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(54) **Remote control unit**

(57) A remote control unit for use with an air conditioner has an LCD display (16) offering a choice of control functions and a master control button (14) for selecting and setting a desired function. A night light is incorporated in the display (16) and operates each time the control button (14) is pressed, but only between pre-determined on and off times set by the internal clock of the unit. In another aspect of the invention, the characteristic sound of an acknowledgement signal, emitted by the air conditioner on receipt of a remote command, is dependent on the function being controlled.

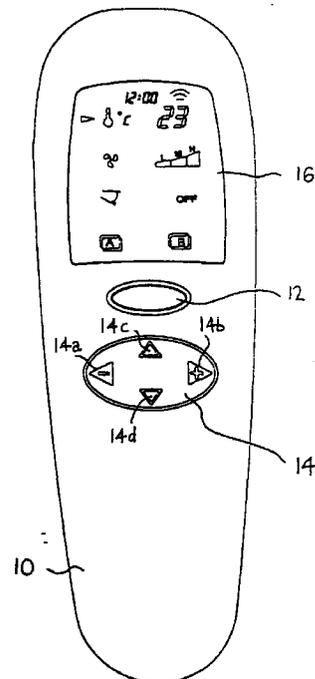


Fig. 1

## Description

**[0001]** This invention relates to a remote control unit for use with an air conditioning apparatus. The invention also relates to a control system for an air conditioning apparatus which is adapted to respond to signals from a remote control unit.

**[0002]** The remote controller has become an everyday object, indispensable for operation of the TV, video recorder and hi-fi. More recently, remote controllers have been provided for controlling the operation of an air conditioning apparatus. The apparatus may be of the wall-mounted or window-mounted type found in most homes or the ceiling-mounted type commonly used in commercial and industrial properties.

**[0003]** The number of functions of the air conditioner which it is desirable to control remotely is many. These range from the basic on/off operation and temperature setting to the more sophisticated adjustment of a timer to switch the apparatus on and/or off at preset times. As a result of these requirements, the conventional remote control unit has a lot of buttons and switches to be operated and is not user-friendly.

**[0004]** A further problem arises in the home when one wishes to change a setting while in bed, for example after having been woken up prematurely due to excessive heat or cold. It is not easy to operate the unit in the dark, yet one is reluctant to switch on the light at such a time.

**[0005]** Finally, as compared with changing channels on the TV, it is sometimes difficult to be sure that the air conditioner has responded properly to a signal sent from the remote controller.

**[0006]** In its various aspects, the invention aims to overcome the above problems by providing user-friendly remote control of the air conditioner.

**[0007]** In one aspect, the invention provides a remote control unit adapted for use with an air conditioning apparatus, the unit comprising display means for generating a display representing a plurality of functions to be controlled, and user-operable control means for selecting and setting a desired function, wherein the user-operable control means is shared by the plurality of functions.

**[0008]** According to this aspect of the invention, the remote control unit can be made user-friendly by reducing the number of buttons thereon. For example, it is possible to provide a master control button for use in selecting and setting all the controlled functions, thereby simplifying the design and use of the remote control unit. In a preferred embodiment, the selection of a function to be controlled is made using a cursor on the display. The cursor is moved up or down on the display using the master control button until it appears next to an icon representing the desired function. The master control button is then operated to adjust the selected function as desired.

**[0009]** Another preferred feature resides in the divi-

sion of the display into a plurality of selectively displayable screens, i.e. pages, the different screens representing different groups of functions. The choice of screen is suitably offered as an additional selectable function, which is displayed on each screen. The principal advantage of dividing the display into two or more screens is that the screen display presented to the user is more simple and less cluttered. The remote control unit is thus easier to use.

**[0010]** In a preferred embodiment, there are two such screens. The first screen includes those functions which are more commonly changed, for example the temperature and fan speed settings. The second screen includes those functions which are less commonly changed, for example the selection of cool, dry or fan mode of operation. The first screen is displayed as a default. That is to say, the second screen is displayed only when selected and the first screen returns when the master control button has not been operated for a predetermined period of time.

**[0011]** Although different functions are shown in the two screens, it is useful to provide in the first screen a display of a second screen function setting, when that setting differs from the normal or default one. In this way, the display provides a relatively complete picture of all the function settings of the air conditioner. Certain features, such as the time clock, are suitably displayed continuously, irrespective of which screen is selected at any one time.

**[0012]** In another aspect, the invention provides a remote control unit adapted for use with an air conditioning apparatus, the unit comprising a display means, a user-operable control means, and means for illuminating the display means when the control means is operated. The display is preferably also lit up when the unit is first switched on.

**[0013]** According to this aspect of the invention, the remote control unit is easy to use even in the dark or in conditions of poor light. If this feature of a night light is provided on the remote control unit of the first aspect of the invention, the result is a device which is particularly easy to use since there need only be one main control button other than the on/off switch.

**[0014]** As a preferred feature, the night light operates only between preset times which are set internally by the unit. In this way, the automatic operation of the display light every time the control button is pressed does not run down the batteries at times when the display will not need to be illuminated.

**[0015]** In a further aspect, the invention provides a control system for an air conditioning apparatus having a plurality of functions which are controllable by means of a remote control unit, wherein the control system comprises means for generating an audible signal whose characteristic sound depends on the function being controlled.

**[0016]** This feature assists the user by confirming that a command sent by the remote control unit to the air

conditioning apparatus has not only been received, but is the desired command.

[0017] In one embodiment, the air conditioning apparatus has a function in which the speed of a fan may be set to one of a plurality of levels using the remote control unit. The generating means produces such an audible signal when the fan speed setting is changed, the audible signal being different for each respective setting.

[0018] According to this embodiment of the invention, the setting of the fan speed is easily and conveniently confirmed by the user. The audible signal may be a tone signal whose pitch depends on the fan speed setting.

[0019] The invention is illustrated, but not limited, by the following description of an embodiment given by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is an overall view of a remote control unit;  
 Fig. 2 is a representation of the display of the unit;  
 Fig. 3 is a schematic representation of the controls of the unit;  
 Figs. 4 and 5 respectively show examples of two screens of the display;  
 Fig. 6 is a block diagram for the remote control unit;  
 Fig. 7 is a simplified circuit diagram for the remote control unit; and  
 Fig. 8 is a block diagram for the receiver/control circuitry of an air conditioning apparatus.

[0020] Referring first to Figs. 1 to 3, the remote control unit includes a moulded plastic body 10, an on/off switch 12, a master control button 14 and a display device 16.

[0021] The on/off switch 12 is operated to switch the air conditioner on and off remotely. The operation of the switch 12 also activates and de-activates the display shown on the display device 16, apart from certain parts of the display which remain active even when the air conditioner is switched off.

[0022] The master control button 14 is used to select and set the desired functions of the air conditioner. It is used in conjunction with the display. The master control button 14 consists of a rocker-mounted member which carries movable contacts. The button 14 can be manipulated to operate any of four switches at any one time by pressing on one of the four arrows 14a-14d. The button 14 returns to its neutral position upon release

[0023] The upper and lower arrows 14c, 14d are used to select a function which it is desired to switch on or off or adjust. This is done by moving a cursor which appears in the display as a triangular arrow. The left and right arrows 14a, 14b are used to set the function after it has been selected.

[0024] The display device 16 is a liquid crystal display (LCD) which has a fixed pattern of display electrodes. Use of a display device of this general type is preferred over a dot-matrix type of device since the drive circuitry is simpler and the cost is lower. The same device can be

used for a number of models of air conditioner. For any functions which are not provided on a particular model, the related parts of the display may be left unconnected or arranged so as not to be driven by the control electronics.

[0025] Fig. 2 shows the complete set of display electrode patterns (apart from the two clock displays and the temperature setting which illustrate sample readings). In use of the unit, this complete set of patterns will never be seen and the display presented at any one time will be clear and easy to read.

[0026] The uppermost part of the display contains a real-time digital clock which is shown continuously, and a transmission symbol which appears momentarily whenever a signal is transmitted by the remote control unit to the main air conditioner unit. In the bottom right of the display, a battery symbol appears when the batteries of the remote unit need replacing. The remainder of the display is given over to the choice of functions. These are, in descending order, the temperature setting, sleep mode, fan speed, principal mode of air conditioning, flap control for adjusting the direction of the fanned air, timer control and screen selection function. The latter function will be described later with reference to Figs. 4 and 5. For now, the remotely controllable functions of the air conditioner will be considered.

[0027] Each of the functions is represented by an icon which appears to the left of the display. The status or setting of each function is represented by an associated icon presented to the right of the display and adjacent to the related function icon. As used in this specification, the term "icon" refers to a graphic symbol or an alphanumeric expression, or a combination of both. Each function has a default setting which is automatically programmed when the batteries are first put in the unit or later replaced.

[0028] The temperature control allows the thermostat to be set for a room temperature in the range 18 to 30°C, adjustable in steps of 1°C. The set temperature is displayed whenever the air conditioner is in operation, except in the fan only mode. The set temperature may be raised by pressing the right-hand (+) arrow 14b of the control button and lowered by pressing the left-hand (-) arrow 14a thereof. The default setting is a temperature of 23°C.

[0029] In the sleep mode, the set temperature is automatically raised by 2°C to provide comfortable cooling and save energy during sleeping hours. The mode is switched on or off using the left and right arrow keys of the master control button. The sleep mode is also automatically switched off one hour after activation. The default setting switches the sleep mode off.

[0030] The fan speed settings are low, medium, high and automatic. The adjustment is made using the left and right keys of the master control button. In each of the low medium and high settings, a respective icon is shown on the display. In the automatic mode, all three icons for low, medium and high appear simultaneously.

The default setting is for automatic control of the fan speed.

**[0031]** The air conditioning modes of operation are cool, dry, fan and, optionally, heat. The mode selection is again made using the left and right keys of the master control until the required icon appears in the display. The default setting is for the cool mode.

**[0032]** The flap control function permits the flap to be moved remotely using a stepper motor in the air conditioning unit, thereby adjusting the direction of the air flow. The motor is switched on and off using either the left or right keys of the master control. When the motor is switched on, the flap will move continuously until an off signal is transmitted, changing direction at the end of the swing. In the default setting, the motor is naturally switched off.

**[0033]** The timer enables the air conditioner to be switched on and/or off at preset times each day. The start time is set by moving the cursor until it is opposite the start icon and then manipulating the left or right key to change the time display. The time can be set in increments of 10 minutes. The stop time is set in a similar manner after moving the cursor to a position opposite the stop icon. A clock symbol appears next to the start icon when the start time is displayed and next to the stop icon when the stop time is displayed. The timer function is inactive in the default setting. The unit clock at the top of the display must be set before the timer can be used. The unit clock is adjusted in the same manner as the timer settings.

**[0034]** Referring to Figs. 4 and 5, the operation of the remote control unit is made more user-friendly by dividing the display into two individually displayable screens. Fig. 4 shows the display of a first screen A, while Fig. 5 shows the display of a second screen B. Screen A presents the temperature, fan speed and flap motor functions. The default settings of these functions are shown in Fig. 4. Screen B presents the sleep, mode and timer functions. The default settings of these functions are shown in Fig. 5. The real-time clock is shown in both screen A and screen B. Also shown in both screens is an additional function for selecting the required screen.

**[0035]** The first screen A contains functions which the user will more commonly wish to change. For this reason, screen A appears whenever the unit is first switched on and is thus presented as the default screen. The second screen B contains functions which the user will less commonly wish to change. To select and adjust one of those functions, screen B must first be selected. This is done by moving the cursor shown in screen A to a position adjacent to screen B icon and then pressing the left or right key of the master control button. When in screen B, screen A can be selected in a similar manner by moving the cursor next to the screen A icon. However, the display will revert automatically to screen A if the master control button is not operated for a predetermined time. In this embodiment, a time lapse of 10 seconds is provided. Although displayed in both screens,

the real-time clock can only be set in screen B. This is an adjustment that rarely needs to be made.

**[0036]** If a screen B function is changed to a setting or status which is other than the default setting or status, the icons for that function and its setting/status will appear in screen A. That function can then be selected and changed in screen A. If the function is later changed back to the default setting status, its icons will disappear from screen A. The function then has to be accessed via screen B. For example, if the sleep mode is switched on using screen B, the word SLEEP and the star-in-a-circle icon will appear in screen A, along with the usual icons for the temperature, fan speed and flap control. The sleep mode can now be switched off, i.e. to the default status, in screen A. Once the sleep mode has been switched off, the selected icons will be removed from screen A.

**[0037]** Fig. 6 is a block diagram and Fig. 7 is a circuit diagram of the electronics of the remote control unit. All of the electronic components including the switches 12, 14 and display device 16 are mounted on a single circuit board housed in the casing 10.

**[0038]** A micro-controller 18 in the form of an integrated circuit forms the heart of the electronics. The micro-controller 18 operates in response to actuation of the on-off switch 20 and the four control switches 22, 24, 26, 28 via the button 12 and the four arrow keys 14a-d of the master control 14. The remote control unit has a 3-volt power supply 30 provided by two pen cell-size batteries 32 contained within the casing. The micro-controller 18 is programmed to generate the drive signals for the display device 16 and a control signal for transmission to the main air conditioning unit. The control signal is transmitted by infra red from an LED 34 following amplification in a drive circuit 36. The infra red LED 34 is located behind a lens (not shown) mounted in the uppermost edge of the unit, that is near the top of the display 16.

**[0039]** The programming of the micro-controller 18 to realise the functions described herein is within the ability of the ordinary skilled person in the art. The programmed features may be incorporated in a programmable read-only memory (PROM) contained within the chip. Alternatively, the programmed features may be physically incorporated into the chip 18 at the time of its manufacture by semiconductor masking techniques.

**[0040]** An infra red control signal is transmitted by the remote unit every time the left or right control key 14a, 14b is released, preferably after a short delay of, say, 0.5 seconds. Thus, a control signal is transmitted every time a function setting is changed.

**[0041]** However, if one of the keys 14a, 14b is held down continuously, for example to sweep through a range of temperature settings, the signal will not be transmitted until the key has been released. A control signal is also sent when the unit is switched on using the button 12. No control signal is generated when merely

moving the cursor to select a function or to switch between the screens A and B.

[0042] The control signal transmitted on each occasion is coded so as to contain the status of all settings of the remote unit, including the real-time clock. This ensures that the operation of the air conditioner conforms to what is expected from the settings revealed to the user on the remote display. Thus, if a setting is changed on the remote unit but the transmitted signal is not received by the main unit (for example, because the remote was not pointed to the main unit when transmitting), the main unit will be updated the next time the remote unit is operated.

[0043] In order to assist the user in operating the remote unit at night or in conditions of poor light, the LCD display 16 is provided with a light. In this embodiment, the light consists of a pair of LEDs 38 arranged adjacent the top edge of the display panel. The LEDs 38 are energised to light up the display whenever the master control button is manipulated or the switch 12 is operated to switch the unit on. The LEDs remain on for a predetermined time lapse after the last operation of any of those buttons. In this embodiment, the time lapse is about 10 seconds. It may also be arranged for the display light to be activated when master control is operated, even if the unit is switched off. This will enable the user to check the time at night using the real-time clock display at the top of the LCD display.

[0044] In this embodiment, the display light 38 only comes on between predetermined on and off times, which are measured with respect to the reading of the internal real-time clock. Since the activation of the light is made in response to the operation of any of the switches 20 - 28, the light control signal output by the micro-controller 18 can be disabled at times outside of the operating hours, by suitable programming of the chip 18. The on and off times may be preprogrammed in manufacture, or programmable by the user in a similar manner to setting up the main unit timer operation. The preferred operating hours are from 2000 (8 pm) to 0800 (8 am). The light control signal output by the micro-controller 18 switches on the LEDs 38 through drive circuitry 40.

[0045] Fig. 8 is block diagram of the infra red receiver and control system of an air conditioner which receives transmissions from the remote control unit. At the heart of the system there is again a micro-controller in the form of an integrated circuit 42. The micro-controller is programmed to perform the functions described herein in the same manner as mentioned above in relation to its counterpart chip 18 in the remote unit. The required programming is within the ability of the ordinary skilled person in the art.

[0046] The integrated circuit 42 incorporates a non-volatile memory which registers the various function settings. This is useful for when the power supply to the main unit fails or is otherwise interrupted. The memory enables the air conditioning unit to be restored to its pre-

vious operating state, even when switched back on manually, i.e. without using the remote unit.

[0047] The micro-controller 42 receives input signals from an infra red sensor 44 which picks up the transmission from the remote unit, and, via an analog-to-digital converter 46, from sensors 48 which measure the indoor air temperature and the indoor fan coil temperature. In response to these input signals, the micro-controller 42 generates output signals for controlling an LED display 50, the stepper motor 58 for the flap movement, relays 56 for controlling the fan motor and its speed and the compressor, and an audible signal generator 60. The generator 60 is suitably a miniature buzzer of the piezo-electric type.

[0048] A power supply 52 provides a low voltage 5V supply to the micro-controller 42 and the converter 46, and a 12V supply for the relays 56, motor 58 and audible signal generator 60 via driver circuitry 54.

[0049] The display 50 consists of two LEDs, suitably of different colour, one showing the power on status of the air conditioner, the other showing that the timer function is in operation.

[0050] In conventional air conditioners, the buzzer 60 is arranged to emit a short "beep" in response to every signal received from the remote control unit. While this confirms reception of the signal, it does not guarantee to the user that a required function has been set as desired.

[0051] In accordance with this embodiment of the receiver/control system, it is arranged that the buzzer 60 emits different sounds for each setting of the fan speed. Specifically, the low, medium and high fan speed settings are distinguished by respective beeps of different, here higher, pitch or tone. This function is conveniently set up by programming of the micro-controller 42. The audio frequency of the buzzer output depends on the frequency of the input signal. Thus, the micro-controller 42 is programmed to generate an output signal of a first frequency when the low fan speed is selected, a second frequency higher than the first one for the medium speed, and a third frequency higher than the second one for the high speed. There can also be a fourth signal of a frequency different to the other three to identify the auto setting of the fan speed. In this way, the set fan speed can be readily confirmed by the user.

[0052] It will be appreciated that the above principle of generating distinctive audible signals can be extended to distinguish between different functions to be controlled. Thus, there may be one type of signal for, say, fan speed control and another type of signal for, say, timer operation. There are also many other ways of generating the required different sounds. These include varying the duration of the beep, varying the number of a series of beeps emitted in succession as a single signal, and varying the speed of succession of such a series of beeps, plus any combination of all these characteristics.

[0053] The invention may be embodied in many other ways than those specifically described herein without

departure from the scope thereof. The following variants are noted by way of example only.

**[0054]** It is not essential to divide the display into screens, since all the functions could be made selectable and settable from a single page of display. When the display is divided, there may be more than two screens. There may even be provided an individual screen for each function. The master control button 14 may be replaced by four separate push-buttons corresponding to the respective switches 22, 24, 26 and 28. Alternatively, there could be one rocker-type button for operating the up and down switches 26 and 28, and another such button for operating the left (-) and right (+) switches 22 and 24. The display light feature can be applied to a conventional air conditioner remote control unit which has separate control buttons for the different functions.

### Claims

1. A remote control unit for use with an air conditioning apparatus, the unit comprising display means (16) for generating a display representing a plurality of functions, and user-operable control means (14) for selecting and setting a desired function in conjunction with the display, wherein the user-operable control means (14) is shared by said plurality of functions.
2. A remote control unit accordingly to claim 1, wherein the display comprises a plurality of selectively displayable screens which represent different said functions.
3. A remote control unit according to claim 2, wherein the choice of screen is one of the functions represented in the display.
4. A remote control unit according to claim 2 or claim 3, wherein the display is divided between a first screen and a second screen.
5. A remote control unit according to claim 4, wherein the first screen is displayed by default, unless the second screen is selected.
6. A remote control unit according to claim 5, wherein a function selectable from the second screen is displayed in the first screen when the function is changed from a default setting.
7. A remote control unit according claim 6, wherein a second screen function which is displayed in the first screen may be selected and set from the first screen.
8. A remote control unit according to any preceding claim, wherein the display comprises a plurality of icons representing the respective functions.
9. A remote control unit according to any preceding claim, wherein the display comprises a plurality of icons representing the settings of the respective functions.
10. A remote control unit according to any preceding claim, wherein the display includes a cursor, the cursor being movable by operation of the control means (14) to select a function.
11. A remote control unit according to any preceding claim, wherein the control means comprises a plurality of switches (22, 24, 26, 28) which are operable by means of a master control button (14).
12. A remote control unit according to any preceding claim, further comprising means (38) for illuminating the display means (16) when the control means (12, 14) is operated.
13. A remote control unit for use with an air conditioning apparatus, the unit comprising a display means (16), a user-operable control means (14), and means (38) for illuminating the display means (16) when the control means (14) is operated.
14. A remote control unit accordingly to claim 12 or claim 13, wherein the unit contains a clock and the illuminating means (38) is operative only between predetermined on and off times set by the clock.
15. A remote control unit according to claim 14, wherein said on and off times are user-programmable.
16. A control system for an air conditioning apparatus having a plurality of functions which are controllable by means of a remote control unit, wherein the control system comprises means (42, 54, 60) for generating an audible signal whose characteristic sound depends on the function being controlled.
17. A control system for an air conditioning apparatus according to claim 16, the apparatus having a function in which the speed of a fan may be set to one of a plurality of levels using the remote control unit, wherein said generating means (42, 54, 60) produces a said audible signal when the fan speed setting is changed, the audible signal being different for each respective setting.
18. A control system for an air conditioning apparatus according to claim 17, wherein said audible signal is a tone signal whose pitch depends on the fan speed setting.

19. A remote control unit according to any one of claims 1 to 10, wherein the control means comprises a first switch means (26, 28) for function selection and a second switch means (22, 24) for function setting.

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20. A remote control unit according to any one of claims 1 to 12, 14, 15 and 19, wherein said plurality of functions include temperature control, fan speed control, and air conditioning mode control.

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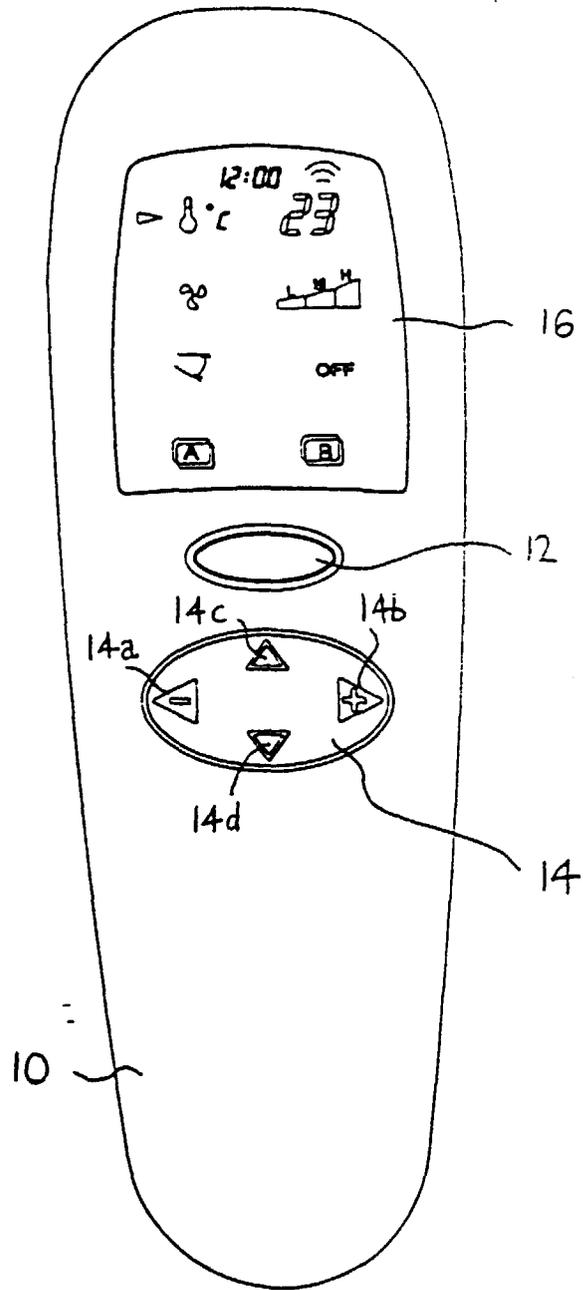


Fig. 1

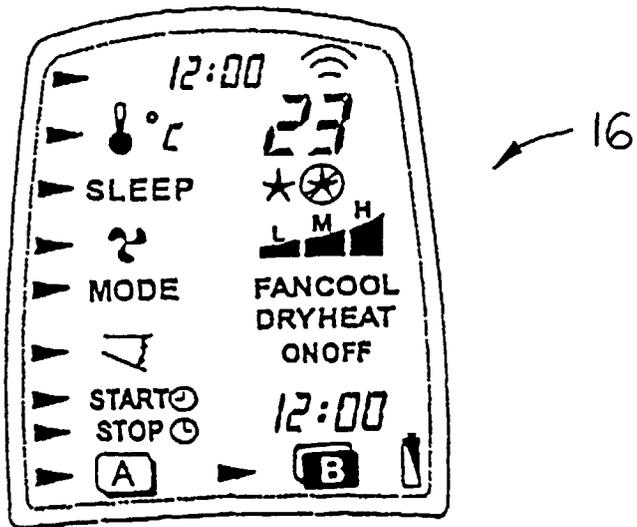


Fig. 2

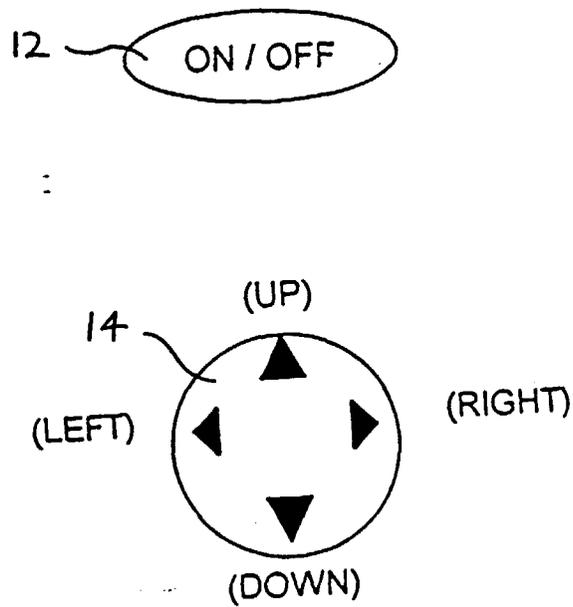


Fig. 3

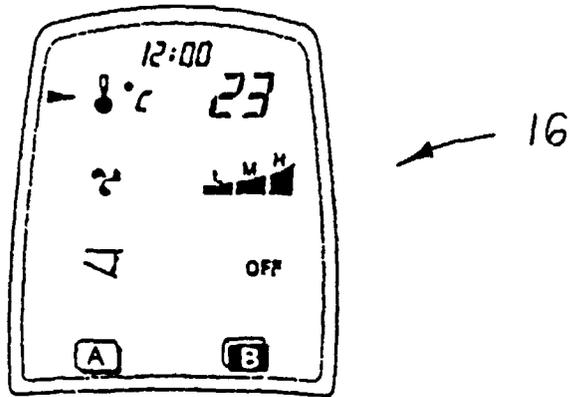


Fig. 4

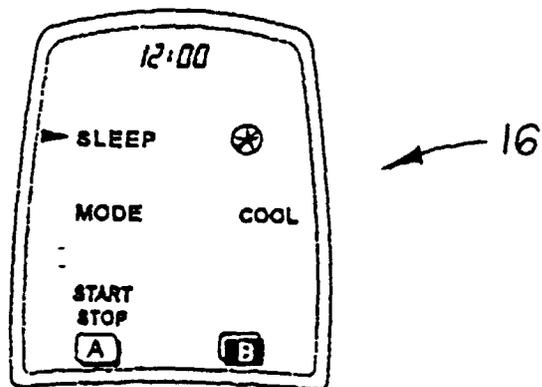


Fig. 5

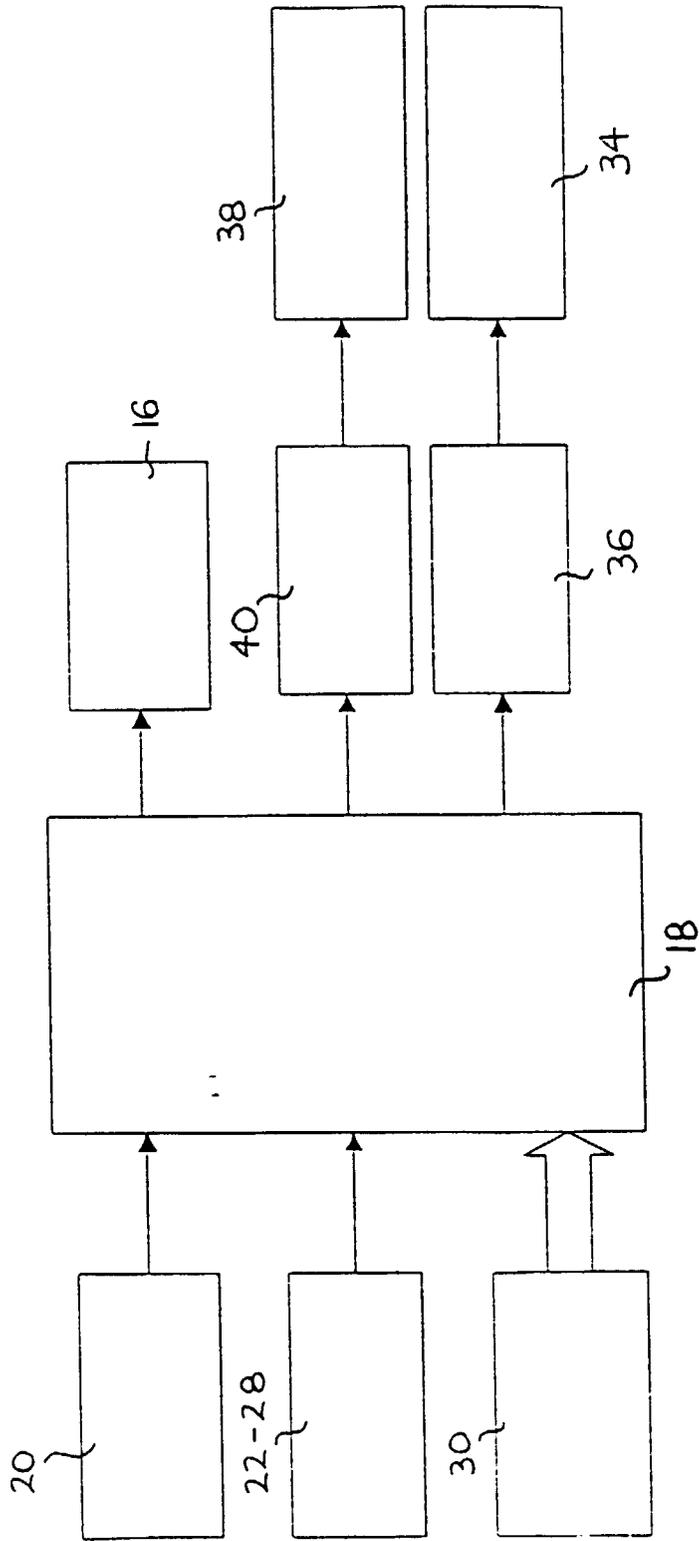


Fig. 6

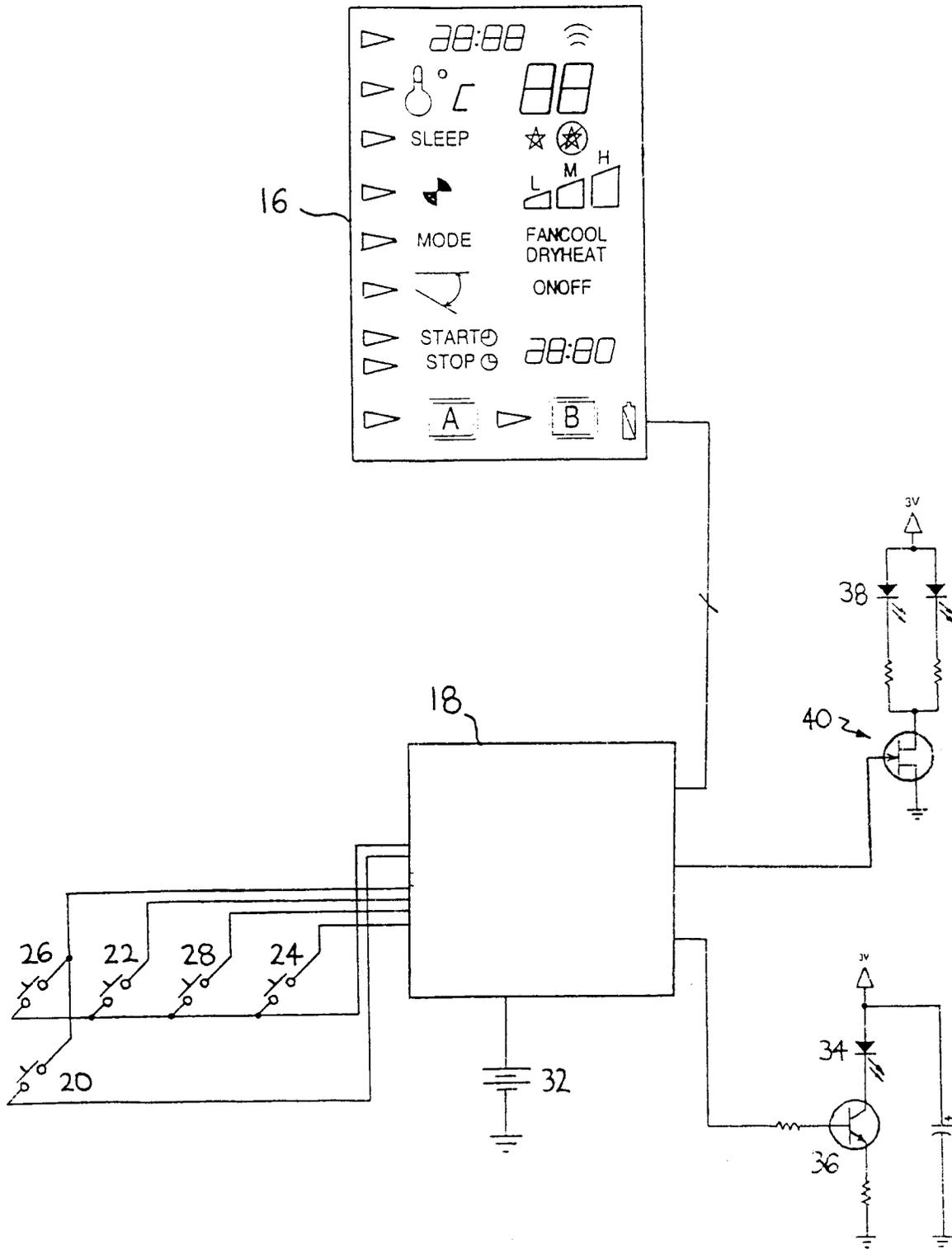


Fig. 7

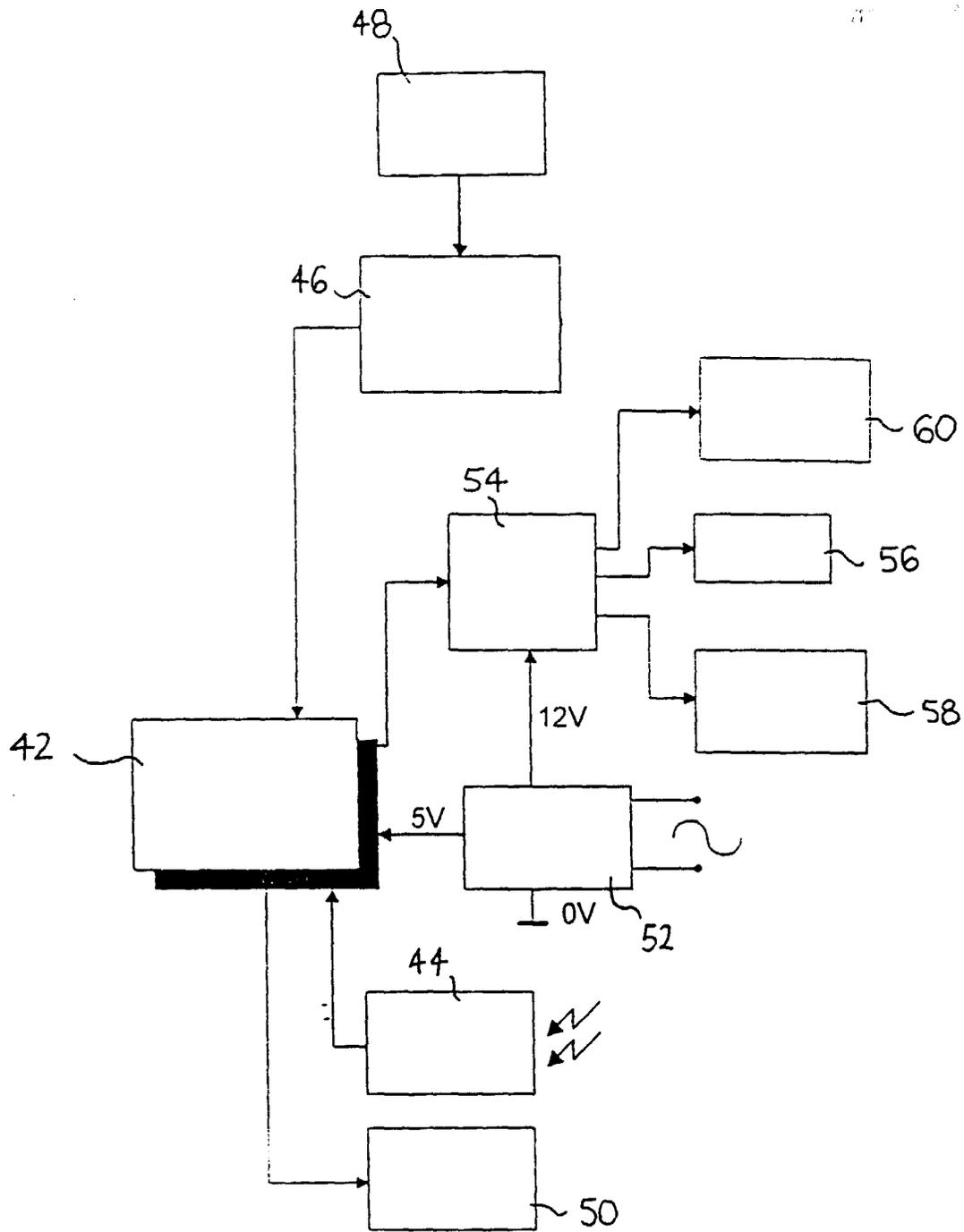


Fig. 8