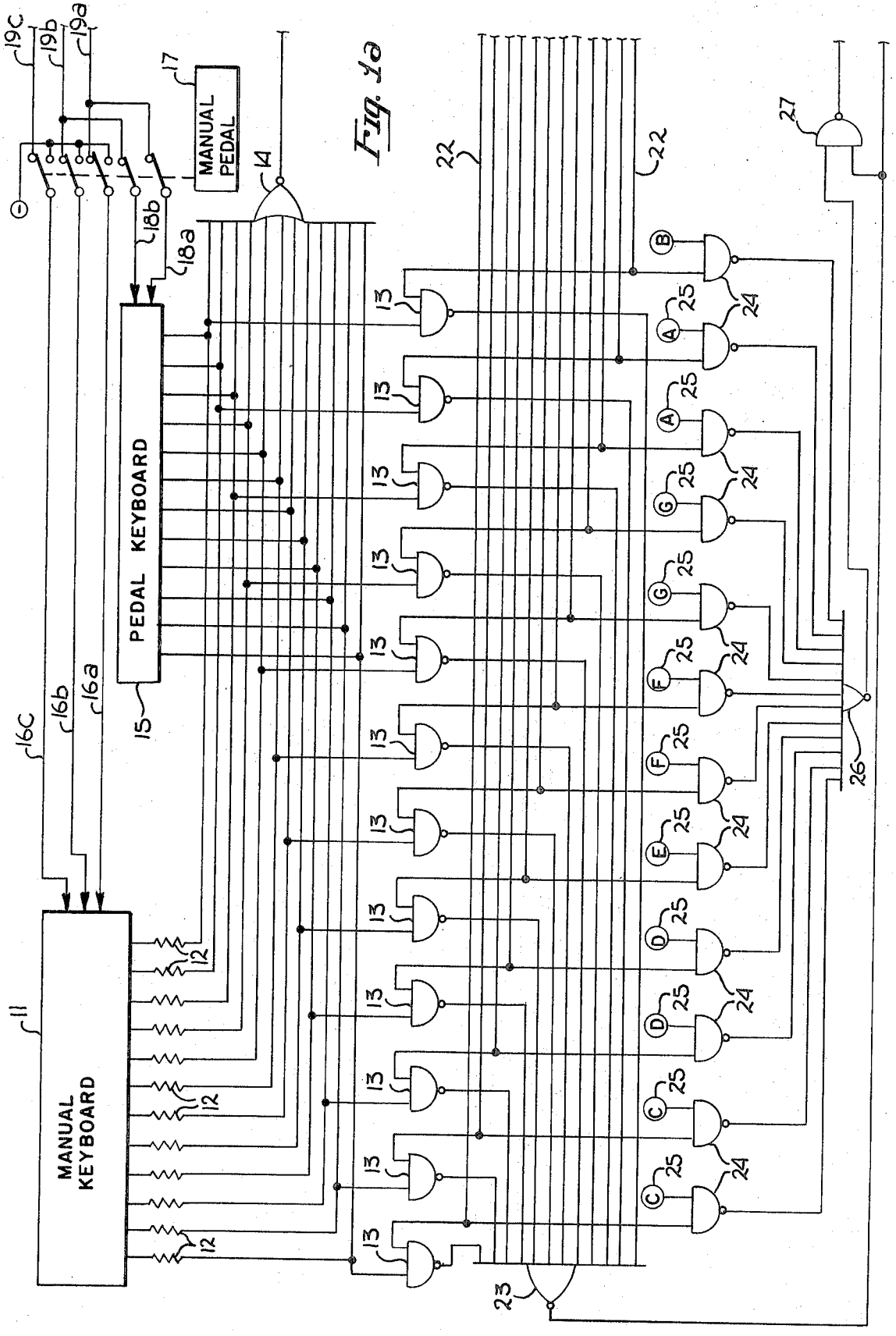

MANUAL KEYBOARD
PEDAL KEYBOARD
MANUAL PEDAL
11
12
13
14
15
16a
16b
16c
17
18a
18b
19a
19b
19c
22
23
24
25
26
27
A
B
C
D
E
F
G

Fig. 1a

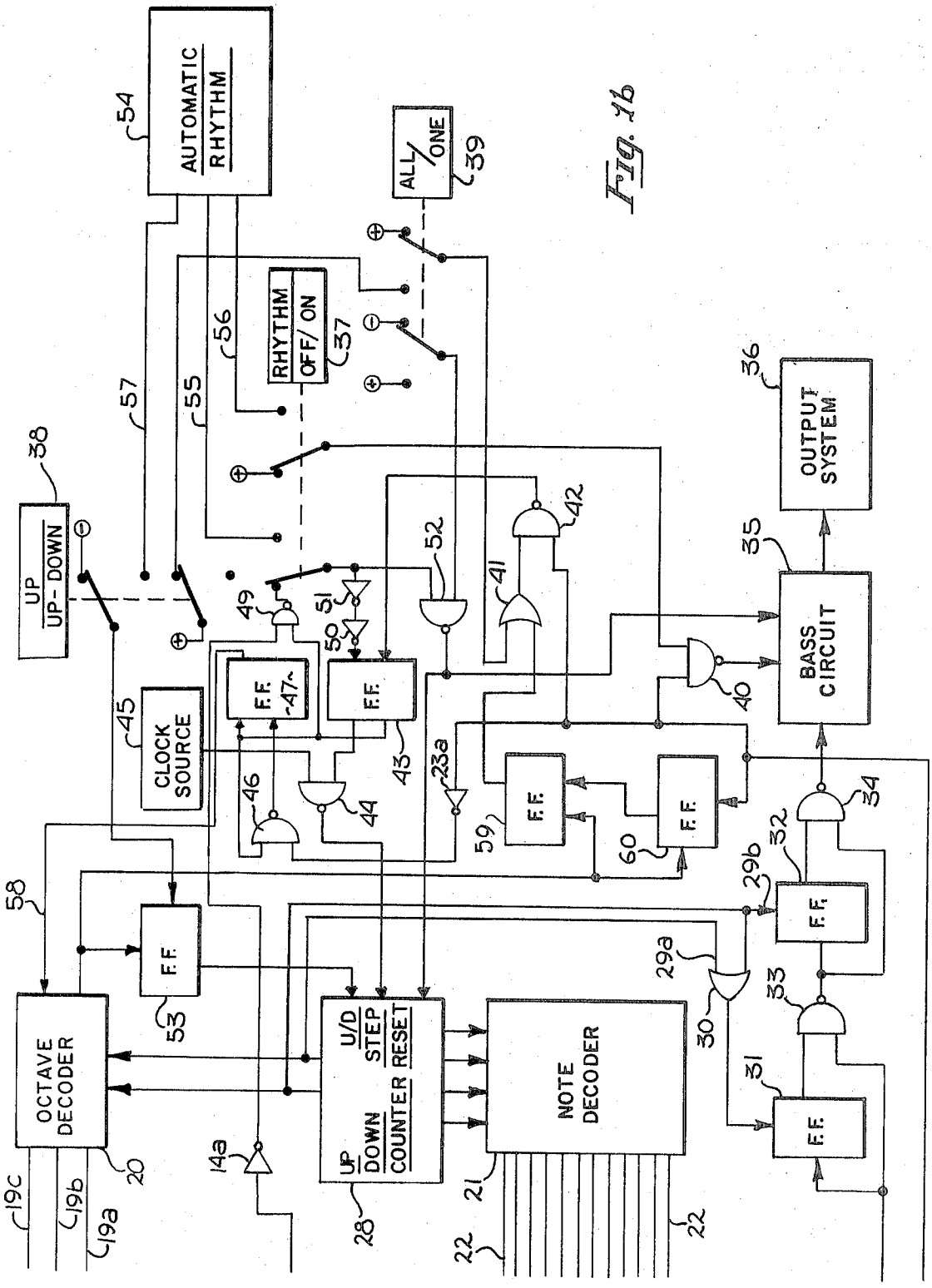

AUTOMATIC RHYTHM
54
ALL/ONE
39
RHYTHM OFF/ON
37
56
57
55
38
UP UP-DOWN
OUTPUT SYSTEM
36
BASS CIRCUIT
35
42
41
52
49
51
50
F.F.
47
F.F.
43
CLOCK SOURCE
45
46
44
40
23a
59
F.F.
60
F.F.
34
32
29b
F.F.
58
F.F.
53
29a
30
33
31
F.F.
OCTAVE DECODER
20
19c
19b
19a
14a
U/D STEP RESET
UP DOWN COUNTER
28
NOTE DECODER
21
22
22

Fig. 1b

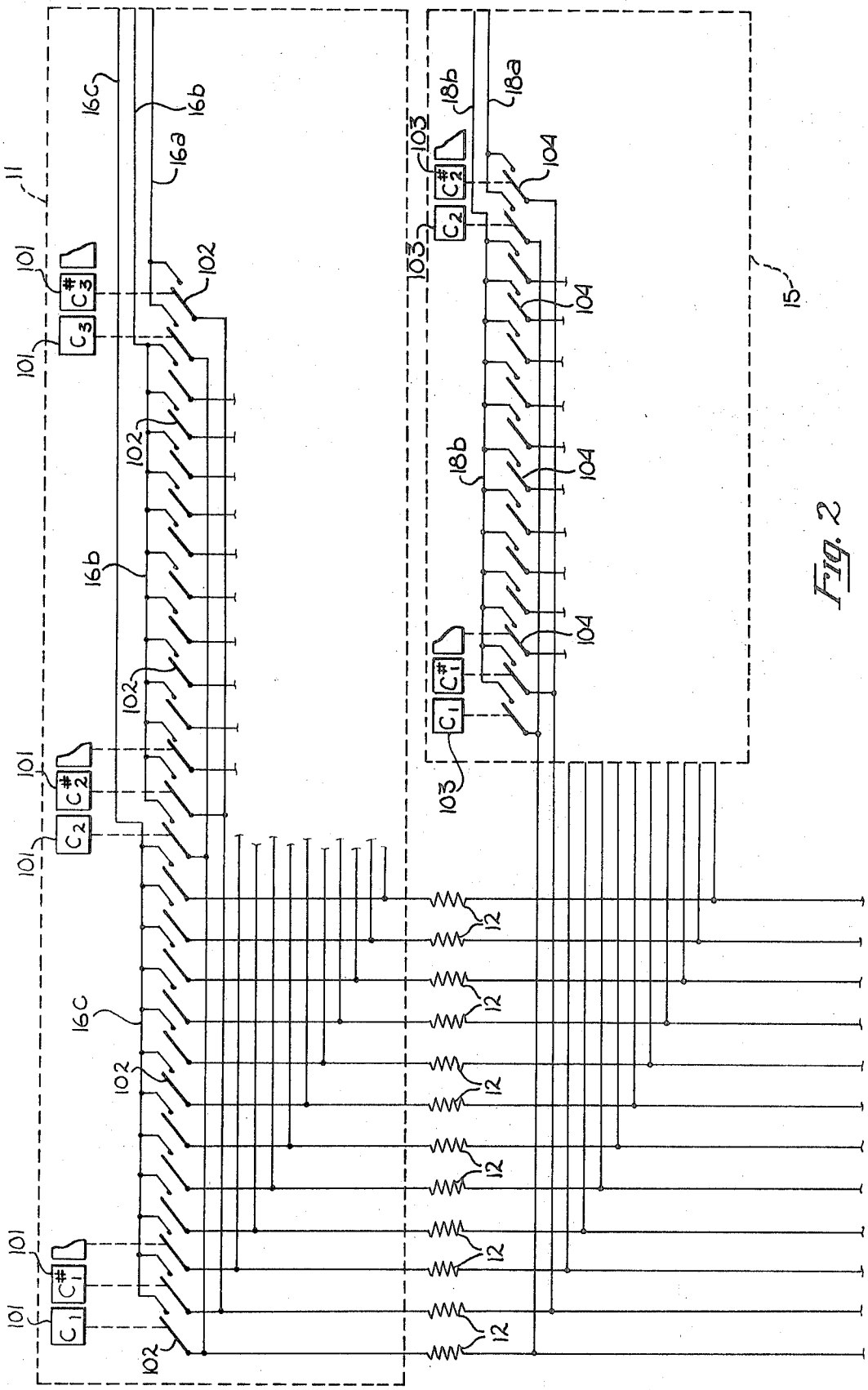


Fig. 2

PLURAL MODE AUTOMATIC BASS SYSTEM WITH PEDAL SUSTAIN

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is directed to an improved system for playing bass notes from pedals and from accompaniment chords according to a plurality of modes.

2. Description of the Prior Art

My U.S. Pat. No. 3,548,066 discloses a system for playing bass notes automatically in a plurality of modes. One of these modes uses a scanner to play all of the notes held in an ascending pitch order. The system could be operated by playing keys or pedals but could not be changed from one to the other without changing at least twelve connections. The system further uses large capacitors to store keying voltages for sustain as in a conventional organ pedal system. Such capacitors are expensive and cannot be implemented by an integrated circuit.

U.S. Pat. No. 3,567,838 to Tennes and Kern discloses a system for playing the highest and lowest pitch notes of accompaniment chords alternately in the bass. Playing may also be restricted to the lowest note only. No provision is provided to play all notes of the chords in bass nor to play bass notes in response to pedals.

Pedal sustain keying systems of present electronic organs typically use electrolytic capacitors to store keying signals so the bass signal can be sustained after the pedal is released. When a new pedal is operated, the capacitors must be discharged to terminate the sustain and avoid a possible clash between the old and new bass notes. The pedal switches are wired in interlocking fashion to prevent more than one bass note from sounding at a time when the player's foot inadvertantly operates more than one pedal. Such systems have an appreciable cost.

It is an object of the present invention to provide a system for automatically playing bass notes from manually held accompaniment chords in a plurality of modes or patterns.

A further object of the present invention is to provide a system of the aforementioned type which can further respond to pedals for normal organ bass playing.

A still further object of the present invention is to provide a system meeting the aforementioned objects which can be implemented by an integrated circuit pack requiring a minimum number of pins.

Other objects and advantages of the present invention will become apparent as the description proceeds.

BRIEF SUMMARY OF THE INVENTION

In accordance with the invention, an improved system is provided for automatically playing bass notes in response to manually held chords and also for playing normal organ bass in response to pedals. Means are provided for scanning each of the playing controls of selected manual or pedals one at a time in turn. Means are provided for stopping the scanning means when it encounters an actuated playing control. Means are further provided for producing a bass note while the scanning means is stopped, with the note produced corresponding to the actuated playing control which caused the scanning means to be stopped by the stopping means. Means are also provided for sensing when any

control is actuated after the control which caused the scanning means to stop is released. Means are also further provided for restarting the scanning means responsive to said sensing means or to a signal from an automatic rhythm device. Still further, means are provided for controlling the scanning means in different ways to play bass notes in different rhythmic patterns or modes.

In the illustrative embodiment, playing control outputs for the same note in different octave locations from a manual and a set of pedals are connected together to an input for the note. A manual pedal switch connects the set of octave keying busses for manual or pedals to the scanning means which energizes the connected busses one at a time turn while scanning the note inputs. The producing means keys tone signals corresponding to the note inputs on which the scanning means stops and divides the keyed signals by the proper ratios to produce bass notes in the octave ranges corresponding to the energized keying busses. This arrangement provides a considerable savings in the number of pins required on an integrated circuit pack implementing the system.

In the illustrative embodiment, bass notes corresponding to actuated playing controls are sounded in sequence in order of ascending pitch by having the scanning means run in one direction and having an automatic rhythm device restart the scanning means in a rhythmic pattern. Bass notes are sounded in ascending and descending pitch order without successive repeat of the highest and lowest pitch notes by having the controlling means reverse the scanning direction after each cycle and cause the first actuated control after each reversal to be skipped. The highest and lowest pitch notes are sounded alternately in the bass by having the controlling means also reset the scanning means before each restart and change of direction. These different modes provide a variety that adds to the musical value which can be obtained from the automatic playing.

Also in the illustrative embodiment, bass notes corresponding to the lowest pitch playing controls actuated can be played without automatic rhythm by having the scanning means reset and restarted only by the sensing means. If no other control is actuated when the one for which a bass notes is being played is released, the scanning means will remain in position and maintain the bass signals so they may decay naturally. If another control is actuated, the scanning means will terminate the old signals and go immediately to the new note. This mode thus provides for normal organ bass playing with sustain from pedals, or lowest note in bass from manual. Pedal switches need not be wired in series for interlocking as the scanning means allows only one bass note to play at a time under any circumstances and electrolytic capacitors are not required to provide sustain.

The system will be most often used with an electronic organ or the like which can provide the manual, pedals, tone signals for keying, bass circuit, and sound transducer. Integrated circuits in a single pack can perform the other functions for the system.

A more detailed explanation is provided in the following description and claims, and is illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B connect together to form a partial

schematic and partial block diagram of an embodiment of the invention.

FIG. 2 is a schematic diagram of part of the manual and pedal keyboards and their interconnections in the apparatus of FIG. 1A.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

In the apparatus of FIGS. 1A and 1B, manual keyboard **11** is the accompaniment manual or keyboard section of an electronic organ or other musical instrument. Keyboard **11** has a multiple octave range but controls for the same note in different octaves are tied together so each note has a single output. Each of the 12 note outputs is connected by a resistor **12** to the input of an associated NAND gate **13.** All 12 outputs are also connected to the NOR gate **14.** Pedal keyboard **15** is a normal pedal keyboard of the type used in electronic organs and the like. Keyboard **15** covers a two octave range but controls for the same note are tied together so it also has only one output for each note. The twelve outputs from keyboard **15** are connected to the respective inputs from resistors **12** for the same notes.

Keyboard **11** receives keying voltage inputs for three octave keying busses via lines **16***a*, **16***b* and **16***c* from pedal manual selection switch **17.** Keyboard **15** likewise receives keying voltage inputs for two octave keying busses via lines **18***a* and **18***b* from switch **17.** With switch **17** in the position shown, lines **18***a* and **18***b* are connected to lines **19***a* and **19***b* respectively from octave decoder **20,** and lines **16***a*, **16***b*, and **16***c* are connected to a negative potential supply. With switch **17** in its other position, lines **18***a* and **18***b* are disconnected and lines **16***a*, **16***b*, and **16***c* connected to lines **19***a*, **19***b*, and **19***c* respectively. Decoder **20** applies a positive voltage to each of lines **19***a*, **19***b*, and **19***c* in turn to enable controls in the respective octave ranges of keyboard **11** or keyboard **15** to produce a positive voltage output when actuated. Decoder **20** may also apply a positive voltage to all of lines **19***a*, **19***b*, and **19***c* at the same time.

Actuation of a playing key or pedal in an octave range having a positive keying voltage applied through switch **17** will enable the one of gates **13** for the associated note and will operate gate **14.** Gate **14** may consist of a combination of circuits which produce a negative output when any of the 12 inputs are positive. Resistors **12** prevent playing key actuation from interfering with response to pedals when switch **17** is in the pedal position and accompaniment chords are being played on keyboard **11.** Pedals will not normally be actuated when switch **17** is in the manual position as bass will then be obtained from keyboard **11.**

Note decoder **21** applies a positive voltage to only one of its 12 output lines **22** at a time. Each line **22** goes to an associated one of gates **13** and an associated one of NAND gates **24.** If a gate **13** is also receiving a positive voltage input for its respective note from keyboard **11** or keyboard **15,** its output will go negative when its line **22** goes positive. The outputs of gates **13** all go to NAND gate **23** and the output of gate **23** will go positive when any of its inputs go negative. Gates **24** each receive a tone signal input corresponding to their associated note and pass it to NAND gate **26** while their input line **22** is positive. The outputs of gates **23** and **26** go to NAND gate **27** which will pass the tone signal only when the corresponding gate **13** is operated causing gate **23** to have a positive output.

Up and down counter **28** provides four digit outputs to run note decoder **21** and two digit outputs to run octave decoder **20.** The output of octave decoder **20** advances from one octave to the next each time note decoder **21** cycles through its 12 note outputs. Counter **28** may be stopped in any position and a positive voltage will then be maintained on the corresponding one of lines **19***a*, **19***b*, or **19***c* and the corresponding one of lines **22.** Control of the running and stopping of counter **28** will be described later.

The digit outputs from counter **28** to octave decoder **20** also go to OR gate **30** on lines **29***a* and **29***b*. Lines **29***a* and **29***b* will both be negative when counter **28** is positioned for the first, or lowest, octave. Line **29***a* will be positive and line **29***b* negative for the second octave. Line **29***a* will be negative and line **29***b* positive for the third octave. Flip flop **31** receives the output of gate **30** on its reset input and will be held in its reset position while the input is positive. Flip flop **32** has its reset input connected to line **29***b* and is similarly held in the reset position while the input is positive.

Tone signals from the output of gate **27** are applied to the toggle input of flip flop **31** and to one input of NAND gate **33.** If its reset input from gate **30** is negative, flip flop **31** will change state with each cycle of the signal from gate **27** and enable gate **33** during alternate cycles. Gate **33** then passes alternate cycle and so a signal which is half the frequency of the signal from gate **27.** If its reset input is positive, flip flip **31** will remain in the position which enables gate **33** and the output from gate **33** will then be of the same frequency as that from gate **27.** The output of gate **33** goes to the toggle input of flip flop **32** and to one input of NAND gate **34.** Flip flop **32** and gate **34** operate in the same manner as flip flop **31** and gate **33** so that the input frequency is passed unchanged when line **29***b* is positive and halved when it is negative.

The output of gate **34** is applied to the input of bass circuit **35** and will correspond in frequency to the output of gate **27** when line **29***b* is positive. The output will be two octaves lower than the output from gate **27** when lines **29***a* and **29***b* are both negative and one octave lower when line **29***a* only is positive. The frequency of input to bass circuit **35** will thus correspond to the note and octave positions of counter **28.** Bass circuit **35,** which may be substantially the same as percussion bass circuits in commercially electronic organs, such as the Lowry TBO model includes frequency dividers, tone forming circuits, controls, and keyers and has its output connected to output system **36.** Output system **36** includes at least a power amplifier and a sound transducer.

RHYTHM OFF/ON switch **37,** UP/UP-DOWN switch **38,** and ALL/ONE switch **39** can provide different operational responses for the remaining apparatus and thereby obtain different playing modes. The first mode considered will be that for the switches in the positions shown which is the OFF, UP, and ONE positions for switches **37, 38,** and **39** respectively. If switch **17** is in the pedal position, bass notes will be played in response to pedal actuation in the normal manner including bass sustain. If switch **17** is in the manual position, a bass note will play for the lowest pitch playing key actuated.

NAND gate 40 is held enabled by a positive voltage from an arm of switch 37 and the output of OR gate 41 is held positive to enable NAND gate 42 by a positive voltage from an arm of switch 39. When counter 28 reaches the position of an actuated playing key or pedal, the output of gate 23 goes positive. This output from gate 23 causes gate 40 to produce a drive to turn on the keyers of bass circuit 35 and gate 42 to produce a drive to reset flip flop 43. Reset of flip flop 43 disables NAND gate 44 to block the output of clock source 45 from the set input of counter 28. Counter 28 then stops on the position for the actuated playing key or pedal and bass circuit provides output signals for the corresponding note to sound transducer 36. This condition obtains as long as the playing key or pedal remains actuated.

When the playing key or pedal is released, the output of gate 23 goes negative. This turns off the drive from gate 40 to the keyers and the signals from bass circuit 35 begin to decay at a rate dependent upon control settings and parameters. The negative signal from gate 23 also goes through inverter 23*a* and enables NAND gate 46. Gate 46 is already receiving a positive voltage on its other input from flip flop 43 and immediated produces a negative output to set flip flop 47. The voltage from flip flop 47 on line 58 to octave decoder 20 then causes a positive voltage to be applied to all output lines 19*a*, 19*b*, and 19*c*.

If any playing keys or pedals, depending on the position of switch 17, are actuated, gate 14 will operate and cause a positive voltage output from inverter 14*a* to NAND gate 49. Gate 49 is already receiving a positive voltage on its other input from flip flop 43 and so immediately produces a negative output to inverters 50 and 51 which are connected in cascade to the set input of flip flop 43. Gate 52 is also driven to reset counter 28 and the keyers of bass circuit 35. Inverters 50 and 51 provide a short decay to insure the resetting of the keyers and counter 28 will be accomplished before gate 49 is turned off by the setting of flip flop 43. The setting of flip flop 43 also resets flip flop 47 to remove the voltage on line 58 and restore decoder 20 to its normal condition responsive to counter 28 and further enables gate 44 to pass the signals from clock source 45 to the step input of counter 28. Counter 28 then resumes scanning at a rate dependent on the frequency of output from source 45 which is high enough to avoid any appreciable decay in reaching any actuated control.

Flip flop 53 is held in the reset condition by the negative voltage applied to it from an arm of switch 38. Counter 28 thus runs in the direction for an ascending pitch order only. As it is also reset before each restart, counter 28 always stops first for the lowest pitch control actuated. If no other control is actuated, the keyers of bass circuit 35 will turn off the signals for the note with normal decay. The note will thus not continue to sound although counter 28 remains in the same position until another control is actuated.

If rhythm switch 37 is next placed in its ON position, the output from gate 49 will be replaced with the output from automatic rhythm 54 on line 55, and gate 40 will receive its enabling input from line 56. Each pulse out on line 55 will set flip flop 43, if it was reset, and reset counter 28 and the keyers of bass circuit 35. Counter 28 will then run until it finds an actuated control which causes gate 23 to operate. Operation of gate 23 will reset flip flop 43 as before and stop counter 28. With gate 23 operated, gate 40 will be enabled and the keyers of circuit 35 will be responsive to pulses on line 56 to sound the corresponding bass note. The corresponding note can thus be sounded in any selected rhythmic sequence while the control is held actuated.

If switch 38 is next moved to its UP-DOWN position, the voltage holding flip flop 53 in the reset condition will be removed. Each reset of counter 28 will then cause flip flop 53 to change state in response to an output from octave decoder 20. The input from flip flop 53 to the up down input of counter 28 then causes it to alternately run up and down as flip flop 53 changes state. If a plurality of controls are actuated, notes corresponding to those of the lowest and highest pitch will alternately be sounded in the bass. If only a single control is actuated, the same note will sound repetitively as the counter 28 will simply reach the same position each time from alternate directions. The alternation of flip flop 53 may be momentarily interrupted by a pulse output on line 57 from automatic rhythm 54 which will force the lowest pitch note to sound at particular times, such as the downbeat.

If switch 38 is returned to the position shown and ALL-ONE switch 39 placed in its other position, gate 52 is disabled so counter 28 and the keyers of circuit 35 are no longer reset by automatic rhythm 54. Gate 41 receives its positive input through the series combination of an arm of switch 39 and an arm of switch 38. Each pulse on line 55 thus starts counter 28 and each operation of gate 23 stops it. Bass notes corresponding to actuated controls will then be sounded in turn in order of ascending pitch with the sequence being repeated as long as the controls are held actuated.

If switches 39 and 38 are both in different positions than those shown, the positive input to gate 41 will be removed. It is then necessary for gate 41 to receive a positive voltage input from flip flop 59 to enable gate 42. Gate 42 must be enabled to allow operation of gate 23 to reset flip flop 43 and stop counter 28. The output from decoder 20 which triggers flip flop 53 to change state when counter 28 reaches its reset position also resets flip flops 59 and 60. The next operation and release of gate 23 then changes the state of flip flop 60 to the set condition and this in turn sets flip flop 59 so it povides a positive voltage to gate 41. The next operation of gate 23 and succeeding operations will stop counter 28 until flip flop 59 is again reset. The first actuated control encountered after each change of direction thus does not stop counter 28. If this were not done, the highest and lowest pitch notes would each be sounded twice in succession.

It will be recognized by those skilled in the art that the apparatus in many models of electronic organs would require only minor modifications to serve as the keyboards 11 and 15, bass circuit 35, output system 36, and automatic rhythm 54 of FIGS. 1A and 1B. It will further be recognized by those skilled in the art that the remaining circuits of FIGS. 1A and 1B; aside from switches 17, 37, 38, and 39; could be implemented by discrete component circuits, by available integrated circuits, and by a custom designed integrated circuit in a single package. Those skilled in the art may make minor changes to the system to better adapt to particular implementations.

The blocks labeled note decoder 12, octave decoder 20, and up down counter 28 represent apparatus which

is well know to those skilled in the art. Texas Instruments Incorporated of Dallas, Tex., among others, produces medium scale integrated circuits which function as decoders and up down counters. Examples are Up/Down Binary counters SN 54191 or SN 74191 and Decoder/Demultipliers SN 54154, SN 74154, SN 54155, or SN 74155.

FIG. **2** shows keyboard **11** to have playing keys **101** which mechanically couple to operate their respective switches **102.** Playing keys **101** may also operate other switches not shown and not associated with the bass system. Each of switches **102** for the same note in different octave locations are connected together to one end of an associated resistor **12** as shown for the notes C and C # . Lines **16***c*, **16***b* and **16***a* are shown connected to the keying busses for switches **102** of the first second, and third octaves respectively. If playing keys **102** for the same note in two octave locations are actuated at the same time, the associated switches **102** will connect the busses **16***a*, **16***b*, or **16***c* together so both will be energized when either receives voltage from scanner **20.** This will cause the corresponding note to sound in both octaves, as it should, if switch **39** is in the all position. Notes for actuated playing keys **101** in either octave will also sound in both octaves. This is not believed to be a defect which would justify placing a diode in each lead from a switch **102.**

Keyboard **15** has pedals **103** mechanically coupled to switches **104.** Lines **18***b* and **18***a* connect to the keying busses for the first and second octave ranges respectively. Switches for the same note in both octave ranges are connected together and to the other end of an associated resistor **12** as shown for the notes C and C # . Resistors **12** isolate switches **102** from switches **104** so busses **16***a*, **16***b*, and **16***c* may be connected to a negative supply and playing keys **101** actuated without affecting the response to switches **104.** It is not expected that pedals **103** will be actuated except when it is desired to produce bass notes from them but playing keys **101** will be actuated to play accompaniment chords whether or not bass notes are to be played from them.

What is claimed is:

1. In an electronic musical instrument having a set of playing controls for the notes of a musical scale and an output system including a sound transducer, an improved bass playing system comprising the combination of:

a. means coupled to said playing controls for scanning each of said playing controls in turn, said scanning means having an individual position for each of said playing controls;

b. means coupled to said playing controls for sensing when any one of said playing controls is actuated;

c. means connected to said sensing means for enabling said scanning means to run when any one of said playing controls is actuated;

d. means coupled to said scanning means for detecting when the one of said playing controls for which said scanning means is positioned is actuated;

e. means connected to said detecting means for stopping said scanning means when said detecting means finds an actuated playing control; and

f. means connected to said scanning means and said detecting means for producing a bass tone signal to drive said sound transducer, said bass tone signal being for a note determined by the position of said scanning means.

2. The combination according to claim **1** including an automatic rhythm device producing output signals in rhythmic patterns and means coupled to said scanning means for restarting said scanning means in response to a signal from said automatic rhythm device while said stopping means is operated.

3. The combination according to claim **2** including means connected to said scanning means for controlling the direction in which said scanning means runs through its positions.

4. The combination according to claim **3** wherein said controlling means responds to each operation of said stopping means to reverse the direction of said scanning means.

5. The combination according to claim **4** including means connected to said scanning means for resetting said scanning means to a predetermined position each time said scanning means starts to run.

6. The combination according to claim **3** wherein said controlling means reverses the direction in which said scanning means runs each time said scanning means reaches a predetermined position.

7. The combination according to claim **6** including means connected to said stopping means for inhibiting its response to the first operation of said detecting means after each change of direction by said controlling means.

8. The combination according to claim **1** wherein said producing means includes a controllable ratio frequency divider for shifting the octave range of the output from said producing means, said frequency divider being controlled by said scanning means to divide by different ratios while different octave ranges of said playing controls are being scanned.

9. The combination according to claim **1** wherein said playing controls are comprised of first and second groups connected in parallel to said scanning means, said first and second groups being energized one at a time by said scanning means, said detecting means being responsive only to actuated playing controls of the one of said groups which is energized.

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