(12) UK Patent Application (19) GB (11) 2 340 286 (13) A

(43) Date of A Publication 16.02.2000

(21) Application No 9817035.0

(22) Date of Filing 06.08.1998

(71) Applicant(s)
William Currie
East Lodge, 2 Clober Farm Lane, Milngavie, GLASGOW, G62 7HW, United Kingdom

(72) Inventor(s)
William Currie

(74) Agent and/or Address for Service
Fitzpatricks
4 West Regent Street, GLASGOW, G2 1RS, United Kingdom

(51) INT CL^7
G10H 1/00 1/36

(52) UK CL (Edition R)
G5J JEBA JESM J1B

(56) Documents Cited
GB 1496522 A **US 5700966 A**

(58) Field of Search
UK CL (Edition P) **G4H HKH , G5J JEAC JEAR JEAS JEAX JESA JESD JESM**
INT CL^6 **G10H 1/00 1/36**

(54) Abstract Title
Remote control system for electronic musical equipment

(57) There is disclosed a system for controlling electronic musical equipment during a performance by remote control. The system comprises a portable keypad unit 100 providing a group of keys (204(0-16), and is suitable to be worn by a guitarist or similar musician. The system further comprises a base station 102 for receiving keypad signals and for generating therefrom digital commands. The keypad unit 100 and the base station 102 are arranged to generate each specific command in response to a specific simultaneous combination of key presses of keys within said group. In this way, the range of commands that can be generated at a given time is greater than the number of keys (204(0-16) on the keypad 100.

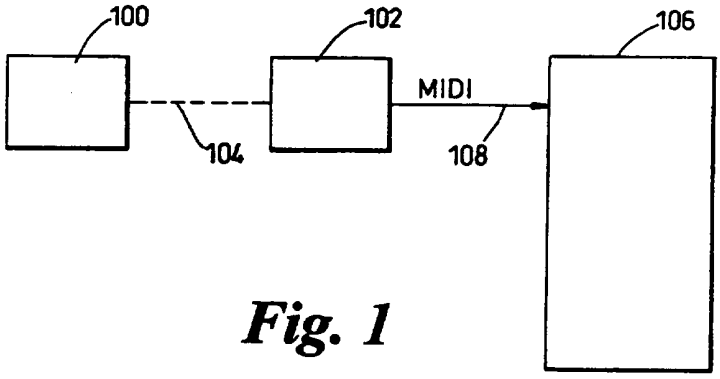


Fig. 1

GB 2 340 286 A

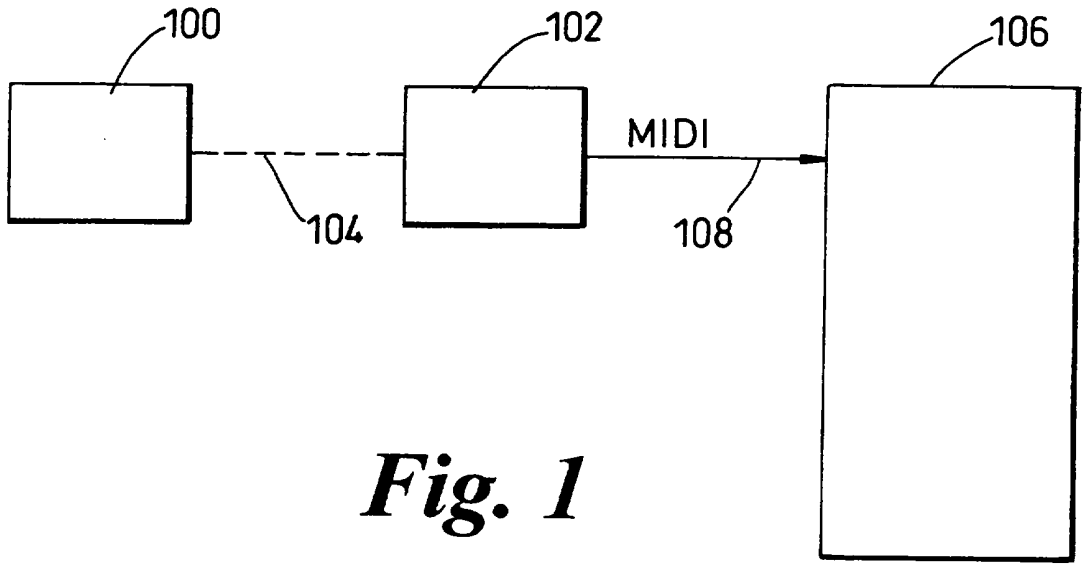

100
102
106
MIDI
104
108

Fig. 1

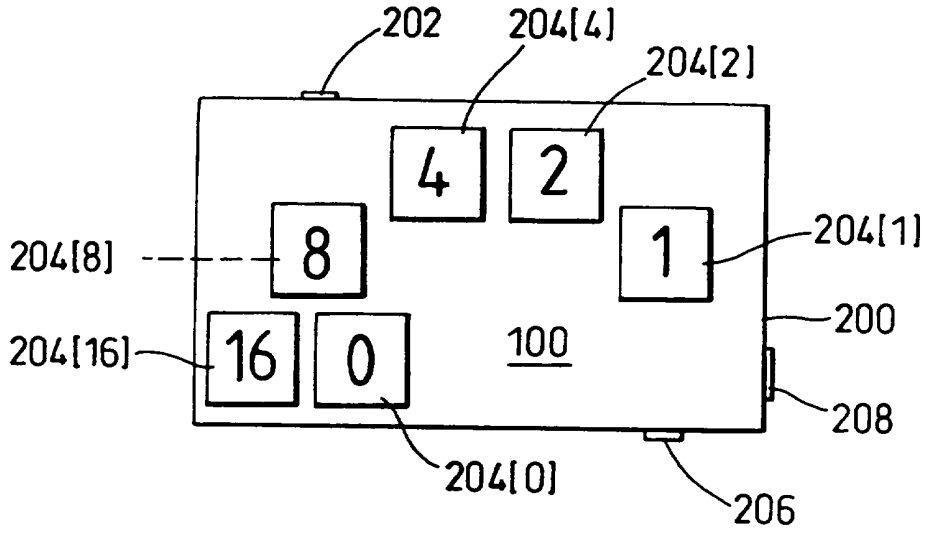

202
204[4]
204[2]
4
2
8
1
204[8]
204[1]
200
204[16]
16
0
100
208
204[0]
206

Fig. 2

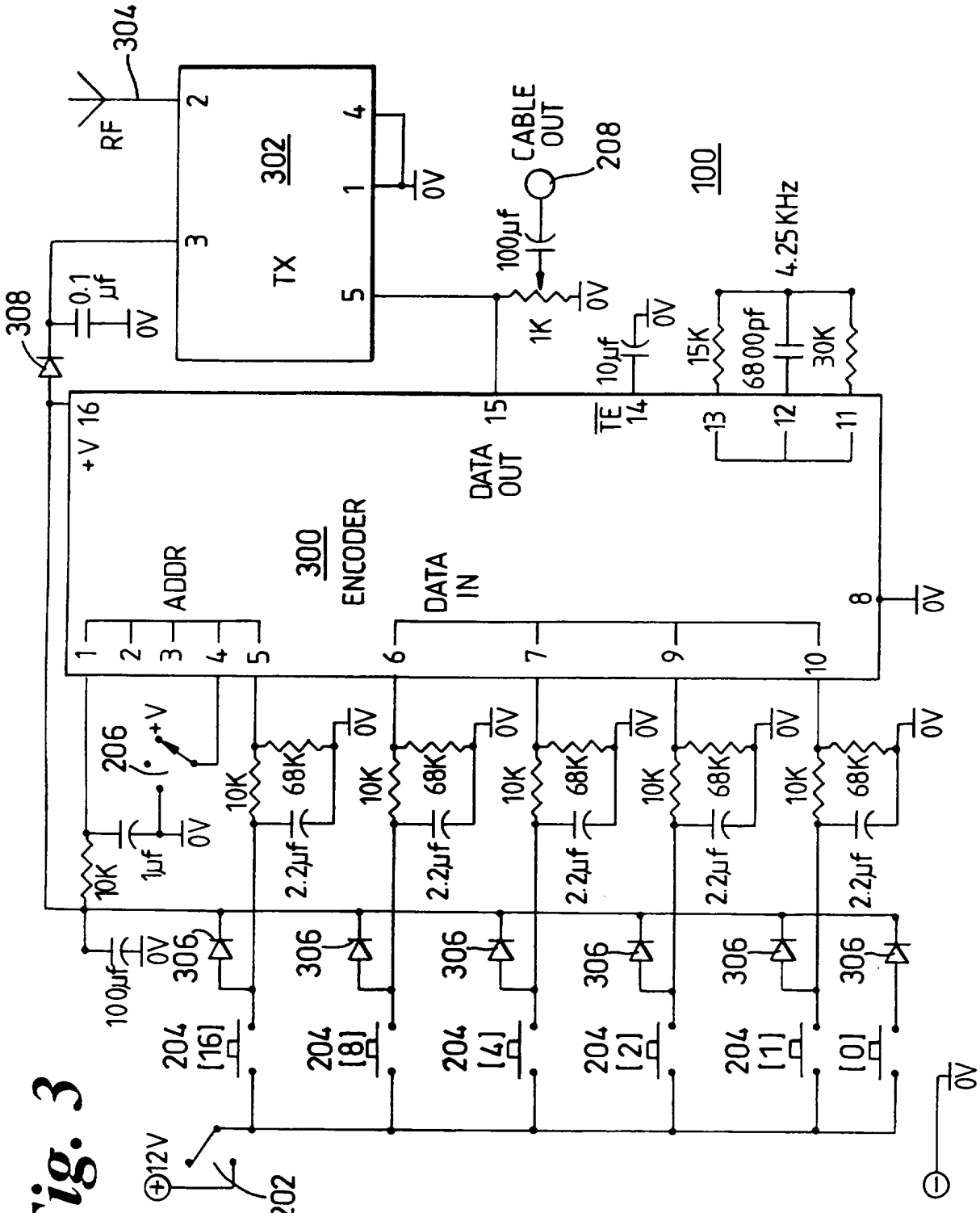

RF
304
302
TX
2
3
5
4
1
0V
0.1 µf
308
CABLE OUT
208
100µf
1K
10µf
100
4.25KHz
15K
6800pf
30K
+V 16
15
TE 14
13
12
11
DATA OUT
ADDR
300
ENCODER
DATA IN
1
2
3
4
5
6
7
9
10
8
206
+V
10K
1µf
68K
2.2µf
306
204
[16]
[8]
[4]
[2]
[1]
[0]
⊕12V
202
⊖

Fig. 3

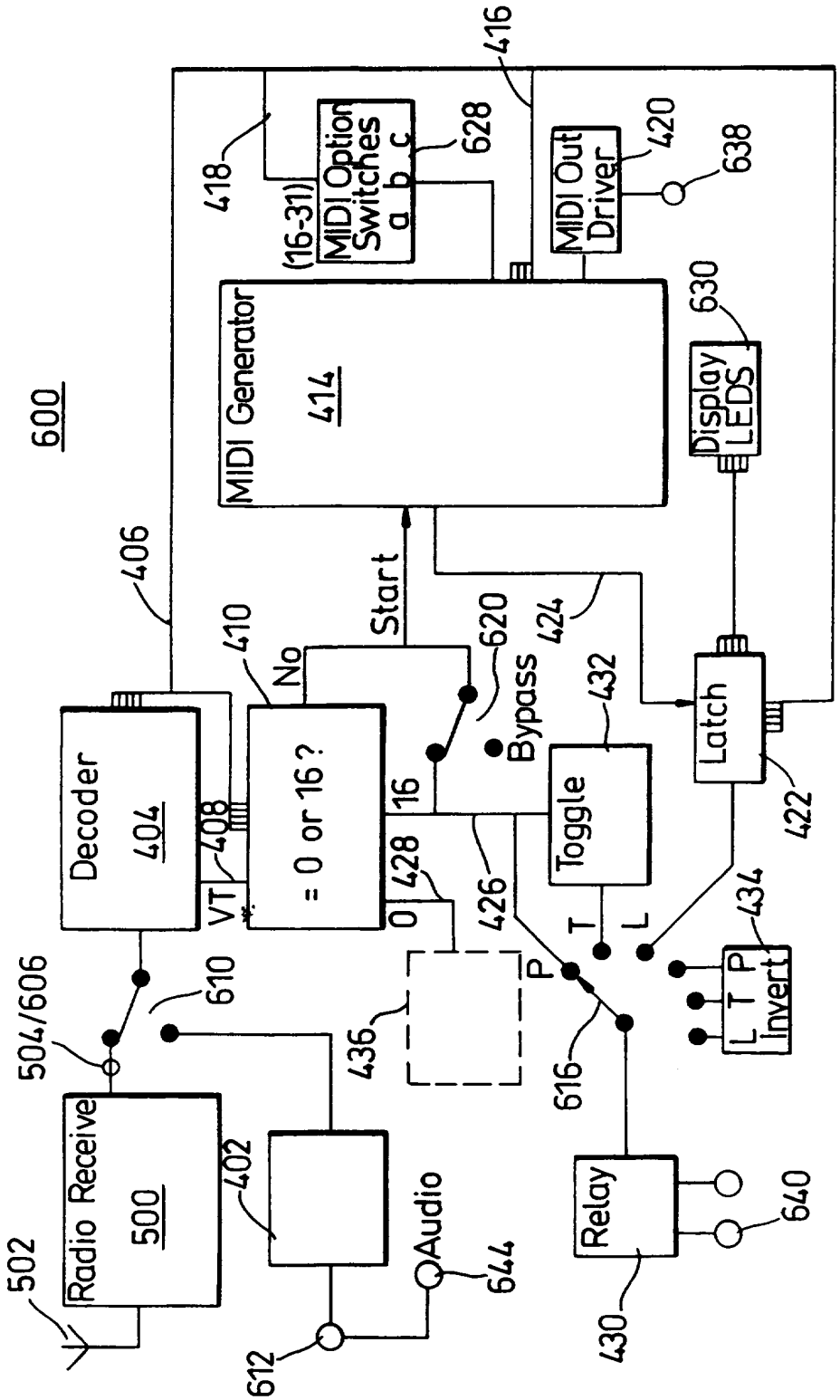

600
MIDI Generator
414
MIDI Option Switches
(16-31)
a b c
MIDI Out Driver
Display LEDS
Decoder
404
= 0 or 16 ?
Start
No
Bypass
Toggle
Latch
Invert
L T P
Radio Receive
500
Audio
Relay
502
504/606
610
612
616
620
630
638
640
644
406
408
410
416
418
420
422
424
426
428
430
432
434
436
VT
0
16
T
L
P

Fig. 4

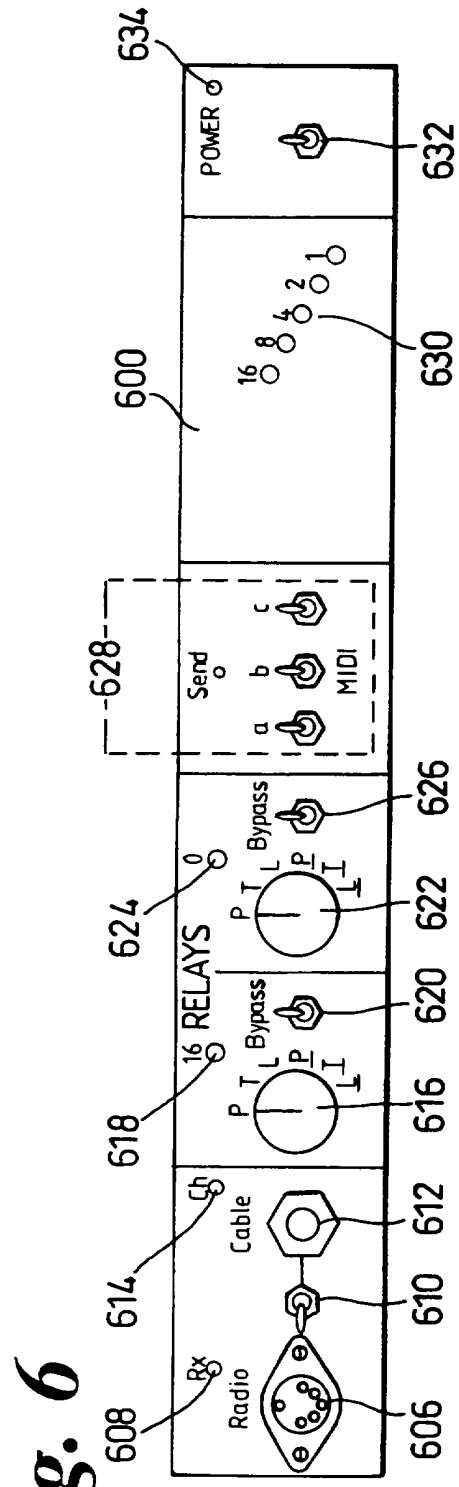
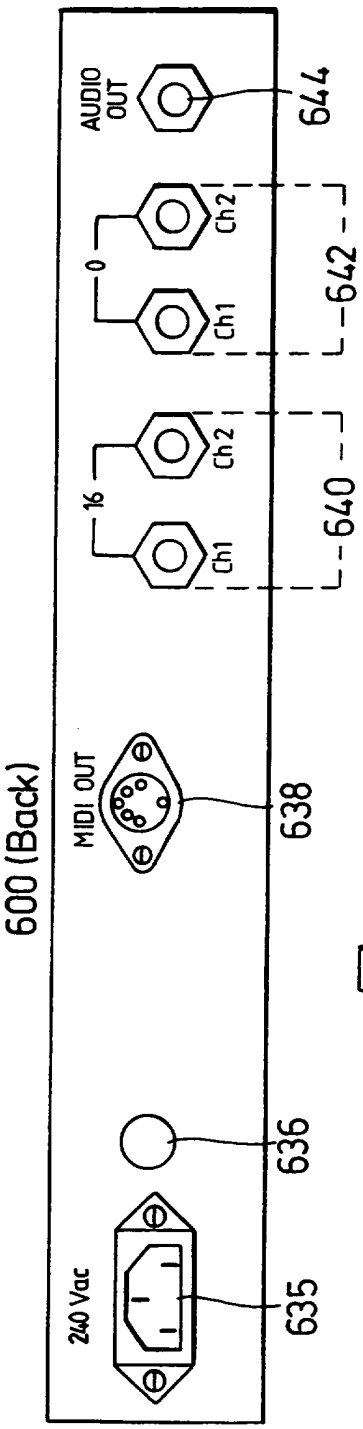

608
Rx
Radio
606
614
Ch
Cable
612
610
618
16
RELAYS
0
624
Bypass
620
Bypass
626
622
616
628
Send
a
b
c
MIDI
600
630
16 8 4 2 1
634
POWER
632

Fig. 6


600 (Back)
240 Vac
635
636
MIDI OUT
638
16
Ch1
Ch2
640
0
Ch1
Ch2
642
AUDIO OUT
644

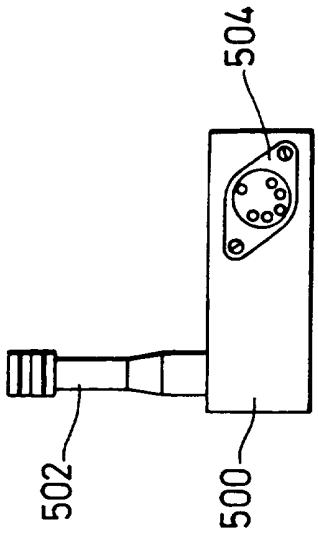
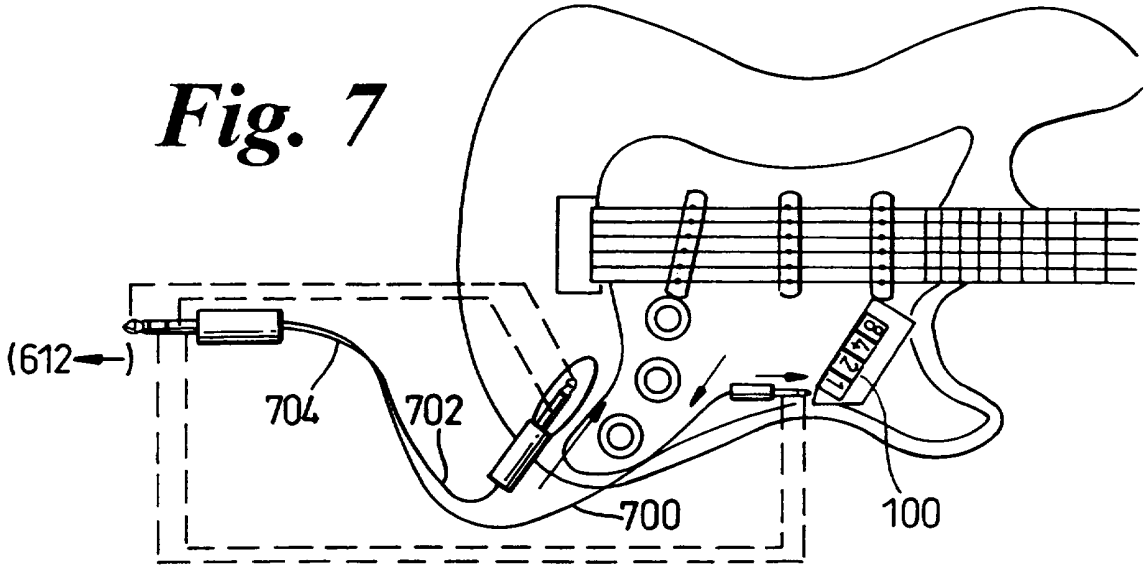

502
500
504

Fig. 5

Fig. 7


(612
704
702
700
100

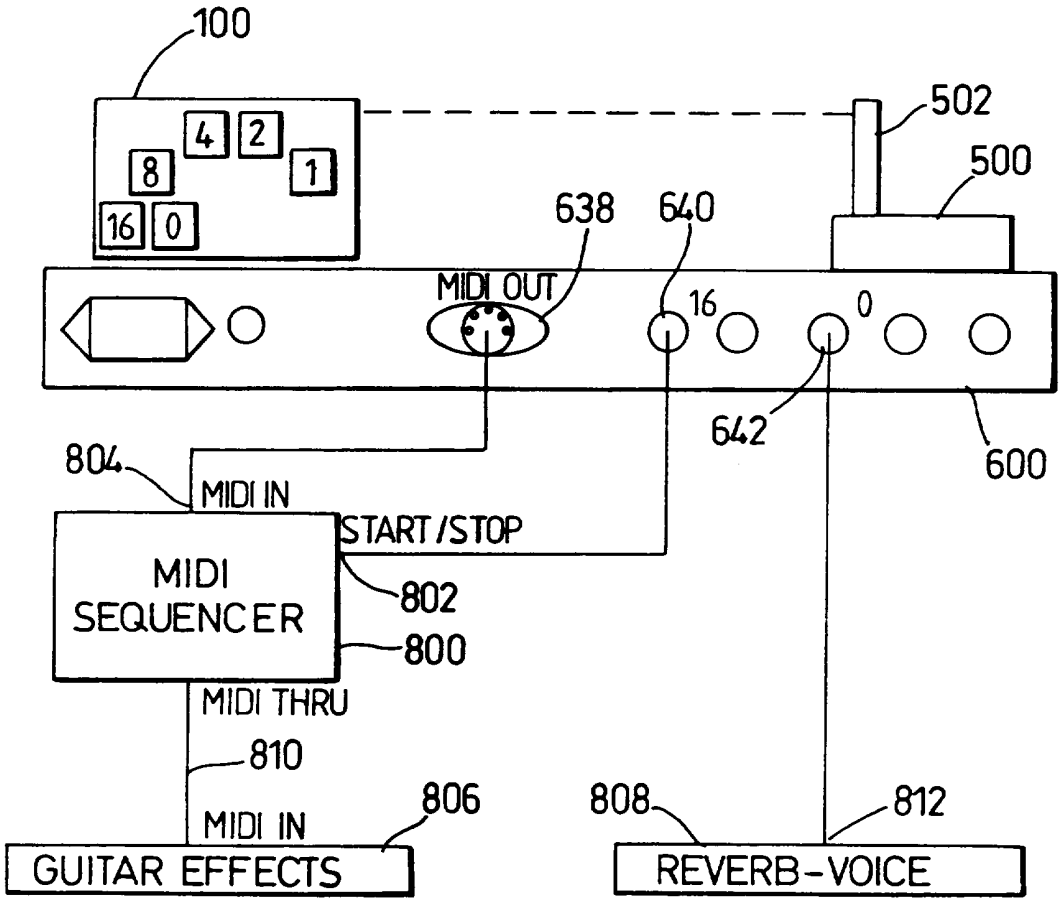
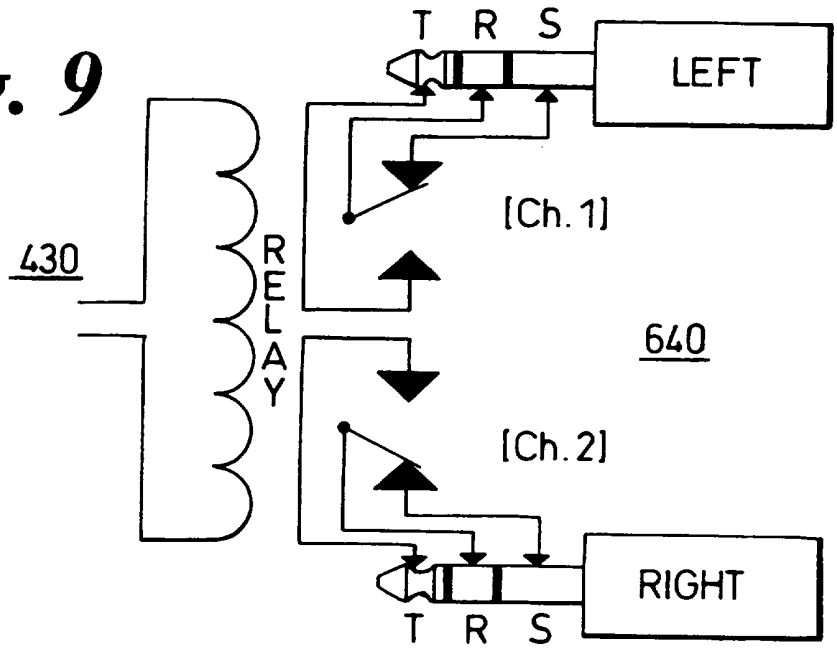

100
4
2
8
1
16
0
502
500
638
640
MIDI OUT
16
0
642
600
804
MIDI IN
START/STOP
MIDI
SEQUENCER
802
800
MIDI THRU
810
806
808
812
MIDI IN
GUITAR EFFECTS
REVERB-VOICE

Fig. 8

Fig. 9



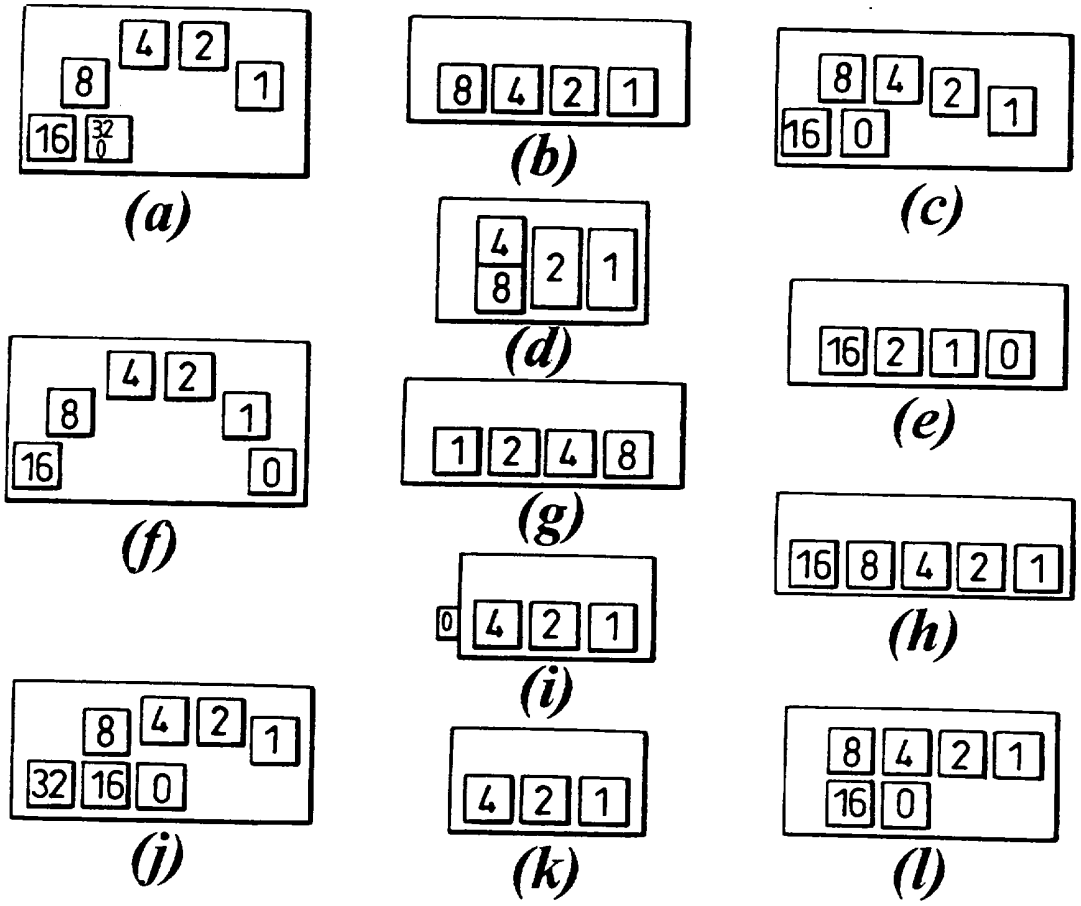


Fig. 10

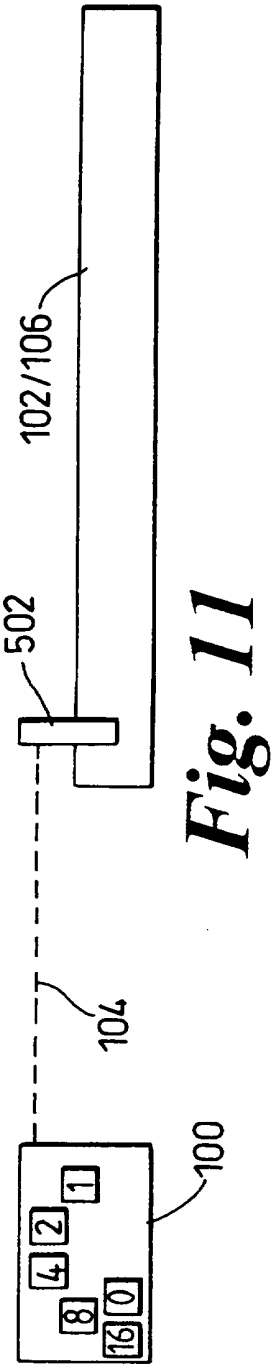


Fig. 11

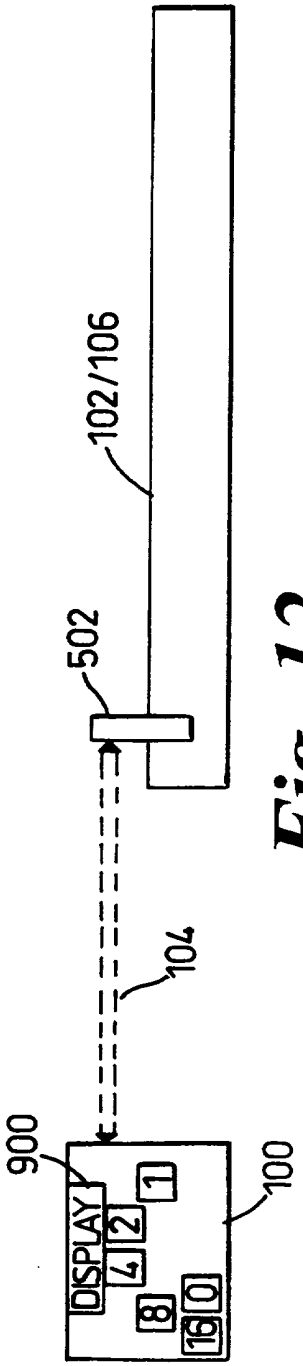


Fig. 12

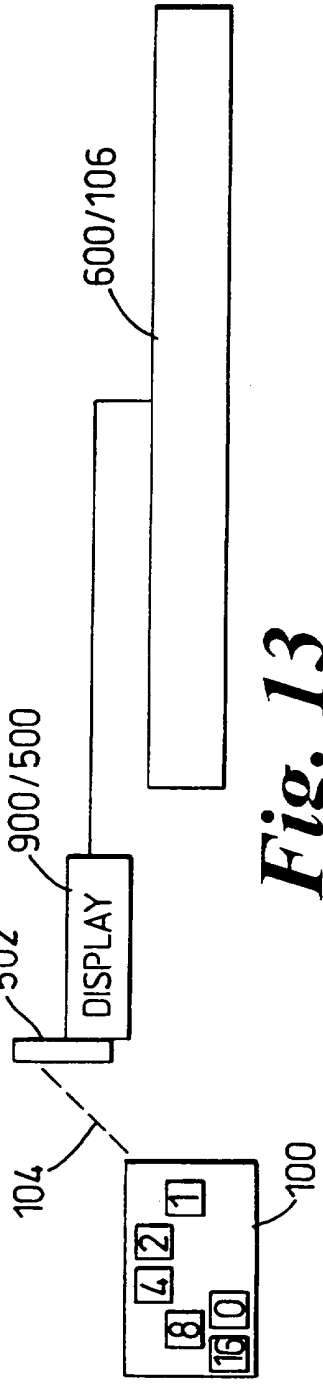


Fig. 13

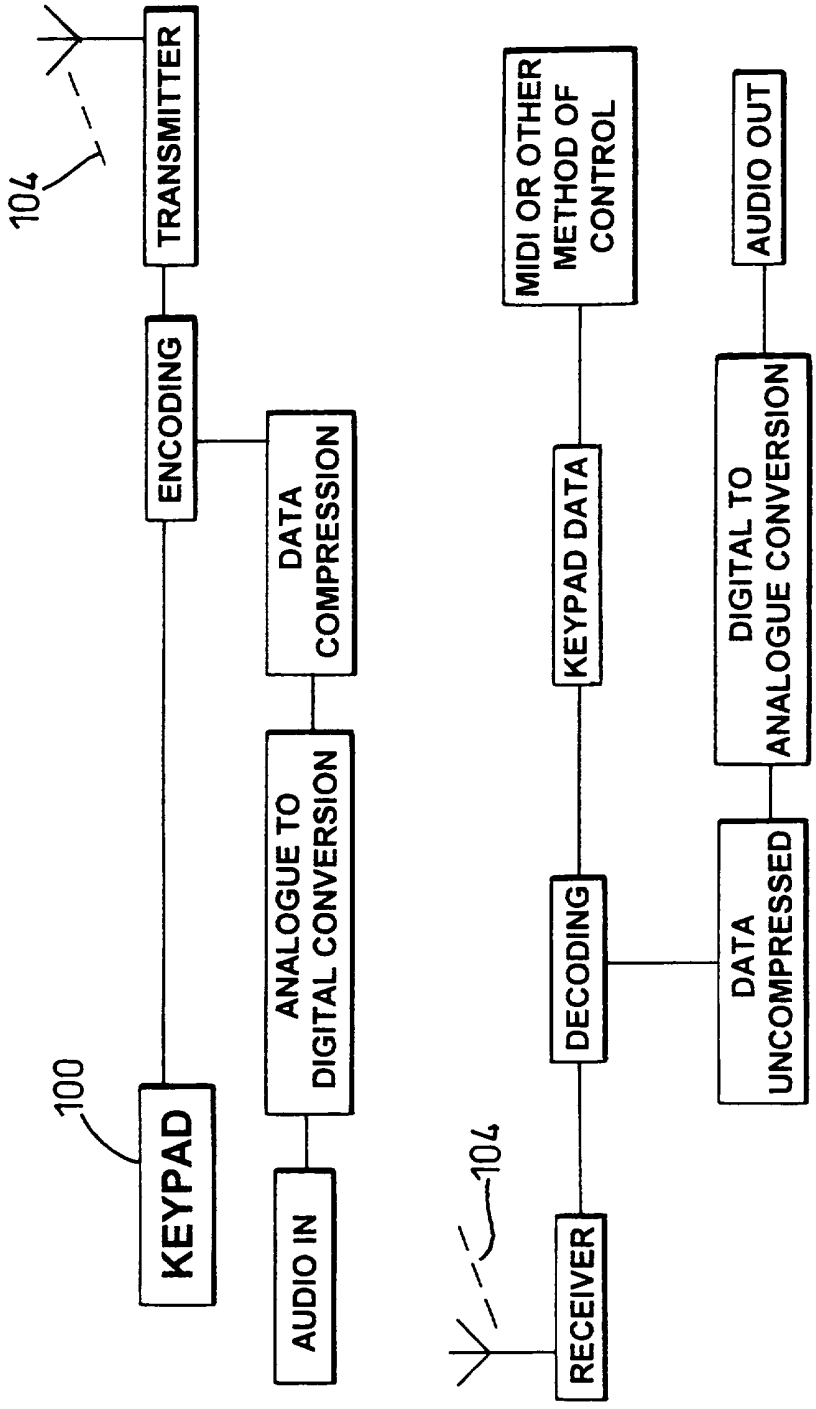

104
TRANSMITTER
ENCODING
DATA COMPRESSION
ANALOGUE TO DIGITAL CONVERSION
AUDIO IN
100
KEYPAD
MIDI OR OTHER METHOD OF CONTROL
KEYPAD DATA
DECODING
DATA UNCOMPRESSED
DIGITAL TO ANALOGUE CONVERSION
AUDIO OUT
104
RECEIVER

Fig. 14

2340286

Remote Control System

The invention relates to control systems for electronic equipment. A particular application is control of equipment used by musicians such as guitarists who are not ordinarily seated at a control console in the manner of a keyboard player.

In modern performance and studio situations, the musician requires to control a wide range of equipment, such as sequencers and drum machines for backing, effects units for processing sound signals, amplifiers, mixers, lighting, and so forth. By the use of such technology, a sophisticated presentation can be achieved without a large number of supporting players and technicians.

The musical instrument digital interface (MIDI) is a well known aid in such systems, although simple analogue foot switches and voltage controls remain important for various reasons. With regard to guitarists, effects processors are generally controlled by one or more foot pedals. These require careful setting up prior to each performance, they occupy space which may be at a premium, and they force the musician to return to a fixed position to operate the pedals when a command is to be given to the electronic equipment. Where the equipment is rack-mounted, front panel controls are of course provided, and a computer console may be used, but there are not suited to rapid operation by the lead musicians during a live performance.

The invention provides a remote control system comprising a remote keypad unit providing a group of keys and suitable to be worn by a guitarist or similar musician, and a base station for receiving keypad signals and for generating therefrom digital commands for controlling electronic equipment during performance, wherein the keypad unit and base station are arranged to generate each specific command in response to a specific simultaneous combination of key presses of keys within a group of keys on the keypad, such that the range of commands that can be generated at a given time is greater than the number of keys in said group. This allows the musician to effect program changes without returning to a bank of foot pedals. Simple

finger patterns on a bank of a few keys can select between dozens of programs, which avoids the need for visual contact with a keypad having a large number of keys. The number of specific commands that can be generated at a given time may be greater than twice or three times the number of keys on the keypad.

The novel keypad unit may be housed separately from any specific musical instrument, or may be housed within a portable musical instrument housing (eg, guitar body). Similarly, the base station (or part of it) may be housed separately from or within a specific sound generator or sound processor apparatus.

The base station may be arranged to transmit the generated commands via a musical instrument digital interface to separate sound generating or processing equipment. This interface will typically comprise the MIDI standard interface, but an alternative standard or proprietary interface is of course possible.

The keypad may comprise keys arranged in a non-rectangular array, corresponding approximately to the array of fingers on one hand. Said group of keys on the keypad unit may number between three and nine keys inclusive.

Different specific commands can be generated by pressing specific combinations of one, two and three keys. Up to four keys, up to five keys or up to six keys may be permitted (for example the thumb may press two keys at a time). Commands may be identified by a numeric index, while the numeric index is specified by binary weighting the keys on the keypad

The keypad unit may be arranged to send signals to the base station by wireless link, and may for example be provided with a radio transmitter for communication with the base station. Radio links are well-established in musical performance applications (wireless microphones and other audio links), and have advantages over alternatives such as infrared and cable.

The base station may be provided with an array of visual indicators corresponding one to each of the keypad keys in said group. The base station or keypad unit may be provided with a numeric indicator to confirm which specific command has been selected by operation of the keypad unit.

To increase flexibility, in one embodiment one or more special commands can be associated with a single specific key combination (which may be a specific key pressed alone). The specific key combination may then (at the user's option) be excluded from generating commands, while the relevant key or keys can still operate in combination with the other keys. Various control functions such as sequencer start/stop and foot switch inputs can conveniently be activated in this way. In the preferred embodiment, switching audio signals between the different paths is also possible. The specific key combination may provide a latching operation, by default or as an option.

In the base station, the specific key or a specific key combination may be associated with a direct electrical control function (acting in place of a footswitch, for example), while said commands comprise pre-arranged sequences of digital data (MIDI comments).

Other features and advantages of the invention in its various aspects will be apparent to the skilled reader.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1	is a block diagram of the remote control system according to a first embodiment of the invention;
Figure 2	is an external view of the keypad unit in the system of Figure 1;
Figure 3	is a circuit diagram of the keypad unit in the system of Figure 1;

Figure 4	is a block diagram of the base station in the system of Figure 1;
Figure 5	is an external view of the radio receiver in the base station of Figure 4;
Figure 6	shows external views (front and back panel) of the base station;
Figure 7	illustrates a cable-spaced application of the system of Figure 1;
Figure 8	illustrates application of the system in the control of a MIDI sequencer, guitar effects processor and voice processor in a typical performance set up;
Figure 9	is a circuit diagram of a relay output section in the base station of Figure 6;
Figures 10(a)-(l)	illustrates alternative keypad;
Figure 11-13	show alternative embodiments of the invention; and
Figure 14	illustrates combined transmission of audio and keypad signals in a further embodiment.

Detailed Description of Exemplary Embodiments

Figure 1 shows a wireless remote control system with a special keypad configuration for controlling various devices, particularly in the 'live' music performance. The intended application for this embodiment is to replace a conventional bank of pedal switches with a remote portable keypad carried or worn by a guitarist, although many other uses, both related and unrelated, will be apparent. The system will be referred to herein as the "WFP" system; meaning "Wireless Finger Pedals" (trade mark)

The WFP system comprises a remote keypad transmitter 100 and an appropriate base station comprising receiver/decoder 102, creating a radio communication channel 104. The receiver 102 controls a machine 106 via a command cable 108. Typical forms for machine 106 are such as MIDI sound effect processors, drum machines, sequencers, stage lighting

controllers etc. The command cable 108 in this embodiment may be a MIDI cable and/or a footswitch cable.

The receiver/decoder 102 does not necessarily have to be a separate device. For example, it can be built into a guitar effects processor 106. This eliminates the need for the command cable 108, unless MIDI and/or non-MIDI commands are to be fed to further apparatus.

In the present embodiment the receiver/decoder 102 is constructed from off-the-shelf logic gates and LSI integrated circuits. A production embodiment may replace the bulk of these components with a single programmed microprocessor.

Figure 2 is an external view of the remote keypad transmitter 100 in the system of Figure 1. A small portable casing 200 is provided, suitable to be worn on a belt clip, or attached by hook and loop fabric, etc to a guitar body, microphone stand. The features of the keypad unit On/Off Switch 202 disconnects the battery, preventing unwanted triggering and battery drain. The WFP keypad only uses power when buttons 204[0] etc are pressed. Keypad Push Buttons 204[0] to 204[16] positioned in a manner which enable the five fingers of the hand to press the buttons in separate and simultaneous combinations. The buttons are labelled for the user with binary weighting values 0, 1, 2, 4, 8 and 16 respectively, and are also colour coded. Pressing buttons [8], [4], [2] simultaneously will generate a command number 14 (8+4+2=14).

The [0] button in the present embodiment is always pressed separately, giving a 0 - 31 range (32 remote changes). Since a complete absence of key presses does not generate a command at all, only values from 1 to 31 could otherwise be sent. However, a circuit design could utilise the [0] in simultaneous combinations with the other push buttons giving a total of 63 remote changes with no extra button (see discussion of Figure 10(a) below). The [16] and [0] buttons are placed close so that the thumb can press them together.

Channel Select Switch 206 allows controlling more than one receiver from the same WFP keypad and has two positions: Left addresses commands to Receiver 1 (e.g. MIDI sequencer), while Right addresses commands to Receiver 2 (e.g. MIDI lighting). With a microprocessor based receiver (for example) this switch could be used to change MIDI parameters remotely. For example, Left may cause MIDI bank numbers to be sent in response to the keypad operations, while Right sends MIDI song select numbers.

Cable Socket 208 is provided so that a cable connection can be used in areas where wireless operation is not desired or unreliable.

Figure 3 shows the internal circuit of the WFP keypad transmitter 100. The main blocks in this circuit are an encoder 300 (in this case SGS-Thomson chip M145026), and a UHF wireless transmitter 302 (radiometrix product TXM-418-A). These and similar products are readily available from electronics suppliers such as Maplin Electronics Supplies in the United Kingdom. Reference signs 202 to 208 show the correspondence between circuit components and the external switches and sockets of the unit as shown in Figure 2, the circuit will not be described in detail, but basic features are as follows.

In the encoder circuit 300, pin numbers are shown for the SGS-Thomson chip mentioned above. Pins 1-5 are address inputs, which accept trinary values (positive rail, floating, zero rail). Pins 6, 7, 9 and 10 represent binary data inputs with the value 8, 4, 2 and 1 respectively. A serial data output pin 15 produces signals which encode both the address and data in a stream suitable for modulating onto the RF signal by the transmitter 302. The RF signal is radiated by an antenna 304. It will be understood that the exact components used and the values thereof are shown for illustration only and a wide range of alternative designs can be envisaged.

Address bit 5 (pin 5) of the encoder 300 receives push button 204[16] input, and so on is used as a 5th data bit. Two matching 4-bit decoders are used in the receiver 102 to achieve the necessary range of 32 possible outputs.

The prototype circuit of Figure 3 contains some components for precautionary measures that may not be needed in a final design. Input resistors keep the input voltages below the encoder's supply voltage. Power supply to the circuits 300, 302 is via diodes 306 and 308, as shown, so that a key press (204[16] etc) is required before any power is supplied from the battery to the circuit. A design using 2 - pole push button switches would significantly reduce the number of components.

Address bit 1, set high in the receiver's decoder circuit, is slightly delayed before becoming set high in the transmitter to ensure the input data values have stabilised before the receiver acts on the correct address. The voltage sustaining 2.2μF capacitors provide an appropriate margin of error for button releases that are not quite simultaneous. With these values the operator will feel any clumsy button releases. The circuit recovers quickly enough for the following keying correction.

The 10μF capacitor from Transmit Enable (TE) pin 14 to 0V was found to avoid errors in the transmitted data. Data transfer rate 4.25KHz was chosen - the radio receiver module maximum being 5Kbs.

The cable signal voltage is reduced to -10dBV (0.316V) as this is better if sharing a twin cable with audio (see Fig. 7 and description below for details) and also enables an alternative transmitter/receiver (e.g. wireless guitar system) to be used. Note that some wireless audio systems invert the phase of the signal.

Figure 4 shows the circuit diagram of the base station 102 in the system of Figure 1, which in fact comprises separate radio receiver 500 and decoder/relay/MIDI generator unit 600. The external features and operation of these units will be described separately below with reference to Figures 5 and 6.

With regard to the construction of the base station 500/600 in the present embodiment, this comprises the radio receiver module 500 (Radiometrix-418-A) corresponding to the transmitter module in the keypad

unit, with appropriate antenna 502 and data output 504. A cable input section 402 is provided an alternative input means for the digital serial signal received from keypad transmitter 100. A decoder section 404 performs the reverse function of the encoder 300 (Figure 3). However, since in this embodiment the fifth address bit of the encoder is effectively used to convey a fifth bit of data corresponding to the [16] key press, two SGS-Thomson decoders type M145027 are used to obtain 5-bit data which is output to other components on bus lines 406. The decoder block 404 also provides a "valid transmission" (VT) signal at line 408.

A further decoder block 410 comprising suitable logic gates is provided to effect the special treatment of values 0 and 16. An output 412 indicates that a valid transmission not including these special values has been received, and is fed to a MIDI generator circuit 414. This signal initiates generation of a MIDI command. The MIDI generator circuit comprises various logic circuits including: a clock (IC type 4040); counter (4017); buffers (74HC244); a parallel to serial converter (UART 6402) and miscellaneous logic gates. Four bits of the data bus 406 are connected at 416 to an input of the MIDI generator circuit. The fifth bit is connected at 418 to a mode selector corresponding to switches a, b, c (628 in Figure 6 described below). The UART serial output is connected to a MIDI output driver 420, which drives MIDI output socket 638. The data bus 406 also travels, through latches 422 to a set of display LED's 630 (see Figure 6). Latching events are determined by a control line 424 from the MIDI generator unit 414.

Logic unit 410 provides outputs 426 and 428 indicating receipt of the special values "16" and "0" respectively. These are used in control of a relay output circuit 430. The exact mode of operation is determined by a selector switch 616, and involves a toggle flip flop 432, inverters 434 and the latch unit 422. A bypass switch 620 determines whether the value 16 also causes a signal on line 412 to initiate MIDI command generation. A "0" logic unit 436 receives output 428 from the detector 410 and comprises similar components to those 430, 432, 434, 616, 620, 640 provided for processing of the "16" signal 426.

The manner of operation of these components will be discussed in relation to the external features of the base station shown in Figures 5 and 6. It will be readily apparent that alternative internal circuits can be provided to achieve the same or similar effects and in particular a microprocessor-based embodiment can equally be envisaged.

As shown in Figure 5, the external radio receiver has a separate housing 500 which carries antenna 502 and contains the Radiometrix SILRX-418-A receiver module 500. A cable is used to connect from a socket 504 to the Decoder/Relay/MIDI Generator Unit 600. In this case, a short or long standard MIDI cable can be used, although the signal is not MIDI format. The external receiver can therefore be moved for best reception. The cable also supplies power for the attenna/receiver.

Figure 6 shows the external controls and connectors for the Decoder/Relay/MIDI Generator 600 when provided as a separate unit. However, all of its features and more could be incorporated into many MIDI devices (e.g. MIDI Effects Processor). This MIDI device could then have an interface for the external Antenna/Receiver 500. Manufacturers adopting an interface would allow purchasers to choose options such as the Operation Frequency and Type of WFP system, choose a Foot Controller if preferred or an Infra-red/Wire keypad system for use in a studio-only set up or to avoid the cost of any external controller when not needed. This interface could be shared with a Standard MIDI socket, the user selecting its purpose. It may also exploit the fact that MIDI normally only uses only two or three pins of the standard 5 pin DIN socket.

Returning to the present embodiment, the features of the front panels of the decoder/relay/MIDI generator unit 600 are shown in the upper part of Figure 6 with the rear panel shown below.

The external radio receive module 500 (Fig 4, socket 504) is cable connected to receiver interface socket 606. An RX (Carrier Detect) LED 608 lights whenever the chosen operation frequency is detected by the receiver

in this case 418 MHz. A Radio/Cable Switch 610 can be switched left for wireless operation, or right for cable link.

Referring also to Figure 7, Cable In socket 612 (quarter inch stereo type) allows a keypad wire link 700 and an audio input 702 to share a twin cable 704. An audio signal fed in here is directly output on the back panel at 644. The keypad unit 100 in Figure 7 may be attached to or built into the guitar as shown, and has only four keys as an alternative to the six keys of Figure 2. Different keypads can be used in the system, as will be described with reference to Figure 10. The base unit 500/600 can be common to several differnet keypad designs.

Channel Match LED 614 lights when the internally set (could be external) receive address matches the WFP transmit address. A code match must be made for the unit to proceed and generate commands.

The Relay control section 616-626 is designed for use with almost any device that has footswitch control options. When such control is desired, one or both of the [16] and [0] keys on the keypad when pressed alone cause a special action of footswitch (relay) control. Each key continues to contribute to generating MIDI commands when pressed in combination with other keys. Optionally, the generation of MIDI commands when the [16] or [0] key is pressed alone can be suppressed by use of a "bypass" switch when pressed alone. The number of MIDI commands that can be generated is of course reduced at such times. The relay outputs 640 & 642 on the rear panel imitate the action of the most common types of footswitch - two footswitch imitators are available here each with dual channel output. These are triggered by pressing the [16] or [0] buttons on the WFP keypad. Although the present embodiment always uses the [16] or [0] buttons, a microprocessor based device could allow the operator to define the numbers (key combinations) used to generate footswitch commands.

As illustrated in Figure 8, one of the main uses of this the relay section is to stop/start a MIDI music sequencer 800 via its footswitch start/stop input 802. First, the song to be played would be chosen via a MIDI cable connecting the decoder 600 MIDI output 638 to a "MIDI in"

socket 804 on the sequencer 800. Then the sequencer can be started/stopped via a quarter inch mono to mono cable between sockets 640 and 802.

In principle, the footswitch connection ought not to be needed for sequencer start/stop commands, since the MIDI cable can be used to send a standard MIDI start/stop command to the sequencer 800. Unfortunately the majority of MIDI sequencers can only respond to MIDI start/stop messages when CLOCK = EXTERNAL SOURCE is selected. Although this is a logical simplification for tempo-syncing sequencers together, the WFP controller in the present embodiment does not generate MIDI clock messages or know the song tempo, and sending a "MIDI start" would mean the song never leaves the first beat of bar one. Fortunately, most (if not all) MIDI sequencers offer a footswitch start / stop. A MIDI start/stop could be offered in a microprocessor based system as more sequencers in the future may support separate MIDI start/stop and internal clock option.

The Relay Section is also useful for many other remote switching applications - music related or otherwise, including older analogue effects controllers built in to amplifiers and the like. Further features shown in the application example of Figure 8 will be discussed later.

To maximise flexibility, the relay action is highly configurable, as follows.

'16' Rotary Selector 616 selects the appropriate relay switch action in response to the [16] button on the keypad 100. Desired settings P, T, L, P, T and L are defined in this embodiment. P (PULSE) setting is equivalent of a non-latching, contacts normally open (closed during press) footswitch. T (TOGGLE) stimulates a press on, press off footswitch-contacts latching.

One of the weaknesses of the TOGGLE action is that confirmation of whether the contacts are open or closed is often required - this is difficult if the device is not nearby. In a microprocessor-based design a number (key combination) can be assigned to close the contacts and a different number to open (break) contacts - the user can always be certain of the contacts'

state. In this present embodiment, however, this problem is addressed by the L (LATCH IF) setting of selector 616. With the [16] relay and the L setting, any number 16 and above will close the contacts, while numbers below 16 open the contacts. A similar 'PULSE IF' could also be provided.

The L setting in the present embodiment supports particular applications. All keyed numbers send MIDI commands as normal but ranges of numbers automatically switch something non-MIDI (eg monitor speaker on/off, the path of an audio signal taken, lighting control, etc.) that has a coherence with the MIDI devices used. For example, one may want an electric guitar sound to play through just a guitar amplifier, and an acoustic guitar to play through just an acoustic instrument amplifier or public address (PA) system. The performer will probably want to use the same MIDI effects processor for both guitars (even more so when using the same wireless transmitter for both guitars). The LATCH IF setting allows the electric guitar to have 0-15 electric guitar effects automatically switched through the guitar amp, and 16-31 acoustic guitar effects automatically switched through the acoustic amp.

Selector settings P , T , L have the same action as P , T , L resepectively except the relay output state is reversed. That is, normally open contacts are now normally closed contacts.

'16' LED 618 shows the relay output state. LED 618 lit means closed contacts, while LED 618 unlit means open contacts

When '16' bypass switch 620 is in the down position, the number 16 (key 204[16] pressed alone) is not sent to the MIDI generator section. The number 16 becomes purely a relay switch trigger and is removed from the range of selectable MIDI numbers, leaving 0 - 15, 17 - 31. Without this feature, a relay start/stop would, for example, only play MIDI song number 16 in the sequencer control application of Figure 8.

'0' Rotary Selector 622 has the same features as the '16' selector 616 in relation to the key 204[0], except in the L (LATCH IF) setting. In the L setting, when number zero (key 204[0] pressed alone) is entered, the

contacts will be closed, and any number above zero (any other key(s) pressed) will cause the contacts to open. With setting L (INVERTED LATCH IF) these effects are reversed. The [0] relay would for example be used with this setting for muting a guitar speaker while tuning/unplugging.

'0' LED 624 Lights when corresponding relay [0] contacts are closed.

A '0' bypass switch 626 provided similar to the '16' bypass switch 620. The number zero is not sent to the MIDI generator when this switch is down. When both the '0' and '16' bypass switches are down, the range of numbers available for MIDI commands is 1-15 and 17-31.

With regard to the '16' Relay outputs, either of these quarter inch stereo jack sockets 640 can be used for start/stop, signal switching, etc. The relays used are 2-pole, and so the two jack sockets contacts are electrically isolated from each other. This allows the '16' Relay to switch stereo audio signals. Tip, ring and sleeve contacts of standard stereo jacks are labelled T, R, S, respectively in Figure 9.

This wiring arrangement gives versatile possibilities. Most audio and MIDI devices use quarter inch mono jack sockets for footswitch control. A standard mono to mono cable plugged into either socket 640 will produce the correct operation. For remote non-MIDI muting of audio mixers, a standard stereo jack to stereo jack cable from the audio mixer insert socket to socket 640. Two stereo cables and both sockets can be used for stereo muting.

Using non-standard cables or an adaptor box, (stereo) input signals (to ring) can be switched (tip and sleeve) to two different (stereo) destinations. Similarly, two (stereo) input signals (to tip and sleeve) can be selected for one (stereo) destination (from ring).

Guitar non-MIDI effect pedals can be remotely switched using '16' Relay (and '0' Relay) outputs - specialist cables may be required. Of course, a design could utilise semiconductor switches instead of relays.

'0' Relay Output 642 has the same features as the '16' Relay output, but triggered by '0' instead of '16'.

Referring to Figure 6, MIDI control section 628 gives seven useful MIDI set up options (modes) selected by three switches a , b , c in binary combinations. The MIDI LED 630 lights when each MIDI data transmission is completed. The seven modes are summarised in Table 1 below. In modes 4-7, the number ranges 0-15 and 16-31 are assigned to different types of command.

TABLE 1

	WFP Number Range	MIDI Option a	b	c	MIDI Message Type	Sent MIDI Value	MIDI Channel Number
1	0 - 31	OFF	OFF	-	Prog. Change	0 - 31	0
2	0 - 31	OFF	ON	OFF	Prog. Change	0 - 31	3
3	0 - 31	OFF	ON	ON	Song Select	0 - 31	-
4	0 - 15 16 - 31	ON	OFF	OFF	Prog. Change Prog. Change	0 - 15 0 - 15	0 3
5	0 - 15 16 - 31	ON	OFF	ON	Prog. Change Song Select	0 - 15 0 - 15	0 -
6	0 - 15 16 - 31	ON	ON	OFF	Prog. Change Prog. Change	0 - 15 0 - 15	0 0
7	0 - 15 16 - 31	ON	ON	ON	Song Select Song Select	0 - 15 0 - 15	- -

Coloured LED Display 630 uses colours and labels corresponding to colours and labels used on the WFP keypad keys 204[0] etc. Blue, green, yellow , orange and red LEDs are provided, and the same colour code is used on the keys 204[0] to 204[16] respectively. The display holds the last code (finger combination/number) acted on by the MIDI generator. In many ways, this display is better than a 'digit' display because the numbers sent by a keypad are not necessarily the MIDI values used.

Remembering colour combinations is a fresh alternative memory aid. Remembering finger combinations is better still, because musicians

regularly press their ten fingers in different combinations (possible 1023) over many different keys. Remembering numbers is an abstract process - remembring finger combinations is a sensory one.

The MIDI Out socket 638 allows a Standard MIDI cable to be connected to the MIDI In socket on the target device. Audio out socket 644 is described above in relation to the cable input 612. The front panel also carries the Mains Power Switch 632 and Power on LED 634. The back panel carries a Mains Power Euro Connector 635 and Mains Fuse 636.

Figure 8 (mentioned already above) shows a typical set up of equipment including the WFP system for a solo singer/guitarist with electronic backing (MIDI sequencing) using the WFP keypad. In addition to the sequencer 800 discussed already a guitar effects unit 806 and voice reverb (effects) unit 808 are provided. Audio connections are not shown, for simplicity.

The guitar effects unit 806 receives MIDI commands from the WFP decoder 600 via the "MIDI thru" socket of the sequencer and MIDI cable 810. '16' Relay socket 640 is connected to provide start/stop control of the sequencer. '0' Relay socket 642 is connected to footswitch input 812 of voice effects unit 808, so that the reverb can be disabled while the perfomer talks between songs.

For this application, the settings shown in Table 2 may be appropriate:

Table 2

Control	**Setting**
MIDI Options switches a , b , c (628)	5 (ON , OFF , ON)
Rotary [16] (616)	P
Bypass [16] (620)	DOWN (BYPASS ON)
Rotary [0] (622)	T
Bypass [0] (626)	DOWN (BYPASS ON)

With these settings the commands available by selecting numbers 0 to 31 on the keypad 204[0] to 204[16] are as follows:

Table 3

Keypad Action	Result
0	MUTES / UNMUTES the Voice Reverb unit 808
1-15	(MIDI Programme Change) Selects1-15 different Guitar Sounds in the effects unit 806
16	STARTS/STOPS the MIDI Sequencer 800
17-31	(MIDI Song Select) Selects1-15 MIDI Songs in the Sequencer 800

Using the WFP channel select switch (206, Fig 2) also could offer even more versatility e.g. MIDI lighting, etc, provided that a separate reciever/decoder unit 102 would be provided.

Again, a more elaborate microprocessor-based system could provide more MIDI message types to choose from. For example, MIDI BANK SELECT is a MIDI message type being increasingly used. MIDI NOTE ON could be used with sound samplers to remotely trigger sound effects in theatre plays, etc. A MIDI NOTE OFF could be sent automatically after a delay of say 0.3 seconds (which does not mean the sound effect must end after 0.3 seconds). A MIDI ALL NOTES OFF could be assigned a specific WFP keypad number. To avoid accidental triggering of this "emergency" command it might for example be assigned so that all keys are to be pressed at once. MIDI START and MIDI STOP would function as mentioned earlier. Standard MIDI controllers for Volume, Modulation, Pan, etc, can also be generated.

A microprocessor-based system could also provide number remapping (often used in MIDI effect machines). In that case the number sent by the WFP keypad is not necessarily the MIDI number used.

In a possible base unit design using a microprocessor, a relay (there may be several) could be programmed to respond either pulse, toggle or latch by the user. Each number (from the WFP keypad) received by the base

unit could have the option (programmable by user) to trigger (either pulse, set or clear) a particular relay or not. Each number could have a bypass MIDI yes/no option. Each number could select a different MIDI command (and related parameters). Each number could be re-mapped to a different MIDI number. Such a device would perform all the operations and more of the present embodiment. Of course, other features may be involved too.

Those skilled in the art will recognise that a very convenient and reliable control system is provided by the WFP system described. Particular advantages can be seen as follows:

- Instant changes and instant correction of changes if an error is keyed (0 - 9 'telephone style' keypads require 3 sequential button presses for numbers greater than 9).

- WFP is wireless - freedom to change settings anywhere within range (up to 200 metres). At present there do not appear to be any battery powered wireless MIDI controllers on the market (foot pedals using mains power and cable link are common).

- WFP is far tidier than foot pedals and does not use so much floor space (especially important on smaller stages). It does not require so much set up/pack up time. This also enables quicker changes between acts in concerts, clubs, and theatres.

- WFP has fewer buttons/switches than the 0 - 9 'telephone style' keypad. The WFP is therefore cheaper and smaller.

- The WFP keypad can be small (even though the keys are amply sized for easy operation). It can be attached to musical instruments such as guitars by means of 'Velcro™', double sided adhesive pads or other fixing method. It can also be attached to microphone stands, belt clips, etc. It can be easily stored in instrument cases. It can easily be built in to a guitar or the like.

- The WFP keypad uses less battery power than other keypad designs, because it requires fewer overall button presses and does not require the electronic display confirmation essential in some other keying methods. The WFP when switched on only uses battery power during button(s) press. A small 12V alkaline cigarette lighter battery (Duracell MN21) could provide several thousand presses and, therefore, fewer battery replacements. It can be operated by touch alone - visual confirmation is not needed. Hence, the keypad can be used in low light areas such as theatres, clubs, discos, etc or by the blind/visually impaired.

- The WFP direct electronic coding is binary unlike other keypads that require decimal to binary conversion. This enables this more efficient unit to be produced more cheaply.

Figure 10 shows at (a) to (l) various alternative key pad configurations. The physical case shapes and layouts are shown schematically, and in two dimensions only. The form of case and key layout can be ergonomically shaped in three dimensions if desired. A WFP keypad may involve only three or four buttons useful where space is tight on instruments like violins, clarinets, mandolins, etc. and could be built into radio microphones, belt pack transmitters, etc. The keypad external case design may include a clip or slot for holding a plectrum - guitarists using a 5 finger version. Even in prototype form , the WFP keypad is easily mounted on instrument, belt clip or microphone stand clamp using hook and loop fabric (Velcro™).

The buttons are positioned so that the fingers can press these buttons in separate and simultaneously combinations e.g. Pressing [8], [4], [2] buttons simultaneously will generate a number 14 (8 + 4 + 2 = 14). Layouts can be right handed (shown for example at (a) and (b), left handed (not shown), switchable, or generic to left or right-handed users. When built in a guitar, for example, dual keypads might be provided.

The user does not necessarily have to remember any numbers, remembering finger combinations (or colour combinations) will achieve the

same result. Many MIDI music devices do not always display MIDI numbers. Although, MIDI numbers 0 - 127 can be implemented by some MIDI devices - for 'live' music use fewer is usually sufficient.

Most of the examples in Figure 10 are self-explanatory. Layout (a) has six buttons, [1], [2], [4], [8], [16], and [32]. Pressing [16] and [32] together with the thumb as required, this allows the range 1-63 to be covered. The [32] button in (a) optionally has both a '0' function (when pressed alone) and a '32' function. This sacrifices the value 32 for the special value zero, giving a possible range 0 to 31 and 33 to 63,.

A simple guitarist layout is shown at (b), comprising simply four keys, weighted 1, 2, 4 and 8. While holding a plectrum between thumb and forefinger, guitarists can still instantly select within the range 1-14 using the second, third and fourth fingers of one hand. Example (d) shows an alternative layout for the same, with different sized buttons for ease of keying. Pressing both [8] and [4] together with the middle finger would allow 1-15 to be generated.

The examples shown range from three keys only in example (k) to seven keys in example (j). Example (i) has [1], [2], [4] buttons on one face and a [0] button on the side for thumb operation. Example (g) retains the "special" buttons [16] and [0], but omits the [8] and [4] buttons. This reduces the range of MIDI values that can be generated, while preserving the full range of relay functions available with the standard decoder 600 (Figures 4 and 6). Examples (b), (d), (e), (f), (h) and (k) are equally suitable for left or right handed use, while the others are shaped primarily for the right hand.

It will be understood that the group of keys forming the WFP keypad need not be the only performance control device provided on the transmitter unit. For example, miniature joystick and wheel controllers may also be provided, with appropriate signals transmitted and decoded at the base station. A full numeric keypad may also be provided, without detracting from the convenience of the WFP group of keys.

Figure 11 shows how the WFP system receiver need not involve the use of an external interface or relays or even MIDI processing. In this case, WFP keypad information would be read to directly interact with the microprocessor programmed features of the equipment 102/106.

Figure 12 shows how the WFP system may include a two way radio link 104', with a display 900 in the keypad 100 used to confirm reception.

Figure 13 shows how the display 900 and antenna 502 could also be separate from both keypad and decoder 102/processor 106. The former could be at front stage, for example, while the latter is backstage.

The WFP keypad transmitter 100 may have an external antenna (not shown).

It should be noted that the "intelligence" of the decoder/relay/MIDI generator sections could equally be included physically within the keypad unit, with the decoded signals being sent by cable or wireless link to a simplified base station. Minimal decoding in the base station would be required to actuate the relays, display and MIDI output driver. Clearly a higher degree of miniaturisation, and higher power consumption would be involved at the keypad transmitter unit, and generally the data rate provided by the cable or wireless link would need to be higher.

As shown in Figure 14, the WFP keypad could be used in combination with wireless audio, sharing the same radio frequency, antenna etc. An audio input 1400 is provided, with analogue to digital converter 1402 and optional digital audio compression encoder 1404. The encoded audio signal is combined in encoder 1406 with the WFP keypad signals, to be transmitted by suitable radio transmitter 1408. A matching radio receiver 1410 is provided at the base station, and a decoder 1412 which separates the digital audio and WFP keypad signals. The audio signals pass through optional decompression unit 1414 and digital to analogue converter 1416 to audio output 1418. The keypad data is decoded at 1420 to MIDI command or other command generator 1422, These operate just as

described previously. Data compression methods like the ones used in Minidisc, DCC can be used. The keypad unit may contain the audio input, analogue to digital converter and encoder, and transmitter for both control audio functions, making a valuable multi-function accessory for stage performers.

Where digital audio is used, standard formats such as SPDIF (AES/EPU) provide for user data to be incorporated in the audio bit stream, which could be used for the WFP keypad signals. Alternatively, the audio and control links could be transmitted in analogue or digital form on different frequency channels.

These and other modifications will be readily apparent to a person skilled in the art. The invention is accordingly not limited to the specific embodiments shown.

Claims

1. A remote control system comprising a portable keypad unit providing a group of keys and suitable to be worn by a guitarist or similar musician, and a base station for receiving keypad signals and for generating therefrom digital commands for controlling electronic equipment during performance, wherein the keypad unit and base station are arranged to generate each specific command in response to a specific simultaneous combination of key presses of keys within a group of keys in said group, such that the range of commands that can be generated at a given time is greater than the number of keys on the keypad.

2. A system as claimed in claim 1, wherein the number of specific commands that can be generated at a given time is greater than twice the number of keys on the keypad.

3. A system as claimed in claim 2, wherein a number of specific commands that can be generated at a given time is greater than three times the number of keys on the keypad.

4. A remote control system as claimed in any of claims 1 to 3, wherein the keypad unit is housed separately from any specific musical instrument.

5. A system as claimed in any of claims 1 to 3, wherein the keypad unit is housed within a portable musical instrument housing.

6. A system as claimed in any preceding claim, wherein the base station is housed separately from any specific equipment being controlled.

7. A system as claimed in any of claims 1 to 6, wherein the base station is integrated within a specific sound generator or sound processor apparatus.

8. A system as claimed in any preceding claim, wherein the base station is arranged to transmit the generated commands via a musical instrument digital interface to separate sound electronic equipment.

9. A system as claimed in any preceding claim, wherein the said group of keys comprises keys arranged in a non-rectangular array, corresponding approximately to the array of fingers on one hand.

10. A system as claimed in any preceding claim, wherein different specific commands can be generated by pressing specific combinations of at least one, two and three keys.

11. A system as claimed in any preceding claim, wherein said group of keys on the keypad unit numbers between three and nine keys inclusive.

12. A system as claimed in any preceding claim, wherein the keypad unit is arranged to send signals to the base station by wireless link.

13. A system as derived in claim 12 wherein the keypad unit further provides a wireless audio transmitter.

14. A system as claimed in claim 12 or 13, wherein the keypad unit is provided with a radio transmitter for communication with the base station.

15. A system as claimed in any preceding claim, wherein the base station is provided with an array of visual indicators corresponding one to each of the keypad keys in said group.

16. A system as claimed in any preceding claim, wherein the base station or keypad unit is provided with a numeric indicator to confirm which specific command has been selected by operation of the keypad unit.

17. A system as claimed in any preceding claim, wherein at least for a sub-range of the possible key combinations the base station is adapted to generate at said serial data output a range of command sequences having a common part signifying the type of command and a variable parameter part determined by the specific key combination within said sub-range.

18. A system as claimed in claim 17, wherein a user may select whether the base station generates command sequences of one type over substantially the entire range of key combinations, or generates command sequences of at least two different types, over respective sub ranges of the possible key combinations, the commands of each type having different common parts.

19. A system as claimed in any preceding claim, wherein the base station provides at least one electrical switching output and at least one serial data output for pre-defined sequences of digital data, both controllable by said key combinations.

20. A system as claimed in claim 19, wherein for one specific key combination, which term includes one of said keys pressed alone, the base station is adapted to change the state of said electrical switching output at least momentarily.

21. A system as claimed in claim 20 wherein said specific key combination comprises one specific key of said group pressed alone.

22. A systems as claimed in claim 21 wherein at least one further electrical switching output is controlled in response to pressing alone a second specific key of said group.

23. A system as claimed in claim 20, 21 or 22 wherein said specific key combination is, at least as a user option, excluded from generation of digital data sequences.

24. A stage performer's remote control system substantially as described herein with reference to Figures 1 to 10 and/or 11, 12, 13 or 14 of the accompanying drawings.

25. A wireless keypad unit substantially as described herein with reference to figures 2, 3 and any of 10(a) to (l) of the accompanying drawings.

The Patent Office

Application No:	GB 9817035.0	**Examiner:**	Hannah Bryant
Claims searched:	1-25	**Date of search:**	10 November 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G5J (JESA,JESD,JEAC,JEAR,JEAS,JEAX,JESM), G4H (HKH)

Int Cl (Ed.6): G10H 1/00, 1/36

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	UK1496522	(ENDFIELD) see abstract	Atleast 1-4, 6-10, 12-15,19-22, 24,25.
Y	US5700966	(LAMARRA) see whole document	Atleast 1-4, 6-10, 12-15, 19-22, 24,25.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.