United States Patent [19]

Cockerell

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[45] **Sept. 17, 1974**

[54] **DATA INPUT DEVICES**

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[73] Assignee: **Electronic Music Studios (London) Limited,** London, England

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[52] **U.S. Cl.** ..... **340/365 C,** 84/1.01, 84/1.27, 84/DIG. 7, 84/445

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

[58] **Field of Search** ..... 340/365 C; 84/1.01, 1.27, 84/DIG. 7, 23, 1.04, 1.03, 445, 446, DIG. 4

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Primary Examiner—John W. Caldwell
Assistant Examiner—Marshall M. Curtis
Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

A keyboard is disclosed having static, conductive, pads and means for sensing the change in charge on said pads produced by finger proximity, these means being respective gating circuits each having a plural emitter transistor, one emitter in each case being connected to an associated pad and the other emitters being supplied with gating signals which will cause the associated pad to be charged by way of the one emitter. Such a keyboard is disclosed for musical use having additional such pads for creating signals defining transposition intervals by means of pulse width modulation, and means responsive to impact on the keyboard.

16 Claims, 11 Drawing Figures

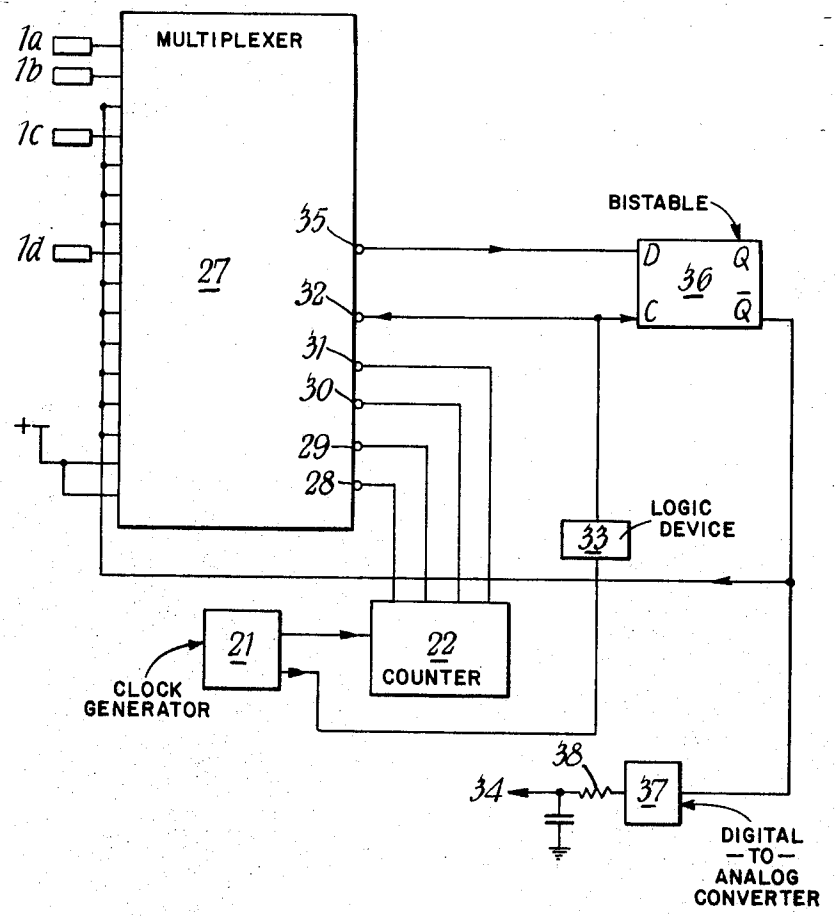


FIG. 1

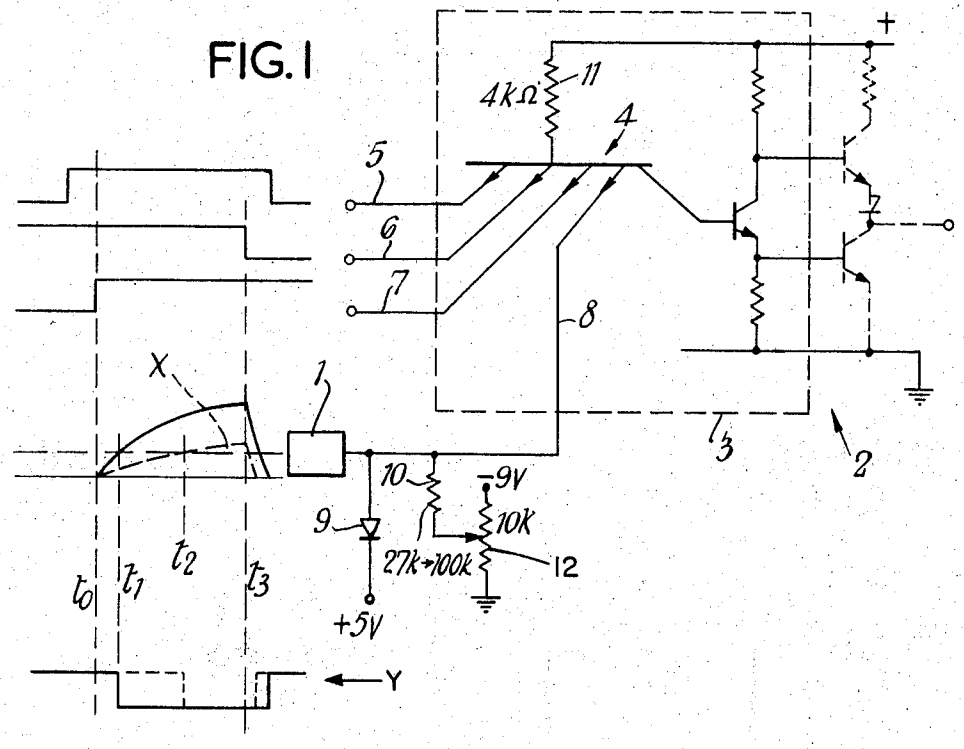

+
4kΩ
11
4
5
6
7
8
X
1
10
-9V
10K
9
27k+100k
12
+5V
t0
t1
t2
t3
t3
2
Y

FIG. 2

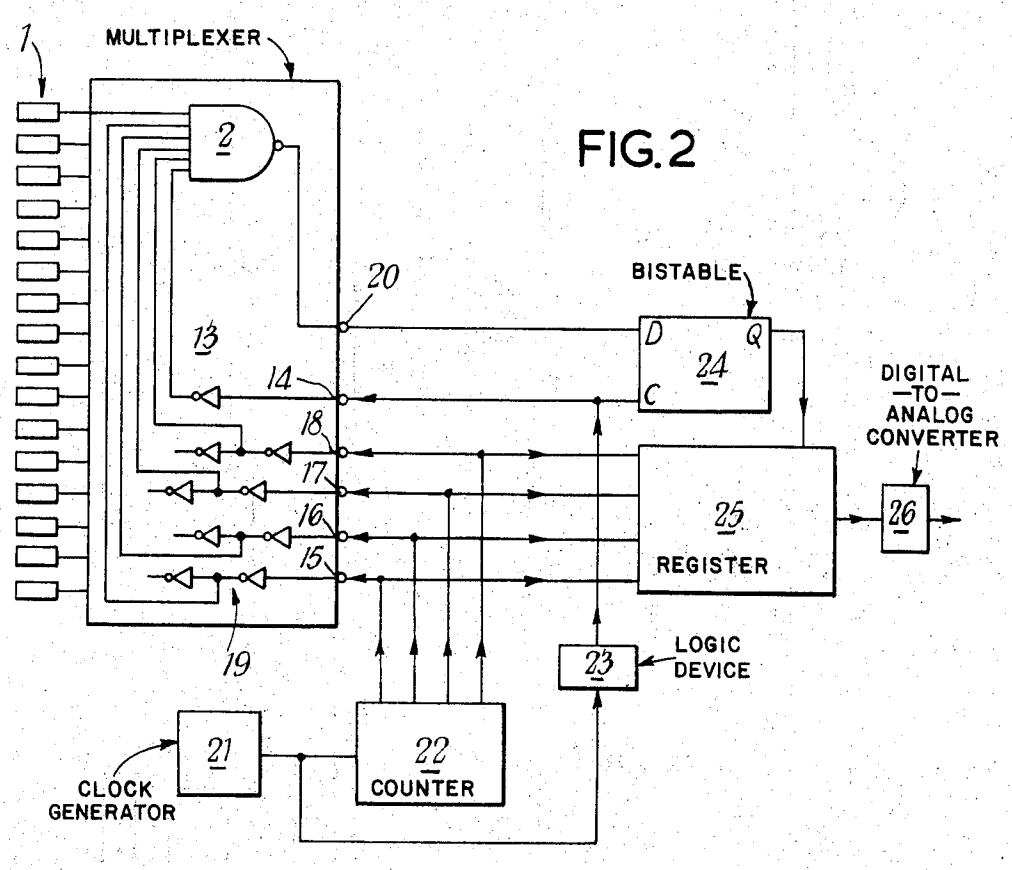

1
MULTIPLEXER
2
20
BISTABLE
D
Q
C
24
13
14
18
17
16
15
19
DIGITAL
—TO—
ANALOG
CONVERTER
25
REGISTER
26
23
LOGIC
DEVICE
21
CLOCK
GENERATOR
22
COUNTER

FIG. 3

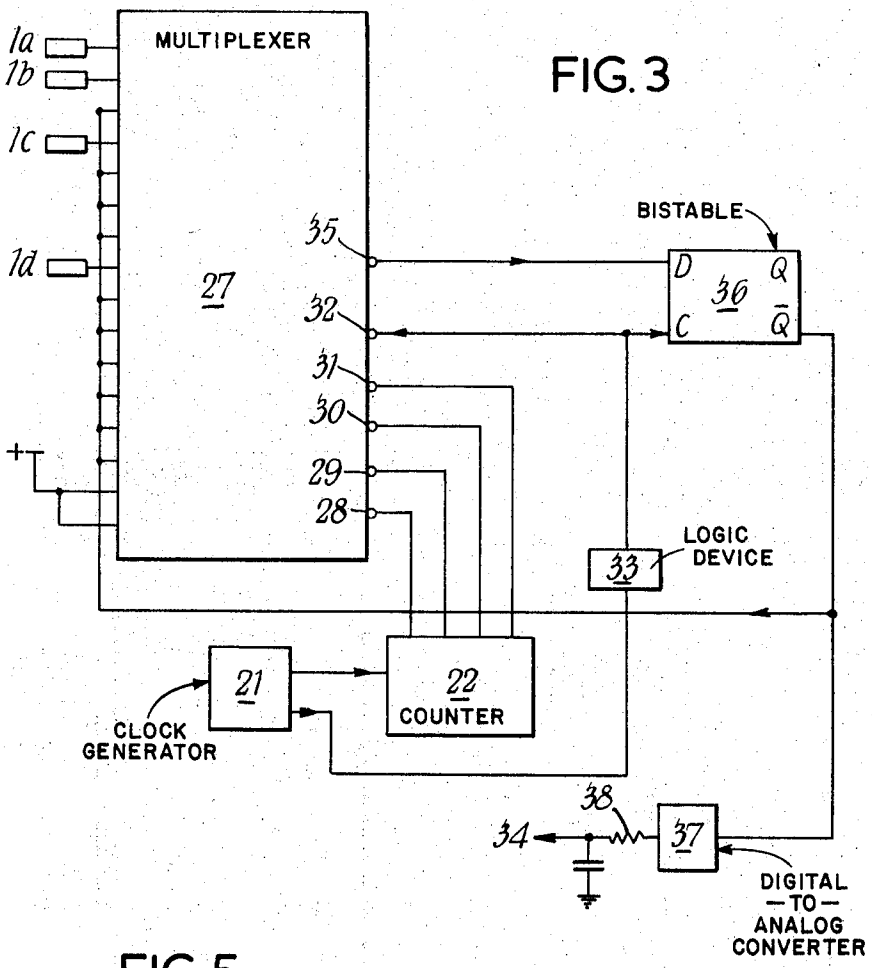

1a
1b
1c
1d
MULTIPLEXER
27
35
32
31
30
29
28
BISTABLE
D
Q
C
Q̄
36
LOGIC DEVICE
33
21
CLOCK GENERATOR
22
COUNTER
38
34
37
DIGITAL —TO— ANALOG CONVERTER

FIG. 5

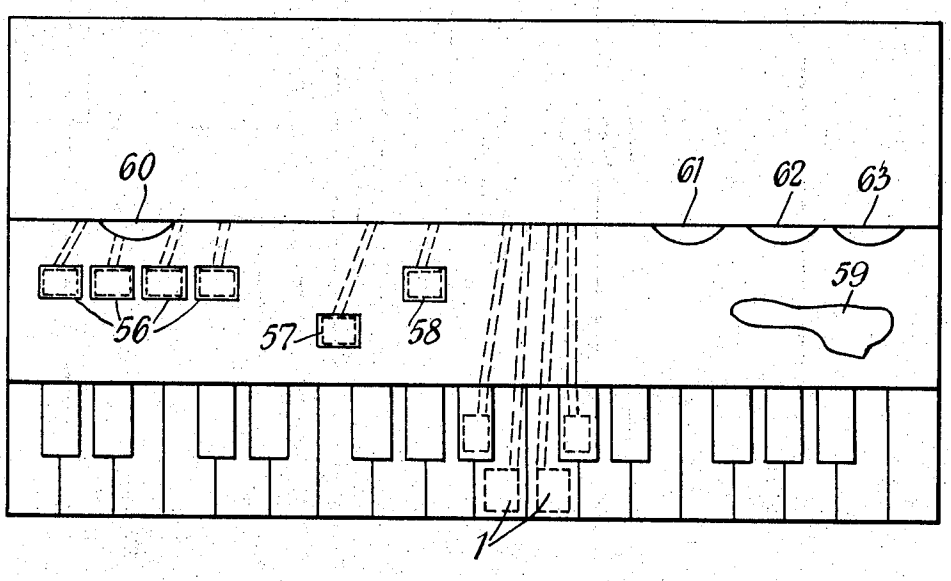

60
61
62
63
59
56
57
58
1

FIG.4

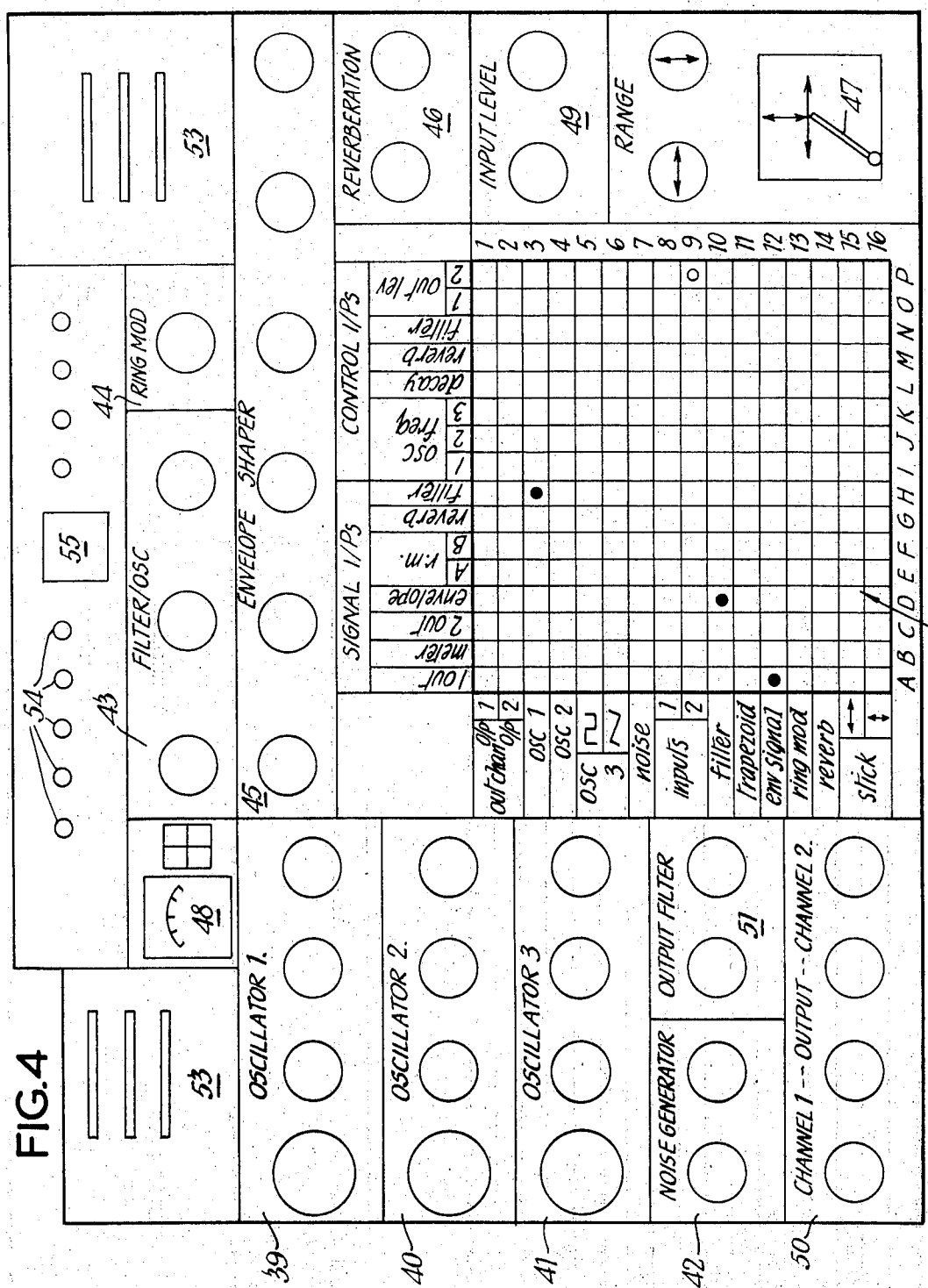

53
54
55
44
43
FILTER/OSC
RING MOD
48
45
ENVELOPE SHAPER
53
REVERBERATION
46
CONTROL I/P3
SIGNAL I/P3
INPUT LEVEL
49
RANGE
47
OSCILLATOR 1.
OSCILLATOR 2.
OSCILLATOR 3
NOISE GENERATOR
OUTPUT FILTER
51
CHANNEL 1 -- OUTPUT -- CHANNEL 2.
39
40
41
42
50
52
out channel
o/p 1
o/p 2
osc 1
osc 2
osc 3
noise
inputs
filter
trapezoid
env signal
ring mod
reverb
stick
1 out
mixer
2 out
envelope
r.m.
A
B
reverb
filter
osc freq
1
2
3
decay
reverb
filter
out lev
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
A B C D E F G H I J K L M N O P

FIG.6A

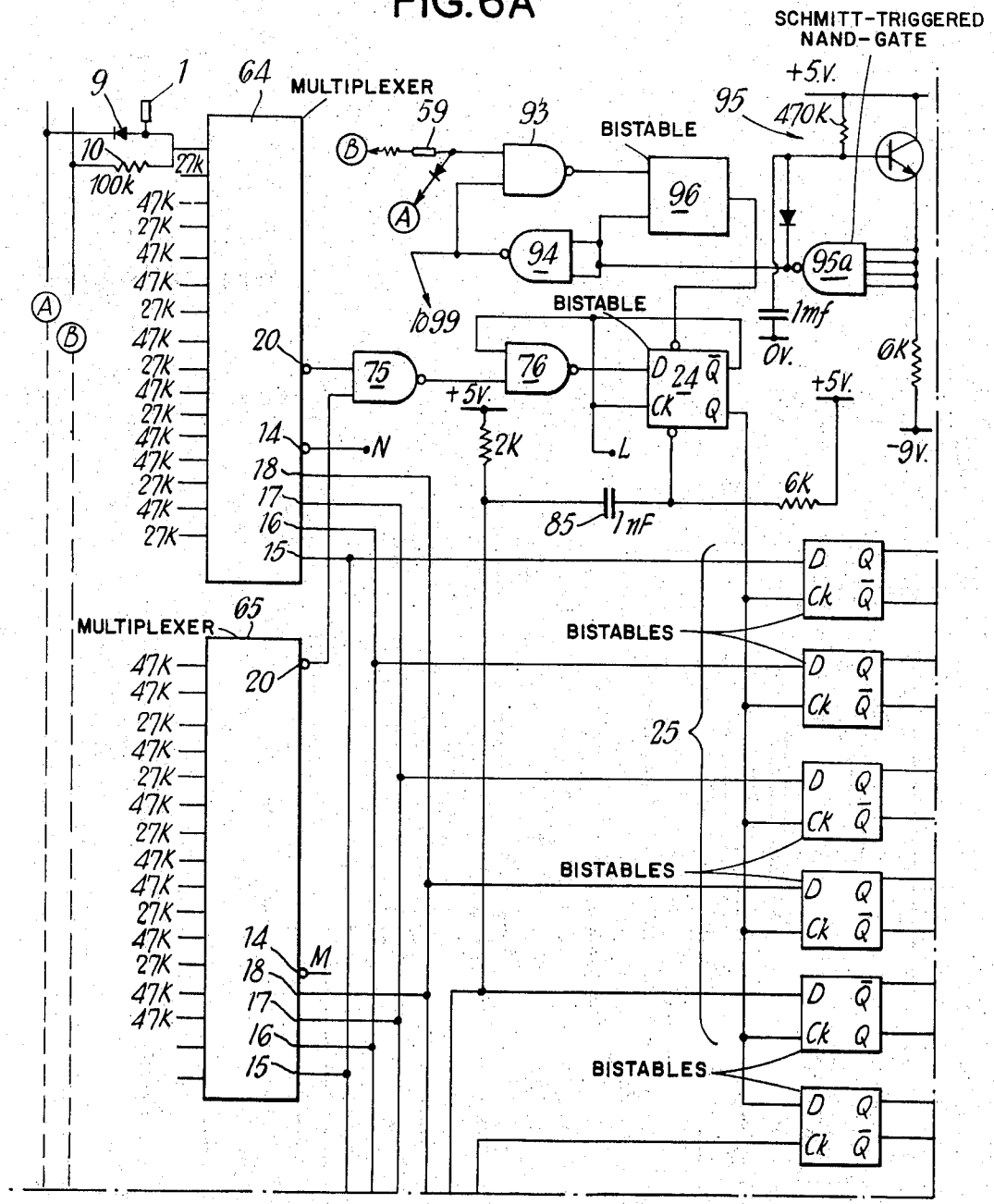

SCHMITT-TRIGGERED NAND-GATE
+5V.
MULTIPLEXER
BISTABLE
BISTABLE
MULTIPLEXER
BISTABLES
BISTABLES
BISTABLES
9
1
64
59
93
95
470K
10
100k
27k
96
94
95a
99
1mf
0V.
0K
-9V.
20
75
76
+5V.
2K
14
N
18
17
16
15
L
6K
85
1nF
65
M
25

FIG. 6B

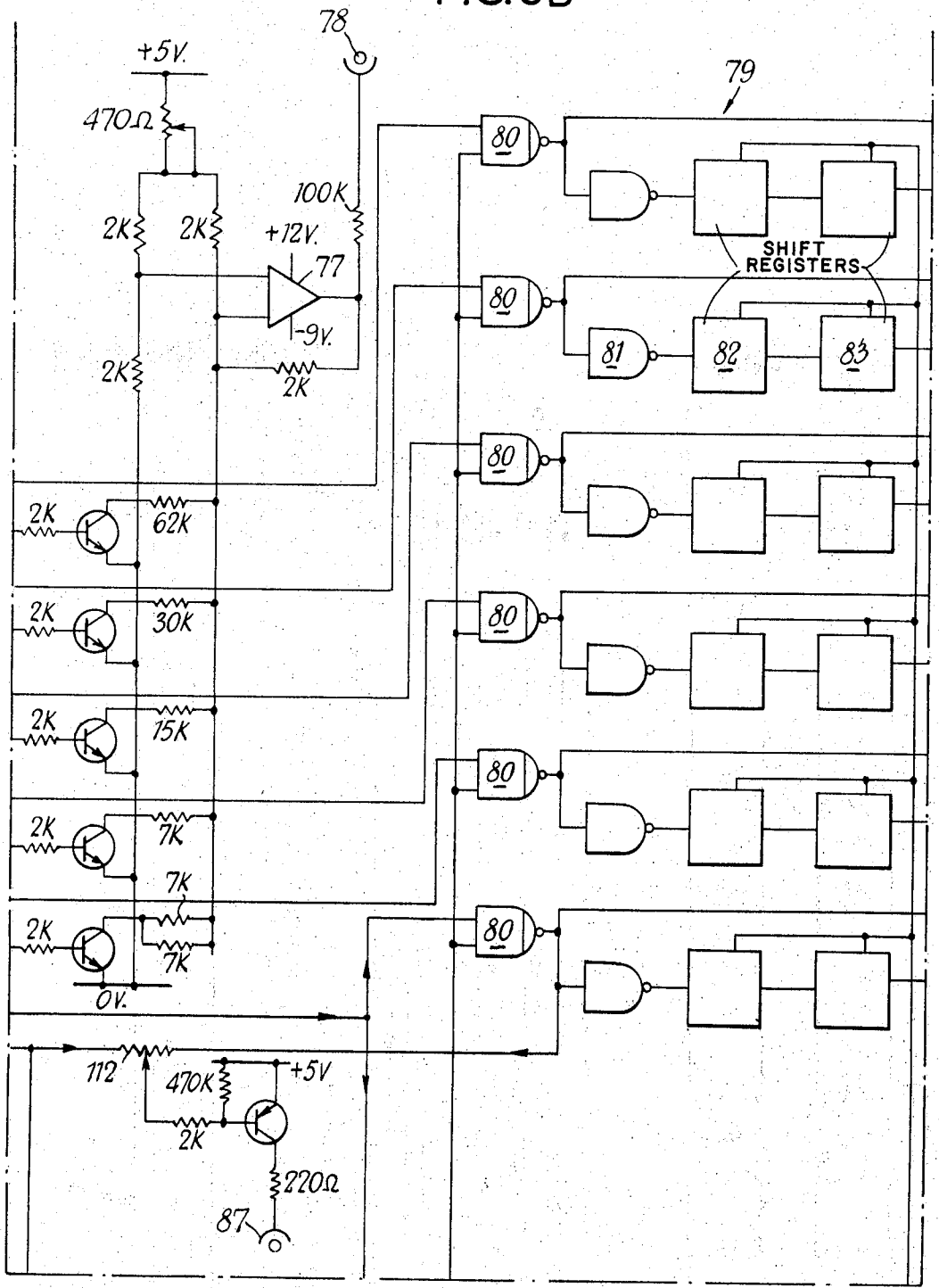
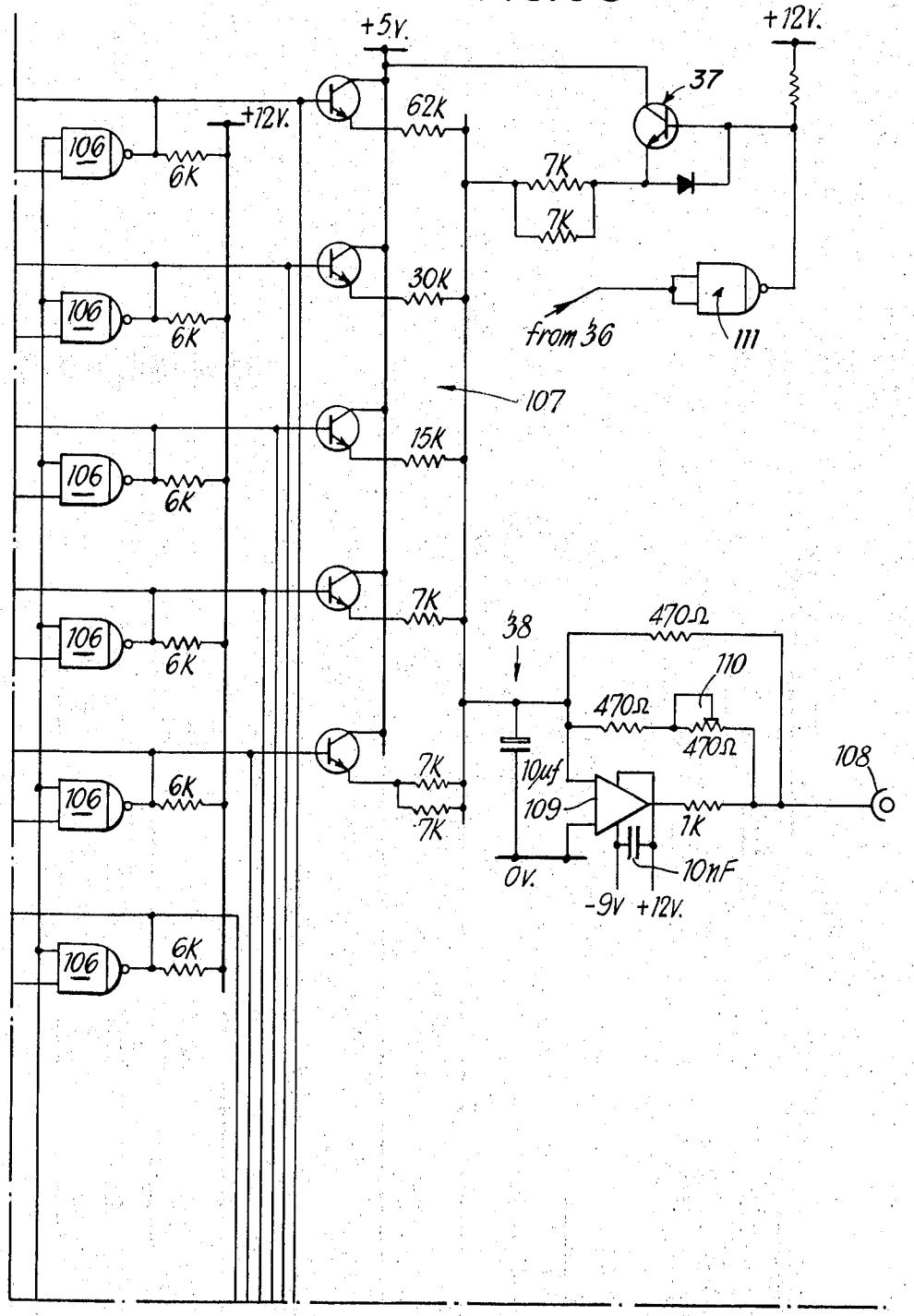

78
+5V.
470Ω
2K
2K
100K
+12V.
77
-9V.
2K
2K
79
80
SHIFT REGISTERS
81
82
83
2K
62K
30K
15K
7K
7K
2K
0V.
112
470K
+5V
2K
220Ω
87

FIG.6C


+5V.
+12V.
37
62K
+12V.
106
6K
7K
7K
30K
from 36
111
107
15K
7K
38
470Ω
110
470Ω
470Ω
10μf
108
109
7K
7K
7K
0V.
10nF
-9V
+12V.

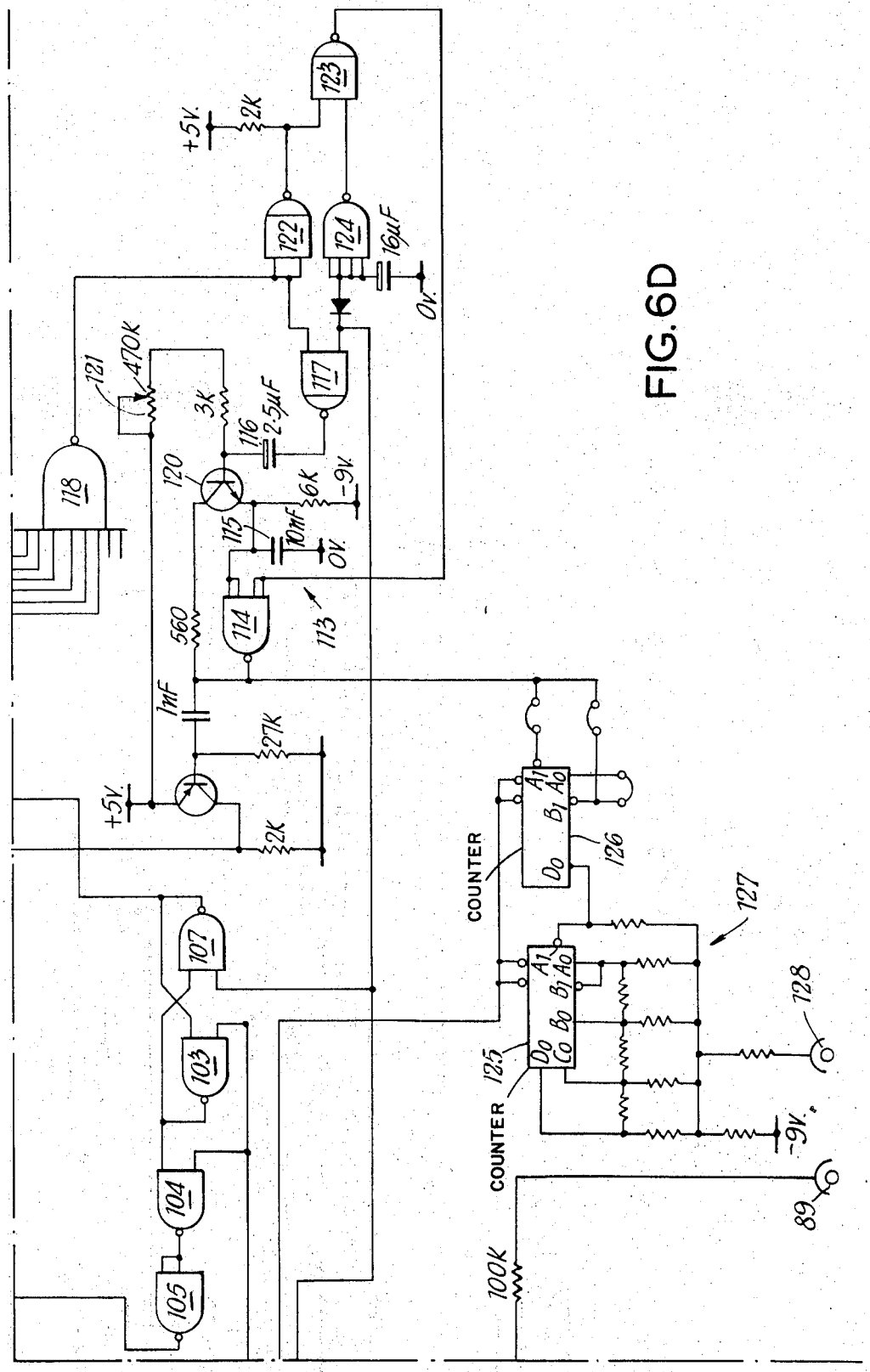

+5V.
2K
123
122
124
16μF
0V.
121
470K
3K
116
2·5μF
117
118
120
6K
-9V
115
10mF
0V.
114
113
560
1mF
27K
2K
+5V.
107
103
104
105
100K
COUNTER
126
127
128
125
COUNTER
-9V.
89

FIG. 6D

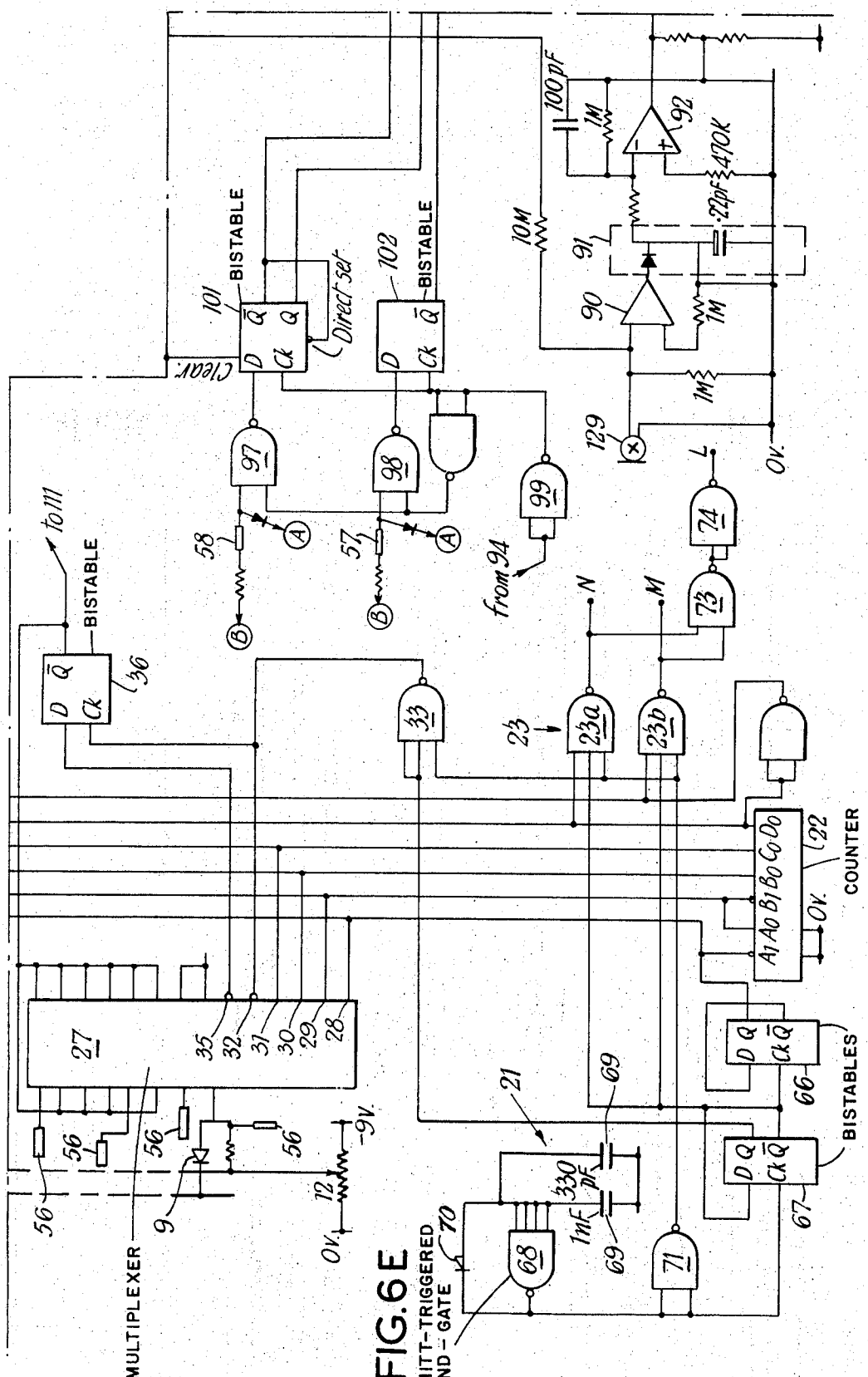

BISTABLE
101
102
Clear
Direct set
100 pF
1M
92
470K
.22pf
10M
91
90
129
0v.
97
98
99
58
57
from 94
74
73
N
M
23
23a
23b
33
to 111
36
27
35
32
31
30
29
28
56
9
12
-9v.
MULTIPLEXER
21
69
330 pF
1nF
70
68
71
SCHMITT-TRIGGERED NAND-GATE
66
67
BISTABLES
22
COUNTER

FIG.6E

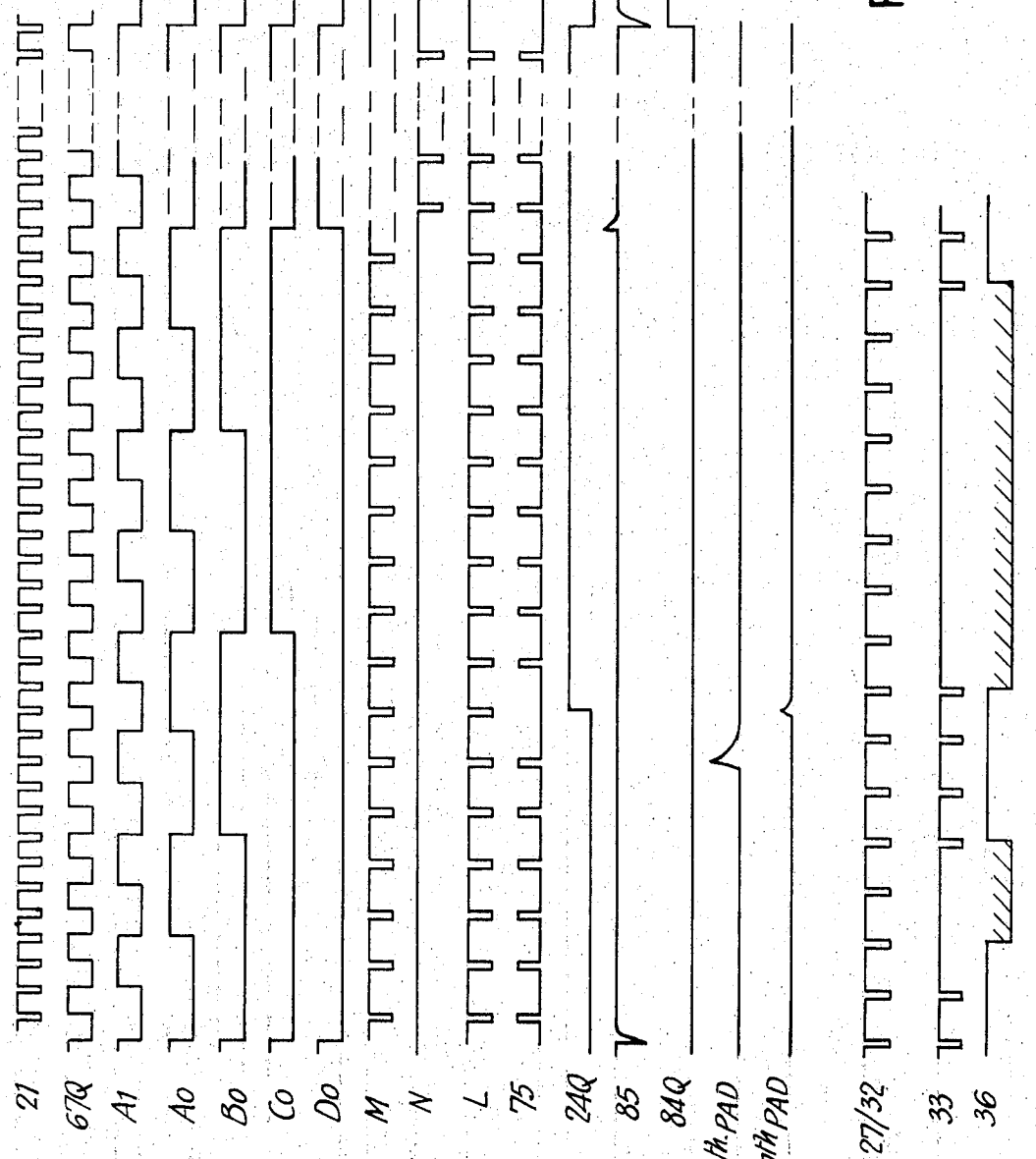


FIG.7

DATA INPUT DEVICES

BACKGROUND OF THE INVENTION

This invention relates to data input devices and has particular application in the field of electronic sound producing apparatus such as apparatus known as synthesisers.

Data input devices for equipment such as electronic sound producing apparatus, typewriters and so on normally comprise switches with operating keys manually displaceable to actuate the switches.

It is an object of the present invention to provide input devices simulating such known devices but without relying on manually displaceable parts.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a data input device comprising a conductive member having capacitance and means for sensing the change in the charge on said member as produced by placing a finger in proximity with said member, the sensing means comprising a gating circuit having a semiconductor input stage having a plurality of inputs to a first of which said member is coupled and to the remaining input or inputs there being coupled gating signal means operable to supply a signal or combination of signals to the remaining input or inputs to define the beginning of a gating interval in which a current will exist to change the charge on the capacitance, this change being dependent upon finger proximity with said member such that the gating circuit will have an output signal the form of which also depends upon said finger proximity.

It will be appreciated that the input device may replace in any known context a key or switch used to introduce data. In particular, the conductive member will replace the, normally movable, key member such as is used in calculating machines and keyboard instruments to provide a response to manual actuation.

In one embodiment of this aspect of the invention, the input device is formed in the manner of a musical keyboard in which there are a plurality of conductive members arrayed in the manner of a musical keyboard. In such a case the conductive members will be associated with respective semiconductor input stages.

Preferably the gating circuit is of such a kind that the current which changes the charge on the capacitance will flow via the first input under control of the signal or combination of signals applied to the remaining input or inputs. For example, the input stage may comprise a transistor having a plurality of emitters which constitute said inputs.

In a specific embodiment of this aspect of the invention, the arrangement is such that the current will act to increase the charge on said capacitance. For example, the gating circuit may be an AND-function circuit such as an AND or NAND circuit from which current flows to the remaining input or inputs outside said gating interval and to said first input in said gating interval. The charging of the capacitance then creates a further gating signal at the first input which acts in combination with the signal or signals of the remaining input or iputs to change the output condition of the gating circuit. The moment of change will depend upon the capacitance of the conductive member and thus upon finger proximity.

Means may be provided responsive to the output of the gating circuit being in a specific state at a predetermined time after the beginning of the gating interval to indicate that the capacitance has at least a certain value, corresponding to finger proximity, greater than the intrinsic capacitance of the conductive member.

In one embodiment, a plurality of conductive members are provided with respective gating circuits and there are means for supplying the signal or combination of signals to the remaining inputs of these gating circuits to give a sequence of their gating intervals. Said means responsive to the output can be responsive to the output of any one of the gating circuits and operate to cause an identification to be made of the gating interval existing when the specific output state has been sensed. Data defining the specific gating interval may thus be obtained and, for example, converted into a form suitable for selecting at an electronic sound producing apparatus an appropriate sound pitch.

According to a second aspect of the invention, there is provided a data input device for operating an electronic sound producing apparatus responsive to electrical signals which define sound pitch, the device having a transposing arrangement comprising input members to define transposition by respective intervals, and pulse width modulation means responsive to signals from said members to produce signals of respective durations. The pulse width modulation means may have a plurality of inputs, a signal at any one of which will produce a pulse of unit duration. The members are coupled to supply some of said inputs with said signals whilst others of said inputs are connected to the output of the pulse width modulation means. There are also means for sequentially scanning said inputs and each of said some inputs is followed in the scanning sequence by a number of the other inputs, that number being dependent in each case upon the transposition interval required by the associated input member.

The input members may be provided by a data input device according to the first aspect of the invention. By way of example, the pulse width modulation means may comprise a plurality of gating circuits gated in successive gating intervals, with the outputs of the gating circuits connected to a bistable circuit the output of which is connected to said other inputs of the pulse width modulation means.

According to a third aspect of the invention there is provided a data input device suitable for operating an electronic sound producing apparatus the device comprising an array of substantially static members, means responsive to finger proximity to said members to produce signals representing finger position in the array and means responsive to the impact of a finger on the array to produce a signal the amplitude of which depends upon the level of said impact.

One embodiment of the present invention is a keyboard-like arrangement for operating an electronic music synthesiser, the arrangement comprising a keyboard array of said conductive members and further conductive members for transportation purposes. The first aspect of the invention is also incorporated in the provision of further conductive members for control of the mode of operation of the keyboard arrangement, for example to set up "play" and "record" modes and also to initiate the generation of random notes. In this embodiment, there is also provision for digitally storing the data introduced by the conductive members re-

garding pitch levels and the transportation arrangement is effective during the playing of the recorded information.

DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 is a circuit diagram and wave forms of a data input device;

FIG. 2 shows an example in block diagram form of a keyboard arrangement based upon the features of FIG. 1;

FIG. 3 shows in block diagram form a transposition arrangement for a keyboard arrangement of an electronic music synthesiser;

FIG. 4 shows the front panel of an electronic music synthesiser;

FIG. 5 is a plan view of a keyboard and storage arrangement for the synthesiser of FIG. 4;

FIGS. 6*a* to 6*e* (referred to hereinafter as FIG. 6) show a circuit diagram of the arrangement of FIG. 5, FIG. 6*a* showing that portion of the arrangement which is connected to the pitch determining portion of a keyboard, FIG. 6*b* showing a continuation of the arrangement at the righthand side of FIG. 6*a*, FIG. 6*c* showing a continuation of the arrangement at the right-hand side of FIG. 6*b*, FIG. 6*d* showing a continuation of FIG. 6*b* and 6*c* at their lower edges, and FIG. 6*e* showing a continuation of the arrangement at the lower edges of FIGS. 6*a* and 6*b*;

FIG. 7 shows wave forms at various places in the circuit of FIG. 6.

FIG. 1 shows the basic elements of a data input device with no moving parts and intended to replace a key or other manually displaceable actuator with its associated movement sensing means in, for example, an electronic keyboard music instrument or electronic calculator.

In this example, the key is replaced by a conductive pad 1, formed on a printed circuit for example and possibly covered with a plastics protective layer. It is intended that a finger be placed on the pad 1 or its protective layer to achieve operation of the data input device.

The pad 1 has a certain capacitance with its environment which is increased by between 10 and 100 picofarads when a finger is placed on it or its protective layer.

In operation, current is allowed to flow through the effective capacitance provided by the pad to change the voltage stored at the pad and means are provided to sense whether this voltage passes a certain threshold within a certain time from the initiation of said current, thereby to sense whether or not a certain capacitance value exists at the pad.

In the present example, the sensing means is a semiconductor gate 2 the input circuit 3 of which is shown within a dotted line block. This gate 2 may be a NAND gate as shown by the dotted-line circuitry following block 3 or an AND gate, according to the positive logic system chosen for this example.

The input circuit 3 has an input transistor 4 having at least two, and in this case four, inputs designated 5,, 6, 7 and 8.

Means, not shown in FIG. 1, supply clock signals to the inputs 5, 6 and 7 and examples of such signals, switching between +3 and 0 volts, are illustrated alongside the corresponding inputs. On and AND or NAND function basis, these signals together define a period from t_0 to t_3. In this period, the current at other times flowing from transistor 4 to those of the inputs 5, 6 and 7 at 0 volts flows to the pad 1 to charge it, as shown by a voltage waveform alongside the pad 1 in FIG. 1. The full line waveform represents the voltage on the pad with no finger contact and the dotted line waveform represents that voltage with increased capacitance due to finger proximity.

When the voltage on the pad 1 reaches a threshold level X of about 1.5 volts, the signal combination at the inputs of transistor 4 causes the gate output level to change. Assuming that the gate is a NAND gate, its output voltage waveforms Y are shown corresponding to the two voltage waveforms at the pad 1. In the case of no finger proximity the gate output goes low or false at a time t_1 and in the case of finger proximity at a later time t_2. Sampling means, not shown in FIG. 1, sample the gate output at a moment between t_1 and t_2 to determine whether or not finger proximity exists.

In this example, a diode 9 is connected to input 8 to protect it against excessive signals and a resistance 10 is provided for the discharge of the capacitance of the pad after t_3. The resistance 10 has a large value compared with that of base resistance 11. A variable resistance 12 is provided to adjust the sensitivity of the device.

FIG. 2 shows how the principle of the device of FIG. 1 may be incorporated in a 16 key data input device.

In this case sixteen pads 1 are connected to the sixteen inputs of a digital multiplexer 13, the diodes 9 and resistances 10 being omitted from this figure for clarity. The multiplexer is type SN74150 marketed by Texas Instruments and comprises at each of its sixteen inputs a NAND gate as shown in FIG. 1 except that each gate has two additional input emitters, i.e. six inputs altogether.

In each gate (one of which is shown in FIG. 2), one of the six inputs is connected to an input 14 via an inverter and that one input receives a high signal defining the extent t_0 to t_3. Four other inputs of each gate receive signals derived by the multiplexer from four clock signals at inputs 15, 16, 17 and 18 by means of a network 19 of inverters.

These four signals to each gate define a time interval larger than and wholly containing t_0 to t_3 and this larger time interval is exclusive to its associated gate, such that the gates operate in sequence. Effectively, then, the voltages on the pads 1 are scanned cyclically by the multiplexer 13.

In the present case, there is a clock pulse generator 21 which drives a four-bit counter 22 to produce the signals required for inputs 15 to 18. A logic device 23 is also driven by the clock generator 21 to produce a strobe signal for input 14. This strobe signal also supplies the clock input C of a D type bistable circuit 24 having a D input connected to output 20 of the multiplexer 13.

It is noted here that the arrangement can be (and is in the embodiment disclosed with reference to FIG. 6) such that, when a finger contacts a pad, the voltage on that pad does not rise to the corresponding threshold

in the time t_0 to t_3 so that the voltage at output **20** of the multiplexer remains high throughout t_0 to t_3. In practice, sufficient delay exists in the arrangement for the circuit **24** not to respond until the aforesaid time between t_1 and t_2. In any case, the Q output of the bistable circuit **24** thus goes high when a pad has been contacted. This Q output opens a register **25** connected to receive the signals from counter **22.** Thus, when a pad is contacted, its address, as represented by the signals at the output of counter **22,** is entered into the register. The output of register **25** is connected to a digital-to-analog converter **26** to produce a voltage level representing the address of the pad contacted.

In a particular application to be described in more detail later, the embodiment of FIG. **2** is used to provide a keyboard for an electronic musical instrument. The pads **1** are arranged in the manner of a piano keyboard and the embodiment produces a voltage the level of which depends upon the position of the pad. This voltage is supplied to an audio, voltage-controlled, oscillator.

In the same instrument, the above-described keyboard simulation principle is also used for the purpose of generating a transposition voltage.

This is diagrammatically shown in FIG. **3.** The illustrated transposition arrangement includes a multiplexer **27,** again of the type SN74150, addressed at inputs **28** to **31** by the output signals of the counter **22** and receiving a strobe signal at an input **32.** The strobe signal is derived from a logic device **33** driven by the clock pulse generator **21.** In this case four conductive pads, **1***a*, **1***b*, **1***c* and **1***d* are employed to correspond, respectively, to a transposition of a semitone, a tone, a major third and a perfect fifth. Combinations of keys may be touched to provide transpositions by corresponding intervals, e.g. keys **1***a* and **1***b* to achieve one and a half tones.

At output **34** will appear a voltage having any one of fifteen discrete values depending upon the pad or combination of pads touched.

The output **35** of the multiplexer **27** is connected to the D input of a D type bistable circuit **36** the $\overline{Q}$ output of which is connected to a reference switch in the form of a one bit digital-to-analog converter **37** which feeds a leaky integrator **38.**

The required pulse length at the $\overline{Q}$ output of the circuit **36** is achieved by feeding the $\overline{Q}$ output back to certain of the multiplexer inputs. Pad **1***a* is associated with no such input, so that if it is contacted alone a pulse is produced until the next input (of zero) causes the circuit **36** to be reset. Pad **1***b* is associated with one further input, so that if pad **1***b* is contacted a pulse is produced on addressing the two inputs, giving a pulse of length twice that produced by pad **1***a*. Similarly pad **1***c* is associated with three further inputs and pad **1***d* is associated with six further inputs. The integrator **38** effectively sums the number of pulse intervals in one cycle of the scan of the multiplexer and thus produces a voltage of amplitude proportional to the reqn1ired transposition.

The described features will now be described further with reference to an embodiment intended for use with a synthesiser marketed under the name Synthi by Electronic Music Studios (London) Ltd. The front panel of this synthesiser is illustrated in FIG. **4** as this panel also represents the main electronic sections of the synthesiser.

The synthesiser incorporates two audio, voltage-controlled, oscillators **39** and **40,** an audio and subsonic, voltage-controlled, oscillator **41,** a white and coloured noise generator **42,** a multi-purpose filter, resonator and oscillator **43** with adjustable bandwidth and frequency, a ring modulator **44,** an envelope shaper **45** with manual controls for attack, on, decay and off times, a reverberation unit **46,** a joystick **47** by which two manually controlled voltages are produced by moving the joystick up or down and from side to side, a meter **48** for monitoring, input amplifiers **49** with level controls, output amplifiers **50** with level control and output filters **51.**

The majority of the components mentioned can be interconnected in a variety of fashions by means of a patch board **52** at which, by way of example, the case is illustrated of the oscillator **39** connected by its output to the input of filter **43** the output of which is connected to the envelope shaper **45** connected to one of the output amplifiers. In the figure the dots on the patch board represent plugs containing resistances through which the connections are made.

Other features of the synthesiser include monitoring speakers **53,** input and output jack sockets **54** and an input multi-pin socket **55** to receive voltages from a keyboard to operate the synthesiser.

Some modifications are required to this synthesiser to adapt it to the embodiment now to be described with reference to FIGS. **5, 6** and **7** and these modifications will be dealt with in the description of FIGS. **5, 6** and **7.** Moreover, as illustrated the patch board has new facilities in that its first two rows provide output connections from the output amplifiers **50.**

The embodiment of FIGS. **5, 6** and **7** is a keyboard and storage arrangement shown in plan view in FIG. **5.** The circuit of the arrangement is shown in FIGS. **6***a* to **6***e* and waveforms at certain places in the circuit are shown in FIG. **7.**

This embodiment comprises a printed circuit on which are formed 30 conductive pads **1** some of which are indicated in dotted lines in FIG. **5.** These pads are covered by a plastics layer on which is printed the configuration of a conventional keyboard. Seven similar pads are also provided, four denoted **56** for transposition purposes according to FIG. **3,** a pad **57** to initiate a "play" mode, a pad **58** to initiate a "record" mode, and a pad **59** for initiating a random tone. The arrangement also has four control knobs **60, 61, 62** and **63** the functions of which will be explained hereinafter.

The circuit of FIG. **6** shows two multiplexers **64** and **65** each as described with reference to FIG. **2.** Multiplexer **64** has 16 inputs connected respectively to sixteen of the keyboard pads only one of which is shown in FIG. **6** for clarity. The diodes **9** are connected to a common line A and the resistances **10** are connected to a common line B leading to a common adjustment resistance **12.** Fourteen of the inputs of the multiplexer **65** are connected to the remaining keyboard pads, and their diodes **9** and resistances **10** are similarly connected to lines A and B.

A multiplexer **27** corresponds to the multiplexer **27** of FIG. **3** and is accordingly connected to the four pads **56** provided for transposition.

The three multiplexers are addressed by an input signal A_1 and by output signals A_0, B_0 and C_0 of the counter **22,** these signals being shown, together with an output signal D_0 of the counter **22,** in lines **3** to **7** of

FIG. 7. The signal A_1 is derived by two D type bistable circuits **66** and **67** from a clock pulse generator **21.** The Q output of circuit **67** is shown in line **2** of FIG. **7** and the output of the generator **21** is shown in line **1** of FIG. **7.** The generator **21** is formed as a multivibrator from a 4-input Schmitt-triggered NAND gate **68,** timing capacitors **69** and a diode **70.**

As two multiplexers **64** and **65** are employed for tone generation, they are scanned in a cycle of 32 steps, the first 16 at multiplexer **65** and the second 16 at multiplexer **64.** The enable signal M at input **14** of multiplexer **65** is therefore as shown at line **8** in FIG. **7** and the enable signal N for the other multiplexer is as shown at line **9** of FIG. **7.** The signals M and N are produced by the device **23** comprising NAND gates **23***a* and **23***b* fed by clock pulses from NAND gate **71,** signals from output D_o of counter **22** (via inverter **72** for gate **23***b*) and the signals from the $\overline{Q}$ output of circuit **67.**

The enable signal for multiplexer **27** is obtained from device **33** which is a NAND gate fed by clock pulses from gate **71** and signals from the Q output of circuit **67.** The signals from device **33** have the same frequency as the signals M and N but are evenly interspersed between the signals M and N, so that the transposition pads are not sampled at the same time as the keyboard pads.

The signals M and N are combined to form signal L by NAND gates **73** and **74,** the signal L being delayed slightly in relation to M and N and being used to clock the bistable circuit **24** at the time between t_1 and t_2, as described with reference to FIG. **1.** The circuit **24** is fed with the outputs from both multiplexers **64** and **65** via NAND gates **75** and **76,** the output of NAND gate **75** being shown at line **11** of FIG. **7** for the case in which the pad corresponding to the seventh note has been touched. The corresponding Q output of bistable circuit **24** is shown at line **12** of FIG. **7.** The voltages on the pads **1** corresponding to the sixth note (not played) and the seventh note are also shown at lines **15** and **16** of FIG. **7.** The $\overline{Q}$ output of circuit **24** is fed back to gate **76** to ensure that, if two pads are contacted simultaneously, the most significant, corresponding to the higher note, predominates. The circuit **24** is cleared at the end of each cycle by a signal from a differentiator **85** fed by D_o, the signal being shown at line **13** of FIG. **7.**

The Q output of the circuit **24,** when it goes high, clocks the register **25** composed of five D type bistable circuits to store the then existing address defined by the outputs of the counter **22.** This address is fed to the converter **26** and thence via an amplifier **77** to an output **78** which supplies a pitch voltage to control the oscillator **39** of the synthesiser. The converter **26** has a variable resistance controlled by one of the four knobs **60** to **63** to vary the pitch interval.

The sequence of addresses produced during use of the keyboard arrangement is also taken in digital form to a **256** word register **79** via open-collector-output NAND gates **80.**

The register can store a six-bit word and for each of the six bits has a sequence of a NAND gate **81** and two **128** bit shift registers **82** and **83.** The upper five sequences are used to store the addresses from register **25** and the sixth sequence is used to store signals denoted whether or not a keyboard pad has been contacted and derived from a D type bistable circuit **84** the D input of which receives the Q output of circuit **24** and the clock input of which receives $\overline{D}_o$ from NAND gate **72.** Circuit **84,** the output of which is shown for the present example at line **14** of FIG. **7,** holds the state of circuit **24** sampled at the instant before D_o goes low. The $\overline{Q}$ output of the circuit **84** is inverted by inverter **86** and passed to output **87** for connection in the synthesiser to control the attack of the envelope shaper **45.**

The Q output of circuit **84** is also employed in a circuit **88** to provide a component in a dynamic signal at output **89** used to control the level of an output amplifier of the synthesiser. The output **89** will be connected to input **2** of the synthesiser, and this input will be connected at the patch panel to the control input of the second output amplifier, as indicated by a circle in FIG. **4.**

The circuit **88** comprises an amplifier **90,** an envelope detector **91** and an amplifier **92** and is fed by a crystal microphone **129** attached to the arrangement to detect the level of mechanical movement at the arrangement as varied by variations in touch on the keyboard pads. The output of circuit **88** has a trapezoidal waveform to modulate the relevant output amplifier of the synthesiser.

The random-note pad **59** is connected in the manner described with reference to FIG. **1** to an input of a NAND gate **93** enabled by a clock signal from a NAND gate **94** driven by a clock generator **95** including a Schmitt-triggered NAND gate **95***a*. The generator **95** has a low repetition rate as compared with generator **21** and a short mark/space ratio.

The NAND gate **93** acts to set the circuit **24** via a D type bistable circuit **96,** thereby to cause an address to be selected and registered in register **25** in a substantially random manner to introduce a substantially random note into the sequence defined by the keyboard pads.

The "record" and "play" pads are similarly connected to NAND gates **97** and **98,** enabled by the clock generator **95** via NAND gates **94, 99** and **100.** Gates **97** and **98** feed D-type bistable circuits **101** and **102** clocked by the output signal of NAND gate **99.**

The $\overline{Q}$ output of circuit **101** is used to enable the gates **80** via NAND gates **103, 104** and **105** to input data to the register **79.** The $\overline{Q}$ output is also connected to a direct set input of circuit **101** whilst a clear input of circuit **101** is connected to the $\overline{Q}$ output of circuit **84,** so that when the pad **58** is contacted recording will not commence until a pad **1** has been contacted.

The $\overline{Q}$ output of circuit **102** is used to enable open-collector-output NAND gates **106** via NAND gate **107** to output data from the register **79** to a digital-to-analog converter **107** which passes its analog output to an output **108** via a feedback amplifier **109.** The signal at output **108** will be used to control the oscillator **40** in the synthesiser. The feedback path of amplifier **109** contains variable resistor **110** connected to one of the four knobs of the arrangement to vary the actual pitch interval between the notes by use of the register **79.**

The input of amplifier **109** is also connected to the integrator **38** so that the signal at the output **108** will contain an analog component corresponding to the transposition determined by pads **56.** This component is obtained from a transistor stage constituting the switch or one bit digital-to-analog converter **37** re-

ferred to with reference to FIG. 3. This converter is fed via a NAND gate 111 from the $\overline{Q}$ output of circuit 36.

FIG. 7 shows at lines 17 to 19 an example in which the tone and fifth transposition pads have been contacted. Line 17 shows the waveform at input 32 of multiplexer 27, line 18 shows the output waveform at 33 and line 19 shows the output of circuit 36.

It is also to be noted that, when the register 79 is delivering its stored addresses to the converter 107, it will also deliver the stored trigger signals to a variable resistance 112 (controlled by one of the four knobs of the arrangement) and thence to the output 87.

It will be described now how the register 79 is clocked. This is achieved by a clock generator 113 comprising a Schmitt-triggered NAND gate 114, two capacitors 115 and 116, a feedback path including a transistor 120 and a charging path for capacitor 116, containing a variable resistance 121 controlled by one of the four knobs of the arrangement to control the clock rate. During normal operation, the output of a NAND gate 117 is low and capacitor 116 is effective to give a relatively slow repetition rate for introducing data into the register 79 and removing data from that register.

During playing of the keyboard arrangement by way of pads 1 or during playing of the recorded data, this slow rate is achieved as a high signal is supplied to gate 117 from circuit 102 and from NAND gate 118. Gate 118 normally receives a low at at least one of its inputs to provide a high signal at its output for gate 117 because the stored data always includes at least one high bit (inverted by gates 106). However, empty storage locations of register 79 will cause the output of gate 118 to go low to make the gate 117 output high. Similarly, when the play pad 57 is contacted, the gate 117 output goes high.

When the output of gate 117 goes high, capacitor 116 becomes ineffective and the generator 113 produces a high repetition rate for recirculating the stored data until a position is reached at which data exists in the register and until the output of circuit 101 is reversed.

NAND gates 122, 123 and 124 are provided to block the generator 113 for a short time when the "play" pad has been contacted to eliminate switching scratch.

The output of the generator 113 is also fed, together with the Q output of circuit 101, to two counters 125 and 126 feeding a digital-to-analog converter 127 having an output 128 for connection to the meter 48. In this way, a staircase waveform is produced at 128 for operating the meter when recording so that the available storage time can be visually monitored.

In the present case it is proposed to energise the arrangement from the synthesiser, the power supply of which may therefore require modification. Also provision must be made at the synthesiser for receiving voltage from outputs 78 and 108 simultaneously. Output 78 can be coupled to the input of oscillator 39 whilst output 108 is coupled to a switch added to the synthesiser to connect output 108 to an existing row of the patch board 52, e.g. row 15 or 16. The normal facility provided by that row will therefore be lost when using the keyboard arrangement.

In FIGS. 6*a* to 6*e*, the individual blocks represent commercial components as follows:

77, 90, 92 and 109 are component 741;
126, 22 and 125 are component SN 7493;
25, 84, 36, 101, 102, 24, 96, 66 and 67 are component SN 7474;
118 is component SN 7430;
68, 95a, 124 and 114 are component SN 7413;
23 and 33 are component SN 7410;
81 is component SN 7404;
106, 117, 122 and 123 are component SN 7403;
75, 76, 97 to 100, 103 to 105, 107, 71, 73 and 74 are component SN 7460;
82 and 83 are component MF 7104; and
27, 64 and 65 are component SN 74150.

I claim:

1. A data input device comprising:
a data input member which is a conductive member having capacitance with its environment and positioned so that the finger of an operator may be placed in proximity with the member to change its capacitance;
a gating circuit having an output, a plurality of inputs to a first of which said member is connected, and means, including a transistor having a plurality of emitters coupled to respective ones of said inputs, for producing a predetermined output signal condition at said output when voltages of predetermined values exist at said inputs;
gating signal means operable to supply the associated predetermined voltage to the remaining at least one other of said inputs to define the beginning of a gating interval, which voltage has a polarity to cause a current to flow via the first input to change the voltage at the input member towards the predetermined value for the first input;
sensing means connected to receive the output signal of the gating circuit and having an enabling input to receive a signal to render the sensing means responsive to the output signal condition; and
means operable to provide said enabling signal for said enabling input at such a time in relation to the beginning of the gating interval that the sensing means is responsive to signal the presence and absence of said proximity.

2. A device as claimed in claim 1, wherein said transistor is an NPN transistor whereby said current will flow to increase the charge on said capacitance.

3. A device as claimed in claim 1, wherein said gating circuit is a NAND circuit.

4. A device as claimed in claim 2, wherein the sensing means is a bistable circuit responsive to the output signal condition of said gating circuit being absent at a predetermined time in relation to the beginning of said interval to indicate that said capacitance has at least a certain value, corresponding to finger proximity, greater than the intrinsic capacitance of said member, and the means to provide the enabling signal comprising a pulse generating circuit operable to produce a pulse and a first circuit path to said enabling input, the gating signal means comprising a second circuit path from said pulse generating means to the gating circuit and the two circuit paths having different signal transit times to produce the difference between the predetermined time and the beginning of the gating interval.

5. A device as claimed in claim 1, wherein there are a plurality of said conductive members and associated gating circuits, and said gating signal supply means are operable to address said gating circuits sequentially by

providing them with voltage defining successive gating intervals.

6. A device as claimed in claim **5**, and comprising digital register means having data input means connected for receiving gating signals from said supply means which signals define respective ones of said members, and also having write input means connected to receive a signal signifying the response of the sensing means to cause the then existing gating signals, identifying the member concerned, to be entered into the register means.

7. A device as claimed in claim **6**, and comprising a digital-to-analog converter for producing from the data in said register means a corresponding signal level.

8. A device as claimed in claim **6**, and suitable for operating an electronic sound producing apparatus, said register means including a register stage with a data input coupled to the sensing means to register a signal representing finger proximity with any of said conductive members, thereby to provide data to control the attack of a sound produced by such apparatus.

9. A device as claimed in claim **5** and suitable for operating an electronic sound producing apparatus, the device including a transposing arrangement operable to provide signal levels corresponding to required transposition intervals, the transposing arrangement having data input members additional to said conductive members to define transposition by respective intervals and pulse width modulation means connected to receive modulating signals derived from said data input members to produce a signal of duration dependent on which of the additional input members supplies a signal.

10. A device according to claim **9**, wherein the pulse width modulation means has a plurality of inputs and means for producing a pulse of unit duration from a signal at any one of said inputs, and the data input members being coupled to supply some of said inputs with said signals whilst others of said inputs are connected to the output of the means for producing a pulse, the pulse width modulation means having means for sequentially scanning said inputs and each of said some inputs being followed in the scanning sequence by a number of the other inputs dependent in each case upon the transposition interval required by the associated input members.

11. A device according to claim **10**, wherein said data input members are further of said conductive members with associated gating circuits connected to be gated by said gating signal means.

12. A data input device for operating an electronic sound producing apparatus responsive to electrical signals which define sound pitch, the device having means for selectively setting up said signals to define sound pitch and the device having in addition to said means a transposing arrangement to provide an additional signal of a duration defining a desired transposition interval, the transposing arrangement comprising a plurality of input means actuable to provide respective signals to define transposition by respective intervals, and pulse width modulation means responsive to said signals from said input means to produce a signal of duration dependent on which of said input means supplies a signal.

13. A device as claimed in claim **12**, wherein the pulse width modulation means is a circuit having a plurality of inputs, means to produce a pulse of unit duration from a signal at any one of said inputs and the input means being coupled to supply some of said inputs with said signals whilst others of said inputs are connected to the output of the means to produce a pulse, the pulse modulation means also having means for sequentially scanning said inputs and each of said some inputs being followed in the scanning sequence by a number of the other inputs dependent in each case upon the transposition interval required by the associated input means.

14. A device as claimed in claim **12** and comprising integrating means for producing a signal representing the sum of the durations produced as a result of more than one of said input means of the transposing arrangement supplying a signal to said pulse width modulation means.

15. A device as claimed in claim **5** and suitable for operating an electronic sound producing apparatus, said device having means responsive to the impact of a finger on any of said conductive members to produce a signal the amplitude of which depends upon the level of said impact.

16. A device as claimed in claim **15** wherein said means responsive to impact comprises a microphone and a circuit connected to receive a signal from the microphone and operable to produce therefrom a transient signal of maximum amplitude directly dependent upon the level of said signal from the microphone.

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